ALAMEDA
County Transportation
Commission

Technical Appendices:

ALAMEDA COUNTYWIDE MULTIMODAL ARTERIAL PLAN

FINAL SUBMITTED OCTOBER 2016 BY

FEHR PEERS

Alameda Countywide Multimodal Arterial Plan

APPENDICES

Appendix 1.1.1
Vision and Goals Memo

FEHR & PEERS

MEMORANDUM

Date: November 26, 2014

To: Alameda County Jurisdictions

From: Francisco Martin and Matthew Ridgway, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan – Final Vision and Goals

OK14-0023

INTRODUCTION

The vision and goals of the Alameda Countywide Multimodal Arterial Plan will serve as a guide for prioritizing investments and designing projects and programs that address important transportation issues in the county and the region. Along with the Countywide Transit Plan, Goods Movement Plan, the Community Based Transportation Plans, and the Bicycle, and Pedestrian Plans, the Arterial Plan will be a key input to the Alameda County Transportation Commission for the update of the Countywide Transportation Plan beginning in 2015. The vision and goals are consistent with the 2012 Countywide Transportation Plan and MTC's Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS).

The vision lays out the strategic direction for the Arterial Plan. Goals describe the desired outcome of the Arterial Plan.

The Draft Vision and Goals were summarized in a memorandum dated October 27, 2014. The consultant team presented the Draft Vision and Goals at the first set of Planning Area meetings held between October 29 and November 13, 2014. Each jurisdiction within Alameda County was given the opportunity to review the Draft Vision and Goals and provide comments by November 21, 2014. The Vision and Goals incorporate recommended revisions by the jurisdictions are presented below.

FINAL MULTIMODAL ARTERIAL PLAN VISION AND GOALS

Transportation and mobility are not goals: the movement of people and goods support economic activity and development.

> *Vision: Alameda County will have a network of efficient, safe and equitably accessible arterials that facilitate the multimodal movement of people and goods, and help create a strong economy, healthy environment and vibrant communities, while maintaining local contexts.*

This vision is supported by five goals and two supportive principles:

1. **Multimodal**: Based on local context and modal priorities, the arterial network will provide high-quality, well maintained and reliable facilities.
2. **Accessible and Equitable:** The arterial network will provide access for people of all ages, abilities, incomes and geographies.
3. **Connected across the County and Region:** Using typologies that are supportive of local land use, the arterial network will provide connections for all modes within the county and across the County and Region's network of streets, highways and transit, bicycle and pedestrian routes.
4. **Efficient Use of Resources**: Investment in the arterial network will make efficient and effective use of resources.
5. **Safe, Healthy and Vibrant:** The arterial network will be designed, built, and managed to reduce the incidence and severity of collisions, promote public health and help create vibrant local communities.

There are two supportive principles in addition to the above five goals. Supportive principles are expected outcomes of the vision and goals. They are less quantifiable but the Multimodal Arterial Plan will include strategies and programs to address them:

- **Support Strong Economy:** Development of the arterial network will support existing land uses and encourage planned land uses**.**
- **Adaptable and Resilient:** The arterial network will be designed to adapt to changes in travel patterns, travel modes and technology improvements. Investments in the arterial network will enhance its ability to withstand and recover from potentially disruptive events.

Please contact Francisco Martin at 510-587-9422 if you have any questions or comments.

Appendix 1.3.1
Typology and Modal Priority Memo

MEMORANDUM

Date: September 16, 2015

To: Saravana Suthanthira, Alameda CTC

Cc: Matthew Ridgway and Francisco Martin, Fehr & Peers

From: Phil Erickson, Bharat Singh, and Warren Logan

Re: Alameda CTC Countywide Multimodal Arterial Plan: Final Arterial Street Typology and Modal Priority Framework Concepts

COMMUNITY DESIGN + ARCHITECTURE

Philip Erickson, Architect, AIA
Timothy Rood, AICP, LEED AP ND

The Alameda CTC Multimodal Arterial Plan (MAP) is developing a street typology framework to enhance the traditional arterial-collector-local functional classification system with a system that recognizes the importance of land use context and all the transportation modes. The development of a countywide typology framework is an unprecedented effort that identifies the characteristics of major streets across Alameda County. The MAP will evaluate street performance as *multimodal complete streets,* and suggest potential improvements to streets that are deficient do not adequately serve their multimodal function within the countywide network.

Alameda CTC defines multimodal complete streets and their benefits as—

> Streets that are designed, built and maintained to be safe, convenient and inviting for all users of the roadway, including pedestrians, bicyclists, motorists, persons with disabilities, movers of commercial goods, users and operators of public transit, seniors, and children.
>
> Streets that are built for all users have multiple benefits, including increased safety, improved air quality through the reduction of auto traffic, improved health through increased physical activity, and greater cost effectiveness.[1]

Jurisdictions such as Alameda, Emeryville and Fremont have developed similar street typology systems unique to these communities' General Plans or Specific Plans. Alameda CTC's typology framework will consider these jurisdictions' adopted typology systems, and ensure that they nest within the MAP street typology framework. Similarly, the typology framework is expected to inform or provide a base for any future effort to develop street typologies by other local jurisdictions in Alameda County as a part of their implementation of their complete streets policies.

This memorandum is an update to the April 15, 2015 memorandum that was distributed, along with the mapping of the street typology mapping and modal priorities memorandum, to all of the jurisdictions and transit agencies in Alameda County for review and comment.

[1] From the Alameda CTC's Complete Streets web page: http://www.alamedactc.org/app_pages/view/8563

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Introduction

Definition of the MAP Typology Framework

This memorandum describes the street typology framework for the MAP. The typology framework consists of three components: a set of land use context types, a set of base street types defined by vehicular functionality, and a set of multimodal emphasis overlays. The following are characteristics that street typology address, and therefore are the key components of the typology framework:

- **Land Use Context Types –** These define the context of built and natural environments that the streets pass through. Land use types have a relationship to specific street cross section elements, such as parking and loading lanes, and the desired width and use of different zones of the sidewalk.

- **Base Street Types –** Base street types are defined by their role in carrying sub-regional and local traffic along the *Study Network's*[2] streets. If a street is serving a high volume of vehicles that are traveling a longer distance, through movement is likely more important to those driving along the street than access to local destinations.

- **Multimodal Transportation Overlays –** While the base street types focus primarily on vehicular function, overlays define the priority given to other transportation modes: transit, bicycle, pedestrian, and goods movement. The multimodal transportation overlays identify levels of multimodal emphasis for segments of the *Study Network*.

At a minimum, all street segments will have a land use context and a street type, and some will have one or more multimodal transportation overlays. A map of the *Study Network* streets and the PDA place types and SCS land use is provided in Attachment B to illustrate the relationship between land use context and the network .

Further detail about how the land use and street types and multimodal overlays were determined, and examples of streets throughout Alameda County are provided in this memorandum, along with mapping in appendices.

How the Typology Framework will be used in the MAP effort

Traditional functional classification - the arterial, collector, and local functional classification system - is based only on vehicular mobility and access characteristics and fails to consider other street characteristics. Typologies diversify the consideration of the street to include land use context and other modes. For the MAP, street typologies and multimodal overlays will inform modal priorities of each street. The street types and multimodal overlays will also help identify *arterials of countywide significance* that are the *Arterial Network* [3].

This process is illustrated in Figure 1. Data collected from local jurisdictions, the ACTC Countywide model, MTC, ABAG, transit agencies, and other sources were used to identify land use context and base

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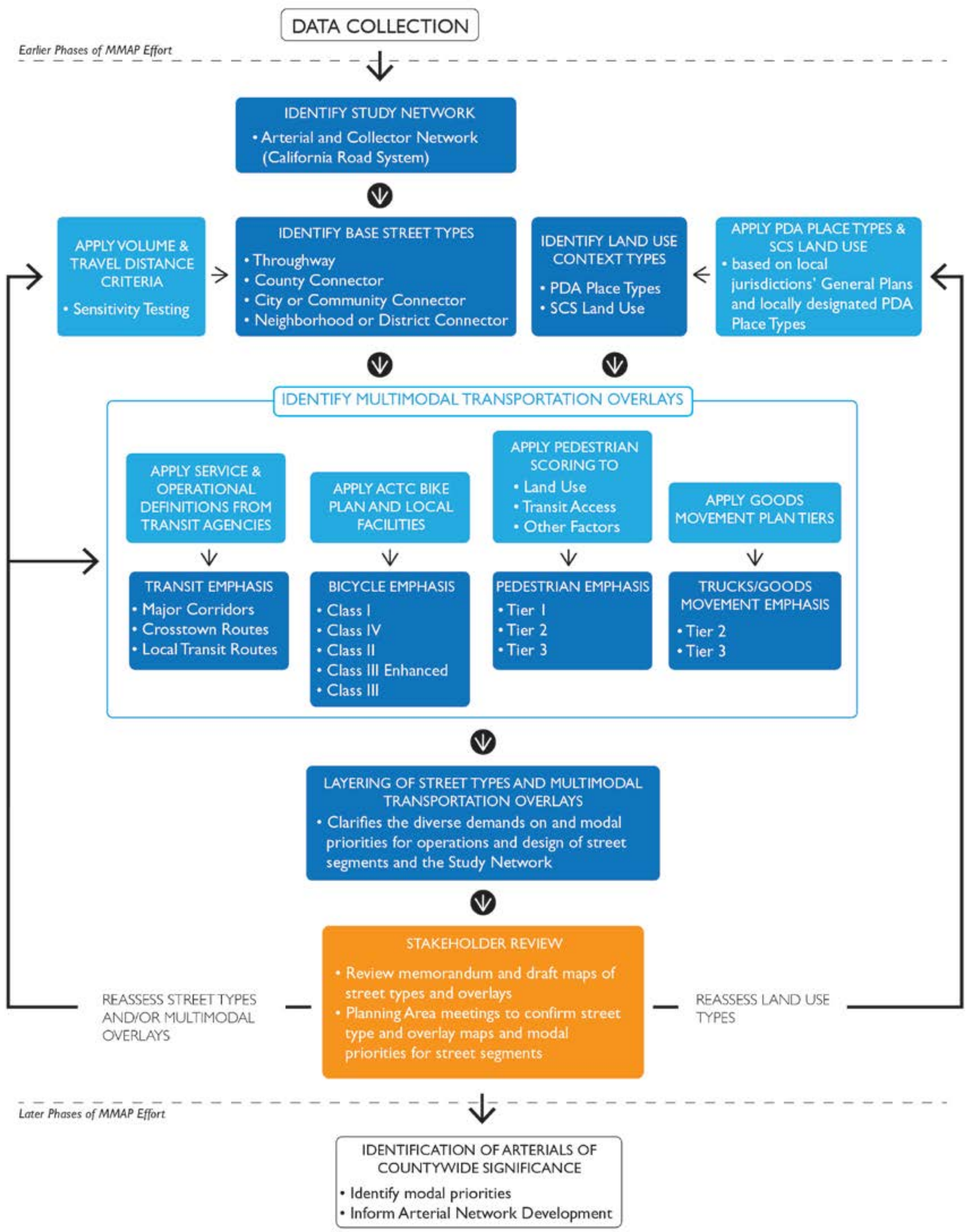
[2] The *Study Network* consists of the arterials and collectors that are part of the California Road System (CRS) which was sent to all Alameda County jurisdictions for review, and to support data collection in December 2014.
[3] The *Arterial Network* is a subset of the *Study Network* consisting of those streets which satisfy the criteria for countywide significance that have been defined in a separate MAP memorandum.

street types and to develop the multimodal overlays. This information is used to define the multimodal demands of the network and determine the modal priorities of each segment of the countywide network. Modal priorities are discussed further in a forthcoming memorandum.

Figure 1: Multimodal Arterial Plan Typology Framework Process Diagram



The typology framework will not only inform modal priorities, but in subsequent phases of the MAP effort, it will be critical to defining desirable street design attributes, particularly using the land use context. For example, a pedestrian priority street along a commercial corridor would have a wider desired sidewalk than a pedestrian priority street in a residential corridor. Thus, street typologies are a critical component of the MAP development, as a particular street segment's land use type, street type, and multimodal overlays will directly inform the design solutions.

A series of initial maps of the land use types, street types, and multimodal overlays were presented to ACTAC on April 9, 2015 and were distributed prior to Planning Area meetings taking place during the week of April 20, 2015. A description of the methodologies used in generating the various mappings is included in the detailed discussion of the land use types, street types, and multimodal overlays. In addition, jurisdictions were given access to the online GIS Server maintained by Fehr & Peers to review the typology mapping and provide comments as necessary.

Land Use Context Types

A key element of the typology framework is the land use context types which define the physical context of streets. The land use types relate to desired design and operational characteristics, such as a priority for on-street parking and loading and a wider sidewalk frontage zone for window shopping and outdoor seating where the land use context is more intensive commercial or mixed use. The land use types are defined by a combination of Priority Development Area (PDA) place types and the land use types developed for the Alameda County version of the Plan Bay Area Sustainable Community Strategy (SCS), which was used in the adopted *2012 Countywide Transportation Plan*. Both intensity and mix of land use are important to consider in terms of defining context for major streets because the context has a relationship to the mix of various transportation modes and the priorities amongst modes. For example, industrial warehousing areas tend to have lower pedestrian activity and high levels of goods movement, while intensive mixed use areas have a mix of modes with an emphasis on pedestrian and transit activity. In addition, land use context affects specific street cross section elements, such as parking and loading lanes and the desired width and use of the sidewalk. Two types of land use classifications provide the starting point for developing land use context types for the MAP:

ABAG - PDA place types defined by ABAG that exist in Alameda County[4]:

- **Regional Center –** PDAs located in the most urbanized centers of the region's major cities, and are assumed under Plan Bay Area to accommodate high volumes of housing growth in the coming decades. ABAG suggests density ranges of 75-300 dwelling units per acre for housing and a 5.0 floor area ratio for employment.
- **City Center –** PDAs in already-established secondary cities in the Bay Area. ABAG suggests density ranges of 50-150 dwelling units per acre for housing and a 2.5 floor area ratio for employment.
- **Suburban Center –**PDAs with mixed-use character surrounding existing or planned transit stations, and typically have densities similar to City Centers but featuring more recent development. ABAG suggests density ranges of 35-100 dwelling units per acre for housing and a 4.0 floor area ratio for employment.

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[4] PDA place type definitions are from PDA Readiness Assessment Final Report, 3/29/13.

- **Transit Town Center –** PDAs with mixed-use areas that offer relatively robust transit services within urban areas, but serve a more localized population of residents and workers, rather than attracting significant patronage from beyond the local area. ABAG suggests density ranges of 20-75 dwelling units per acre for housing and a 2.0 floor area ratio for employment.
- **Urban Neighborhood –** PDAs with moderate- to high-density residential uses that also feature supportive retail and employment centers, rather than being primarily commercial areas. Transit is present but not necessarily a focal point of the neighborhoods. ABAG suggests density ranges of 40-100 dwelling units per acre for housing and a 1.0 floor area ratio for employment.
- **Transit Neighborhood –** PDAs that are primarily residential areas, well served by transit, but with existing low- to moderate densities. ABAG suggests density ranges of 20-50 dwelling units per acre for housing and a 1.0 floor area ratio for employment.
- **Mixed-Use Corridor** –linear PDAs served by transit lines, and typically feature commercial development extended along a major surface roadway with residential neighborhoods flanking these commercial strips. ABAG suggests density ranges of 25-60 dwelling units per acre for housing and a 2.0 floor area ratio for employment.

Alameda CTC SCS Land Use Types – These are the land use types developed in the SCS process that were part of the Alameda CTC's 2012 *Countywide Transportation Plan.* The land use types were developed in coordination with the local jurisdictions and are based on the jurisdictions' general plan designations. The land use types are:

- Mixed Use (Commercial & Industrial)
- Mixed Use (Commercial & Residential)
- Commercial
- Industrial
- Education/Public/Semi-Public
- Residential
- Parks/Open Space
- Rural Residential & Open Space
- Agriculture/Resource Extraction
- Other/Unknown

The PDA place type designations and the SCS land use types have been combined into a set of 11 land use types for the MAP street typology system, as illustrated in Table 1. These were determined by considering which combinations of land use and density affect the function and design of the streets.

Table 1
MAP Land Use Context Types

MAP Land Use Types	Related PDA Place Types	Related SCS Land Use Designations
Downtown Mixed Use	▪ Regional Center ▪ City Center	▪ Mixed Use: Commercial & Industrial ▪ Mixed Use: Commercial & Residential ▪ Commercial ▪ Industrial ▪ Education/Public/Semi-Public ▪ Residential
Town Center Mixed Use	▪ Suburban Town Center ▪ Transit Town Center	▪ Mixed Use: Commercial & Industrial ▪ Mixed Use: Commercial & Residential ▪ Commercial ▪ Industrial ▪ Education/Public/Semi-Public ▪ Residential

Table 1 MAP Land Use Context Types		
MAP Land Use Types	**Related PDA Place Types**	**Related SCS Land Use Designations**
		▪ Agriculture/Resource Extraction
Corridor/Neighborhood Mixed Use	▪ Urban Neighborhood ▪ Transit Neighborhood ▪ Mixed-Use Corridor	▪ Mixed Use: Commercial & Industrial ▪ Mixed Use: Commercial & Residential ▪ Commercial ▪ Industrial ▪ Education/Public/Semi-Public ▪ Residential ▪ Agriculture/Resource Extraction
Mixed Use	N.A.	▪ Mixed Use: Commercial & Residential
Commercial	N.A.	▪ Commercial ▪ Mixed Use: Commercial & Industrial
Industrial	N.A.	▪ Industrial
Education/Public/Semi-Public	▪ All except City Center	▪ Education/Public/Semi-Public
Residential	N.A.	▪ Residential
Parks	▪ All	▪ Parks/Open Space
Rural/Open Space	N.A.	▪ Rural Residential & Open Space ▪ Agriculture/Resource Extraction
Other/Unknown	N.A.	▪ Other/Unknown

A map of the *Study Network* overlaid on the land use context types is provided in Attachment B.

Comments and Responses on Land Use Context

First Round Review Period (April – May 2015)

Several jurisdictions have asked for revisions and updates to the land use mapping provided for review. For the purposes of the MAP effort, the project team determined that if a requested land use change will not affect the resulting modal priorities for a street segment then land use change will not be made. For example:

- If a proposed land use does not shift the street segment from one land use context modal group to another, the land use change will not be made; or
- If the parcel is relatively small (a street frontage of about 250 feet or less), the land use change will not be made because modal priorities should not change for such a small length of street frontage, given that a change in street design over this short of a distance is unlikely.

There are several large areas throughout the County where new land use plans have been adopted since land use mapping was developed during the *2012 Countywide Transportation Plan*:

- Fremont asked that the detailed land use designations for the Warm Springs Community Plan be used in the land use context type mapping for the MAP. But the detailed land uses are not necessary for the MAP typology and modal priority mapping, because land use for this area is defined by PDA place type, and the PDA place type is mapped correctly in the MAP land use context mapping.

- At the request of City of Alameda and Dublin, Alameda Point and Dublin Crossings respectively will be updated to the MAP land use type of Town Center Mixed Use, based on their PDA place types of Transit Town Center and Suburban Town Center respectively. They had been mapped according to their 2012 Countywide Transportation Plan Land Use Scenario designation of public lands.

Second Round Review Period (July – August 2015)

Albany and Emeryville staff provided comments on the land use context overlay during the second round review period:

- Albany provided the latest citywide zoning map to inform the land use context map; relevant changes were made to the land use context map.
- Emeryville requested the inclusion of Doyle Hollis Park to the land use context map, however, the park has less than 250-foot frontage on Hollis Street and will not affect the modal priority, therefore no change to the land use context map was made.

A revised map of land use context overlay is provided in Attachment B.

Base Street Types

The base street types define a streets' vehicular mobility and access functions. Table 2 outlines the functions and characteristics of the proposed *Base Street Types* and the expected degree to which each street type will be included in the MAP *Arterial Network* as arterials of countywide significance. The final prioritized improvements for MAP will focus on improvements to the *Arterial Network*.

The proposed base street type system consists of the following four classification types based on vehicular mobility functions:

1. *Throughway*
2. *County Connector*
3. *City* or *Community Connector*
4. *Neighborhood* or *District Connector*

This framework is similar to the street types developed by various cities in and outside of Alameda County. The City of Alameda's *General Plan* defines major streets as: Regional Arterial, Island Arterial, Transitional Arterial, Island Collector, and Transitional Collector. Another example is the Urban Corridor street types in Fremont's *Warm Springs/South Fremont Community Plan*, which are a combination of the three MAP connector typologies as shown in Table 2. Fremont's *City Center Community Plan's* regional mobility corridors align with the MAP's county connectors as shown in Table 2. The MAP's street type system is also similar to the system used in the update to the City of Pasadena's *Mobility Element*, which defines the city's major streets as: *Connector City* and *Connector Neighborhood*.

Street Type Criteria

A set of planning area maps showing the initial network by applying the proposed *Base Street Types* is provided in Attachment C. Base street types are determined using two sets of criteria shown in Table 2, collectively called *Vehicular Mobility Criteria:*

- **Traffic volume measured by Average Daily Traffic (ADT).** An ADT threshold of 10,000 was used countywide to identify throughways and county connectors. The rationale for this volume threshold is that for a street with 10,000 ADT, typical peaking characteristics would result in it carrying between 800 and 1,200 vehicles during the peak hour of traffic (assuming 8 to 12 percent of daily trips occur in the peak hour) and about 480 to 720 peak hour, peak direction trips (assuming a 60/40 directional split). From a capacity perspective, a simple two-lane local or collector street could carry this volume, and therefore any street with a volume lower than 10,000 ADT would not meet the functional characteristics for being a throughway or county connector.
- **Travel distance** data generated by the Alameda Countywide Travel Demand Model for base year conditions is being used to identify street segments that meet the criteria listed in the table.

Sensitivity Analysis of Street Type Criteria

A sensitivity analysis was undertaken to determine the travel distance thresholds that are appropriate for the various street types. The analysis looked at applying various combinations of ADT volumes and percent trips by travel distance, and reviewed the results for reasonableness to finalize the suitable thresholds for these criteria. For example, for *Throughways*, a combination of ADT volumes and percent trips by travel distance was selected to exclude any obvious *Neighborhood Connectors* or *City Connectors* while still resulting in a reasonable network of streets. The criteria for North and Central Alameda County are different than those for South and East County because the network connectivity and density of these areas differ. Because of the generally lower density and more dispersed land use patterns, and less interconnected street networks, the percentage of trips threshold is higher for South and East County as compared with North and Central County. Therefore, a higher percentage of longer distance trips generally occur on collectors and arterials in the South and East County.

One issue that the sensitivity analysis and initial mapping of the street types has highlighted is that some streets that parallel freeways (e.g., Frontage Road parallel to I-80, Lewelling Boulevard parallel to I-238, and Pleasanton-Sunol Road parallel to I-680) are used as “reliever routes” when freeways are congested; as evidenced by observation of traffic patterns and driver behavior. Some of these parallel streets may be designated as throughways because of the traffic volume (ADT) criteria, but this may not be a desired function for the streets. This is something to address as the MAP study proceeds and stakeholders are reviewing the initial mapping.

Table 2
Typology Framework Summary and Criteria

Base Street Type	Base Functions and Characteristics	Vehicular Mobility Criteria	Expected Extent Street Type included in Arterial Network[1]	Examples
Throughway	Primarily high speed, with at-grade intersections, little direct relationship to surrounding context, and in some cases segments of streets connecting to a freeway with a good portion of trips crossing through multiple cities.	**Countywide:** at least 10,000 ADT **South & East County:** at least 55% of total volume traveling 8+ miles **North & Central County:** at least 50% of total volume traveling 8+ miles	Part of Arterial Network	Portions of Hegenberger Road in Oakland, Hesperian Boulevard in Alameda County, and Stanley Boulevard in Pleasanton and Livermore.
County Connector	Generally moderate speed with a good portion of trips crossing through multiple cities/communities, and segments of streets connecting to a freeway. This will also be applied to multiuse and pedestrian trails that connect to adjacent counties.[2]	**Countywide:** at least 10,000 ADT **South & East County:** at least 50% of total volume traveling 6+ miles **North & Central County:** at least 45% of total volume traveling 6+ miles	Part of Arterial Network	Ashby Avenue in Berkeley, Washington Avenue in San Leandro, A Street in Hayward, Alvarado-Niles Road in Union City, Santa Rita Road in Pleasanton, and South Vasco Road in Livermore.
City or Community Connector	Streets and trails with a good portion of trips made by those traveling across a city/community or to an adjacent city/community. [2]	**Countywide:** at least 50% of total volume traveling 4+ miles	Many will be part of the Arterial Network	Colusa Avenue in Albany and Berkeley, Tilden Way in Alameda, Fruitvale Avenue in Oakland, and Central Parkway in Dublin.
Neighborhood or District Connector	Streets and trails where most trips by those traveling across a neighborhood/district and to an adjacent neighborhood / district.	**Countywide:** at least 50% of total volume traveling less than 4 miles	Many will not be part of the Arterial Network	Portions of Solano Avenue in Albany and Berkeley, Encinal Avenue in Alameda, portions of Logan Drive in Fremont, and Rosewood Drive in Pleasanton.

Notes:
1. Criteria for countywide significance that makes a street part of the *Arterial Network* are defined in a separate memorandum. The *Arterial Network* is a subset of the *Study Network*.
2. Trails will be mapped when the *Arterial Network* is developed.

Comments and Responses on Street Typology

First Round Review Period (April – May 2015)

A range of specific comments about street typology has been provided by jurisdictions throughout the County. Most of these relate to changing a City or Neighborhood Connector street segment to County Connector, such as E. 14th Street in San Leandro and Alameda County, and Grant Line Road in the unincorporated East County. The majority of these changes were made to the street typology mapping. Some comments regard details of street function that the regional model does not fully reflect. For example, Livermore requested changing First Street to Neighborhood Connector from County Connector given the character and function of First Street as Downtown Livermore's main street and that Railroad Avenue provides parallel vehicle functionality as a County Connector. Similarly, Fremont has asked for classification of several streets in the downtown area that are not included in the Study Network. The Study Network is based on the California Roadway System classification, which was previously presented to stakeholders in December 2014 for review and comment, therefore additions to the Study Network will no longer be considered. Finally, a few jurisdictions requested that planned and funded streets in new development areas (e.g., Innovation Way in the Warm Springs area of Fremont) be included as part of the Study Network. Planned and funded roadways to be constructed in the future will be shown on future year maps, but will not be included as part of the Study Network. It is assumed that planned and funded new streets will be designed to the latest complete street standards; therefore, the Multimodal Arterial Plan will not evaluate these new street segments for future needs assessments. However, new street segments are included in the travel demand modal and considered in the development of future year (2020 and 2040) Study Network forecasts.

Second Round Review Period (July – August 2015)

Comments on the base street type overlay were not provided during the second round review period. A couple of first round comments were not adequately addressed within unincorporated Alameda County during the first round and were therefore addressed during the second round of updates (e.g., East Lewelling Boulevard was changed from Community Connector to County Connector).

A revised map of the base street type overlay is provided in Attachment C.

Multimodal Transportation Overlays

Four multimodal transportation overlays are used to provide additional definition to the multimodal characteristics and function of the streets in the *Study Network*. The overlays are used in combination with the base street types and land use context types to define street segments with respect to the vehicular function, multimodal emphases, and land use context. The combined definition of street segments will be used to establish modal priorities that define the design and operational needs of the street; this is discussed further in the accompanying modal priorities memorandum.

At a minimum, all street segments will have a land use context type and a street type, and some will have one or multiple transportation overlays. The multimodal transportation overlays indicate if particular modes should have an emphasis in the function and design of a particular street segment, and include transit, bicycle, pedestrian, and truck route/goods movement emphases.

Transit Emphasis

The transit emphasis overlay will be used to identify transit priority street segments in addition to being part of the selection criteria for arterials of countywide significance for inclusion in the *Arterial Network*. Transit emphasis categories have been defined by the transit providers and consist of three tiers:

- **Major Corridors** for bus rapid transit (BRT) either with or without dedicated lanes as identified by AC Transit's "Priority Corridors," and Wheels Tri-Valley Rapid. These corridors will be part of the *Arterial Network*.
- **Crosstown Routes** are designated on routes that generally have higher ridership, either today or projected for the future. A single "class" has been identified by AC Transit as their "Cross Town" routes and the Hollis and Shellmound/Powell routes of Emery Go-Round service,
- **Local Routes** for other bus transit service on segments of the *Study Network* for AC Transit, the Watergate Express route of Emery Go-Round service, LAVTA Wheels, and Union City Transit.

Maps of the proposed transit emphasis overlay are provided in Attachment D.

MAP transit overlay will coordinate with the proposed transit network from the *Countywide Transit Plan*, to the extent feasible from a timing standpoint. When the Transit Plan network becomes available, the MAP transit overlay will be reviewed and adjusted if the network is available prior to the review of *Arterial Network* cross section recommendations. Similarly, AC Transit is preparing an updated Comprehensive Operational Analysis (COA) which could restructure some routes. To the extent that information from the COA and other studies that transit agencies may have underway is available within time to be incorporated into the MAP (late spring), adjustment may be made to the transit emphasis overlay.

Comments and Responses on Transit Emphasis

First Round Review Period (April – May 2015)

Comments received on the transit emphasis overlay are:

- AC Transit requested additional roadway segments be designated as Major Corridors reflective of their COA study draft alternatives and the draft alternative corridors from the Alameda CTC Countywide Transit Plan. These have been marked as an alternative layer while keeping the initial modal priority in the base layer until the final future network or corridors are adopted, which is expected in October 2015. Keeping the alternative layer showing the new transit emphasis corridors serves two purposes –
    1. enables the project team to verify that the potential suggested improvements in the next steps do not adversely impact transit performance on these roadway segments identified in the final transit network; and
    2. to inform the jurisdictions on the potential modal emphasis change or added modal emphasis and help to initiate discussions between AC Transit and jurisdictions, as appropriate
- The City of Emeryville requested that Emery Go-Round service be added to the transit network and this has been done as discussed above.
- Several cities and LAVTA asked that transit service be located on segments of the network where it had not been indicated. These revisions have been made except for those routes that are not on the Study Network.

Second Round Review Period (July – August 2015)

AC Transit provided one comment on the transit emphasis overlay during the second round: assume that Solano Avenue between San Pablo Avenue and the Alameda in Albany is part of the transit major corridor network. The same comment was provided during the first round review period; however, the requested change was rescinded during the first round of mapping updates. This segment of Solano Avenue is not part of the Major Corridor network; it will remain part of the local route network in the transit emphasis overlay.

A revised map of the transit emphasis overlay is provided in Attachment D.

Bicycle Emphasis

Bicycle emphasis is developed by reviewing the existing bicycle facilities, *2012 Countywide Bicycle Plan* and the four trail types[5]. Comments from several jurisdictions around the county regarding the initial draft typology mapping have also led to many refinements to the bicycle emphasis overlay. The Countywide Bicycle Plan defines five categories of countywide significance: inter-jurisdictional network, access to transit, access to central business districts, inter-jurisdictional trails, and access to *Communities of Concern*. This includes existing and planned bicycle facilities on streets that are part of the *Study Network*, as well as some facilities that are on parallel non-*Study Network* streets or multiuse paths that serve significant connectivity functions. For example, some communities in Alameda County currently focus on placing primary bicycle facilities on non-arterial streets (e.g., Berkeley and Hayward).

The bicycle overlay types are shown below, from highest to lowest bicycle emphasis:

- Class I – bicycle and multiuse paths
- Class IV[6] – cycle tracks and similar protected bicycle facilities
- Class II enhanced –buffered bicycle lanes, and green bicycle lanes
- Class II – bicycle lanes
- Class III enhanced – bike boulevards and similar enhanced bike routes
- Class III – bike routes, shared use arrows, shoulders, and curb lanes

A map of the bicycle emphasis overlay is provided in Attachment E.

Comments and Responses on Bicycle Emphasis

First Round Review Period (April – May 2015)

Comments from eight cities across the County regarding the initial draft typology mapping have also led to many refinements to the bicycle emphasis overlay. To a great degree, this is reflective of the rapid changes that have been occurring at a national level regarding the planning and design of bicycle facilities since the adoption of the Countywide Bicycle Plan in 2012. Piedmont has only recently adopted a bicycle plan, Berkeley is currently doing a major update to their bicycle plan, and Oakland requested comprehensive refinements to their network in anticipation of planned improvement projects, future improvement projects and updates to their bicycle plan. The majority of these refinements will be made

[5] SF Bay Trail, East Bay Greenway, Iron Horse Trail and Inter-jurisdictional Trails.
[6] Class IV bike facilities is a new category that includes facilities that provide a higher level of cyclist separation from traffic than class II facilities.

by either adding or revising bicycle facilities on Study Network streets or by providing “markers” on non-Study Network streets that can be used to identify them as parallel facilities to Study Network streets during the development of design options. These updates were facilitated by several cities providing updated GIS data regarding bicycle improvements. Some requested refinements were about bike trails that are not part of the Study Network. These updates were not made, as they do not directly influence the Modal Priority approach described below.

Second Round Review Period (July – August 2015)

City of Emeryville provided several comments on the bicycle emphasis overlay, the majority of comments requested additions to the Study Network, these changes were not incorporated because additions to the Study Network are not currently being considered for reasons previously specified. Emeryville did however provide a citywide bike network GIS file, which was incorporated into the bicycle emphasis overlay for Study Network segments. In addition to changes in Emeryville, Kato Road in Fremont changed from a Class III to a Class II facility and Enterprise Drive in Newark changed to a Class II facility.

A revised map of the bicycle emphasis overlay is provided in Attachment E.

Pedestrian Emphasis

The mapping for the Pedestrian Emphasis, unlike the other transportation modes, is node- or area-based, instead of street network-based as pedestrian activity is driven by proximity to various uses, destinations, or by living in transit-dependent communities. This includes pedestrian facilities and planning areas of countywide significance as defined in the *2012 Countywide Pedestrian Plan*. These are areas where higher volumes of pedestrians exist or are expected, as well as locations where walking serves an important transportation function, such as access to transit or schools. Pedestrian emphasis also includes central business districts, activity centers, inter-jurisdictional trails, and access within “communities of concern” as defined in the Alameda CTC’s Community-Based Transportation Plans. Portions of the *Study Network* that are not within the areas described above, but are within PDAs, have a lower level of pedestrian emphasis. Several cities have commented that they have pedestrian-oriented main streets or commercial districts that were not emphasized to the degree that they would expect or desire, and adjustments to the Pedestrian Emphasis overlay are being made to correct for these comments. A map of the pedestrian emphasis overlay is provided in Attachment F.

There are three levels of pedestrian emphasis designated by pedestrian priority “scoring,” which combines scores given to street segments based on the following characteristics:

- **Priority Development Area (PDA) Place Type –** Each PDA type within the County was given a score with Regional Centers scoring the highest, while Suburban Center score the lowest.
- **Commercial and Mixed Use Areas –** Commercial and Mixed Use areas as identified from the ABAG standardized Local Jurisdiction General Plan data. These were scored with downtown or city center and other mixed use types scoring higher than predominantly single use type commercial areas. Some of the commercial areas with established high pedestrian activity that are not within multiple transit access areas such as Piedmont Avenue, College Avenue, 4th Street, Solano Avenue, have an eighth-mile buffer also scored (see Attachment A).
- **Census Tracts identified as Communities of Concern per MTC Equity Analysis –** Census tracts in the County were scored by MTC on eight categories wherein tracts over the score of 4

are considered as a Community of Concern. For mapping purposes, tracts with a MTC score of 6 are scored higher for pedestrian emphasis than ones with MTC scores between 4 and 6.

- **Employment Growth Opportunity Areas identified in ACTC 2012 CTP –** These areas were given an additional score.
- **Proximity to BART/ACE/Capitol Corridor stations –** half mile and quarter mile distances are scored.
- **Half-mile buffer off AC Transit's priority corridor –** half mile and quarter mile distances are scored.
- **Half-mile buffers around LAVTA Rapid stops –** half mile and quarter mile distances are scored.
- **One-eighth mile buffers around local bus stops –** one-eighth mile distance is scored.
- **Quarter mile buffers around activity & education centers, and parks –** quarter mile distance is scored.

Attachment A provides the methodology for how these scores combine and the thresholds to determine the three levels of pedestrian emphasis:

- Tier 1: High Pedestrian Score
- Tier 2: Medium Pedestrian Score
- Tier 3: Low Pedestrian Score

The three levels of pedestrian emphasis define increasing levels of improvement to the pedestrian environment[7].

Comments and Responses on Pedestrian Emphasis

First Round Review Period (April – May 2015)

Several cities have commented that they have pedestrian-oriented main streets or commercial districts that were not emphasized to the degree that they would expect or desire, and adjustments to the Pedestrian Emphasis overlay have been made to correct for these comments. Several cities had comments regarding the desire to increase pedestrian emphasis on certain street segments to reflect either community center or downtown pedestrian activity, or levels of pedestrian activity on particular commercial streets or districts. The majority of these revisions have been made. In addition, Oakland had comments related to broader conditions in the city and numerous commercial main streets or districts, and Berkeley commented about pedestrian activity adjacent to narrow PDA corridors. Oakland, as part of its Complete Streets Plan that is underway, has proposed a more comprehensive refinement of the pedestrian scoring method. It includes increasing the score for commercial mixed use zoning component that relate to their pedestrian-oriented main streets, as well as adjustments to some transit access component. It added additional pedestrian emphasis score for areas within an eighth-mile buffer around the commercial main street zones. This additional score reflects the higher levels of pedestrian activity in areas around main streets both from patrons parking adjacent to the main street and from local residents and employees walking to the services on the main streets, such as areas around Piedmont Avenue, College Avenue, 4th Street, and other streets. Considering the reasonableness of this additional step in scoring method, it was incorporated into the Pedestrian Scoring method for the MAP. Additionally, these changes reflect similar comments made by other cities for manual changes to streets in downtowns or commercial main streets.

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[7] All streets should satisfy Americans with Disabilities Act (ADA) requirements and guidance.

Second Round Review Period (July – August 2015)

A couple of second round comments on the pedestrian emphasis overlay were provided by Albany and Newark. Changes requested by either City would require additions to the Study Network segmentation or result in changes that do not impact modal priority determinations, therefore no changes to the pedestrian emphasis overlay were made during the second round review period.

A revised map of the pedestrian emphasis overlay is provided in Attachment F.

Truck Routes/Goods Movement Emphasis

This multimodal overlay is coordinated with the *Countywide Goods Movement Plan* that has initially defined three tiers of truck routes[8] (a map of the truck emphasis overlay is provided in Attachment G).

- Tier 1 consists of interstate and state highways that carry the majority of through truck traffic in the county; note this tier is listed for reference but *it is only designated to freeways and is not designated to any street segments that are part of the Study Network.*
- Tier 2 network refers to other state highways and designated arterials that provide intra-County and intercity connectivity and last-mile connection to the Port of Oakland and Oakland International Airport.
- Tier 3 network refers to designated arterials and collectors that are used in a majority of local pickup and delivery.

Comments and Responses on Goods Movement Emphasis

First Round Review Period (April – May 2015)

Few cities had specific comments about adding or increasing the level of Goods Movement emphasis designations on specific street segments and the majority of these refinements have been made. Some comments were made regarding streets that are not part of the Study Network, and these changes were not made. There was also some confusion regarding the tier levels of the Goods Movement emphasis, in relation to federal and state truck route designations. The tiers used in the MAP work are those that have been determined by the Countywide Goods Movement Plan, and this emphasis does not include the word "truck" and instead only refers directly to "goods movement."

Oakland had a general comment about the Goods Movement emphasis not aligning with where staff would expect to see more truck activity, and therefore had some methodological concerns. Following discussions with city staff, the general concerns were addressed and the result was changes in emphasis for specific street segments.

Second Round Review Period (July – August 2015)

Comments on the goods movement emphasis overlay were not provided by stakeholder agencies during the second round review period. The *Countywide Goods Movement Plan* consultant team did however add the following roadway segments to the three-tier goods movement network:

- Segments of Santa Rita Road and Valley Avenue in Pleasanton were added as Tier 3 routes.

[8] See the Alameda County Goods Movement Plan, Draft Technical Memorandum for Task 3c – Identify Gaps, Needs, Issues, and Deficiencies, pages 2-5 and 2-6.

- Segments of Industrial Parkway and Whipple Road in Hayward were added as Tier 3 routes.

The segments listed above were included in the goods movement emphasis overlay, a revised map is provided in Attachment G.

Modal Priority

Together, these documents describe a technical process for using area character (land use context), street vehicular function (base street type), and modal networks (multimodal overlays) identified from on-going or recent plans (Alameda Countywide Transit, Goods Movement, Bicycle and Pedestrian Plans) to derive modal priorities for specific street segments. As this study progresses, there will be opportunities to adjust these recommendations:

- Consistent with the Vision statement, the Alameda Countywide Multimodal Arterial Plan will be sensitive to local context. If the technically generated modal priorities are inconsistent with local values, they will be modified in consultation with the local agencies.
- While the land use context includes information on aspirational (long term vision) land uses (SCS, PDAs, etc.), the base street types derive from current functions. To the extent that local agencies have aspirations to change the function of streets, the Multimodal Arterial Plan can reflect aspirations for the 2040 planning horizon.
- For analysis purposes, the Study Network is segmented based on CMP segmentation, PDA boundaries, changes in street cross-section and other reasons. Network analysis will be conducted after recommended improvements are generated to assure that segment-level improvements assemble into continuous and connected networks that supports system efficiency. Continuity analysis will include a review of user experience such that the comfort of bicycle improvements is consistent over the length of a corridor and transit improvements knit together into a cohesive/consistent alignment.
- Ultimately, the most important part of the MAP will be a set of recommendations that enhance multimodal mobility in Alameda County while meeting the MAP’s goals; and doing this through an efficient investment strategy. Capital and operating cost estimates will be used in combination with other performance measures to prioritize those improvements that provide the greatest cost-benefit ratio.

Land use context types and base street types of the MAP’s street typology framework inform the modal priority for streets. For example, the throughway street type has the highest level of auto mobility emphasis in most land use contexts. But a throughway in a Downtown Mixed Use land use context will prioritize pedestrians, bicycles, and transit because of the intensity of activity for these modes in the dense mixed use environment of a downtown.

Multimodal transportation overlays, or combinations of overlays, represent priority networks for specific modes – transit, bicycle, pedestrian and goods movement, modify modal priorities. Applying the street types, land use context types, and multimodal overlays results in a nuanced set of modal priorities for street segments in the *Study Network*. Considering the above points, to facilitate the process of identifying modal priority, three types of priority order were developed based on the land use context as shown in Table 3.

Table 3
MAP Modal Priorities – General

Land Use Context Types	Land Use Context Types	Land Use Context Types
▪ Downtown Mixed Use ▪ Town Center Mixed Use ▪ Corridor/Neighborhood Mixed Use ▪ Education/Public/Semi-Public ▪ Parks	▪ Mixed Use ▪ Commercial ▪ Residential ▪ Rural/Open Space ▪ Other/Unknown	▪ Industrial
Associated Modal Priorities 1. Transit 2. Pedestrian 3. Bicycle 4. Auto 5. Goods Movement/Truck	**Associated Modal Priorities** 1. Transit 2. Auto 3. Goods Movement/Truck 4. Bicycle 5. Pedestrian	**Associated Modal Priorities** 1. Transit 2. Goods Movement/Truck 3. Auto 4. Bicycle 5. Pedestrian

This order generally iterates through the first highest order facilities for each mode; then the next highest order, and third highest order. For example, for transit, the highest order facilities are the Major Transit Corridors and the second highest are the Crosstown routes. The main deviation from this iterative approach is for the highest emphasis bicycle facilities: enhanced Class II and enhanced Class III facilities have the same priority as Class I and Class IV facilities. This approach intends to balance autos as the dominant form of transportation in Alameda County with State, regional and local policies related to reducing greenhouse gas emissions that focus on directing local development to creates and enhances activity nodes that support transit, walking and bicycling. It also provides an implementation tool for continuous and connected multimodal networks to facilitate travel by all modes. Table 4 displays the resulting priorities.

Table 4 MAP Modal Priorities – Specific		
Column 1	**Column 2**	**Column 3**
Land Use Context Types ▪ Downtown Mixed Use ▪ Town Center Mixed Use ▪ Corridor/Neighborhood Mixed Use ▪ Education/Public/Semi-Public ▪ Parks	**Land Use Context Types** ▪ Mixed Use ▪ Commercial ▪ Residential ▪ Rural/Open Space ▪ Other/Unknown	**Land Use Context Types** ▪ Industrial
Associated Modal Priorities 1. Transit: Major Corridors 2. Pedestrian: Tier 1 3. Bicycle: Class I, enhanced Class II, enhanced Class III or Class IV 4. Auto: Throughway 5. Goods Movement: Tier 2 6. Transit: Crosstown Routes 7. Pedestrian: Tier 2 8. Bicycle: Class II 9. Auto: County Connector 10. Pedestrian: Tier 3 11. Bicycle Class III 12. Transit: Local Routes 13. Goods Movement: Tier 3 14. Auto: Community Connector 15. Auto: Neighborhood Connector	**Associated Modal Priorities** 1. Transit: Major Corridors 2. Auto: Throughway 3. Goods Movement: Tier 2 4. Bicycle: Class I, enhanced Class II or enhanced Class III or Class IV 5. Pedestrian: Tier 1 6. Transit: Crosstown Routes 7. Auto: County Connector 8. Goods Movement: Tier 3 9. Bicycle: Class II 10. Pedestrian: Tier 2 11. Auto: Community Connector 12. Bicycle Class III 13. Pedestrian: Tier 3 14. Transit: Local Routes 15. Auto: Neighborhood Connector	**Associated Modal Priorities** 1. Transit: Major Corridors 2. Goods Movement: Tier 2 3. Auto: Throughway 4. Bicycle: Class I, enhanced Class II, enhanced Class III or Class IV 5. Pedestrian: Tier 1 6. Transit: Crosstown Routes 7. Goods Movement: Tier 3 8. Auto: County Connector 9. Bicycle: Class II 10. Pedestrian: Tier 2 11. Auto: Community Connector 12. Bicycle Class III 13. Pedestrian: Tier 3 14. Transit: Local Routes 15. Auto: Neighborhood Connector

By way of example, Table 5 highlights some example streets by Planning Area, listing their land use context and base street types, and multimodal transportation overlays. The final column shows their modal priorities (in ranked order). Walking through the first example – Hegenberger Road, the stepwise process proceeds as follows:

Mission Boulevard from Driscoll Road to I-680

Land use Context = Residential, Education, and Commercial (see column 2 of Table 4)

1. Is it a Transit Major Corridor?	NO	
2. Is it a Throughway?	YES	1st priority – Auto
3. Is it part of the Tier 2 Goods Movement network?	YES	2nd priority – Truck
4. Is it a Class I or Class IV Bicycle facility?	NO	
5. Is it a part of the Pedestrian Tier 1 network?	NO	
6. Is it a Transit Crosstown Route?	NO	
7. Is it a County Connector?	NA	

8.	Is it part of the Tier 3 Goods Movement network?	NA	
9.	Is it a Class II Bicycle facility?	YES	3rd priority - Bicycle
10.	Is it part of the Tier 2 Pedestrian network?	NO	
11.	Is it a Community Connector?	NA	
12.	Is it a Class III or Class III Enhanced Bicycle facility	NA	
13.	Is it part of the Tier 3 Pedestrian network?	NO	
14.	Is it a Transit Local Route?	YES	4th priority - Transit
15.	Is it a Neighborhood Connector?	NA	
16.	Does it have no Pedestrian emphasis?	YES	5th priority - Pedestrian

NA (not applicable) occurs when a question relates to a mode that is a priority based on a prior question. As an example, the response to "Is it a County Connector?" - a question that could result in the facility being designated as auto priority- is NA because the facility was already designated as auto priority from the question – "Is it a Throughway?"

In a few cases, the land use context of a segment includes categories within multiple columns of Table 4, such as with Foothill Boulevard between Castro Valley Boulevard and Grove Way. In these cases, the predominant land use contexts are used. In the case of Foothill Boulevard, column 2 of Table 4 is used as the predominant land uses are Mixed Use and Residential.

Comments and Responses on Modal Priority

First Round Review Period (April – May 2015)

As explained in the draft modal priority memorandum, applying the base street types, land use context types, and multimodal overlays results in a nuanced set of modal priorities for street segments along the *Study Network*. Based on the comments received on the draft typology, the approach to identifying the modal priority remains unchanged except for the bicycle emphasis. However, many specific comments were made to the identified modal priority reflecting the local priorities and local knowledge on the function of a particular street.

Regarding the modal priority approach, per recent legislative mandate (AB 1193 signed into law in September 2014) that added an additional class and provided emphasis for the protected bike lanes, enhanced class II and enhanced class III bicycle facilities that provide more protection for bicyclists over the other classes were also added to the highest emphasis for bicycles and have the same priority as Class I and IV. The redline changes to the modal priority approach are shown in Table 1 (on the following page) and the updated example on the following page shows the application of the revised modal priority on Mission Boulevard.

Regarding the specific modal priority changes for certain streets (segments), a majority of the comments have been incorporated by manually overwriting the draft modal priority list.

Second Round Review Period (July – August 2015)

Six jurisdictions (Alameda County, Albany, Dublin, Fremont, Newark and Oakland) requested modal priority changes during the second round review period and the majority of requested changes were made. The City of Oakland is in the process of developing their Citywide Complete Streets Plan and developed a separate methodology to identify modal priorities as part of that project. The modal priorities identified as part of the ongoing citywide plan were incorporated into the Countywide Multimodal Arterial Plan.

Table 5
Example Streets with Street Type and Overlay Designations

Planning Area	Street Segment	Land Use Context Overlay	Street Type	Transit Overlay	Bicycle Overlay	Pedestrian Overlay	Truck Overlay	Modal Priority (in order)
NORTH COUNTY	**International Blvd.** *(Fruitvale Ave. to 38th Ave.)*	Corridor/ Neighborhood Mixed Use	**Community Connector**	Major Corridor	None	***Tier 1 - (>9.0 score)*** ▪ Neighborhood Mixed Use PDA. ▪ On AC Transit Priority Corridor. ▪ Within 1/4 milt of BART Station ▪ Community of Concern Tract.	None	Transit Pedestrian Auto Bicycle Truck
	Telegraph Ave. *(40th to 51st St.)*	Corridor/ Neighborhood Mixed Use	**Community Connector**	Major Corridor	Class II	***Tier 2 - (4.1-9.0 score)*** ▪ Neighborhood Mixed Use PDA ▪ On AC Transit Priority Corridor. ▪ Within 1/4 mile of local bus stops. ▪ Community of Concern Tract.	None	Transit Pedestrian Bicycle Auto Truck
	Sacramento St. *(Dwight Way to Ashby Ave.)*	Commercial and Residential	**Neighborhood Connector**	Crosstown	None	***Tier 3 - (1.1-4.0 score)*** ▪ Within 1/2 Mile of ACT Priority Corridor. ▪ Within 1/4 mile of local bus stops. ▪ Community of Concern Tract.	None	Transit Pedestrian Auto Bicycle Truck

Table 3
Example Streets with Street Type and Overlay Designations

Planning Area	Street Segment	Land Use Context Overlay	Street Type	Transit Overlay	Bicycle Overlay	Pedestrian Overlay	Truck Overlay	Modal Priority (in order)
CENTRAL COUNTY	**Foothill Blvd.** *(Castro Valley Blvd to Grove Way)*	Mix-use (Comm. & Res.) and Residential	**Throughway**	Local (on part of segment)	None	***Tier 3 - (1.1-4.0 score)*** ▪ Within 1/2 Mile of ACT Priority Corridor. ▪ Partially within 1/4 mile of local bus stops	Tier 2	Auto Truck Pedestrian Transit Bicycle
	D Street *(Mission Blvd. to 1st Street)*	Downtown Mixed Use	**Neighborhood Connector**	Local (on part of segment)	Class II	***Tier 1 - (>9.0 score)*** ▪ City Center PDA. ▪ Within 1/4 mile of ACT Priority Corridor. ▪ Within 1/4 mile of BART station. ▪ Community of Concern Tract.	None	Pedestrian [1] Bicycle Transit Auto Truck
	Watkins St. *(B St to D St.)*	Town Center Mixed Use	**Neighborhood Connector**	Local	Class II	***Tier 1 - (>9.0 score)*** ▪ City Center PDA. ▪ Within 1/4 mile of ACT Priority Corridor. ▪ Within 1/4 mile of BART station. ▪ Community of Concern Tract.	None	Pedestrian Bicycle Transit Auto Truck

Note:

[1] Hayward has requested that the modal priorities for D Street be changed to bicycle, pedestrian, auto, transit, and truck; this requested change was made to the modal priority mapping.

Table 3
Example Streets with Street Type and Overlay Designations

Planning Area	Street Segment	Land Use Context Overlay	Street Type	Transit Overlay	Bicycle Overlay	Pedestrian Overlay	Truck Overlay	Modal Priority (in order)
SOUTH COUNTY	**Mission Blvd.** *(Driscoll Rd. to I-680)*	Residential and Education	**Throughway**	Local	Class II	***Pedestrian Emphasis not considered***	Tier 2	Auto Truck Bicycle Transit Pedestrian
SOUTH COUNTY	**Thornton Ave.** *(Paseo Padre Parkway to Fremont Blvd.)*	Corridor/ Neighborhood Mixed Use	**Community Connector**	Local	Class II	***Tier 2- (4.1-9.0 score)*** ▪ Transit Neighborhood PDA. ▪ On ACT Priority Corridor. ▪ Partially within 1/2 mile of Capitol Corridor/ACE station	Tier 3	Pedestrian Bicycle Transit Truck Auto
SOUTH COUNTY	**Fremont Blvd.** *(Nicolet Ave. to Thornton Ave.)*	Corridor/ Neighborhood Mixed Use	**County Connector**	Major Corridor	Class II	***Tier 2- (4.1-9.0 score)*** ▪ Transit Neighborhood PDA. ▪ On ACT Priority Corridor. ▪ Partially within 1/2 mile of Capitol Corridor/ACE station.	None	Transit Pedestrian Bicycle Auto Truck

Table 3
Example Streets with Street Type and Overlay Designations

Planning Area	Street Segment	Land Use Context Overlay	Street Type	Transit Overlay	Bicycle Overlay	Pedestrian Overlay	Truck Overlay	Modal Priority (in order)
EAST COUNTY	**Stanley Blvd.** *(Bernal Ave. to Isabel St.)*	Rural/Open Space	**Throughway**	Local	Class II	***Pedestrian Emphasis not considered***	Tier 2	Auto Truck Bicycle Transit Pedestrian
EAST COUNTY	**Dublin Blvd.** *(Arnold Rd. to Hacienda Dr.)*	Commercial	**Throughway**	Major Corridor	Class II	***Tier 3 - (1.1-4.0 score)*** ▪ On LAVTA Rapid Corridor. ▪ Within Commercial Land use	Tier 3	Transit Auto Truck Bicycle Pedestrian
EAST COUNTY	**Central Pkwy.** *(Grafton St. to Lockhart St.)*	Town Center Mixed Use	**Community Connector**	None	Class II	***Tier 3 - (1.1-4.0 score)*** ▪ Within 1/2 Mile of LAVTA Rapid stops. ▪ Suburban PDA.	None	Bicycle Pedestrian Auto Truck

Maps in Attachment H show the updated top modal priority for the Study Network.

Next Steps

This memorandum describes how the project team had categorized the *Study Network* streets by land use context types, street types, and multimodal overlays, and reflects the first feedback loop of stakeholder review and comment as illustrated in Figure 2. The typology framework and initial mapping of the typologies and modal priorities were presented to the stakeholders for review in April – ACTAC on April 9, 2015; Planning Area meetings during April 20-22, 2015; and non-agency stakeholder meeting on April 20, 2015. The second draft mapping set of the typologies and modal priorities were presented to stakeholders for review at the PlanTAC meeting on July 21, 2015

The typology for the MAP will inform the modal priority for the *Study Network* segments, which in turn will lead to identifying the modal needs on the *Study Network* in combination with the Performance Objectives.

ATTACHMENT A: Pedestrian Emphasis Scoring Methodology

The Pedestrian emphasis scoring was performed by layering the categories listed in Table 4 through GIS mapping. The overlaying individual scores were summed to create a pedestrian emphasis intensity map of the combined layers scores. Maps in Attachment F show the gradation of these scores.

The Transit scores range from .25 to 2 points based upon the existing and planned transit capacity on those routes. Hence, BART Stations, AC Transit Major Corridor and Crosstown routes, select Emery Go-Round routes, and LAVTA Rapid corridors have higher scores than local routes. Locations where multiple transit facilities overlap have higher cumulative scores.

The Land Use/Demographic category scoring is more variable, ranging from .25 to 4 points depending upon the characteristic being scored. Existing commercial mixed use zones that are the most pedestrian oriented also include scoring in an eighth-mile buffer around the zoning boundary. This breadth of scoring occurs, because this category includes factors such as intensity of uses, high activity destinations, and demographic profiles through the scoring of MTC's *Community of Concern* assessment. Land use scoring includes PDA typologies with the highest score assigned to the highest PDA intensity type, a score of 4 for Regional Center. Many of the PDAs contain several types of high-activity uses (commercial and mixed use areas as defined in jurisdictions' general plans); therefore, those areas were assigned additional scores (ranging from .25 to 1) based upon the intended intensity of those specific uses. This additional scoring allows for gradation of pedestrian emphasis of streets within large PDAs. Areas identified as future employment zones in the County's RTP were given one point to highlight activity centers that aren't necessarily within transit corridors or PDAs, but would have a need for pedestrian improvements. Points were given to educational, cultural and government offices areas, as they bring additional pedestrian activity from employees, users, and visitors. Lastly, census tracts identified as Communities of Concern under the MTC equity analysis were scored (1 to 1.5) based upon whether more than four of the demographic factors identified in the MTC analysis were met. Tracts that met more than 6 factors were scored half a point higher.

Across categories, the scoring was scaled to relative expected level of pedestrian activity. For example, BART stations typically have a high level of pedestrian activity around them and a scored a 2. But those in city centers generally have even higher levels of activity, so a PDA place type score of 4 for a Regional Center or 3 for a City Center was added to the BART score. The relatively higher scoring for the PDA designation compared to the BART score is reflective of the pedestrian activity that occurs in these centers regardless of how a person travels to and from the center, such as an employee walking to get lunch or run errands.

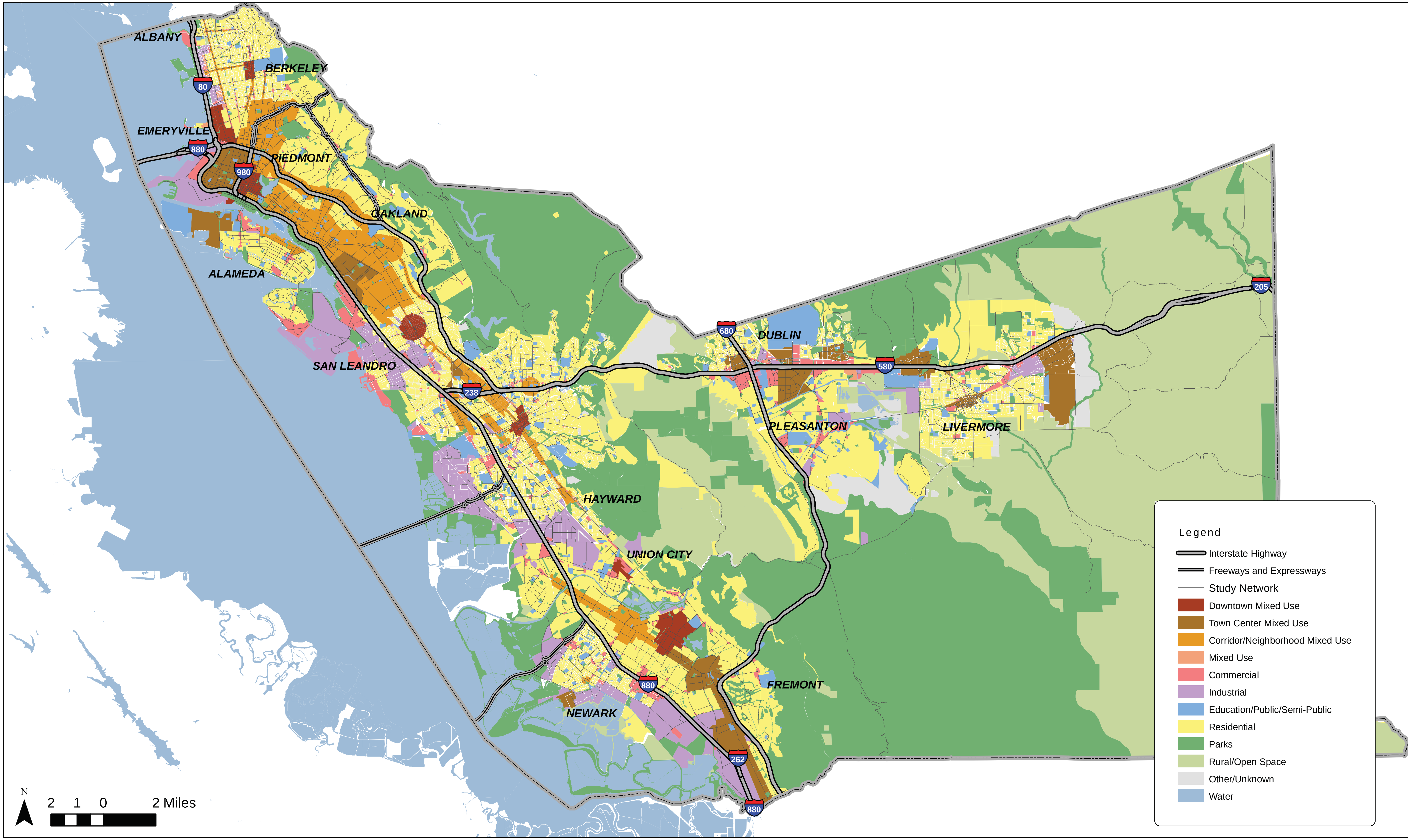
Table 4: Pedestrian Priority Scores

	PEDESTRIAN PRIORITY MEASURE	REVISED SCORE	NOTES
TRANSIT (range of 0.25 to 2 point scores)			
1	**BART STATIONS**		
	.25 Miles	2	
	.5 Miles	1	
2	**ACE STATIONS**		
	.25 Miles	0.75	
	.5 Miles	0.5	
3	**AMTRAK CAPITOL CORRIDOR**		
	.25 Miles	0.75	

	PEDESTRIAN PRIORITY MEASURE	REVISED SCORE	NOTES
	.5 Miles	0.5	
4	**AC TRANSIT PRIORITY CORRIDOR and EMERY GO-ROUND**		
	.25 Miles Major Corridor	2	
	.5 Miles Major Corridor	1	
	.25 Miles Crosstown and Emery Go-Round (selected routes)	0.75	
	.5 Miles Crosstown and Emery Go-Round (selected routes)	0.5	
5	**LAVTA CORRIDOR**		
	.25 Miles	2	
	.5 Miles	1	
6	**LOCAL BUS STOPS (AC/LAVTA/UCT/EMERY GO-ROUND)**		
	0.125 Miles	0.25	
	.25 Miles	0	
LAND USE/DEMOGRAPHIC (range of 0.25 to 4 point scores)			
7	**PRIORITY DEVELOPMENT AREAS**		
	Regional Center	4	
	City Center	3	
	Suburban Center	2	
	Transit Town Center	1.5	
	Urban Neighborhood	1	
	Transit Neighborhood	0.75	
	Mixed Use Corridor	1	
8	**EMPLOYMENT GOWTH OPPORTUNITY AREAS**	**1**	
9	**COMMUNITIES OF CONCERN**		
	below 6	**1**	
	6 and above	1.5	
10	**ACTIVITY CENTERS**		
	.25 Miles	0.25	
11	**LAND USE**		
	ALAMEDA		
	101 - Business Park or Office	0.25	
	101 - Community Commercial	0.25	
	101 - Island Auto Movie or Mariner Square	0.5	
	101 - Neighborhood Business or Northern Waterfront	0.75	0.5 for 1/8 mile buffer
	ALAMEDA COUNTY		
	199 - Mixed Use	0.5	
	ALBANY		
	102 - Community Commercial	0.5	
	102 - General Commercial	0.25	
	102 - Research	0.25	
	102 - Commercial/Service/Light Industrial	0.25	
	102 - Medium Density Res./Recreational/Comm'l	0.5	
	102 - Planned Res./Commercial or Res./Commercial	0.5	
	BERKELEY		
	103 - Avenue or Neighborhood Commercial (Solano Com'l, North Shattuck Com'l and South Area Com'l)	1	0.5 for 1/8 mile buffer
	103 - Avenue or Neighborhood Commercial (West Berkeley Com'l (outside of 4th Street Area), South Area Com'l (from Dwight to Ashby), General Com'l (on University, Shattuck, and Telegraph)., Residential Mixed Use (btwn. Bancroft and Durant), and Elmwood Commercial)	1.25	0.75 for 1/8 mile buffer
	103 - Downtown Mixed Use, Telegraph Commercial, West Berkeley Com'l in 4th Street Area	2	0.5 for 1/8 mile buffer
	103 - Manufacturing Mixed Use	0.5	
	CASTRO VALLEY		
	116 - General or Retail Commercial	0.25	
	116 - Office	0.25	

PEDESTRIAN PRIORITY MEASURE	REVISED SCORE	NOTES
116 - Restaurants & Entertainment	0.5	
116 - Mixed Use	0.5	
CHERRYLAND		
117 - General Commercial	0.25	
117 - San Lorenzo Village	0.5	
117 - Light Industrial and Research & Development/Office	0.25	
117 - General Comm'l or Medium/ High Density Res.	0.5	
117 - General Comm'l/Low-Medium Density Res. allowed	0.25	
117 - General Comm'l/Medium & High Density Res. allowed	0.5	
117 - General Comm'l/Medium Density Res. allowed	0.5	
117 - High Density Res/General Commercial allowed	0.5	
117 - Low-Medium Density Res/General Commercial	0.25	
DUBLIN		
104 - Campus Office	0.25	
104 - General or Neighborhood Commercial	0.25	
104 - General Commercial/Campus Office	0.5	
104 - Retail/Office	0.5	
104 - Retail/Office and Automotive	0.25	
104 - Mixed Use	0.5	
EMERYVILLE		
Doyle-Hollis Office and Office/Technology	0.75	
High Density Residential	1	
Mixed Use with Residential	1	
Mixed Use non-Residential	1	
FREMONT		
106 - Central Business District	1	
106 - Community or Office Commercial	0.25	
106 - Neighborhood Commercial	0.5	
106 - Mixed Use-Neighborhood Commercial (Res. 15-18 d/a)	0.25	
106 - Mixed Use-Neighborhood Commercial (Res. 18-23 d/a)	0.5	
106 - Mixed Use-Neighborhood Commercial (Res. 23-27 d/a)	1	
106 - Mixed Use-Neighborhood Commercial (Res. 27-35 d/a)	1	
HAYWARD		
107 - City Center - Retail and Office Commercial	1	
107 - General Commercial	0.25	
107 - Retail and Office Commercial	0.5	
107 - Commercial/High Density Residential	1	
LIVERMORE		
108 - Community Serving General Commercial	0.25	
108 - Neighborhood Commercial	0.5	
108 - Office Commercial	0.25	
108 - Mixed Use-Downtown Area SP	1	
108 - Mixed Use-Neighborhood Medium Density	0.5	
108 - Mixed Use-Neighborhood Low Density	0.25	
NEWARK		
109 - Community or General Commercial	0.25	
109 - Neighborhood Commercial	0.5	
109 - Office Commercial	0.25	
109 - Regional or Specialty Commercial	0.25	
OAKLAND		
110 - Business Mix	0.75	
110 - Central Business District	2	
110 - Community Commercial	0.5	
110 – Neighbor'd Ctr. Mixed Use (CN-3 and CN-4) or Hsg./Business Mix	0.75	0.5 for 1/8 mile buffer
Neighborhood Commercial 1 and 2 (CN-1 and CN-2)	1.25	0.75 for 1/8 mile

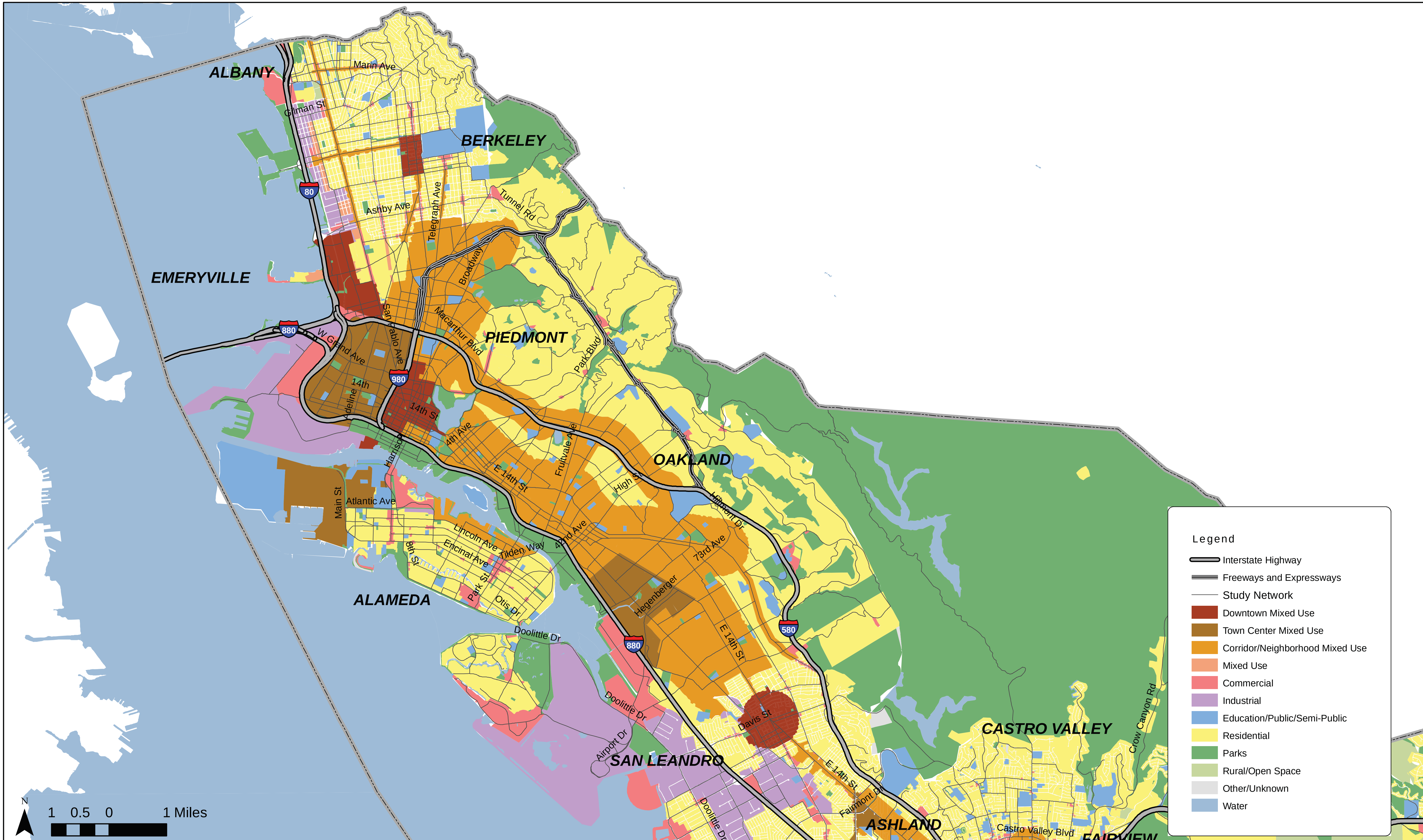
PEDESTRIAN PRIORITY MEASURE	REVISED SCORE	NOTES
		buffer
PLEASANTON		
112 – Comm'l and Office (Retail/Highway/Service/Professional)	0.25	
112 - Business Park (Industrial/Commercial and Office)	0.25	
SAN LEANDRO		
113 - General Commercial or Office	0.25	
113 - Neighborhood Commercial or Corridor Mixed Use	0.2	
113 - Downtown Mixed Use	1	
UNION CITY		
114 - Office Commercial or R&D Campus	0.25	
114 - Retail Commercial	0.25	
114 - Station Mixed-Use Commercial	1	



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment B - Land Use Context Type*

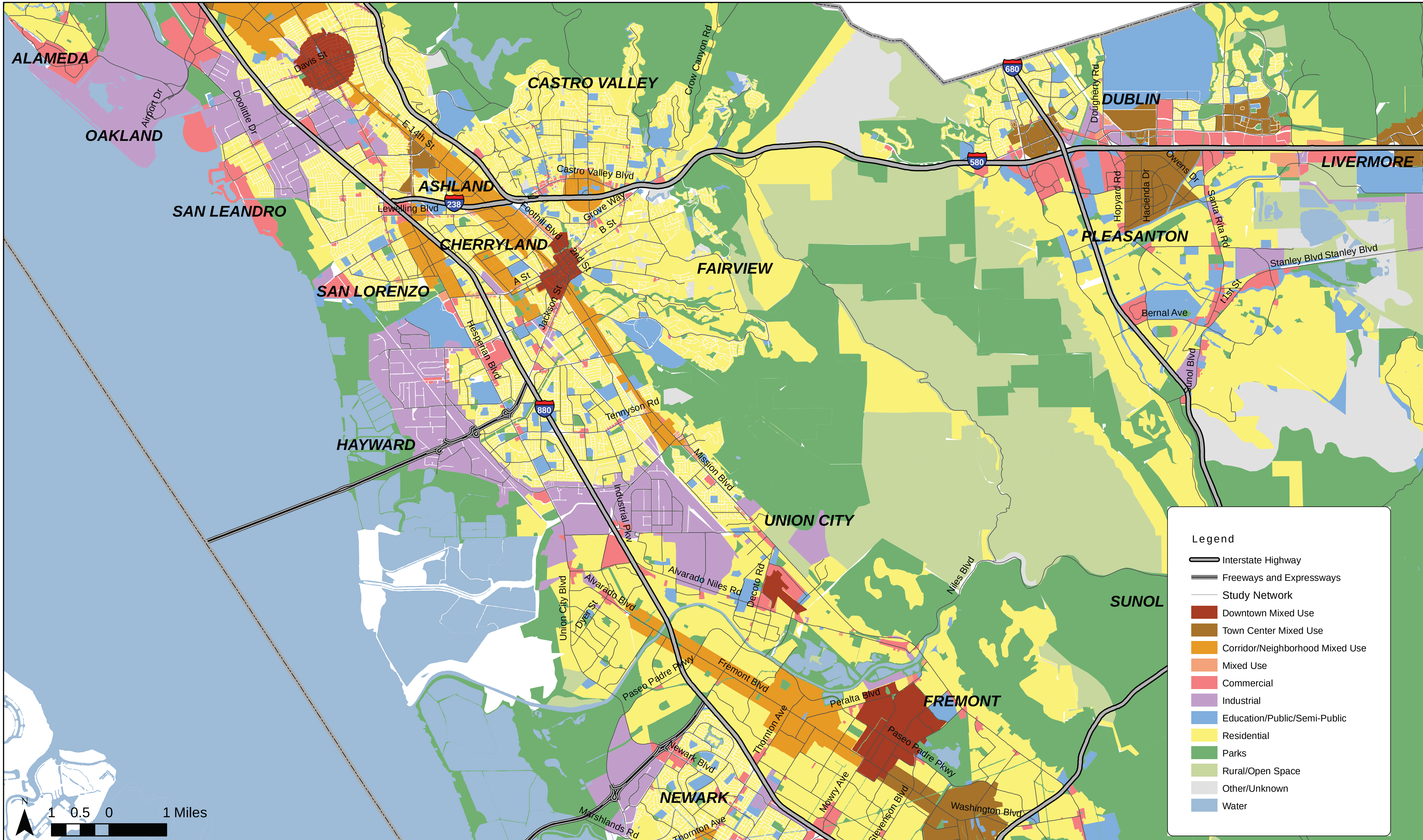


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment B - Land Use Context Type*

North County

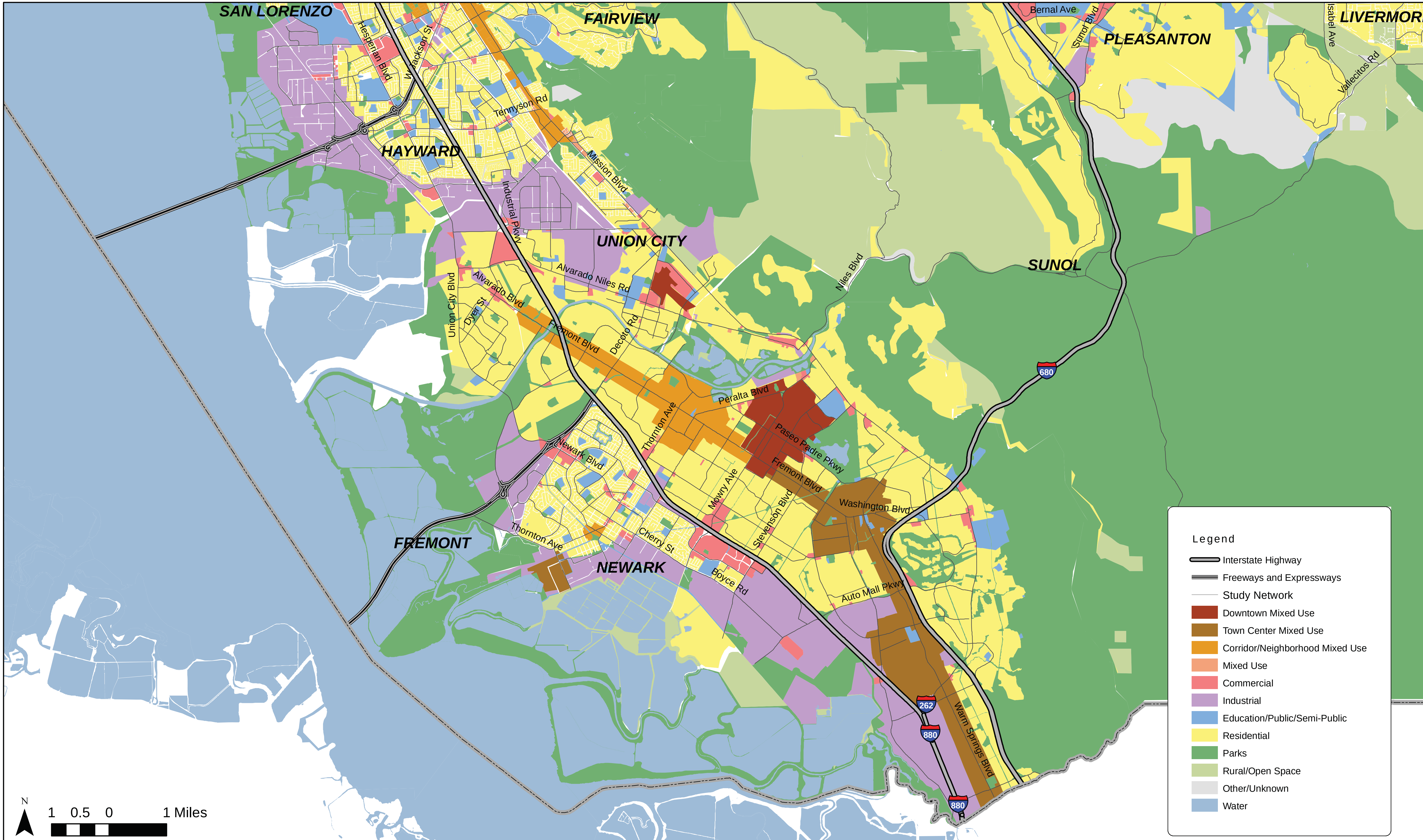


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment B - Land Use Context Type*

Central County

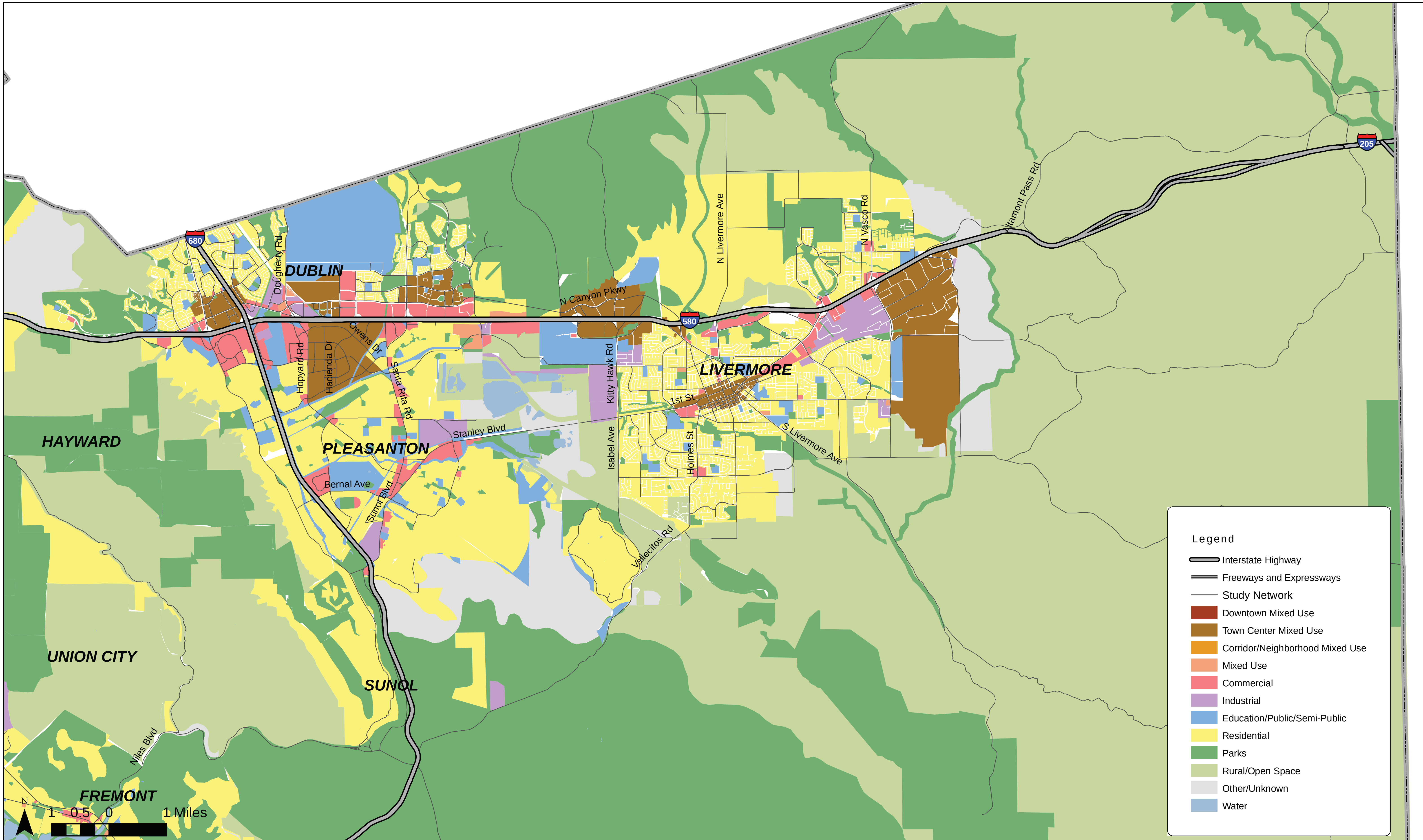


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL ***Attachment B - Land Use Context Type***

South County

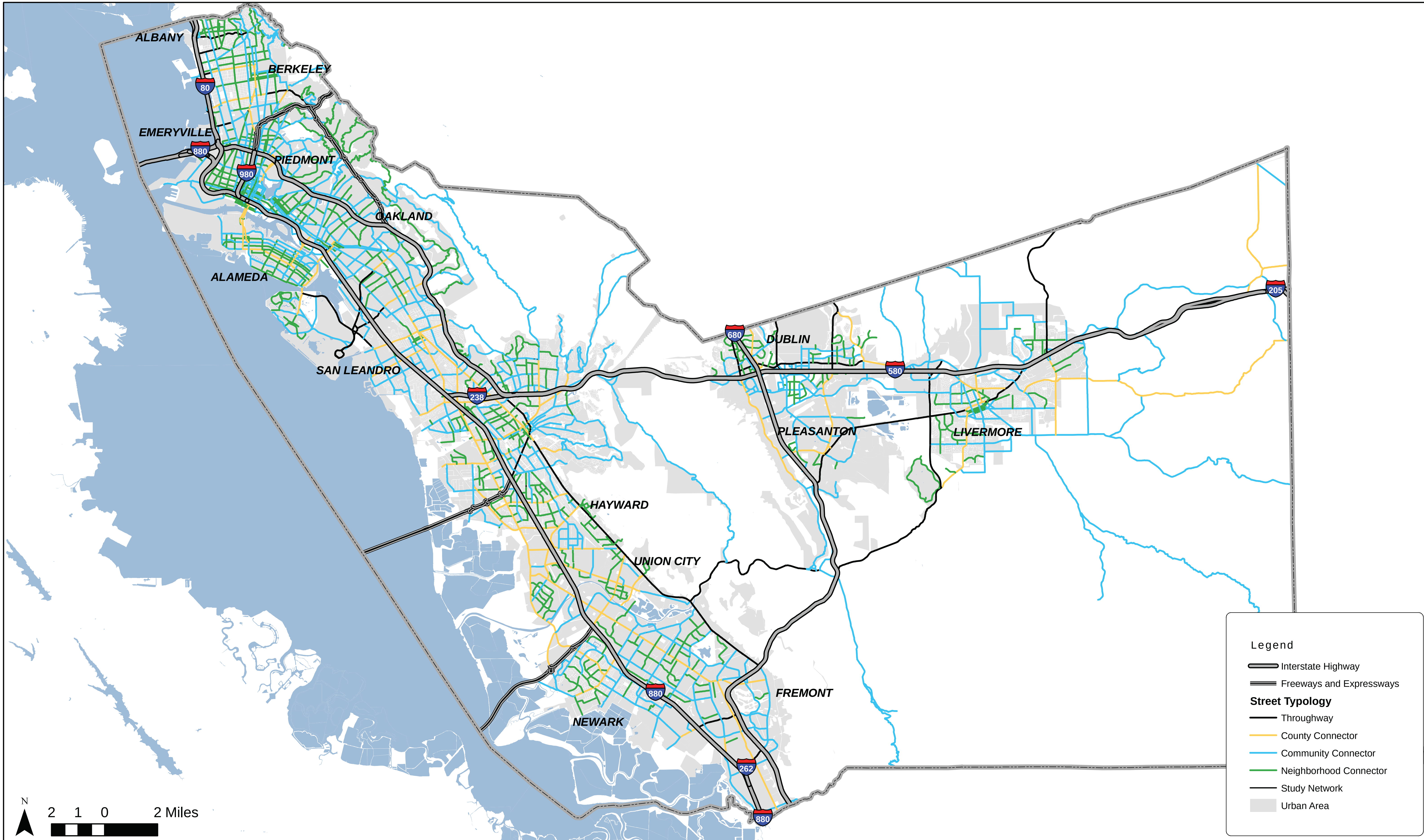


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment B - Land Use Context Type*

East County

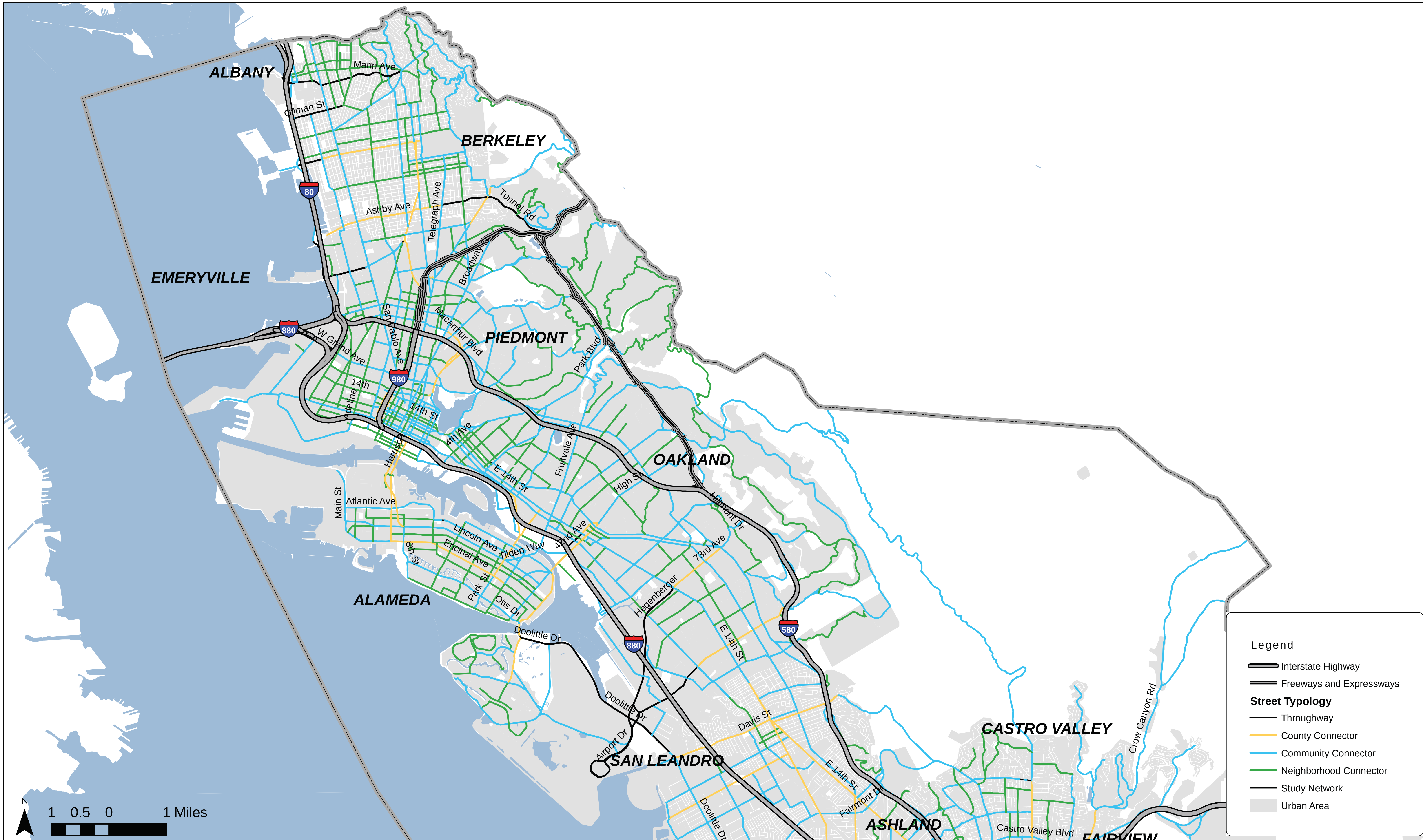


October 7, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment C - Street Typology*

Countywide

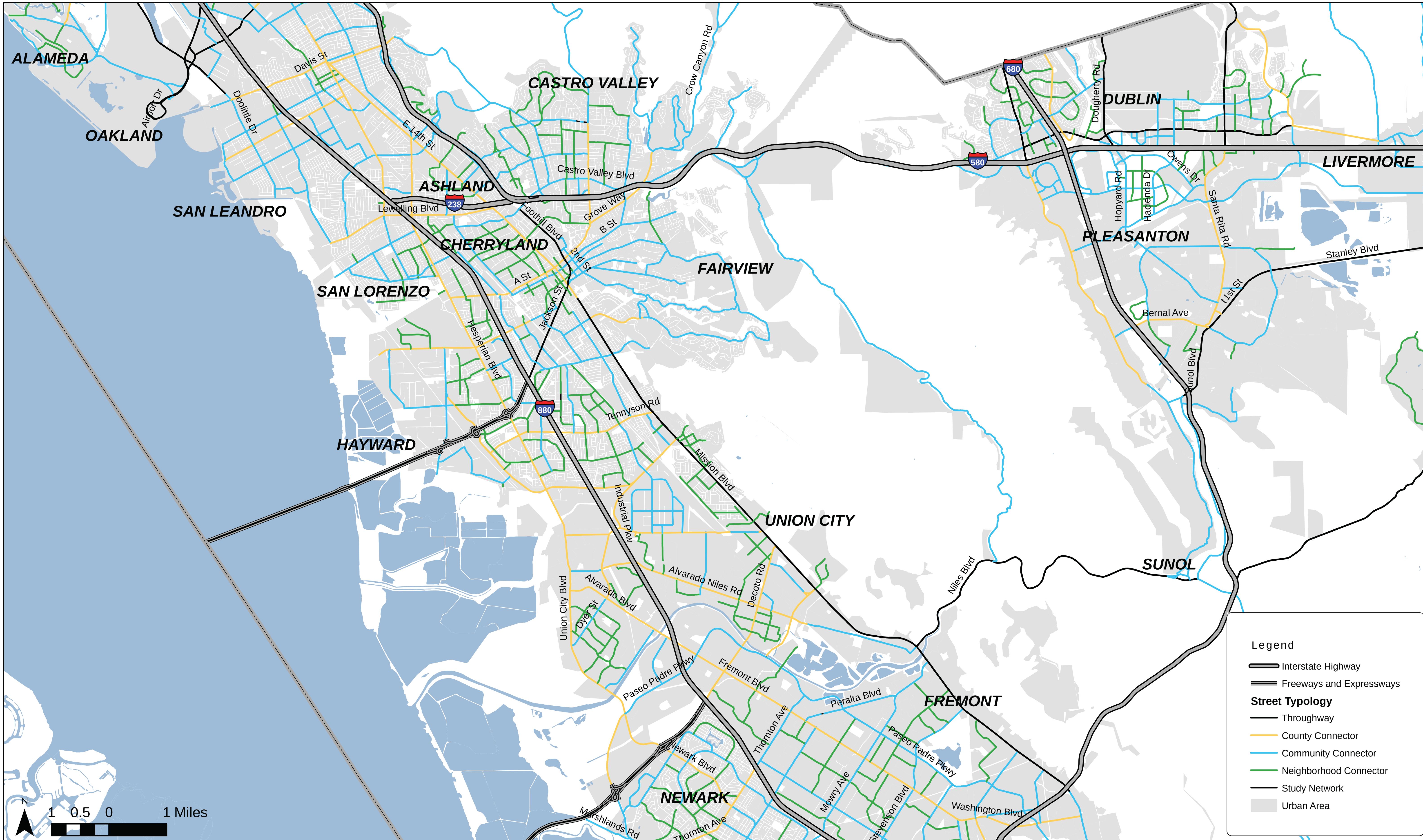


October 7, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment C - Street Typology*

North County

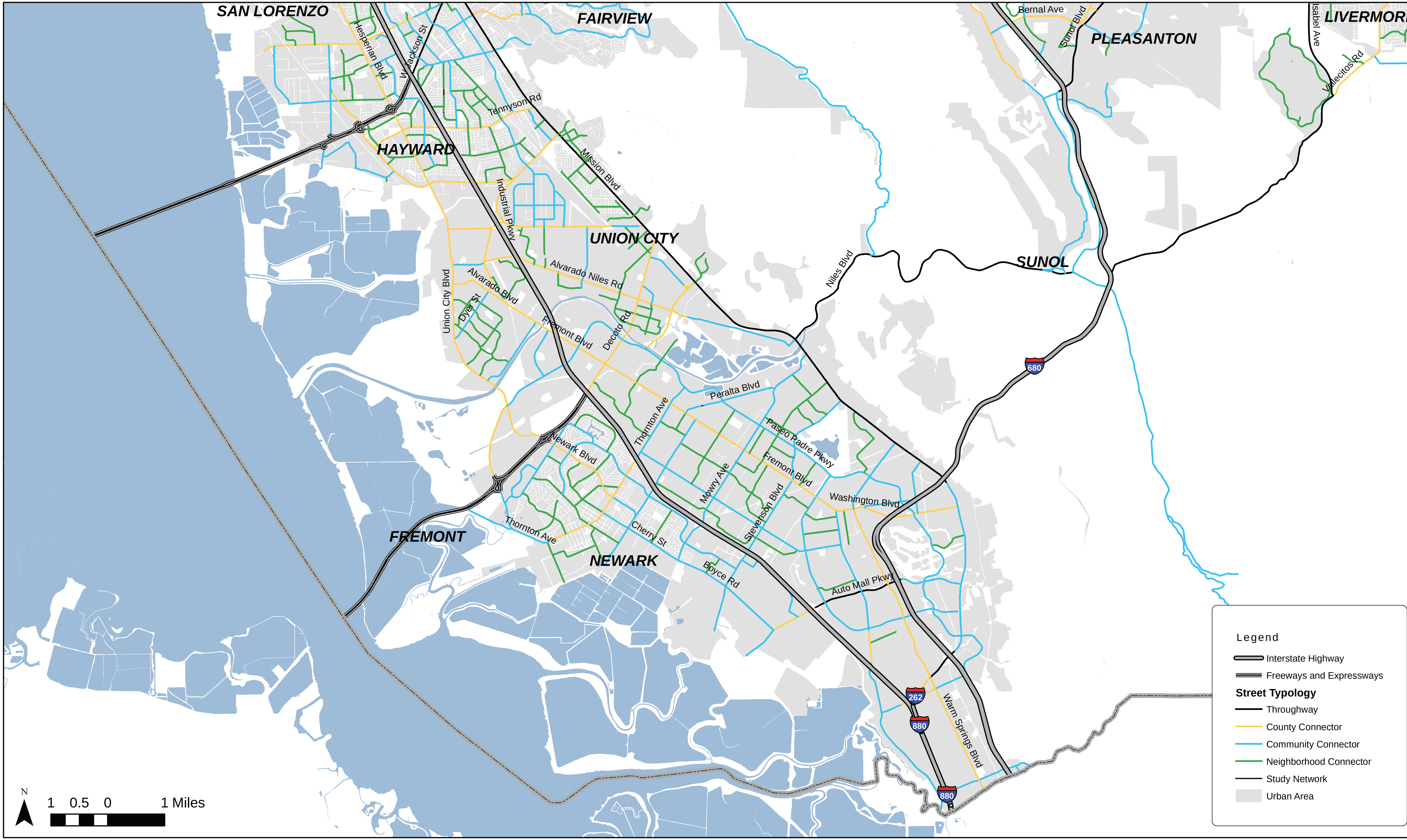


October 7, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment C - Street Typology*

Central County

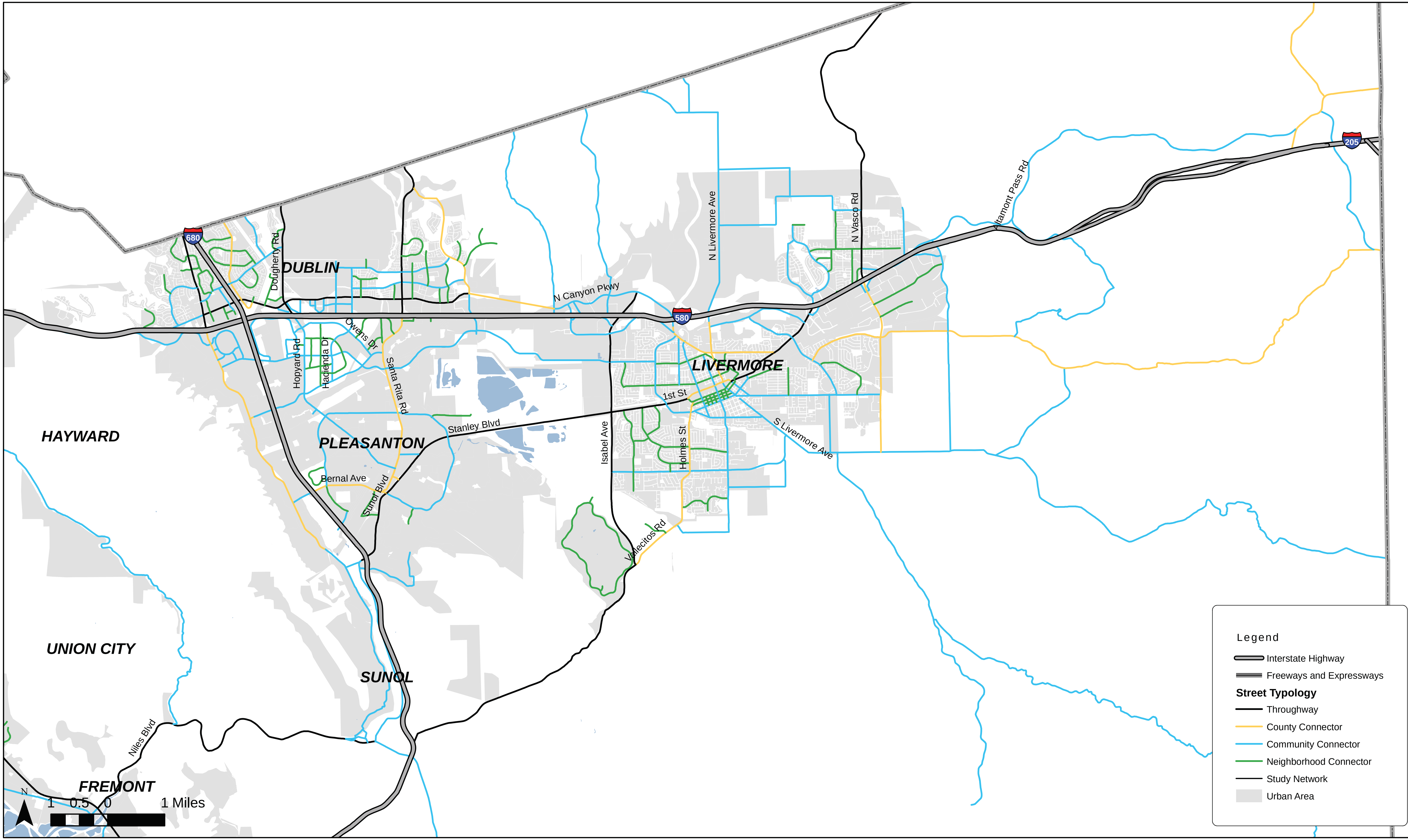


October 7, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment C - Street Typology*

South County

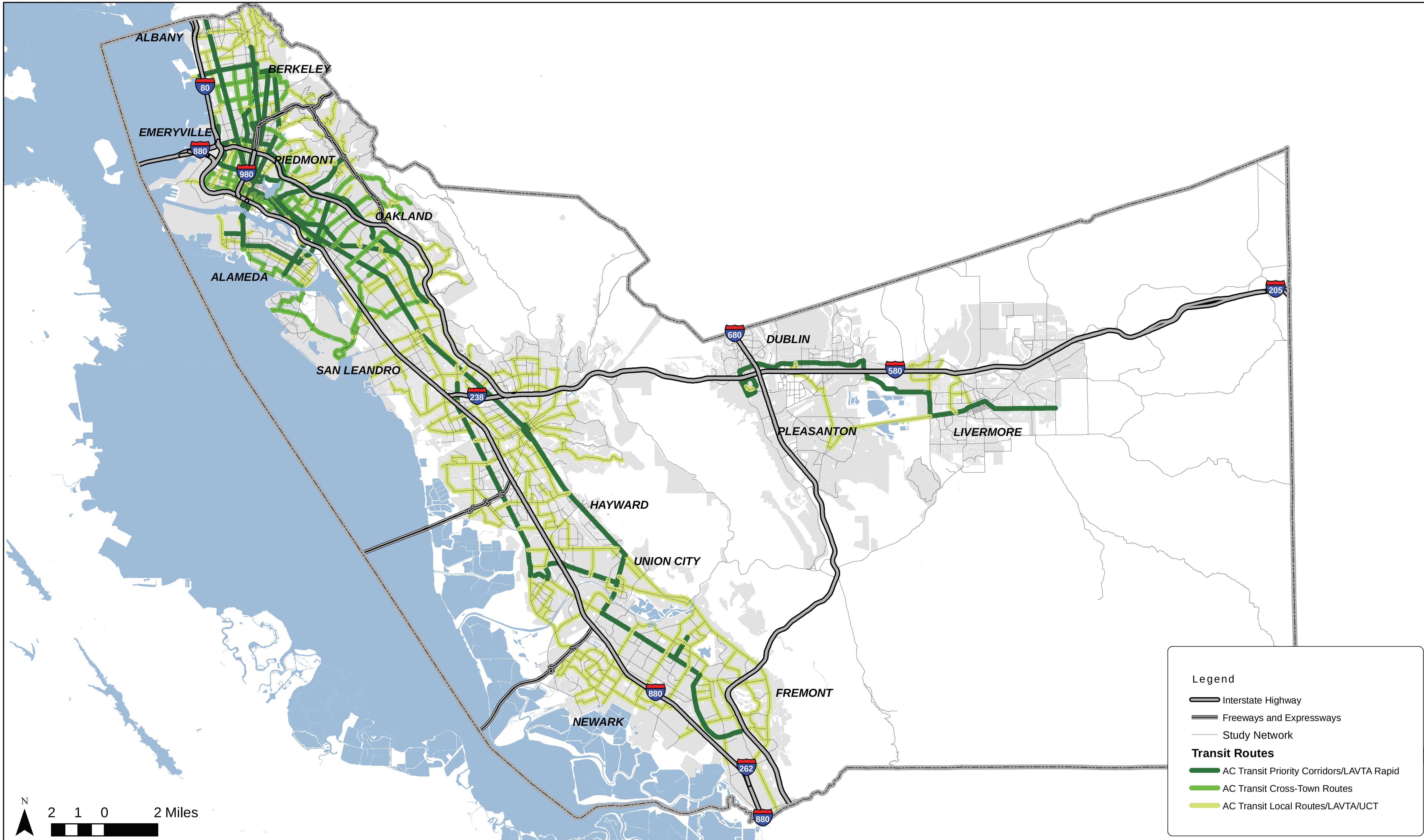


October 7, 2015

ACTC Multimodal Arterial Study Network

FINAL ***Attachment C - Street Typology***

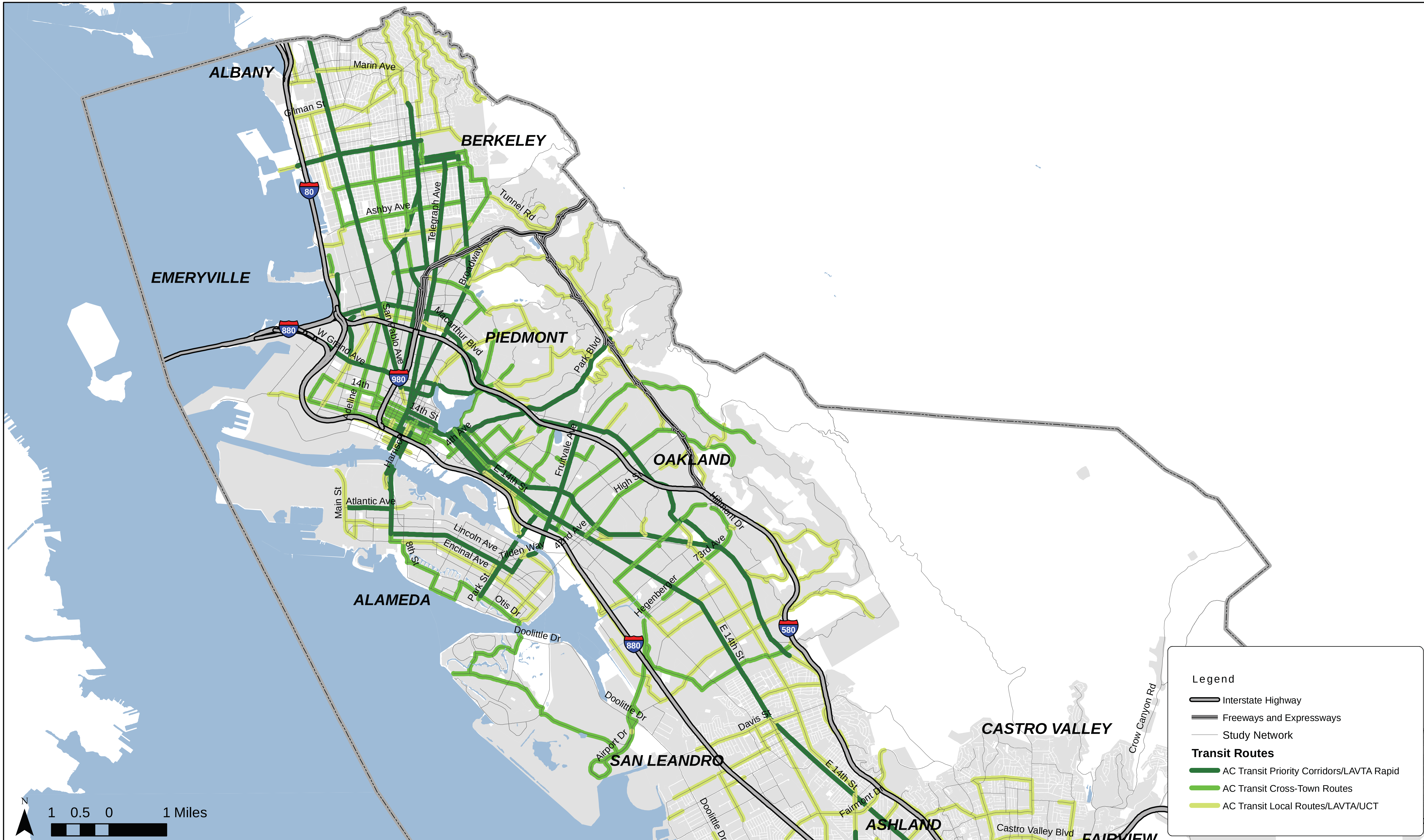
East County



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment D - Transit Emphasis*

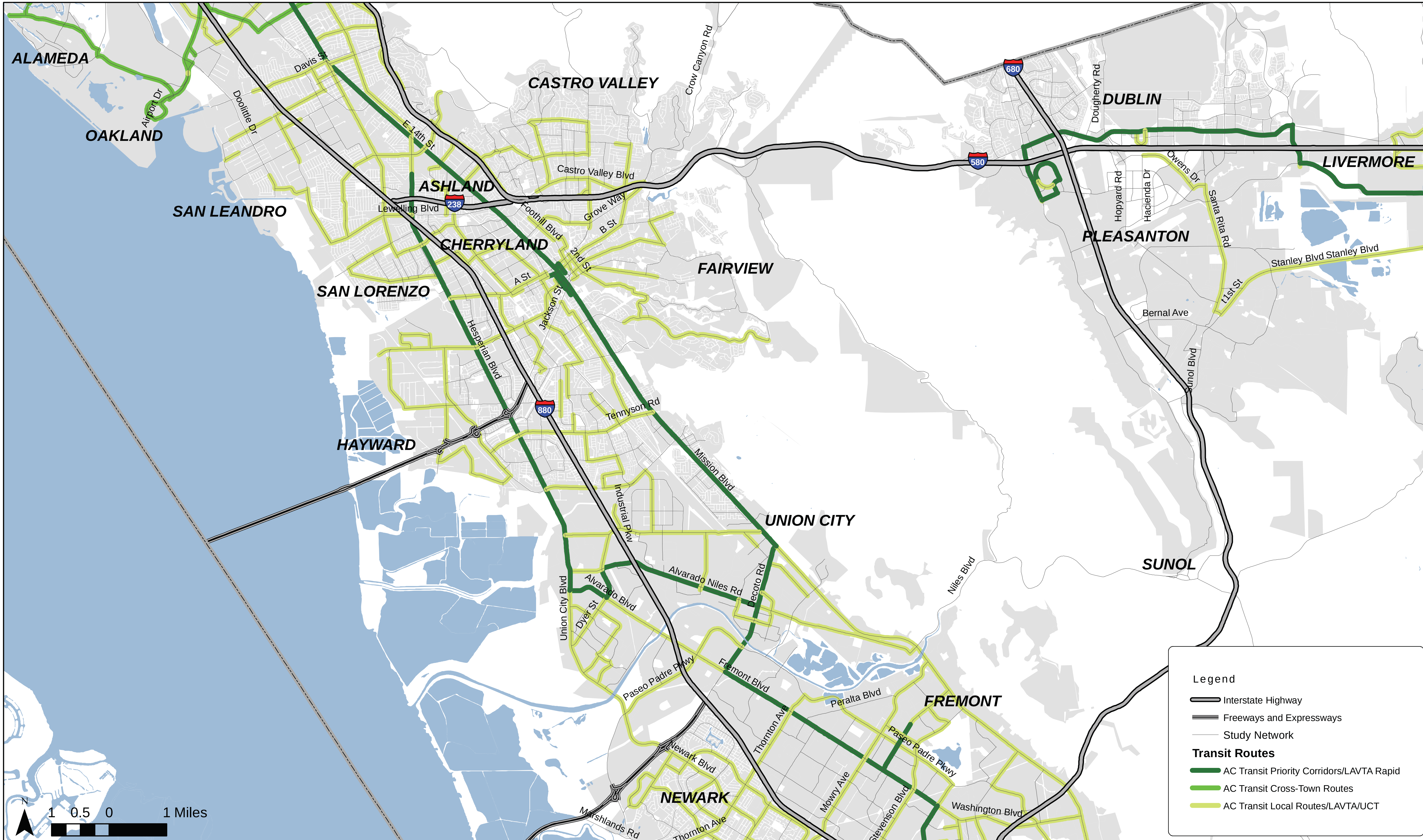


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment D - Transit Emphasis*

North County



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment D - Transit Emphasis*

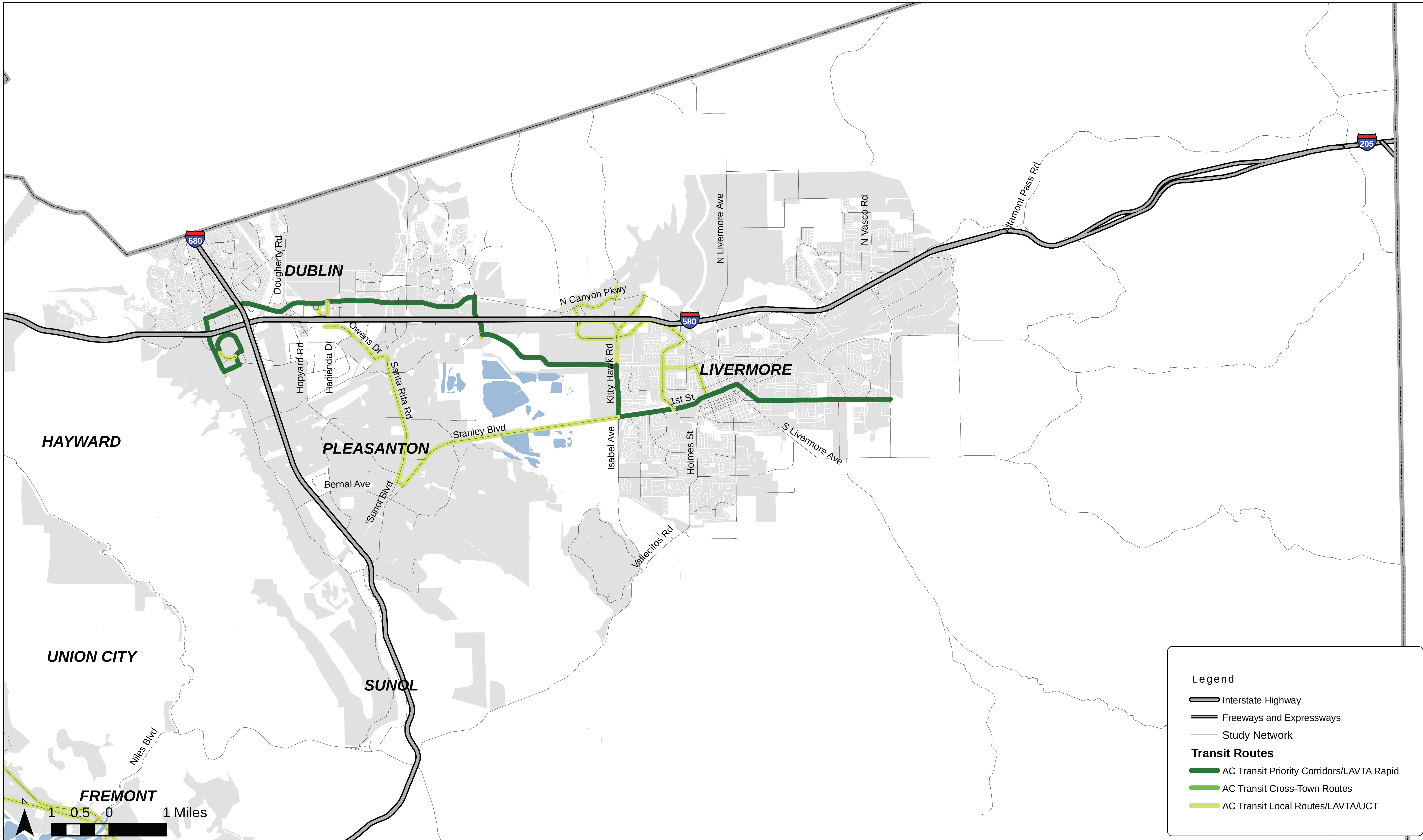
Central County

September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment D - Transit Emphasis*

South County

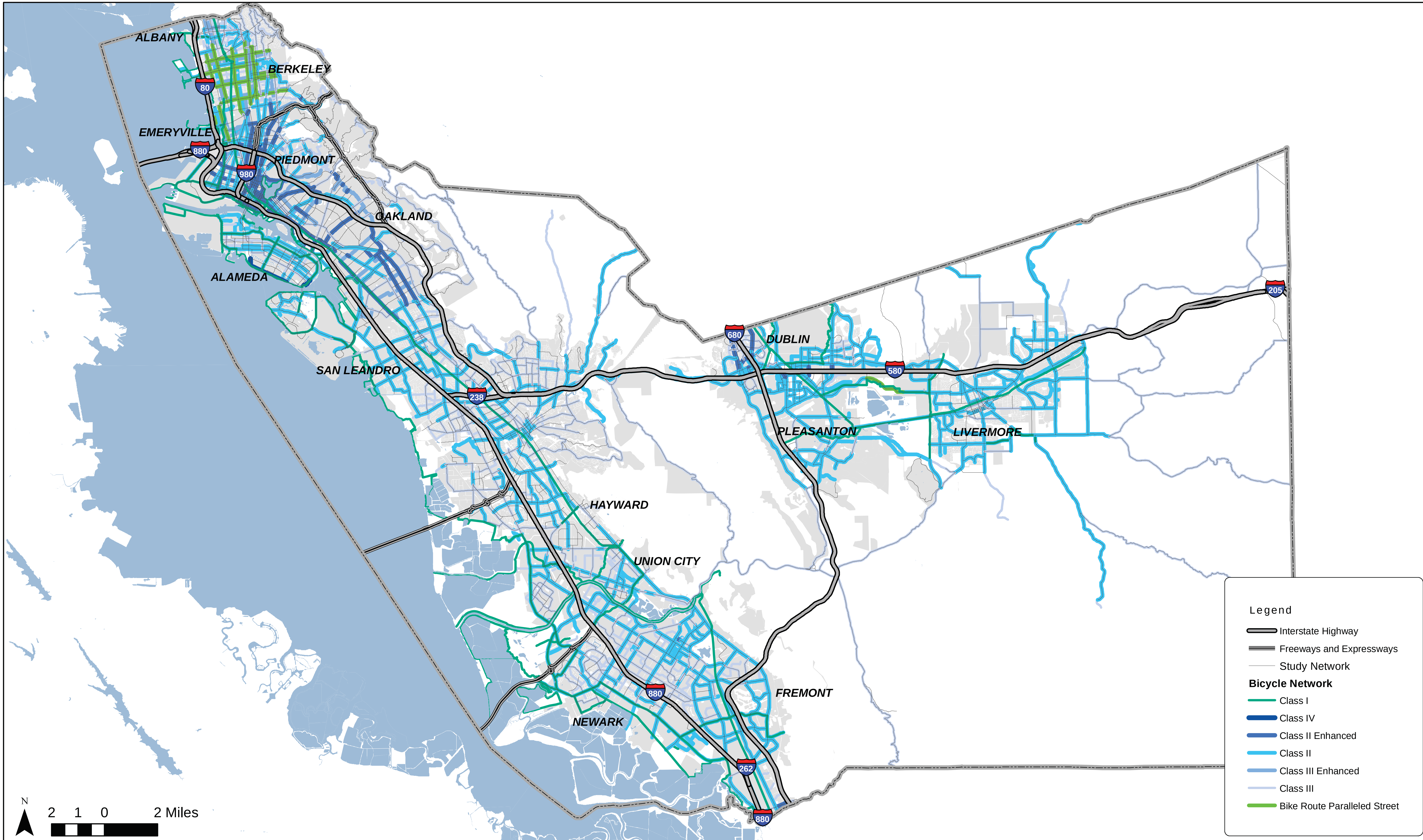


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment D - Transit Emphasis*

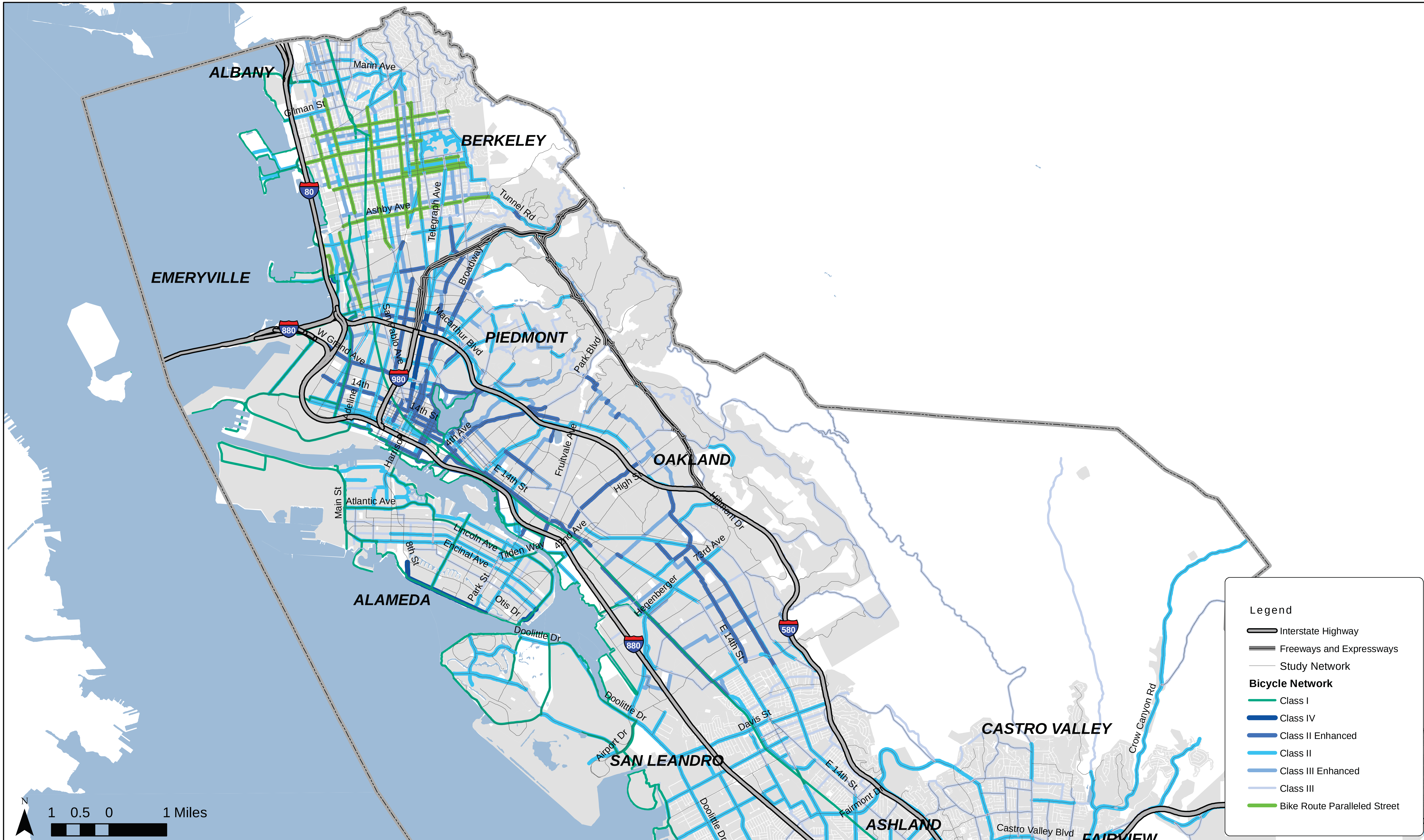
East County



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment E - Bicycle Emphasis*



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL Attachment E - Bicycle Emphasis

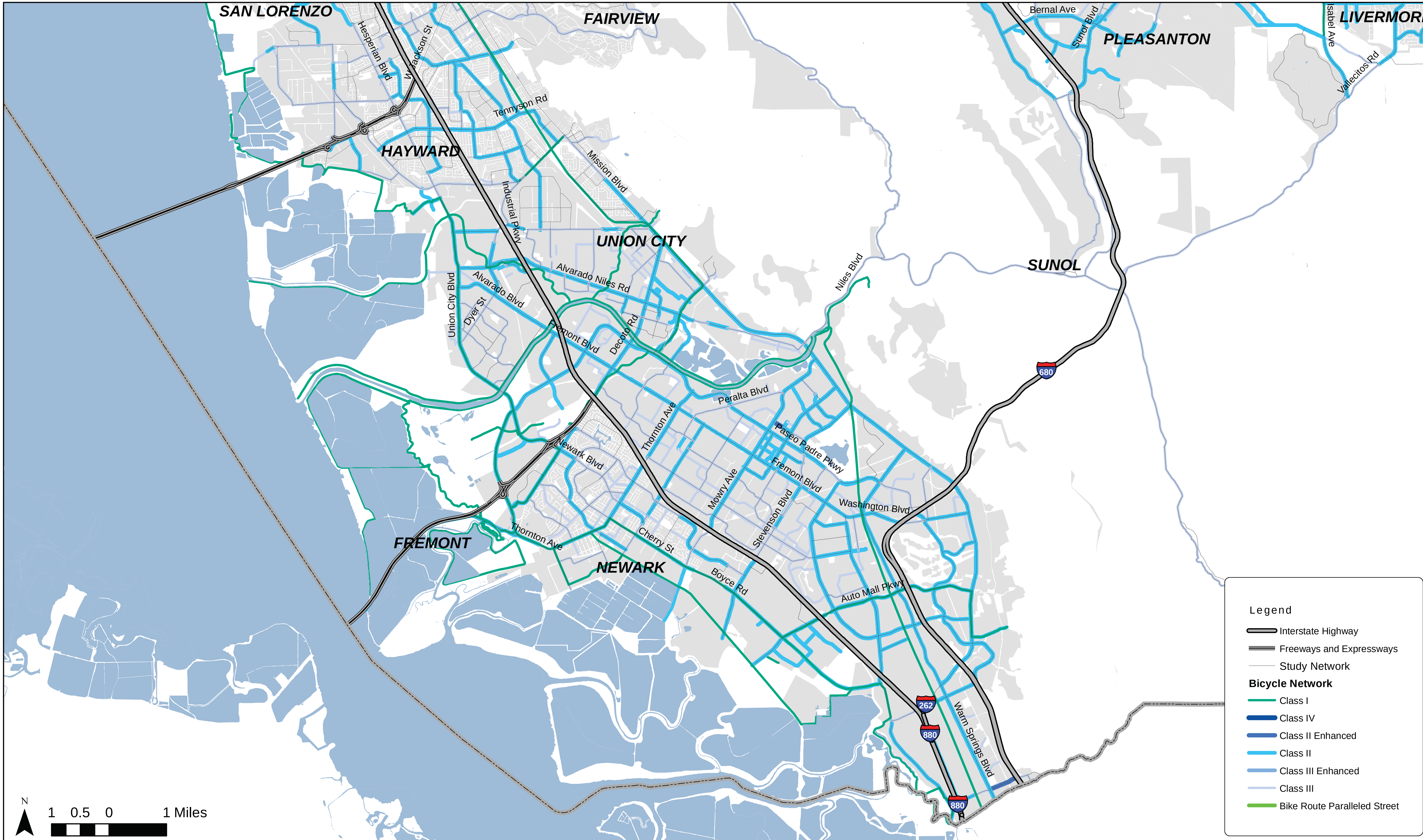
North County

September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment E - Bicycle Emphasis*

Central County

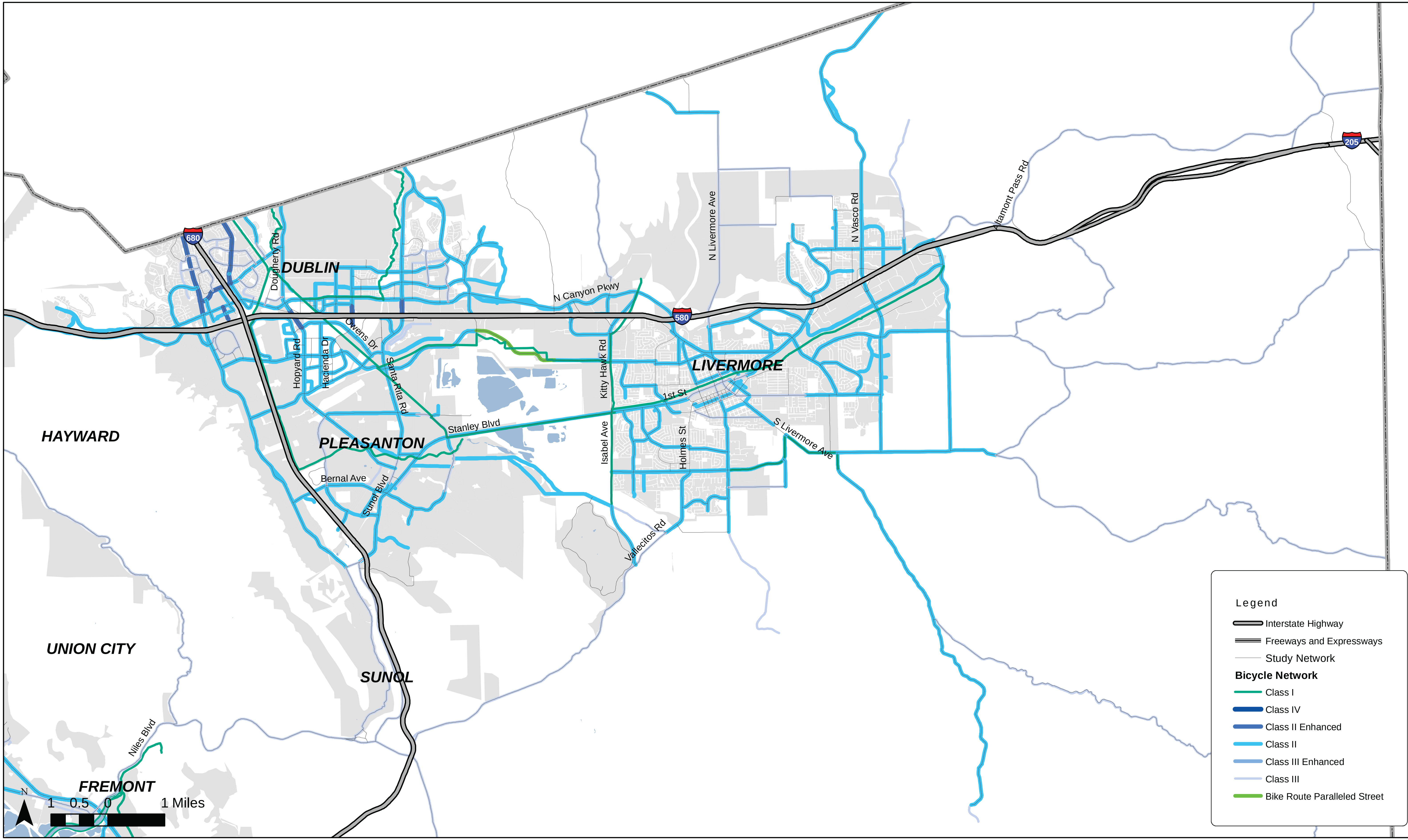


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL Attachment E - Bicycle Emphasis

South County

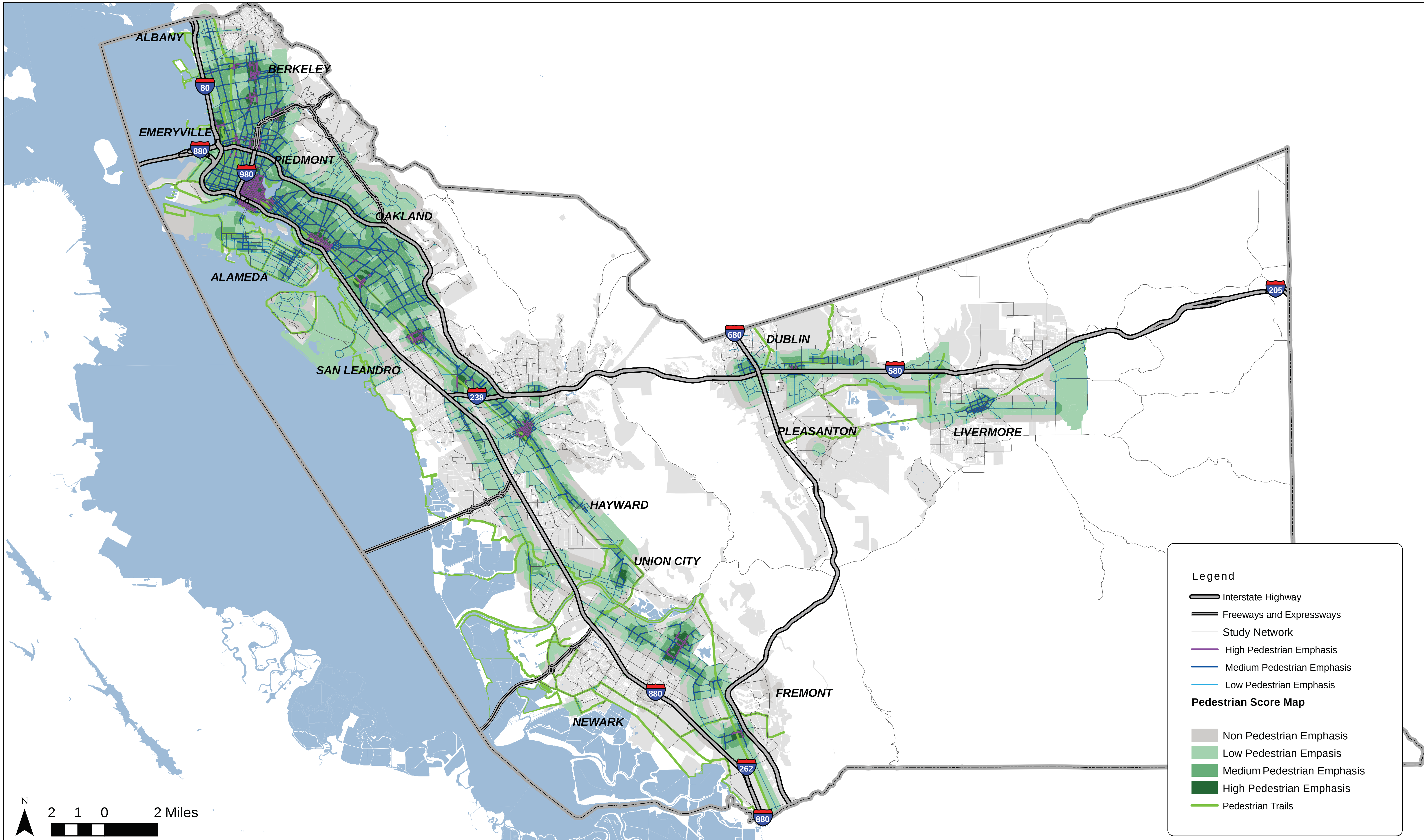


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment E - Bicycle Emphasis*

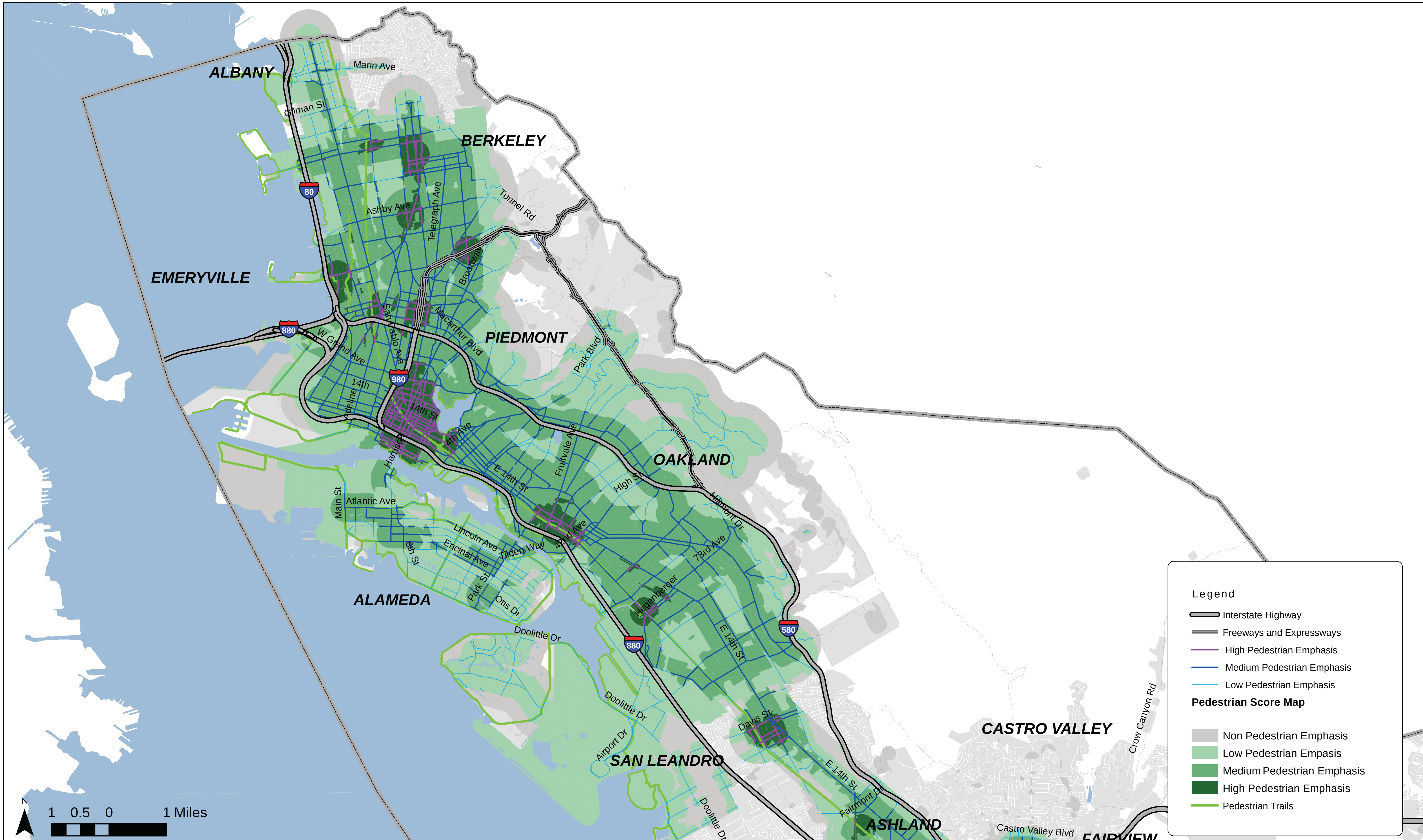
East County



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment F - Pedestrian Emphasis*

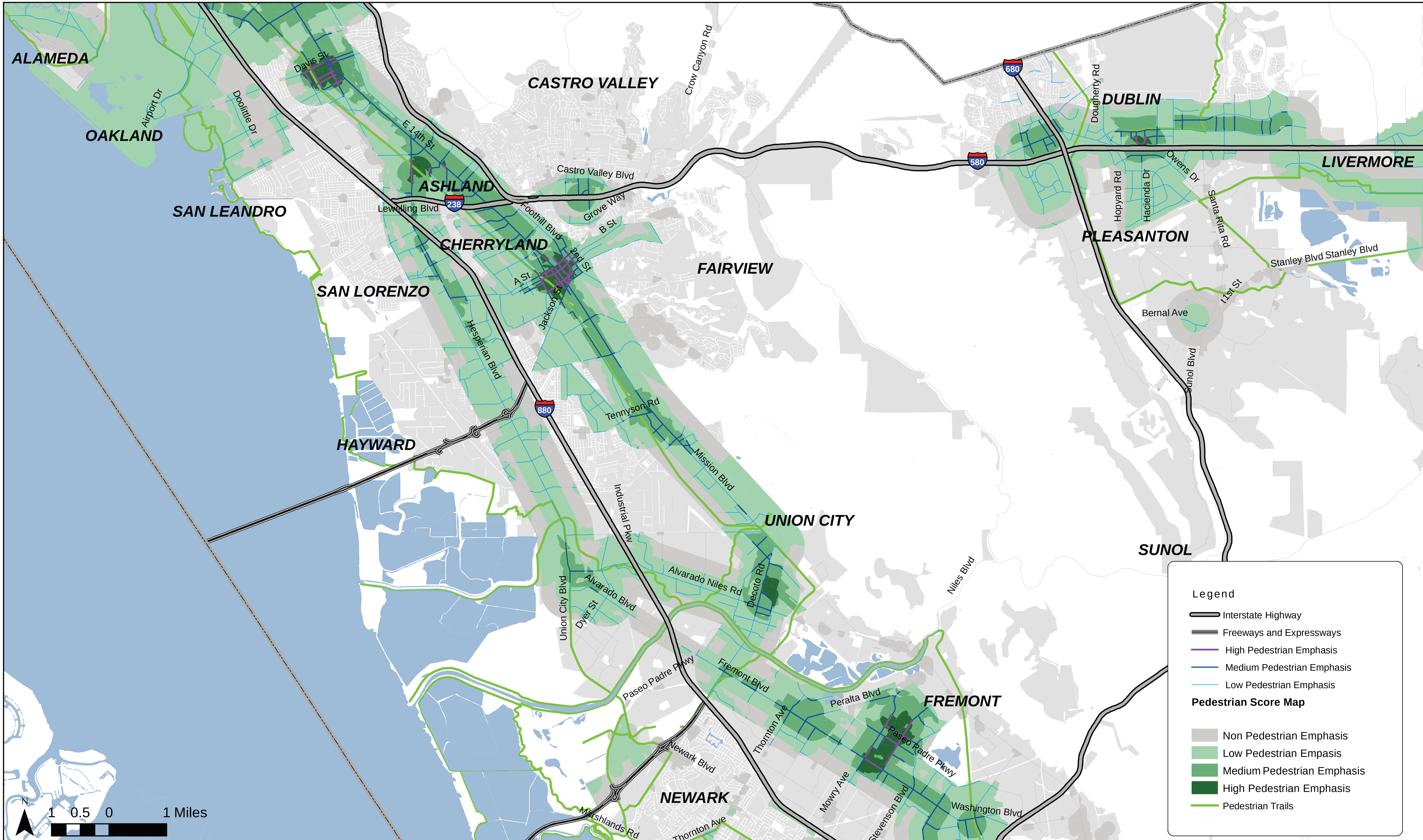


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment F - Pedestrian Emphasis*

South County

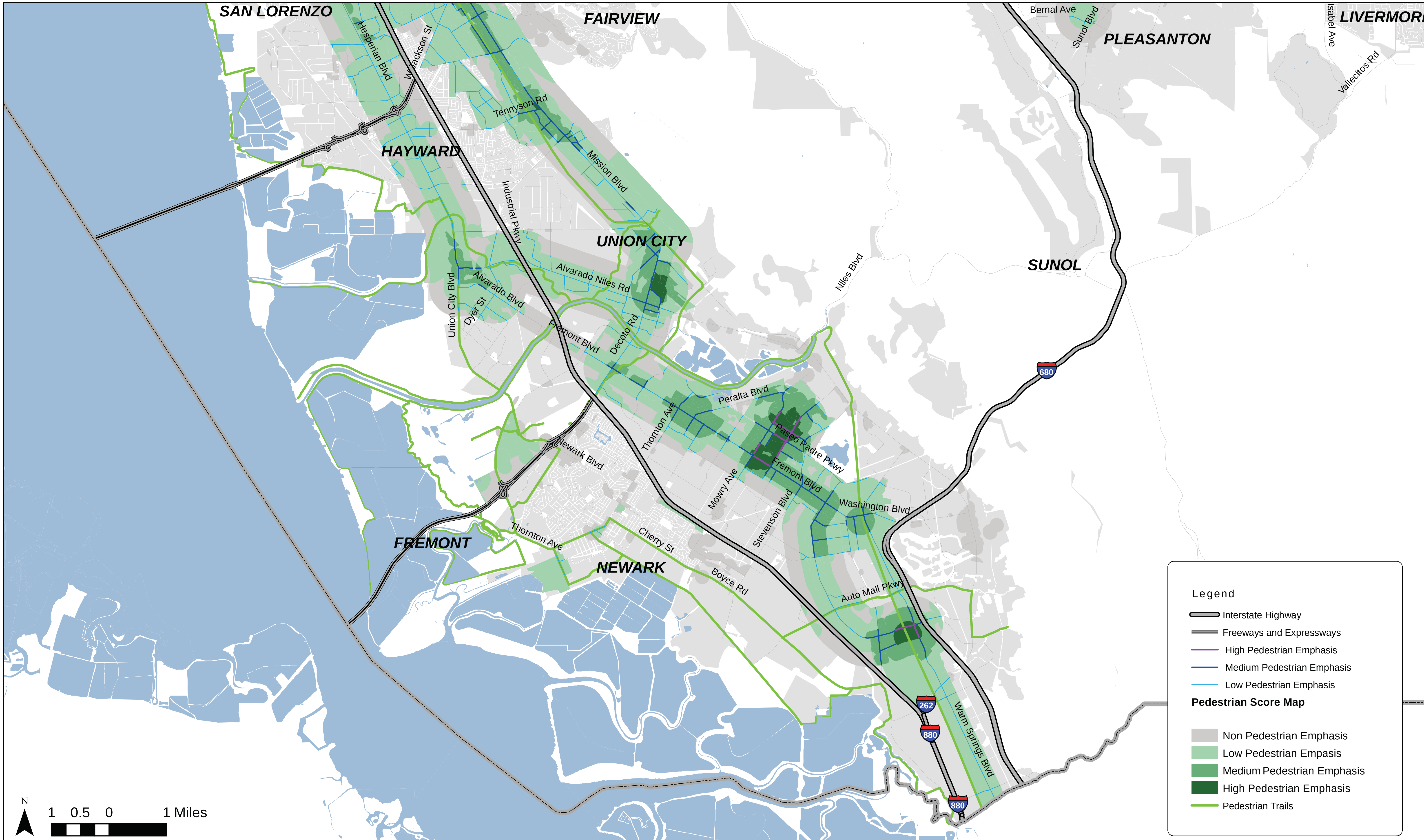


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment F - Pedestrian Emphasis*

Central County

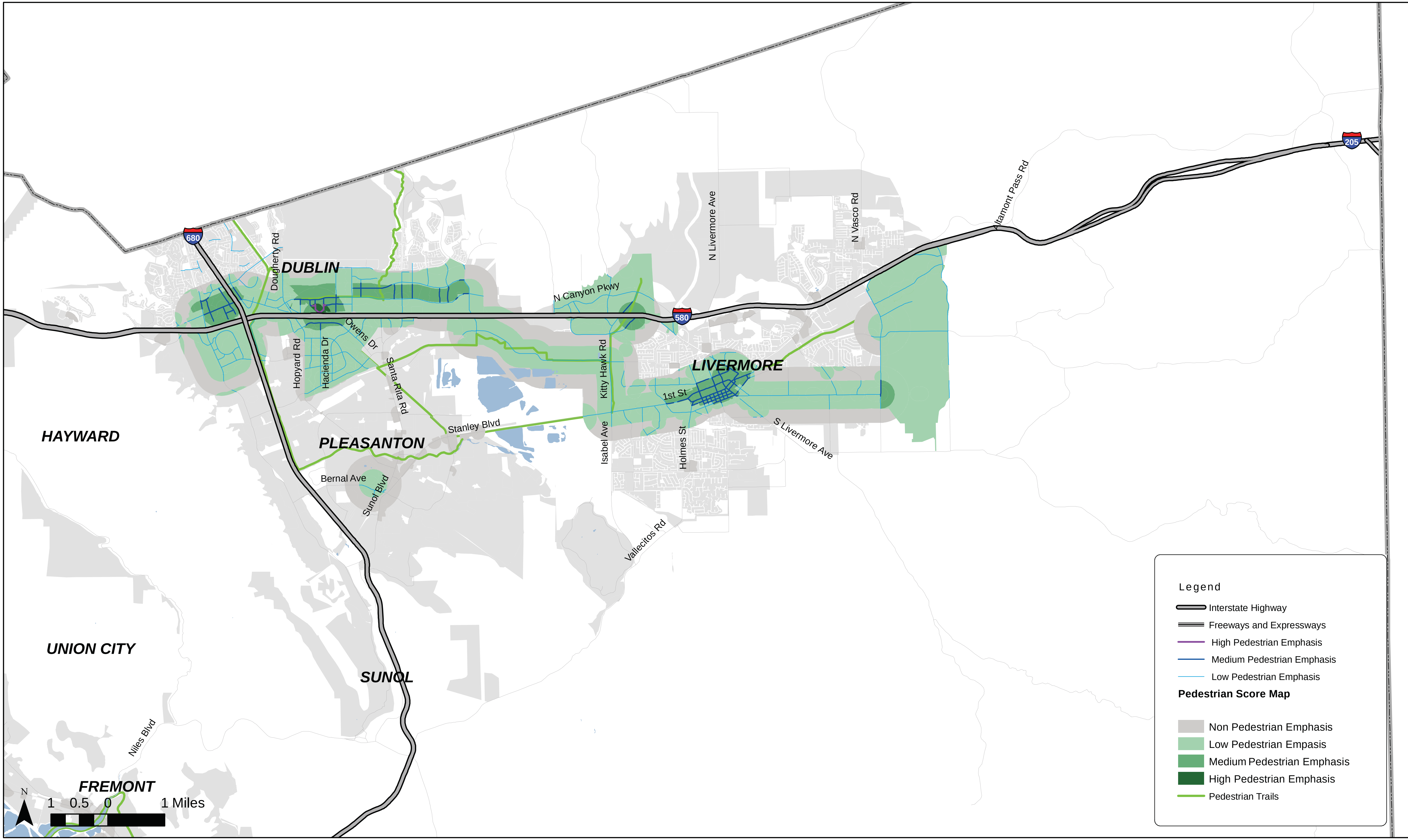


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment F - Pedestrian Emphasis*

South County

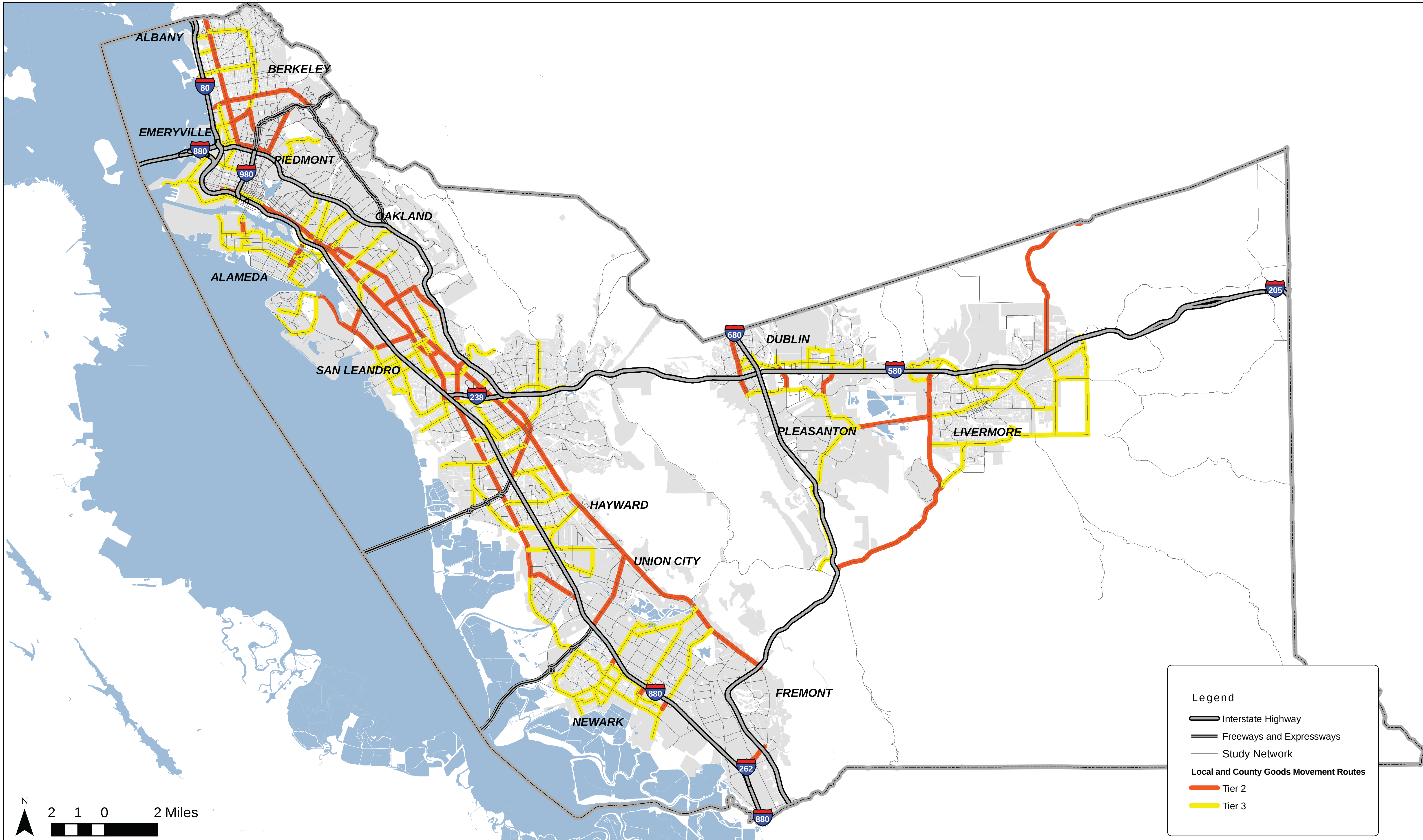


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment F - Pedestrian Emphasis*

East County



September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment G - Goods Movement Routes*

September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment G - Goods Movement Routes*

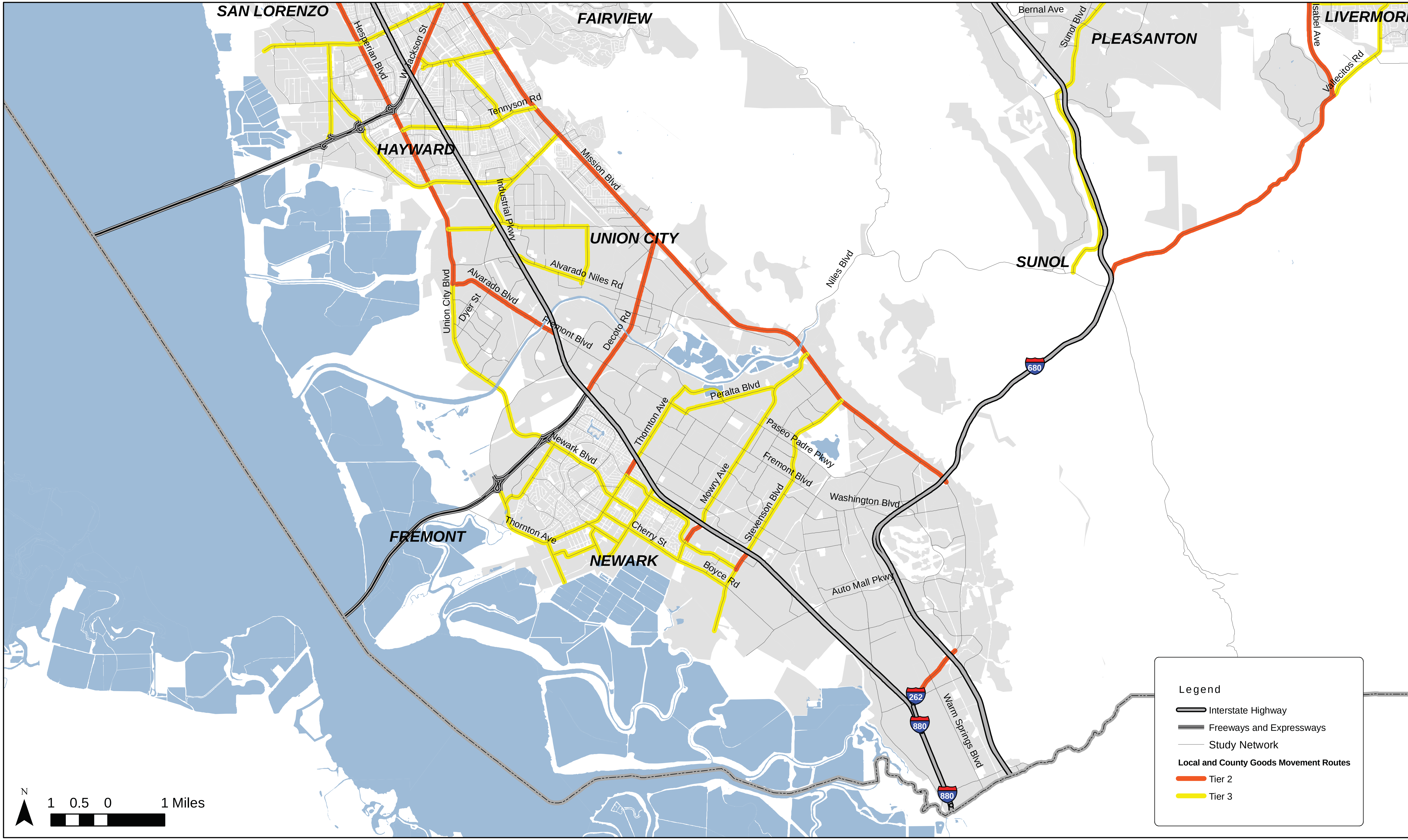
North County

September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment G - Goods Movement Routes*

Central County

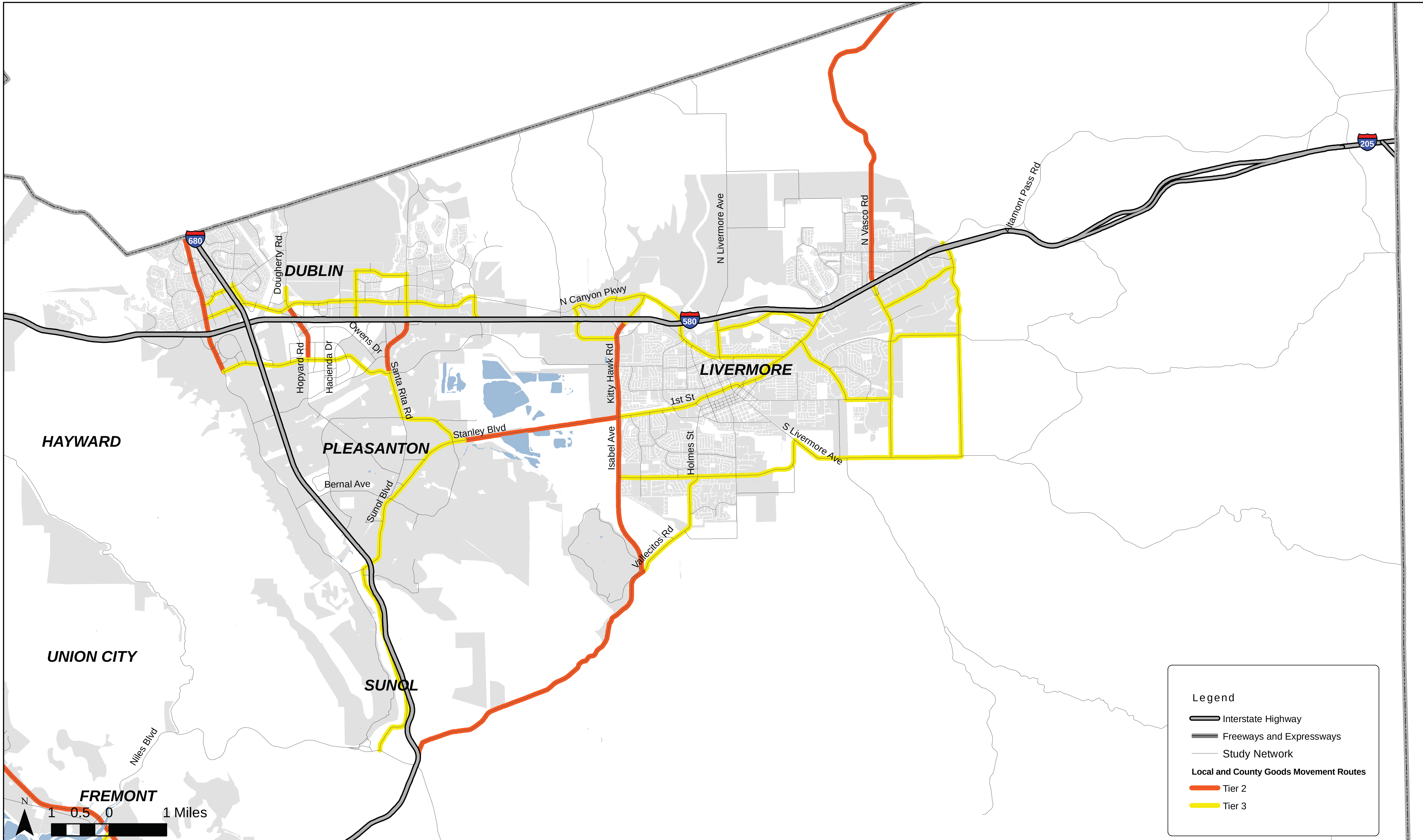


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment G - Goods Movement Routes*

South County

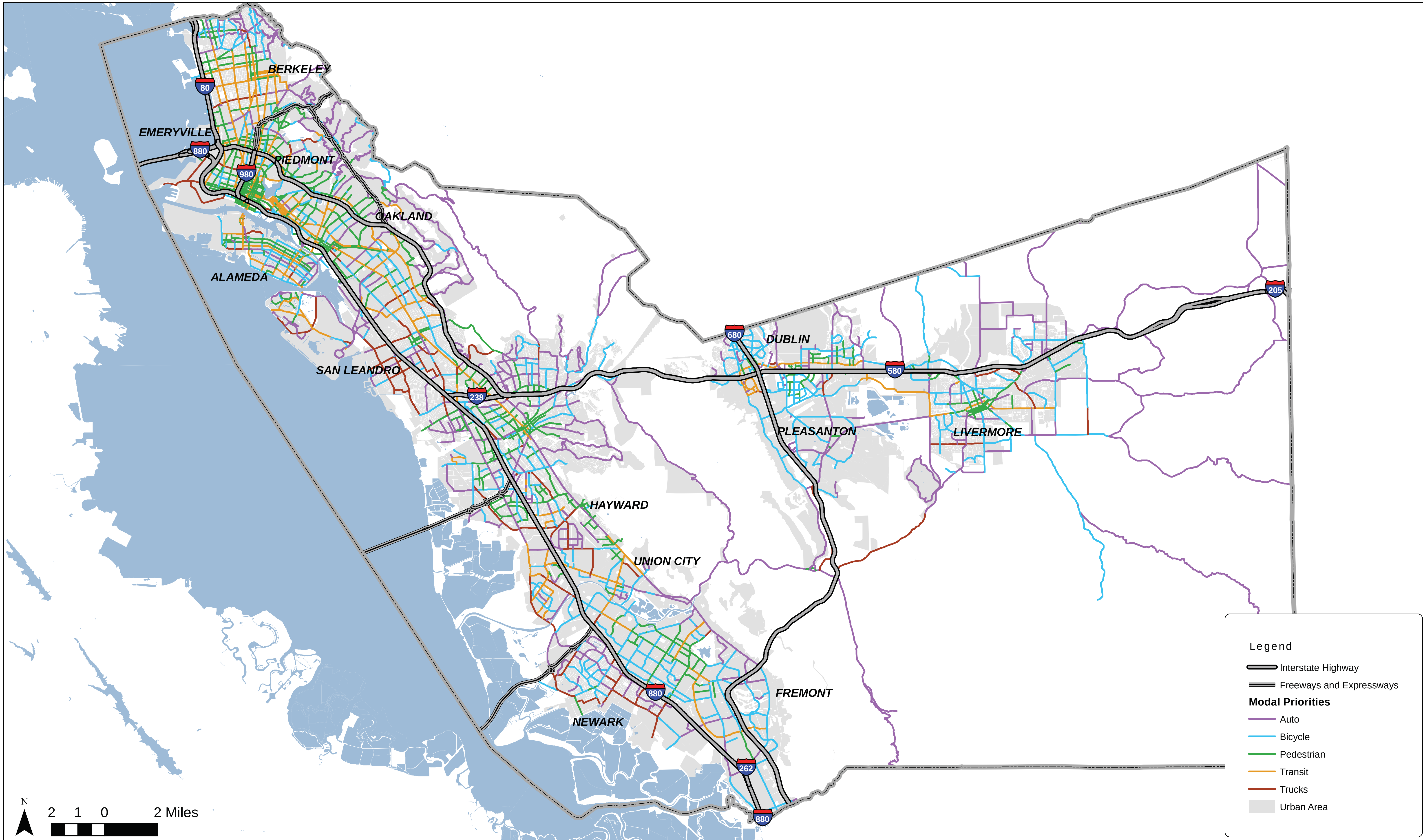


September 16, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment G - Goods Movement Routes*

East County

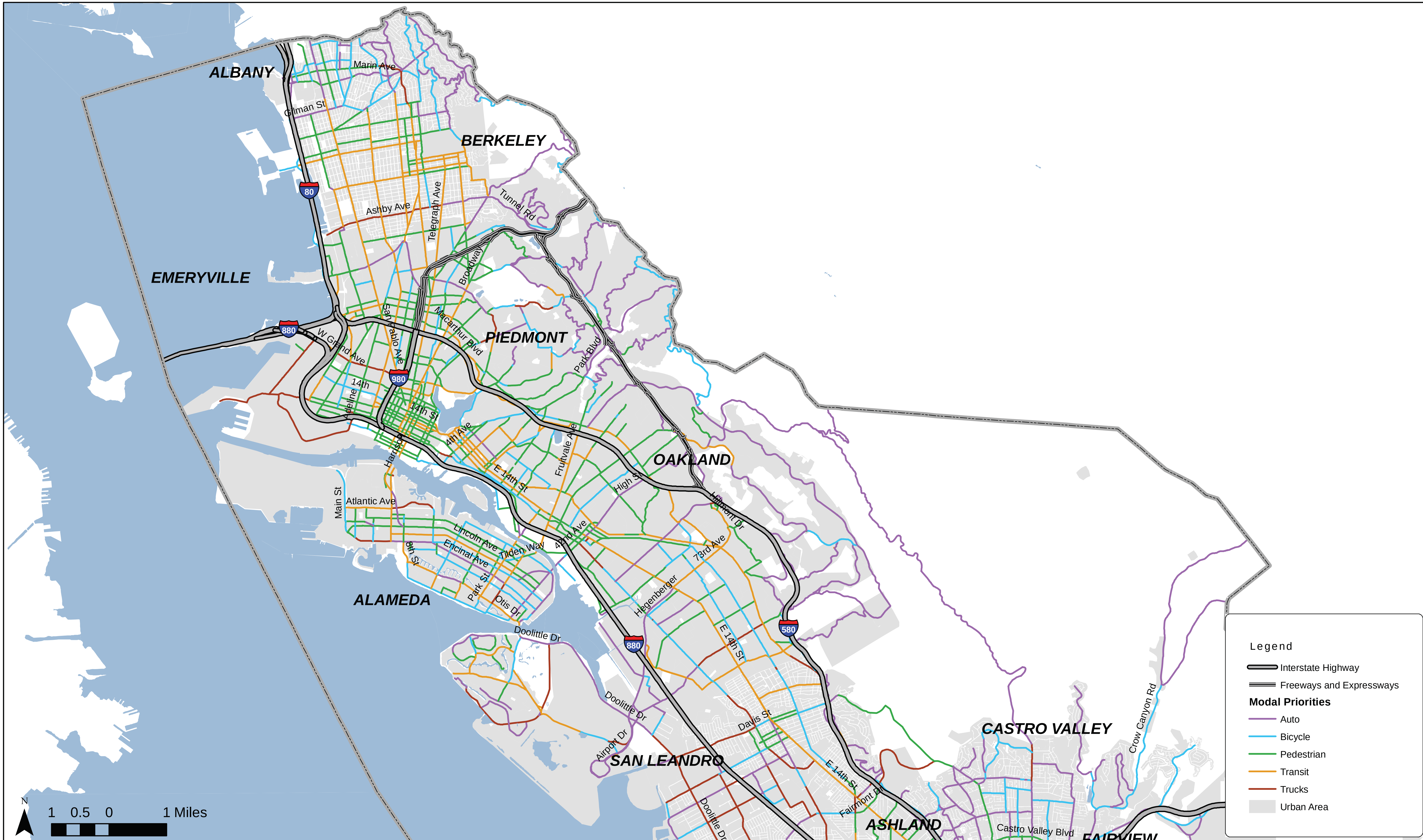


September 28, 2015

ACTC Multimodal Arterial Study Network

FINAL AtachmentH -Modal Priority

Countywide

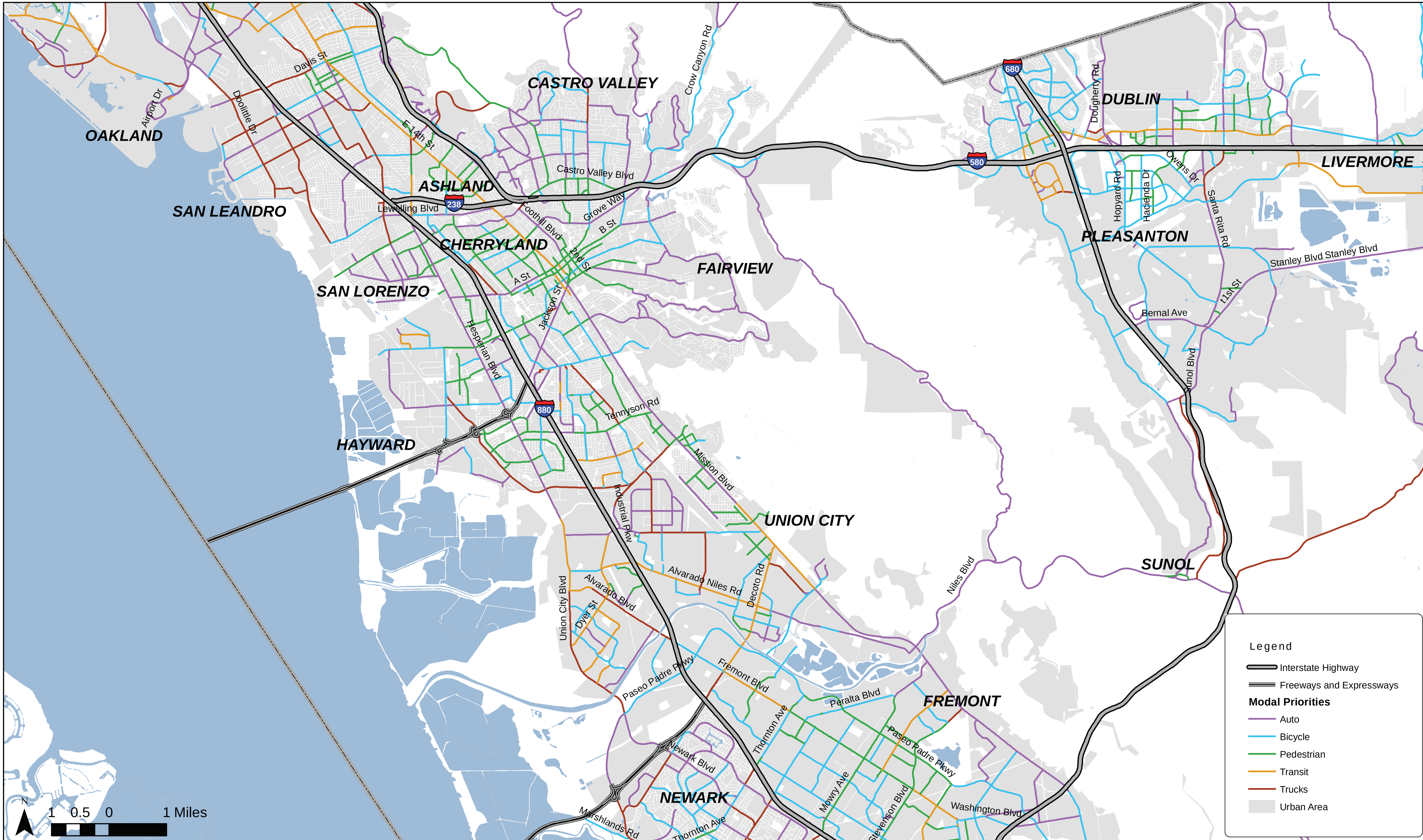


September 28, 2015

ACTC Multimodal Arterial Study Network

FINAL Attachment H- Modal Priority

North County



September 28, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment H- Modal Priority*

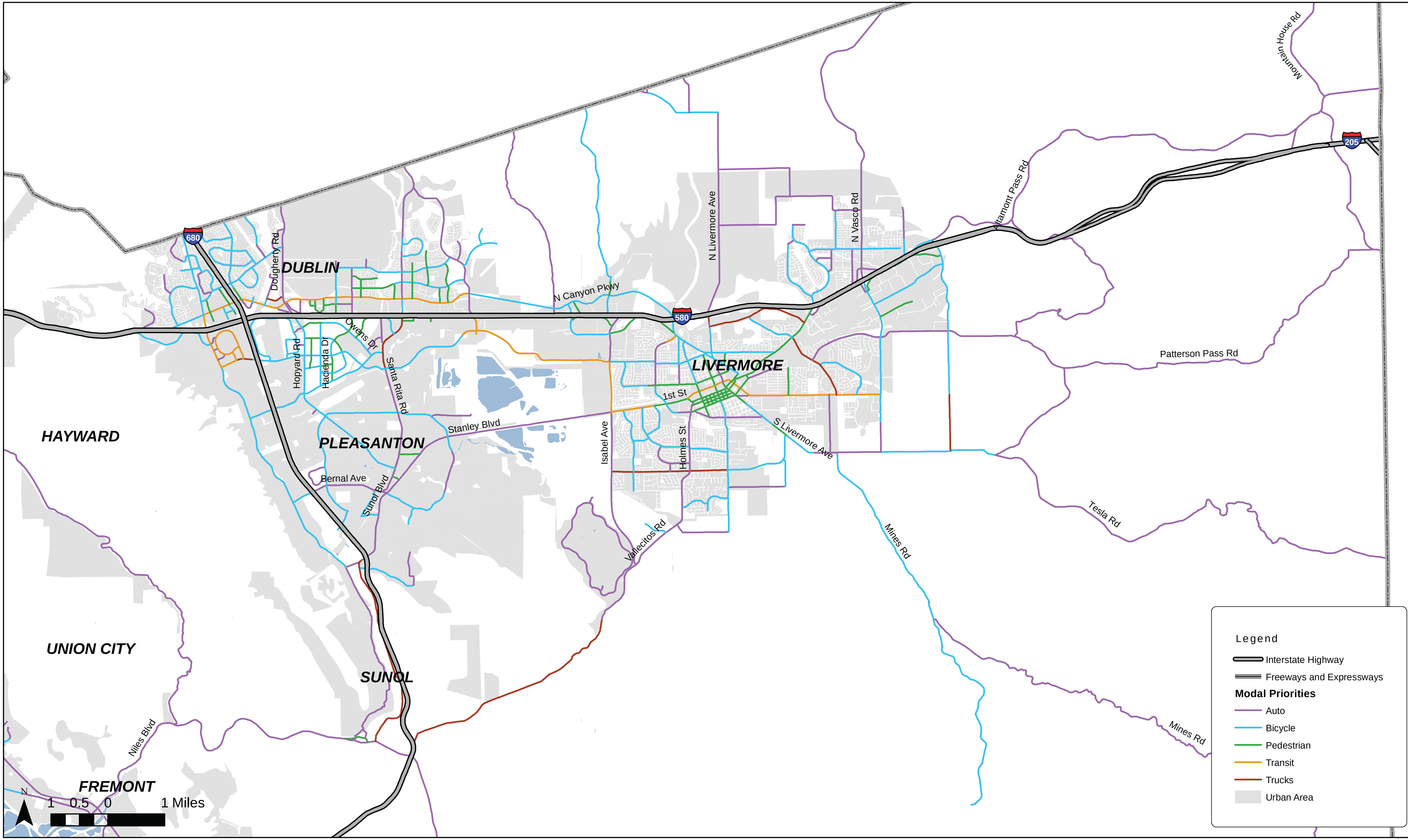
Central County

September 28, 2015

ACTC Multimodal Arterial Study Network

FINAL Attachment H- Modal Priority

South County



September 28, 2015

ACTC Multimodal Arterial Study Network

FINAL *Attachment H- Modal Priority*

East County

Appendix 1.5.1
Arterial Network Memo

FEHR & PEERS

MEMORANDUM

Date: December 4, 2015

To: Saravana Suthanthria, Alameda CTC

From: Francisco Martin and Matthew Ridgway, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan – Final Arterials of Countywide Significance (Arterial Network) Criteria and Map

OK14-0023

The Alameda Countywide Multimodal Arterial Plan uses two types of networks - a broad network, called "Study Network" for general study purposes and a subset of the Study Network, called "Arterial Network" for focused identification and prioritization of short and long-term improvements. The Study Network was developed based on the California Road System classification of arterial and collector streets and consists of approximately 1,200 miles of roadway. The Arterial Plan evaluates the Study Network to understand existing roadway conditions and the function of the roads in supporting all modes and assess multimodal needs in a broader context. To identify and prioritize improvements, the Arterial Plan focuses on a core and subset of approximately 506 miles of the Study Network called Arterial Network. This core network serves as the backbone of multimodal mobility throughout the county for one or more of the following reasons:

- Carrying multimodal users across multiple jurisdictions while still connecting with key land uses,
- Serving as major link in a countywide network for seamless connection for one or more travel modes, and
- Being major roadways that collect and distribute traffic from lower-level roadways to freeways and major transit hubs.

Given the countywide focus of the Multimodal Arterial Plan, the Arterial Network provides the necessary framework containing roads of countywide significance and facilitates the Plan's identification and prioritization of improvements on these roadways that benefit the users of all modes throughout the county.

Traditionally, from the countywide significance perspective, Alameda CTC's Congestion Management Program (CMP) includes routes designated as part of the Congestion Management Plan (CMP) network, and the Metropolitan Transportation Commission's (MTC) Metropolitan Transportation System (MTS) network. However, the CMP and MTS networks include Caltrans state routes and freeways that are not part of the Study Network or the Arterial Network. To reflect a multimodal perspective, the Arterial Network expands on the CMP and MTS networks to include transit, bicycle, pedestrian, and goods movement routes of countywide significance based on the approved typology.

Given the context above, this memo presents draft criteria for selecting the Arterial Network, roads of countywide significance from the Study Network. Consistent with the multimodal nature of this study, this is done by looking at each mode. The summary criteria for each mode are presented in **Table 1** and described in the sections below. The proposed criteria are generally based on the base street type and modal emphasis overlays (transit, bike, pedestrian and goods movement) described in the memo titled *Alameda Countywide Multimodal Arterial Plan: Final Arterial Street Typology and Modal Priority Comments and Responses* (CD+A, September 16, 2015). The Study Network map is attached to end of this memo, the Final Arterial Network segments are highlighted in red on the same Study Network map.

TABLE 1
ARTERIALS OF COUNTYWIDE SIGNIFICANCE – SUMMARY NETWORK CRITERIA

Mode	Arterial Network Selection Criteria
Auto	• CMP Network • MTS Network • State Route Network (Non-Freeway) • Roads designated as Throughway base street type • Other considerations: o Rural roads with average daily traffic (ADT) volume greater than 7,500
Transit	• AC Transit, LAVTA and Union City Transit Major Corridors
Bicycle	• Class II Enhanced, Class III Enhanced and Class IV bicycle facility network
Pedestrian	• High Pedestrian Emphasis network
Goods Movement	• Tier 2 Goods Movement Routes

Source: Fehr & Peers, 2015.

AUTO

The higher order facilities such as CMP, MTS (the version of the network that is used in Alameda CTC's CMP) and state route networks will continue to support auto travel in Alameda County. These are historical systems that were included in the arterials of countywide significance network. Beyond the CMP, MTS and state routes, considering the diverse nature of the county and its central geographic location in the region, other roadway types were included in the Arterial Network:

- All roadways identified as Throughway base street type
- Rural roads in the East County with an average daily traffic (ADT) volume greater than 7,500 and supporting rural economic activities

The 7,500 ADT threshold for rural roads is based on typical weekday volumes along major rural routes in the county.

TRANSIT

Transit priority corridors were derived from the on-going Countywide Transit Plan, which includes AC Transit and LAVTA Major Corridors. All transit priority corridors were designated as part of the arterials of countywide significance.

BICYCLE

Bicycle facilities classified as Class II Enhanced, Class III Enhanced and Class IV were designated as part of the arterials of countywide significance.

PEDESTRIAN

There are three levels of pedestrian emphasis designated by pedestrian priority "scoring," which combines scores given to street segments based on the following characteristics:

- **Priority Development Area (PDA) Place Type** – Each PDA type within the county was given a score with Regional Centers scoring the highest, while Suburban Center score the lowest.
- **Commercial and Mixed Use Areas** – Commercial and Mixed Use areas as identified from the ABAG standardized Local Jurisdiction General Plan data. These were scored with downtown or city center and other mixed use types scoring higher than predominantly single use type commercial areas.

- **Census Tracts identified as Communities of Concern per MTC Equity Analysis** – Census tracts in the county were scored by MTC on eight categories wherein tracts over the score of 4 are considered as a Community of Concern. For mapping purposes, tracts with a MTC score of 6 are scored higher for pedestrian emphasis than ones with MTC scores between 4 and 6.
- **Employment Growth Opportunity Areas identified in Alameda CTC's 2012 CTP** – These areas were given an additional score.
- **Proximity to BART/ACE/Capitol Corridor stations** – half mile and quarter mile distances are scored.
- **Half-mile buffer off AC Transit and LAVTA Major Corridors** – half mile and quarter mile distances are scored.
- **Quarter mile buffers around local bus stops** – quarter mile distance is scored.
- **Quarter mile buffers around activity & education centers, and parks** – quarter mile distance is scored.

The memo titled *Alameda Countywide Multimodal Arterial Plan: Final Arterial Street Typology and Modal Priority Comments and Responses* (CD+A, September 16, 2015) provides the methodology for how these scores combine and the thresholds to determine the three levels of pedestrian emphasis:

- Tier 1: High Pedestrian Score
- Tier 2: Medium Pedestrian Score
- Tier 3: Low Pedestrian Score

High Pedestrian Score segments were designated as arterials of countywide significance.

GOODS MOVEMENT

Non-freeway goods movement routes were derived from the on-going Countywide Goods Movement Plan. The Goods Movement Plan summarizes the current goods movement route designations and sorts routes into three tiers:

- *Tier 1 goods movement routes refer to the state highways that are designated to handle a majority of the through truck traffic.*
- *Tier 2 goods movement routes refer to other state highways and designated arterials that provide intra-county and intercity connectivity and last-mile connection to the Port of Oakland and Oakland International Airport.*

- *Tier 3 goods movement routes refer designated arterials and collectors that are used in a majority of local pickup and delivery.*

Tier 2 goods movement routes were designated as arterials of countywide significance.

STAKEHOLDER REVIEW AND RESPONSE TO COMMENTS

The Draft Arterial Network was presented to all jurisdictions for review and comment in November 2015. The following jurisdictions provided comments on the Arterial Network: Albany, Dublin, Fremont, Hayward and Newark.

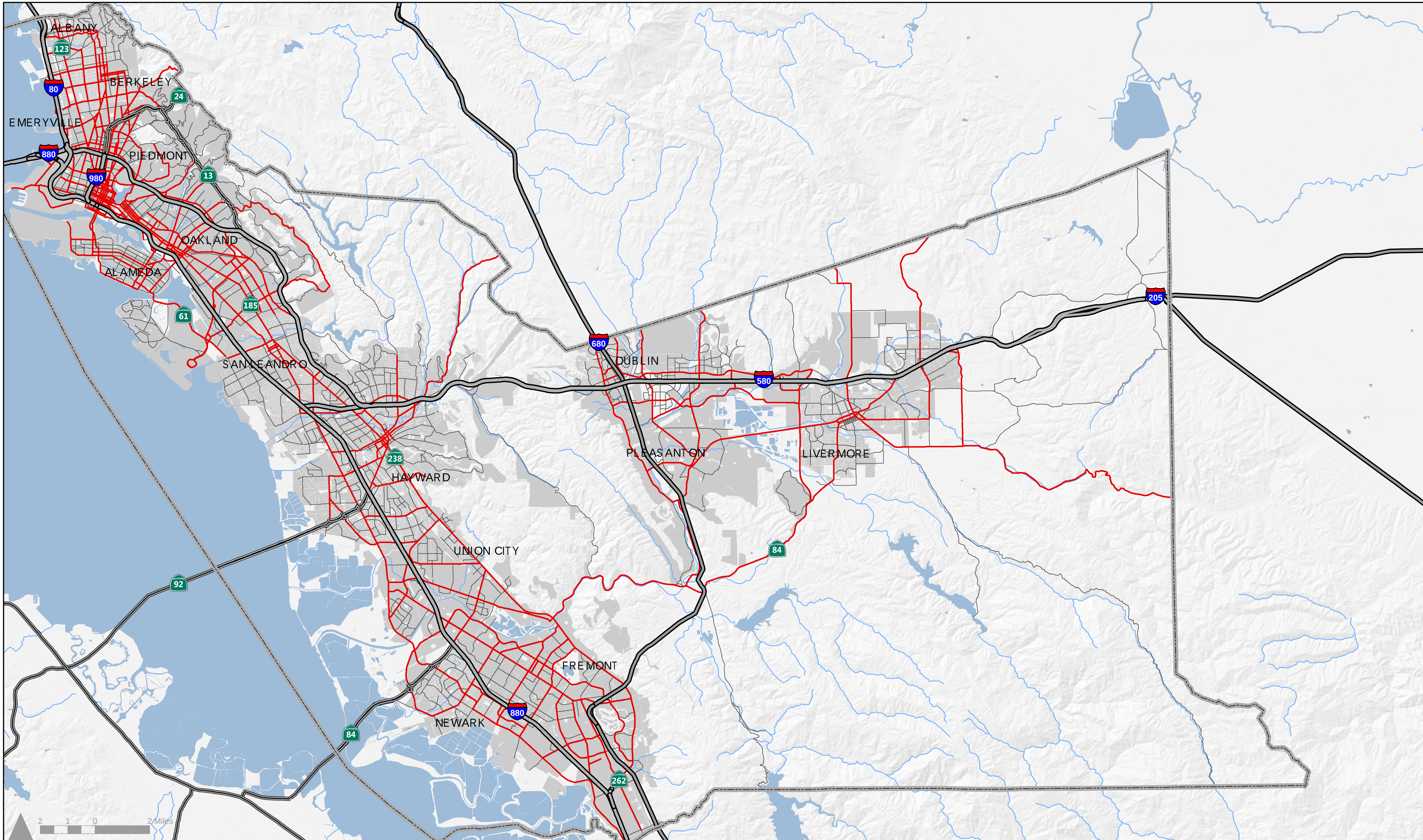
NEXT STEPS

The Arterial Network map has been updated to reflect stakeholder review comments; the consultant team will present the Final map to ACTAC and the Commission for final approval in February 2016. As a next step in the Plan development, the Arterial Network will be used in identifying and prioritizing improvements that supports the multimodal needs assessment.

Please contact Francisco Martin at 510-57-9422 or f.martin@fehrandpeers.com if you have any questions or comments.

Attachments:

Alameda Countywide Study Network and Arterial Network Map



Legend
Arterial Network (510 Miles)
Study Network (1,200 Miles)
Urban Area

ALAMEDA County Transportation Commission

Alameda Countywide Study Network and Arterial Network Map

Appendix 2.1.1
Performance Measure Memo

MEMORANDUM

Date: January 22, 2015

To: Saravana Suthanthira, Alameda CTC

From: Francisco Martin and Matthew Ridgway, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan – Final Performance Measures and Evaluation Approach

OK14-0023

The Alameda Countywide Multimodal Arterial Plan's performance measures are derived from the Plan's vision and goals. These performance measures will be utilized to identify existing and future year multimodal transportation conditions across the county for the Plan's Study Network. Performance objectives[1] or thresholds for these performance measures will be developed after performance measures are approved. These performance objectives will be applied to existing and future year conditions to identify Study Network needs and will also provide guidance in identifying short-term (year 2020) and long-term (year 2040) improvements to adequately address those needs. Performance measures in combination with the performance objectives will ensure that the proposed short-term and long-term improvements meet the Plan's vision and goals. The initial list of performance measures was presented and comments received during each of the following jurisdictional outreach meetings:

- North County Planning Area meeting – October 29, 2014
- Central County Planning Area meeting – October 29, 2014
- East County Planning Area meeting – October 30, 2014
- Plan TAC/ACTAC meeting – November 6, 2014
- South County Planning Area meeting – November 13, 2014
- AC Transit focused meeting – November 14, 2014

[1] Draft performance objectives will be derived from modal priorities and presented to stakeholders in the coming months. Stakeholders will also have an opportunity to review modal priorities and performance objectives during the second set of Planning Area meetings in April.

Comments provided at each of the Planning Area meetings listed above were summarized in a memo titled *Summary of Milestone 1 Planning Area Comments* (November 14, 2014) prepared by Eisen | Letunic. Final Vison and Goals developed based on comments received were shared with the stakeholders on November 26, 2014.

The project team updated the performance measures to incorporate stakeholders' recommended initial revisions. In addition, the project team developed an evaluation approach for each performance measure, as detailed in this memo. Data collection for these performance measures is currently underway. This memo summarizes the Multimodal Arterial Plan's final vision and goals, the updated performance measures, performance measure evaluation approach and planning framework. Comments on the draft performance measures evaluation approach memorandum dated January 12, 2015 received until January 21, 2015 from stakeholders are incorporated into this updated memorandum.

FINAL MULTIMODAL ARTERIAL PLAN VISION AND GOALS

The final Vision and Goals were previously presented and distributed to the local jurisdictions in a memo titled *Alameda Countywide Multimodal Arterial Plan – Final Vision and Goals* (November 26, 2014) and are also included below.

VISION

Transportation and mobility are not goals: the movement of people and goods support economic activity and development.

> *Vision: Alameda County will have a network of efficient, safe and equitable arterials that facilitate the multimodal movement of people and goods, and help create a strong economy, healthy environment and vibrant communities, while maintaining local contexts.*

GOALS

This vision is supported by five goals and two supportive principles:

1. **Multimodal**: Based on local context and modal priorities, the arterial network will provide high-quality, well maintained and reliable facilities.

2. **Accessible and Equitable:** The arterial network will provide access for people of all ages, abilities, incomes and geographies.

3. **Connected across the County and Region:** Using typologies that are supportive of local land use, the arterial network will provide connections for all modes within the county and across the County and Region's network of streets, highways and transit, bicycle and pedestrian routes.

4. **Efficient Use of Resources**: Investment in the arterial network will make efficient and effective use of resources.

5. **Safe, Healthy and Vibrant:** The arterial network will be designed, built, and managed to reduce the incidence and severity of collisions, promote public health and help create vibrant local communities.

In addition to the above five goals, there are two supportive principles. Supportive principles are expected outcomes of the vision and goals. They are less quantifiable but the Multimodal Arterial Plan will include strategies and programs to address them:

- **Support Strong Economy:** Development of the arterial network will support existing land uses and encourage planned land uses**.**

- **Adaptable and Resilient:** The arterial network will be designed to adapt to changes in travel patterns, travel modes and technology improvements. Investments in the arterial network will enhance its ability to withstand and recover from potentially disruptive events.

PERFORMANCE MEASURES AND PLANNING FRAMEWORK

Figure 1 presents a streamlined flow chart of the Multimodal Arterial Plan planning framework and illustrates how performance measures in combination with performance objectives will be used to identify short and long-term improvements. The process is also described below:

1. Performance Measures are derived from the Plan's goals, which are in turn derived from the Plan's vision.
2. Identify the larger level "Study Network" including parallel "layered network" of other modal facilities to support data collection and typology development.
3. Develop criteria to identify Arterials of Countywide Significance (Arterial Network) that will be used towards the end of the Plan development process to develop the list of

preferred improvements for the Plan. The draft criteria are summarized in a memorandum titled Alameda Countywide Multimodal Arterial Plan – Draft Criteria for Selecting Arterials of Countywide Significance (January 21, 2015). The criteria will be discussed and approved by the Alameda CTC Committees and Commission.

4. Roadway typologies[2] will be developed for the Study Network. Typologies will be descriptive of the transportation function, land use context, modal emphasis and the relative scale of local or longer distance travel. The roadway typologies will provide the basis for identifying modal priorities along each Study Network segment/corridor. Modal priority for transit and trucks will be coordinated with the Countywide Transit and Goods Movement Plans that are currently underway. Modal priorities will be vetted and confirmed during the second set of Planning Area meetings.
5. Modal priorities will inform the performance objectives by segment/corridor as different modal priorities can potentially result in different performance objectives. For example, the Bicycle Comfort Index described later in this memo identifies four different ratings, ranging from LTS1 to LTS4 (LTS1 being the highest performance level) . If a Study Network segment is identified as having a bicycle modal priority, the performance measure objective would be to achieve an LTS2 or better rating. If the segment is not identified as having a bicycle modal priority, the performance measure objective would be to achieve an LTS4 or better rating. The draft performance objectives are not provided in this memorandum as they will be presented to stakeholders in the coming months.
6. The performance objectives will be applied to the performance measure assessment of existing and future year transportation conditions to determine network gaps, deficiencies and needs. This step will occur using a GIS based automated macro analysis tool.
7. Recommended multi-modal transportation improvements will be identified to adequately address short and long-term Study Network multimodal needs.
8. The Consultant team will meet with each Alameda County jurisdiction individually to review the recommended set of multi-modal transportation improvements; each jurisdiction will have the opportunity to review and refine the set of recommended improvements which will lead to identifying the preferred set of improvements for the Arterials of Countywide Significance.

[2] The roadway typology framework is being developed. It will be presented to stakeholders in April.

9. After preferred improvements are identified, the project team will utilize the equity and active transportation mode performance measures to ensure that the list of improvements achieve the Plan's vision and goals. Equity checks ensure that a set of equitable improvements are proposed throughout the County. The potential mode shift to active transportation modes will also be assessed; preferred improvements will be revised as necessary. .
10. Prioritization criteria[3] will be developed in coordination with stakeholders to prioritize the list of preferred short and long-term improvements to be included in the Final Multimodal Arterial Plan.

    The project team will also develop a set of ITS, climate action, and TDM strategies that are complimentary to the list of preferred short and long-term improvements.

As shown in **Figure 1** and described above, performance measures play a critical role in developing the Plan and identifying the preferred set of short and long-term improvements.

[3] Short and long-term improvement prioritization criteria will be developed and presented to stakeholders later in the Plan development process. All stakeholders will have an opportunity to review and provide feedback on the prioritization criteria before the criteria are finalized.

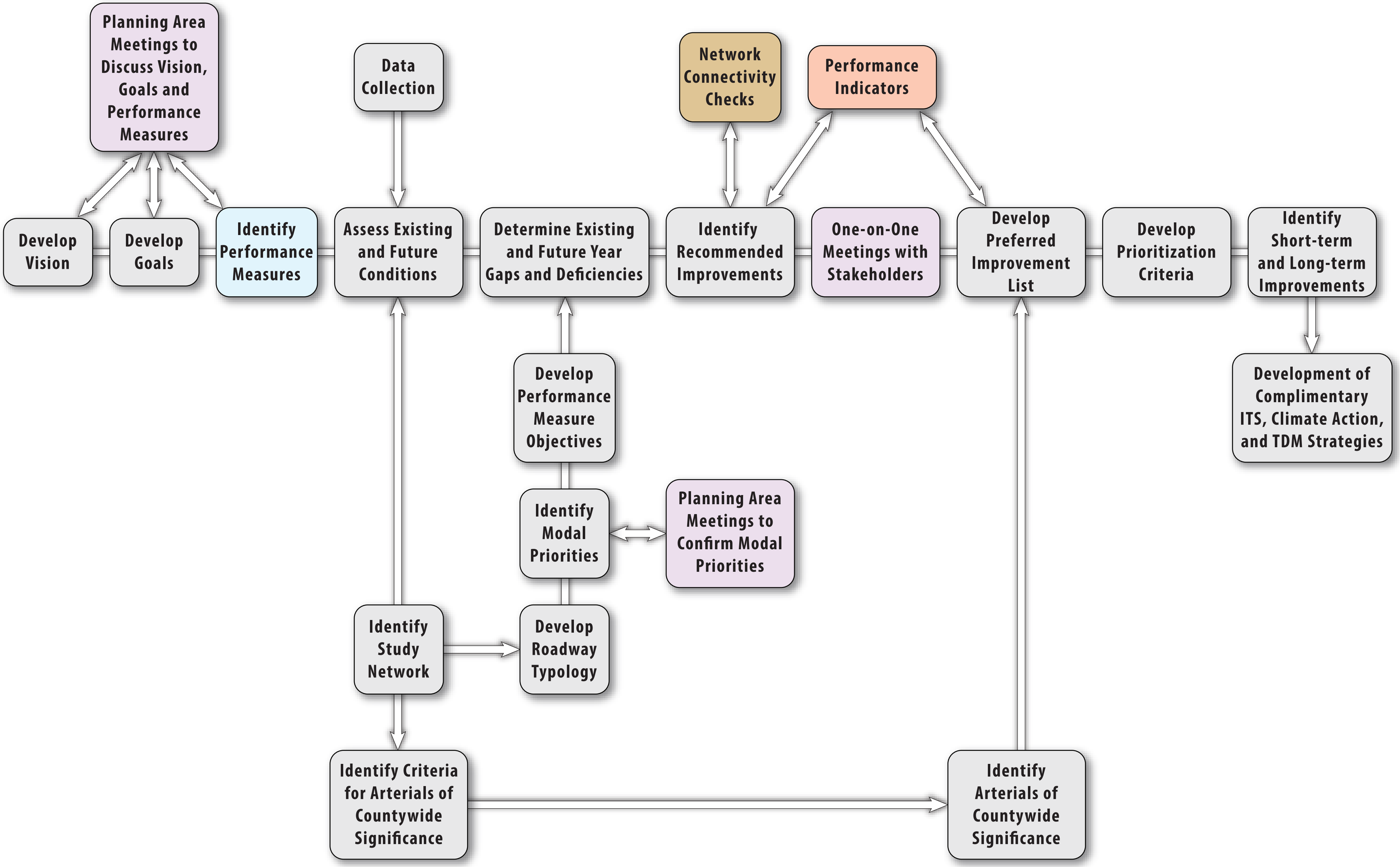


Figure 1

Alameda CTC Countywide Multimodal Arterial Plan Framework

OK14-0023_1_PlanFramework

PROPOSED PERFORMANCE MEASURES AND EVALUATION APPROACH

The proposed performance measures to be utilized as part of the Alameda Countywide Multimodal Arterial Plan development are listed in **Table 1** and described in the sections below. Performance measures will be applied to assess existing and/or future year transportation conditions; These measures also include a few 'Performance Indicators' (non-auto mode share, active transportation mode share, implementation feasibility, VMT and GHG) as these indicators by themselves do not evaluate an existing or future conditions to identify a gap or deficiency, but provide a measurement of the network or facility for a comparative assessment of the proposed improvements against the existing conditions. Therefore, these indicators will be generally applied after preferred short and long term improvements are identified to evaluate and to ensure that the preferred improvements achieve the Plan's vision and goals.

Table 1 also lists the goal that each measure addresses, if the measure is a facility-specific or area-wide application, and whether the measure applies to either existing conditions, future year conditions or both. Arterial corridor performance measure results will be derived from the study segment results along the corridor; for example, automobile congested speed at the corridor level will be estimated by calculating the average (weighted by volume) congested speed from all the individual study segments that are within the corridor limits.

As previously mentioned, modal priorities will inform the performance objectives as different modal priorities can potentially result in different objectives to determine if an arterial study segment is performing adequately to suit the multimodal needs. Modal priorities will also address potential modal conflicts that may arise along arterial segments as short and long term improvements will be prioritized for the identified priority modes. All stakeholders will have an opportunity to review and refine the modal priorities along the Study Network. Jurisdictions will also be given the opportunity to coordinate with neighboring jurisdictions on modal priorities along multi-jurisdictional routes during the second set of Planning Area meetings in April and May of 2015. Because modal priorities are not yet identified, performance objectives will be identified at a later date and therefore are not described in this memo.

TABLE 1
MULTIMODAL ARTERIAL PLAN PERFORMANCE MEASURES

Goal	Category	Performance Measure	Evaluation Approach	Application
1. Multimodal	1.1 – Auto	1.1A – Congested Speed	Based on average PM peak period congested speed.	Facility-Specific Measure, Existing and Future Conditions
		1.1B – Reliability	Based on PM peak hour volume-to-capacity ratio, categorized as: ▪ Reliable (V/C between 0 – 0.8) ▪ Less Reliable (V/C between 0.8 – 1.0) ▪ Unreliable (V/C greater than 1.0)	Facility-Specific Measure, Existing and Future Conditions
	1.2 – Transit	1.2A – Transit Travel Speed	Based on average PM peak hour transit travel speed provided by transit agencies that operate in the County.	Facility-Specific Measure, Existing and Future Conditions
		1.2B – Transit Reliability	Based on average PM peak hour transit travel speed to non-peak hour transit speed ratio. Data provided by transit agencies that operate in the County.	Facility-Specific Measure, Existing and Future Conditions
		1.2C – Transit Infrastructure Index	Based on the following factors: ▪ Provided bus stop amenities ▪ Bus stop location ▪ Bus stop design The measure applies a 50-point scoring system that corresponds to the following rating: ▪ 36 – 50 points = High ▪ 26 – 35 points = Medium ▪ 0 – 25 points = Low	Facility-Specific Measure, Existing and Future Conditions

TABLE 1
MULTIMODAL ARTERIAL PLAN PERFORMANCE MEASURES

Goal	Category	Performance Measure	Evaluation Approach	Application
	1.3 – Pedestrian	1.3 – Pedestrian Comfort Index	Based on the following factors: ▪ Sidewalk width ▪ Presence of buffer between sidewalk and roadway ▪ Land use context ▪ Roadway classification, average daily vehicle volume, number of travel lanes and speed limit ▪ Percent heavy vehicle traffic The measure applies a 24-point scoring system that corresponds to the following rating: ▪ 21 – 24 points = Excellent ▪ 15 – 20 points = High ▪ 8 – 14 points = Medium ▪ 0 – 7 points = Low	Facility-Specific Measure, Existing and Future Conditions
	1.4 – Bicycle	1.4 – Bicycle Comfort Index	Application of the Level of Traffic Stress (LTS) methodology, which is based on the type of bicycle facility provided and separation from vehicle travel lanes. LTS methodology classifies roadway segments into one of four levels of traffic stress, which are termed as LTS1 through LTS4. Groups of cyclists are categorized by how much stress they will tolerate in different environments. For simplicity, the LTS results correspond to the following rating: ▪ LTS1 = Excellent ▪ LTS2 = High ▪ LTS3 = Medium ▪ LTS4 = Low	Facility-Specific Measure, Existing and Future Conditions
	1.5 – Trucks/ Goods Movement	1.5 – Truck Route Accommodation Index	Based on curb-lane width. The measure applies a three-point scoring system that corresponds to the following rating: ▪ 3 points = High ▪ 2 points = Medium ▪ 0-1 point = Low One point is assigned if curb lane width is less than 11, two points are assigned if the curb lane width is between 11 and 12 feet, three points are assigned if the curb lane width is 12 feet or greater.	Facility-Specific Measure, Existing and Future Conditions

TABLE 1
MULTIMODAL ARTERIAL PLAN PERFORMANCE MEASURES

Goal	Category	Performance Measure	Evaluation Approach	Application
	1.6 – Enhanced Mobility	1.6 – Non-Auto Transportation Mode Share	Qualitative assessment of cross-sectional improvements on likelihood of changes to transit, pedestrian, and bicycle travel (proxy for person throughput).	Area-Wide Indicator, Existing, Future Conditions
	1.7 State of Good Repair	1.7 Pavement Condition Index (PCI)	Based on the PCI data obtained from the MTC StreetSaver database. The PCI measure applies a 100-point scoring system that corresponds to the following rating: ▪ PCI 80 – 100 = Very Good ▪ PCI 60 – 79 = Good ▪ PCI 50 – 59 = At Risk ▪ PCI 0 – 49 = Poor	Facility-Specific Measure, Existing Conditions
2. Accessible and Equitable[1]	2.1 – Social Equity	2.1 – Benefit to Communities of Concern	After the preferred list of short and long-term improvements is identified, a ratio will be estimated by dividing the number of arterial miles of identified improvements within Communities of Concern (COC) by the number arterial miles of all identified improvements benefiting each jurisdiction. For Transit, number of population benefitted within COC versus overall population benefitted in the County will be used.	Area-Wide Indicator, Future Conditions
3. Connected Across the County and Region	3.1 – Transit	3.1 – Transit Connectivity	Connectivity measures will be assessed through a mapping exercise. The transit, pedestrian, bicycle and truck networks will be mapped to identify gaps or inconsistencies in the networks. The pedestrian and bicycle assessment will include consideration of relative comfort. The truck network connectivity assessment will be coordinated with the Countywide Goods Movement Plan consultant team to ensure that identified truck network gaps and deficiencies are adequately addressed.	Area-Wide Measure, Existing and Future Conditions
	3.2 – Pedestrian	3.2 – Pedestrian Connectivity		Area-Wide Measure, Existing and Future Conditions
	3.3 – Bicycle	3.3 – Bicycle Connectivity		Area-Wide Measure, Existing and Future Conditions

TABLE 1
MULTIMODAL ARTERIAL PLAN PERFORMANCE MEASURES

Goal	Category	Performance Measure	Evaluation Approach	Application
	3.4 – Trucks	3.4 – Network Connectivity		Area-Wide Measure, Existing and Future Conditions
4. Efficient Use of Resources[2]	4.1 – Efficient Use of Operations Funding	4.1 – Operating Cost Effectiveness	Based on the ratio of improvement costs to existing facility costs: ▪ Develop unit operating costs for cross-sectional elements, including maintenance costs ▪ Estimate operating costs to maintain existing cross-section (O_E) ▪ Estimate operating costs to maintain preferred cross-sectional improvements (O_P) ▪ Operating Cost Effectiveness = O_P/O_E	Facility-Specific Measure, Future Conditions
	4.2 – Implementation Challenge	4.2 – Implementation Challenge Score	Based on a zero to four point scale, zero being most feasible and four being the least feasible based on the following variables: ▪ Travel lane removal required (yes = 1 pt, no = 0 pts) ▪ Parking removal required (yes = 1 pt, no = 0 pts) ▪ Multi-jurisdiction coordination required (yes = 1 pt, no = 0 pts) ▪ Curb changes required (yes = 1 pt, no = 0 pts)	Facility-Specific Indicator, Future Conditions
	4.3 ITS Infrastructure	4.3 Coordinated Technology	Four-point scale (0 – 3) based on the level of ITS investment defined by built infrastructure. Consideration for coordination with adjacent jurisdictions and/or Caltrans, as applicable: ▪ 3: high investment ITS network ▪ 2: medium investment ITS network ▪ 1: basic investment ITS network ▪ 0: no ITS infrastructure	Facility-Specific Indicator, Existing and Future Conditions
5. Safe, Healthy and Vibrant	5.1 – Safety	5.1 – Collision Rates	Collision rates based on the SWITRS database.	Facility-Specific Measure, Existing Conditions

TABLE 1
MULTIMODAL ARTERIAL PLAN PERFORMANCE MEASURES

Goal	Category	Performance Measure	Evaluation Approach	Application
	5.2 – Active Transportation Mode Share	5.2 – Demand for Active Transportation	Potential for mode shift (low, medium, high) based on demand for active transportation.	Area-Wide Indicator, Future Conditions
	5.3 – VMT	VMT per Capita	Based on VMT data from the Alameda CTC Travel Demand Model.	Area-wide Indicator, Existing and Future Conditions
	5.4 – GHG	GHG per Capita	Based on VMT data from the Alameda CTC Travel Demand Model.	Area-wide Indicator, Existing and Future Conditions

Notes:
1. Accessibility is a component of the Transit Infrastructure Index, Pedestrian Comfort Index and Bicycle Comfort Index. Source:
2. Performance measures are generally applied to assess existing and/or future year transportation conditions, performance indicators will generally be evaluated after preferred short and long-term improvements are identified to ensure that preferred improvements achieve the Plan's vision and goals.

GOAL 1 – MULTIMODAL (HIGH QUALITY, WELL MAINTAINED AND RELIABLE)

1.1A – AUTOMOBILE CONGESTED SPEED

Overview

Automobile congested travel speed relates directly to the automobile traveler experience and provides a good indication of vehicular operations along an arterial study segment. This measure is facility-specific and will be applied to existing and future year conditions.

Approach

Automobile congested travel speed will be estimated for Existing and Future Year PM peak hour conditions, consistent with the Alameda County Congestion Management Program. Existing travel speeds will be obtained from either of the following data sources:

- Speed data obtained from the INRIX database, or
- Speed survey data provided by jurisdictions, or
- Speed data obtained from the base year (2010) Alameda Countywide Travel Demand Model

Speed data from the INRIX database will be prioritized, followed by speed data provided by jurisdictions, and if neither INRIX nor survey data is available for an arterial segment then speed data from the Travel Demand Model will be used. Future year 2020 and 2040 PM peak hour travel speeds will be estimated using the Alameda Countywide Travel Demand Model. Adjustment factors comparing observed PM peak hour speed data to base year (2010) modeled speed data will be estimated. This adjustment factors will be applied to modeled speed data for future years 2020 and 2040 to estimate future years 2020 and 2040 PM peak hour travel speeds for the Study Network.

1.1B – AUTOMOBILE RELIABILITY

Overview

Automobile reliability is an assessment of the vehicular volume-to-capacity (V/C) along an arterial segment. Arterial segments that operate below capacity generally provide greater travel reliability compared to segments that operate at or near capacity. This measure is facility-specific and will be applied to existing and future year conditions.

Approach

Automobile reliability will be estimated for existing and future year PM peak hour conditions. Existing PM peak hour volumes will be obtained from existing count data provided by jurisdictions or base year (2010) volume data from the Alameda Countywide Travel Demand Model. Future year 2020 and 2040 volume forecasts will also be estimated using the Travel Demand Model, the process for estimating forecasts is described in a separate memo titled *Alameda Countywide Arterial Plan Travel Demand Forecasting Methods White Paper (December 31, 2014*), which is under review at Alameda CTC . Arterial segment capacity is based on the capacity rates assumed in the Travel Demand Model applied to the number of existing and future year travel lanes along an arterial segment. The volume-to-capacity ratio will be calculated and reliability will be based on the following thresholds:

- Reliable (V/C between 0 – 0.8)
- Less Reliable (V/C between 0.8 – 1.0)
- Unreliable (V/C greater than 1.0)

1.2A – TRANSIT TRAVEL SPEED

Overview

At the request of Alameda County transit agencies, transit travel speed will be included in the performance measure assessment for existing and future year conditions. Transit travel speed influences transit operating costs along an arterial corridor. This measure is facility-specific and will be applied to existing and future year conditions. In addition, the measure will only be applied to Study Network segments that currently provide transit service. Study Network segments that serve as designated transit routes will be prioritized for transit, as such, the performance measure objectives will reflect this modal priority.

Approach

Existing PM peak hour average transit travel speed will be summarized by transit agencies operating transit routes along the Study Network. Existing transit speeds will be estimated using data obtained from on board GPS tracking devices. The data accounts for bus boarding and alighting movements made by patrons at bus stops along a study segment. Future year 2020 and 2040 transit travel speeds will be estimated by applying the existing transit travel speed-to-vehicle congested speed ratio to the estimated future year vehicle congested speed. Where transit improvements are recommended such as signal priority, queue jump lanes or dedicated transit lanes, transit travel speeds will reflect these improvements.

1.2B – TRANSIT RELIABILITY

Overview

Transit reliability provides a general indication of attractiveness of transit for riders along an arterial corridor. This measure is facility-specific and will be applied to existing and future year conditions. In addition, the measure will only be applied to Study Network segments that currently provide transit service. Study Network segments that serve as designated transit routes will be prioritized for transit, as such, the performance measure objectives will reflect this modal priority.

Approach

Existing PM peak hour transit reliability will be summarized by transit agencies operating transit routes along the Study Network. The transit reliability metric is estimated by comparing peak hour transit travel speed to non-peak hour speed.

1.2C – TRANSIT INFRASTRUCTURE INDEX

Overview

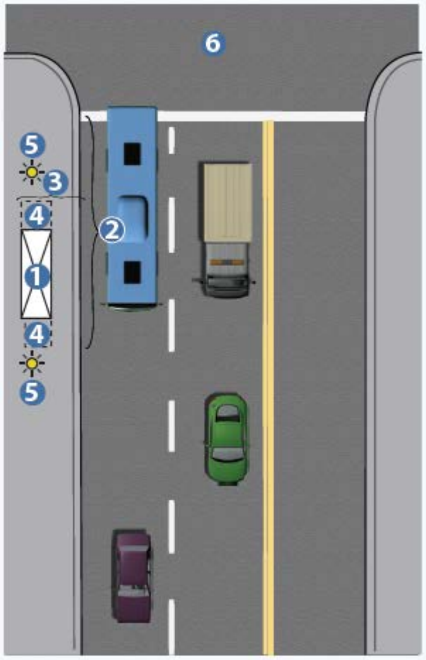
The built environment has a substantial effect on the transit user comfort and peoples' willingness to use transit. The Transit Infrastructure Index performance measure draws on research and existing evaluation tools to assess how well arterials serve transit users. The Transit Infrastructure Index is a facility-specific measure that will be applied to existing and future year conditions. The measure will only be applied to Study Network segments that currently provide transit service. Study Network segments that serve as designated transit routes will be prioritized for transit, as such, the performance objectives will reflect this modal priority.

Approach

Transit Infrastructure Index is rated as poor, good or best on an 12-point rating system based on bus stop design and provided amenities. The point rating system for the Transit Infrastructure Index can be amended if necessary; the consultant team will coordinate with Alameda County transit agencies to modify the methodology as necessary. A customized spreadsheet built into the GIS Tool will be used to calculate the Transit Infrastructure Index for any study segment that provides transit service. The measure will be applied for representative bus stops along a Study Network segment as oppose to each block within a study segment. **Exhibit 1** shows an example of the Transit Infrastructure Index calculation. Curb lane width will also be considered in addition to the bus stop amenities listed in **Exhibit 1**. A point will be scored if the curb lane width is 12 feet or greater. If available, lane width data will be obtained from local jurisdictions; if not, lane width data will be obtained from aerial imagery.

EXHIBIT 1: EXAMPLE TRANSIT INFRASTRUCTURE INDEX CALCULATION

Score one point for each bus stop amenity unless otherwise noted.



① Bus Stop Amenities	Score	
Shelter and Bench	2	
Bench Only, No Shelter	1	
Bus Bulb	1	
Wayfinding/Routing Information	1	
Bicycle Parking	1	
Total		

Enter score from #1 above and score one point for each of items 2-6 that apply.		
Field	Category	Score
1	Bus Stop Amenities	
2	Minimum Bus Stop Length & Red Curb Provided (80’)	
3	Minimum Pedestrian Path of Travel (4’)	
4	ADA Compliant Bus Stop Area (8’ x 5’ landing)	
5	Pedestrian-scale Lighting	
6	Far-side Stop	
	TOTAL	

Notes:

1. The Transit Infrastructure Index calculation methodology will be customized on data availability and evaluation needs while ensuring reasonable results.
2. Consultant team will coordinate with Alameda County transit agencies to modify the Transit Infrastructure Index scoring methodology as necessary.

1.3 – PEDESTRIAN COMFORT INDEX

Overview

The built environment has a substantial effect on the pedestrian comfort and peoples' willingness to walk. The Pedestrian Comfort Index performance measure draws on research and existing evaluation tools to assess how well arterials serve pedestrians. The Pedestrian Comfort Index will be a facility specific performance measure applied to existing and future year conditions.

Approach

The Pedestrian Comfort Index is assessed along street segments and crossing frequency is also considered.

Level of comfort is rated as poor, good or best on an assigned point system based on pedestrian facilities and automobile traffic characteristics; pedestrian infrastructure characteristics are generally weighted higher than automobile traffic characteristics when applying the methodology. A customized spreadsheet tool **StreetScore+** developed by Fehr and Peers can be used to calculate level of comfort for any facility.

The street segment calculation assigns point values (from -3 to 3) to the following variables within the built environment:

- Sidewalk width and presence
- Presence of a buffer (landscaped or hardscaped) between sidewalk and roadway
- Roadway classification, average daily vehicle volume, number of travel lanes and speed limit
- Percent heavy vehicle traffic
- Distance between crosswalks

An example of the Pedestrian Comfort Index calculation in **StreetScore+** tool is shown in **Exhibit 2** below. In regards to the **StreetScore+** tool, we will program these functions into the GIS Tool rather than use as a separate Excel process. For the Pedestrian Comfort Index evaluation, a representative location along a Study Network segment will be selected for each segment rather than assessing every block within a study segment.

EXHIBIT 2: EXAMPLE PEDESTRIAN COMFORT INDEX BASED ON STREETSCORE+

StreetScore+

Input instructions:		
1	Enter the name of the roadway segment below.	
2	All input Fields 1-10 (marked in blue) are required.	
3	The Segment LTS output is provided below the input fields.	
4	Refer to "Streetscore+ Tool Overview" and "About" tabs detailed descriptions of inputs and calculations.	
Segment (Two-Way Roadway) Pedestrian Score		
Segment:	Main Street between Oak and Elm	
Field	**Category**	**Input**
1	Location	Commercial Corridor
2	Sidewalk Present	Yes
3	Sidewalk or Clear Walkway Width (feet)	6
4	Buffer Present	Landscaped
5	Roadway Classification	Collector
6	Roadway Volume (2-way) (AADT)	32500
7	Posted Speed Limit	25
8	% Heavy Vehicle Traffic	1.5
9	Number of travel lanes (total for both directions)	4
10	Crosswalk spacing (ft)	200
	Segment (Non-Directional) Comfort Level	**Medium Level of Comfort**
	Segment score (0-16)	**3**

Notes:

1. The Pedestrian Comfort Index calculation methodology will be customized on data availability and evaluation needs while ensuring reasonable results.

1.4 – BICYCLE COMFORT INDEX

Overview

Fehr & Peers created the **StreetScore+** tool: an easy-to-use Microsoft Excel spreadsheet that calculates Levels of Traffic Stress (LTS) scores from a user's unique input. LTS is a methodology developed by Mekuria, Furth and Nixon (2012) that examines the characteristics of city streets and how various aspects can cause stress on bicyclists and affect where they are likely to ride. The Bicycle Comfort Index is a facility-specific measure based on the LTS methodology and will be applied to existing and future year conditions.

Approach

LTS methodology classifies roadway segments into one of four levels of traffic stress, which are termed as LTS1 through LTS4. Groups of cyclists are categorized by how much stress they will tolerate in different environments:

- LTS1: most children can tolerate and feel safe while bicycling.
- LTS2: the mainstream adult population will tolerate and feel safe while bicycling.
- LTS3: cyclists who are considered "enthused and confident" but still prefer having their own dedicated space for riding will tolerate and feel safe while bicycling.
- LTS4: a level tolerated only by those characterized as "strong and fearless", which comprises just 0.5 percent of the population. The high-stress streets that LTS4 groups will ride are those with high speed limits, multiple travel lanes, limited or non-existent bike lanes and signage, and large distances to cross at intersections.

LTS works on the "weakest link" principle, where the traffic stress for a given arterial corridor is dictated by the most stressful portion. This means a full segment receives the score of its lowest-scored portion. For example, a cross-town ride could have large portions of LTS1 and LTS2, but just one section of LTS3 would present a barrier. Only cyclists that could tolerate LTS3 would ride the entire route. So, LTS3 becomes the score for that route. According to the LTS methodology, Study Network segments with posted speed limits of 40 MPH or greater cannot achieve better than an LTS4 rating unless a barrier separated bicycle lane facility is provided with the exception of the "strong and fearless", typical bicyclists experience a low level of comfort riding on high speed arterials that do not provide a barrier between the cyclists and the automobile travel lanes, hence the LTS 4 rating.

An example of the **StreetScore+** tool is shown in **Exhibit 3** below. Pavement Condition Index will also be considered in addition to the built environment attributes shown in **Exhibit 3**; the recurrence of bike lane blockages will not be considered.

EXHIBIT 3: BICYCLE COMFORT INDEX BASED ON STREETSCORE+

StreetScore+

Input instructions:

1	Enter the name of the roadway segment below.
2	All input Fields 1-8 (marked in green) are required. Fields 9 and 10 will activate when the bicycle lane is selected for the mode separation in Field 2.
3	The Segment LTS output is provided below the input fields.
4	Refer to "Streetscore+ Tool Overview" and "About LTS" tabs detailed descriptions of inputs and calculations.

Segment (Two-Way Roadway) LTS

Segment:

Field	Category	Direction 1	Direction 2
		Input	Input
1	Direction	NB	SB
2	Mode separation	Bicycle Lane	Bicycle Lane
3	Is this a residential street?	Yes	
4	Adjacent parking	No	No
5	Lanes in analysis direction	1	1
6	Is there a median?	None or Striped	
7	Is there a center line?	No	
8	What is the prevailing speed? (Use speed limit if prevailing speed not available)	25	25
9	Bike Lane + Parking Width (if bike lane present)	15	15
10	How often do bike lane blockages occur?	Rare	Rare
	Segment LTS Output	**1**	**1**

Notes:

1. The Bicycle Comfort Index calculation methodology will be customized on data availability and evaluation needs while ensuring reasonable results.

1.5 – TRUCK ROUTE ACCOMODATION INDEX

Overview

The Truck Route Accommodation Index was identified to assess the general built environment of the Study Network in regards to accommodating trucks and goods movement. The Truck Route Accommodation Index is a facility-specific measure that will be applied to existing and future year conditions. Study Network segments that serve as designated truck routes will be prioritized for truck and goods movement, as such, the performance measure objectives will reflect this modal priority. This will be coordinated with the Goods Movement Plan.

Approach

For most contexts, truck route accommodation is based on the effective curb lane width, which is a function of lane width. The Truck Route Accommodation Index generates a score total ranging from zero to 10 points (higher point indicates better rating)

An effective curb lane width 12 feet or greater will score 9 points, compared to 5 points if the curb lane width is 11 feet, or 2 points if the curb lane width is 10 feet or less. In urban contexts, a second consideration is on-street parking. On-street parking would only be considered in urban contexts where many businesses are expected to load from the street; as such, one-point will be scored if an urban arterial provides on-street parking or loading/unloading areas.

1.6 – NON-AUTO TRANSPORTATION MODE SHARE

Overview

The Non-Auto Transportation Mode Share indicator was identified to assess existing and future year non-auto transportation (walking, biking, and transit) mode share for each jurisdiction within Alameda County. It is a proxy for increased person-carrying capacity under the assumption that there are few arterials in Alameda County where more travel lanes could be added. So, moving more people in non-auto modes is the primary basis for adding more system capacity. Similarly, it is assumed that increasing the non-auto transportation mode share correlates with lower vehicle miles traveled (VMT) and emissions (e.g., greenhouse gases, particulate matter) per capita. This measure is an area-wide application.

Approach

Non-Auto Transportation Mode Share is a qualitative indicator of proposed improvements. It assesses, based on transit, bike and pedestrian performance measure changes, whether the proposed improvements support increases in these modes. The order of magnitude of changes in Non-Auto Transportation Mode Share will be described in a low, medium or high rating. The indicator will be assessed after preferred short and long-term improvements are identified to ensure that preferred improvements achieve the Plan's vision and goals.

1.7 – PAVEMENT CONDITION INDEX

Overview

The Pavement Condition Index (PCI) is a standard performance measure that assesses the state of good repair for pavement along an arterial segment. PCI is generally monitored by public works staff at each Alameda County jurisdiction. PCI is a facility-specific measure that will be estimated for existing conditions only, but is considered in the context of future year conditions. PCI relates to the efficient use of resources because street overlays, reconstruction or other maintenance tasks are often opportune times to reconfigure street designs. On this basis, streets in poor states of repair are considered opportunities for achieving more cost-effective redesigns. PCI can also be used to assess bicycling conditions along an arterial segment. PCI is a facility-specific performance measure that will be assessed pm the future conditions.

Approach

The Metropolitan Transportation Commission's (MTC) StreetSaver database will be used to obtain existing conditions PCI estimates for Study Network segments within each jurisdiction. Permission to access the PCI data within the StreetSaver database is requested from each local jurisdiction.

Existing Conditions

The Metropolitan Transportation Commission (MTC) maintains a PCI database for the Bay Area region and categorizes PCI using thresholds that were consolidated for use on the Multimodal Arterial Plan as shown in **Figure 1**.

GOAL 2 – ACCESSIBLE AND EQUITABLE

The performance measures for "Connectivity" included under Goal 3 also address 'Accessibility'. Therefore, measures identified for this goal focus on Equitability.

2.1 – BENEFIT TO COMMUNITIES OF CONCERN

Overview

The Benefit to Communities of Concern (CoC) indicator was derived to address social equity and ensure that preferred short and long-term Study Network improvements are adequately identified for Communities of Concern. This measure will be applied area-wide by jurisdiction for future year conditions only.

Approach

Communities of Concern as defined by MTC will be the basis for estimating the performance measure. Each proposed improvement will be assessed for whether it produces benefits to CoCs. After the preferred list of short and long-term improvements is identified, a CoC ratio will be estimated by dividing the number of arterial miles of identified improvements within Communities of Concern by the number arterial miles of all identified improvements benefiting each jurisdiction. For Transit improvements, number of population benefitted within COC versus overall population benefitted will be used. The indicator will be assessed after preferred short and long-term improvements are identified to ensure that preferred improvements achieve the Plan's vision and goals.

GOAL 3 – CONNECTED ACROSS THE COUNTY AND REGION

3.1-3.4 – TRANSIT, PEDESTRIAN, BICYCLE AND TRUCK NETWORK CONNECTIVITY

Overview

Transit, pedestrian, bicycle and truck network connectivity measures were derived to ensure modal network connectivity and continuity across the countywide Study Network. Each measure will be applied at an area-wide level by Planning Area for existing and future year conditions. Connections at the county lines for Planning Areas, north, south, and east will also be reviewed.

Approach

Connectivity measures will be assessed through a mapping exercise. The transit, pedestrian, bicycle and truck networks will be mapped to identify gaps or inconsistencies in the networks based on the performance results by mode. The pedestrian and bicycle assessment will include consideration of relative comfort. Where inconsistencies are identified, alternative cross-section improvements to close modal gaps and provide complete networks by mode will be presented to jurisdictions for consideration.

GOAL 4 EFFICIENCT USE OF RESOURCES

4.1 – INFRASTRUCTURE OPERATING COST EFFECTIVENESS

Overview

The Operating Cost Effectiveness performance measure was derived to assess the relative maintenance and operating costs of proposed cross-sectional improvements along a Study Network segment compared to the maintenance and operating costs of the existing cross-section along the same segment. This is a facility-specific measure applied to future year conditions only.

Approach

The methodology to estimate the Operating Cost Effectiveness is based on the ratio of maintenance and operating costs of proposed improvements to existing facility costs:

- Develop unit operating costs for cross-sectional elements, including maintenance costs
- Estimate operating costs to maintain existing cross-section (O_E)
- Estimate operating costs to maintain recommended cross-sectional improvements (O_P)
- Operating Cost Effectiveness = O_P/O_E

The Operating Cost Effectiveness measure will be used to identify short and long-term Study Network improvements that minimize relative operating costs. Since this measure focuses on physical infrastructure maintenance and operations, it will not account for transit operating costs.

4.2 – IMPLEMENTATION FEASIBILITY SCORE

Overview

The Implementation Feasibility Score indicator was identified to gauge the general feasibility of implementing recommended short and long-term Study Network improvements. The Implementation Feasibility Score is a facility-specific indicator applied to future year conditions only.

Approach

The methodology is based on a zero to three point scale, zero being most feasible and four being the least feasible based on the following variables:

- Travel lane removal required (yes = 1 pt, no = 0 pts)
- Parking removal required (yes = 1 pt, no = 0 pts)
- Curb changes required (yes = 1 pt, no = 0 pts)

The higher the Implementation Feasibility Score, the more challenging it will be to implement recommended Study Network improvements. The indicator may potentially be used in prioritizing preferred short and long-term improvements.

4.3 – COORDINATED TECHONOLOGY

Overview

The Coordinated Technology indicator was identified to assess level of ITS infrastructure along the Study Network as it will improve the performance of the network at a relatively low cost. The indicator is facility-specific and will be applied to existing and future year conditions.

Approach

The methodology is based on a zero to four point scale based on the level of ITS investment defined by the built infrastructure. Existing and planned future levels of ITS infrastructure are identified based on the following general categories:

- 0: no ITS infrastructure

- 1: basic investment ITS network
- 2: medium investment ITS network
- 4: high investment ITS network

The level of ITS infrastructure pertaining to each category listed above will be defined later during the Plan development process with the help of Iteris, who is developing traffic management strategies and recommendations for inclusion in the Plan. The ITS infrastructure assessment will also include coordination between jurisdictions and/or Caltrans and different operators, as appropriate.

4.4 – PROPERTY VALUE INDEX

Overview

The Property Value Index was identified to assess benefits/disbenefits to adjacent property of transportation infrastructure improvements within the built environment. This indicator is facility-specific and will be applied to future year conditions only.

Approach

The Property Value Index will assess general changes in residential and commercial property values along a Study Network segment based on recommended short and long-term improvements. The methodology to assess general changes in property values is in the process of being developed by Strategic Economics in coordination with Fehr & Peers and Alameda CTC staff. The indicator will be assessed after preferred short and long-term improvements are identified to ensure that preferred improvements achieve the Plan's vision and goals.

GOAL 5 – SAFE, HEALTHY AND VIBRANT

5.1 – COLLISION RATES

Overview

The collision history will be assessed for each Study Network segment under existing conditions only, but will be considered in the context of improvement recommendations as arterial segments with high collision rates will be more likely to be included in the preferred improvement list.

Approach

The collision history for the latest three-year period will be obtained for each Study Network segment using the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS). Collision rates and severity (fatality rates) will be calculated and summarized for each Study Network segment. Using the number of total collisions and fatalities reported and existing average daily traffic (ADT), collision rates will be calculated based on the number of collisions per million vehicle miles.

Existing Conditions

The total collision rates for Existing Conditions are shown in **Figure 2**. Collision history data for the latest three-year period was obtained for each Study Network segment using the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS). Using the number of total collisions reported and existing average daily traffic (ADT), collision rates were calculated based on the number of collisions per million vehicle miles.

5.2 – DEMAND FOR ACTIVE TRANSPORTATION

Overview

The Demand for Active Transportation indicator was identified to assess the potential for shifting people from driving vehicles to active transportation modes such as walking, biking and transit. The measure will be applied at an area-wide level by jurisdiction for future year conditions only.

Approach

The Demand for Active Transportation indicator will qualitatively assess the potential of shifting from driving to active transportation modes on a low, medium or high scale. Proposed short and long-term Study Network active transportation improvements will be assessed at an area wide scale and the Demand for Active Transportation mode shift will be estimated for each Alameda County jurisdiction. The indicator will be assessed after preferred short and long-term improvements are identified to ensure that preferred improvements achieve the Plan's vision and goals.

5.3-5.4 – VMT PER CAPITA AND GHG PER CAPITA

Overview

The Vehicle Miles Traveled (VMT) per capita and Greenhouse Gas Emissions (GHG) per capita indicators were identified to assess the effectiveness of the Arterial Plan's proposed short and long term improvements on the Study Network in reducing VMT and GHG to protect the environment and respond to SB 375. These indicators will be applied at an area-wide level for the county for existing and future year conditions.

Approach

VMT will be assessed using the Alameda Countywide Travel Demand Model. GHG will be estimated using the GHG Estimator, a tool based on Emissions Factors (EMFAC) model developed by California Air Resources Board, added to the Alameda Countywide Travel Demand Model. These indicators will be assessed after preferred short and long-term improvements are identified to ensure that preferred improvements achieve the Plan's vision and goals in reducing VMT and GHG.

OTHER CONSIDERATIONS

Performance measures or indicators specifically relating to parking management or transportation demand management (TDM) policies are not proposed as part of the Multimodal Arterial Plan. Parking management and TDM strategies will however be recommended for each Alameda County jurisdiction as part of the Plan development. Although specific parking performance measures are not proposed, on-street parking will be assessed by various other performance measures listed above, such as the Pedestrian Comfort Index, Bicycle Comfort Index and Truck Route Accommodation Index. Similarly, existing TDM policies and strategies adopted by Alameda County jurisdictions will be inventoried. The consultant team will review existing TDM practices by jurisdiction and recommend additional strategies that build upon existing ones.

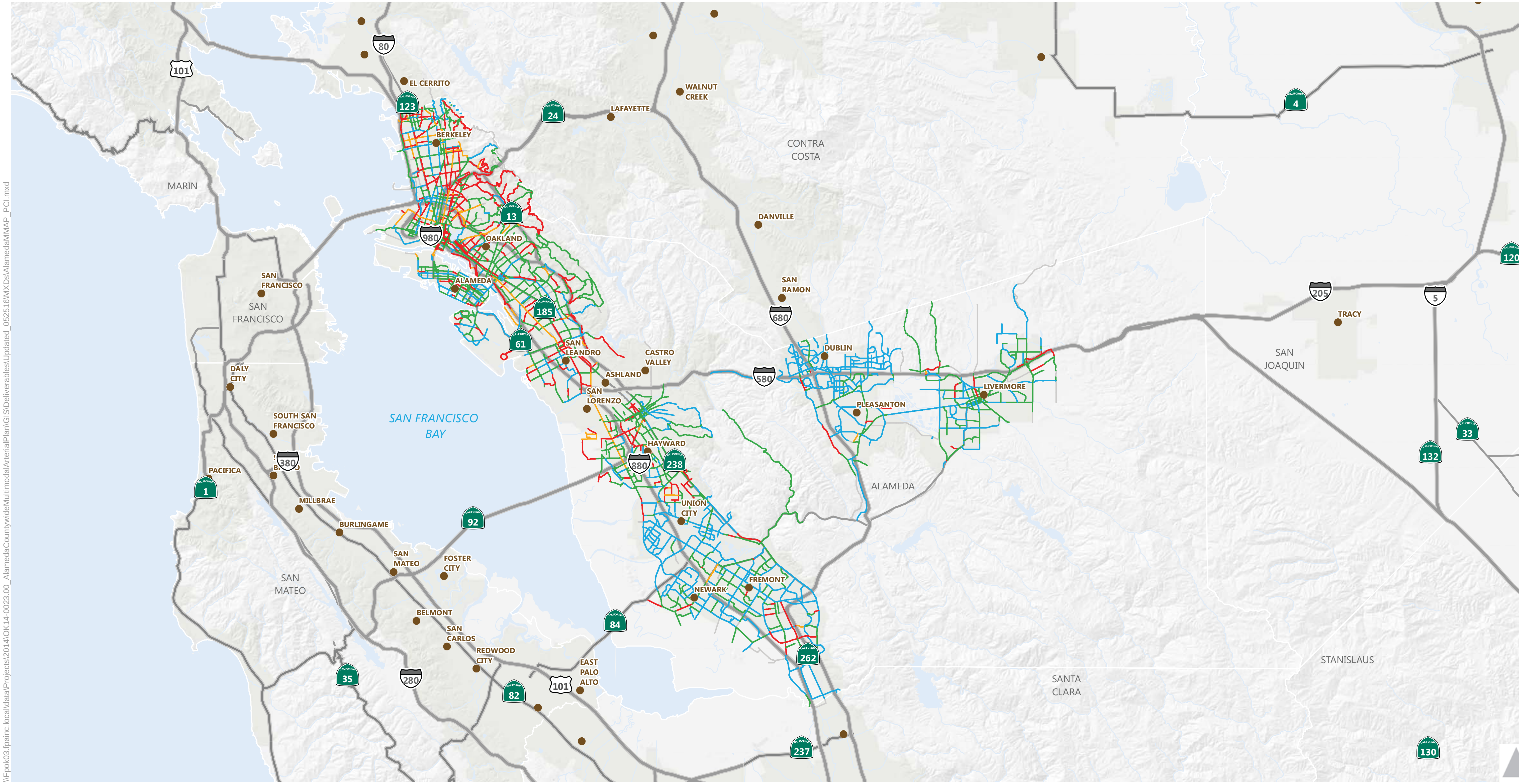
NEXT STEPS

The consultant team and Alameda CTC staff will present the final vision, goals and performance measures for approval at the February 5th ACTAC and February Planning Policy and Legislation Committee and Commission meetings. After receiving approval on the performance measures, the consultant team will move forward with assessing Study Network existing conditions.

Attachments:

Figure 1 – Pavement Condition Index (PCI) Ratings – Existing Conditions

Figure 2 – Collision Rates – Existing Conditions



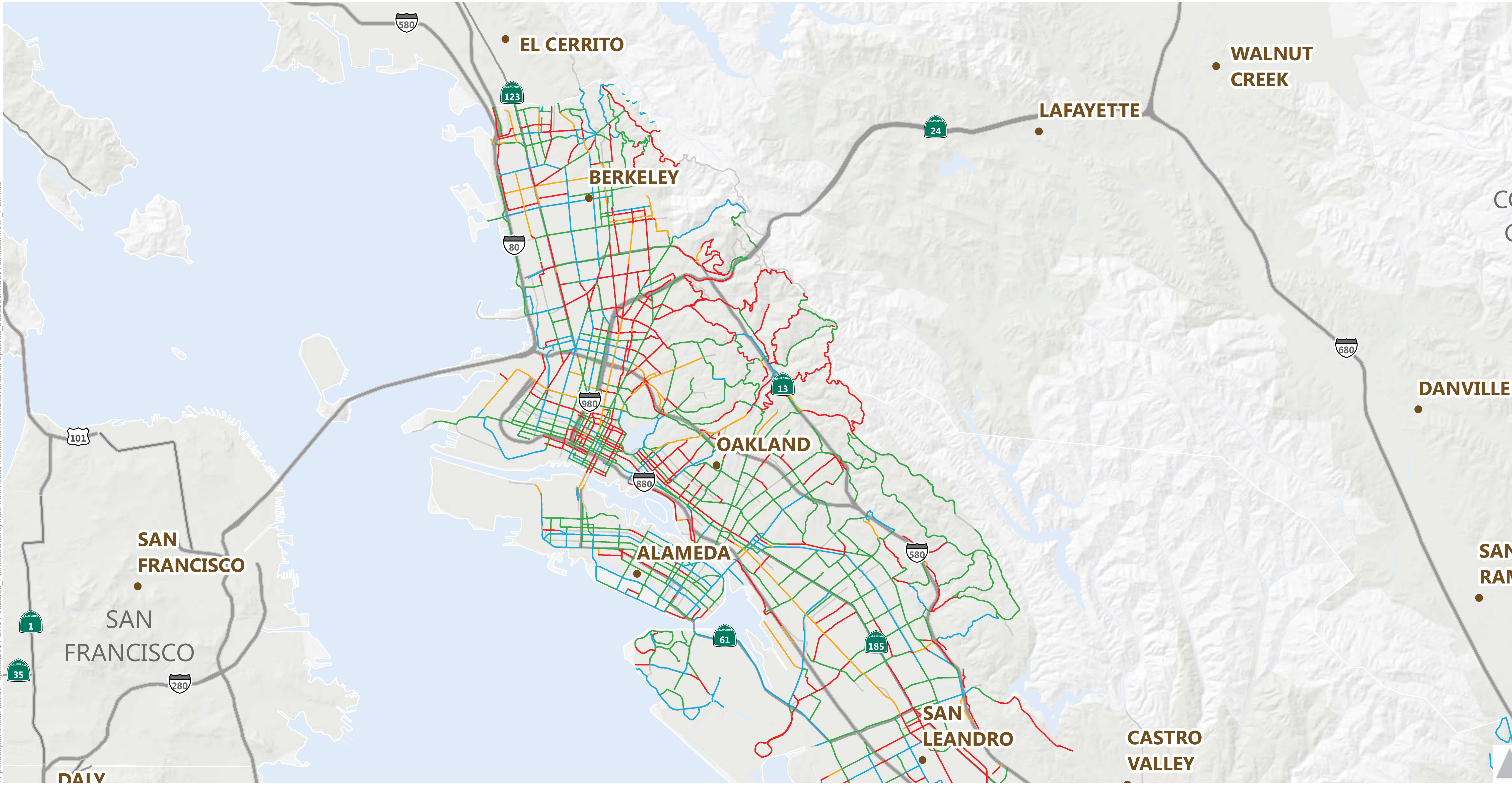
Pavement Condition Index Rating

- At Risk
- Poor
- Good
- Very Good

Alameda Countywide Multimodal Arterial Plan

Figure 1A

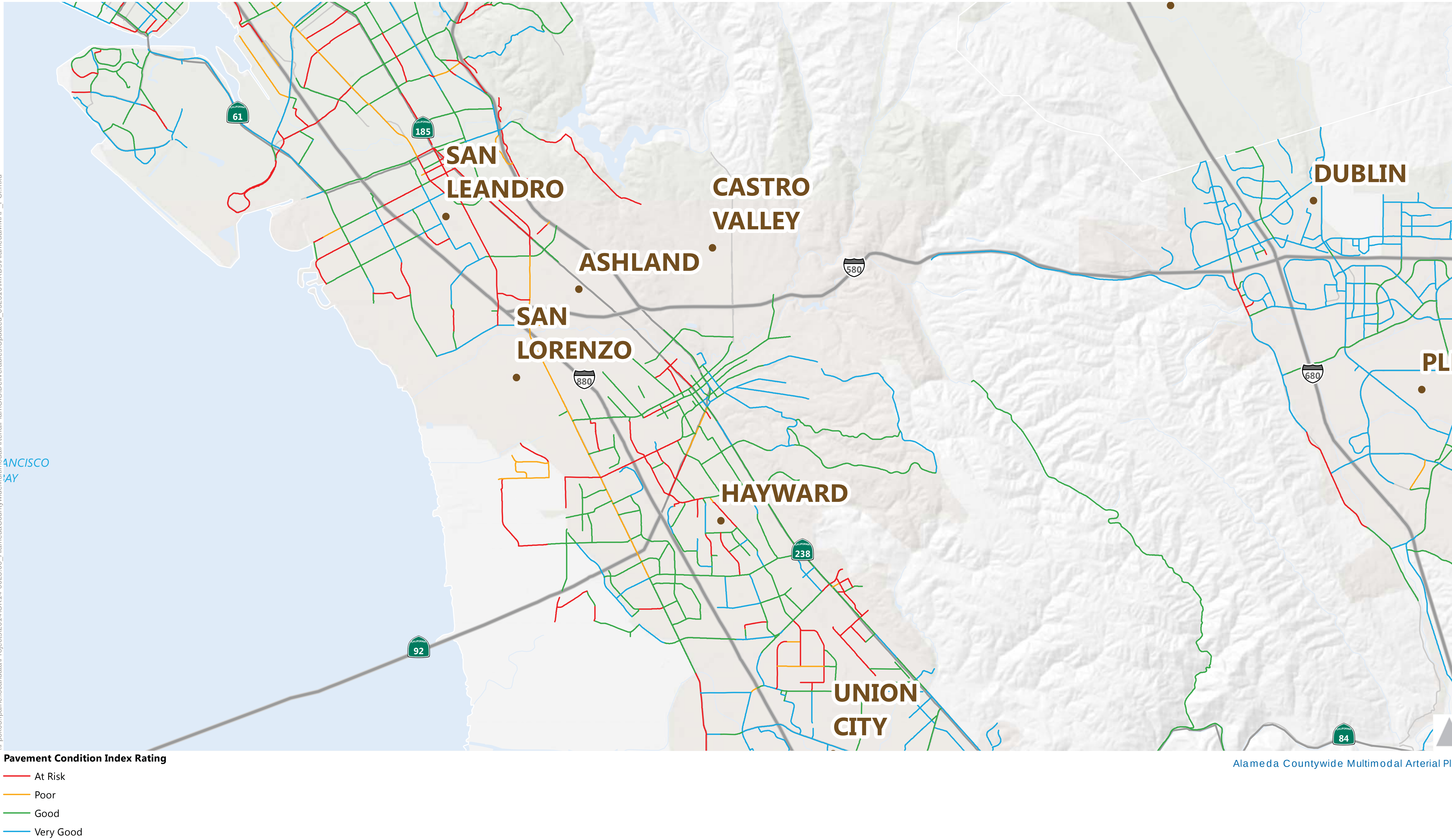
Pavement Condition Index (PCI) Ratings - Existing Conditions - Alameda County



Alameda Countywide Multimodal Arterial Plan

Figure 1B

Pavement Condition Index (PCI) Ratings - Existing Conditions - North County

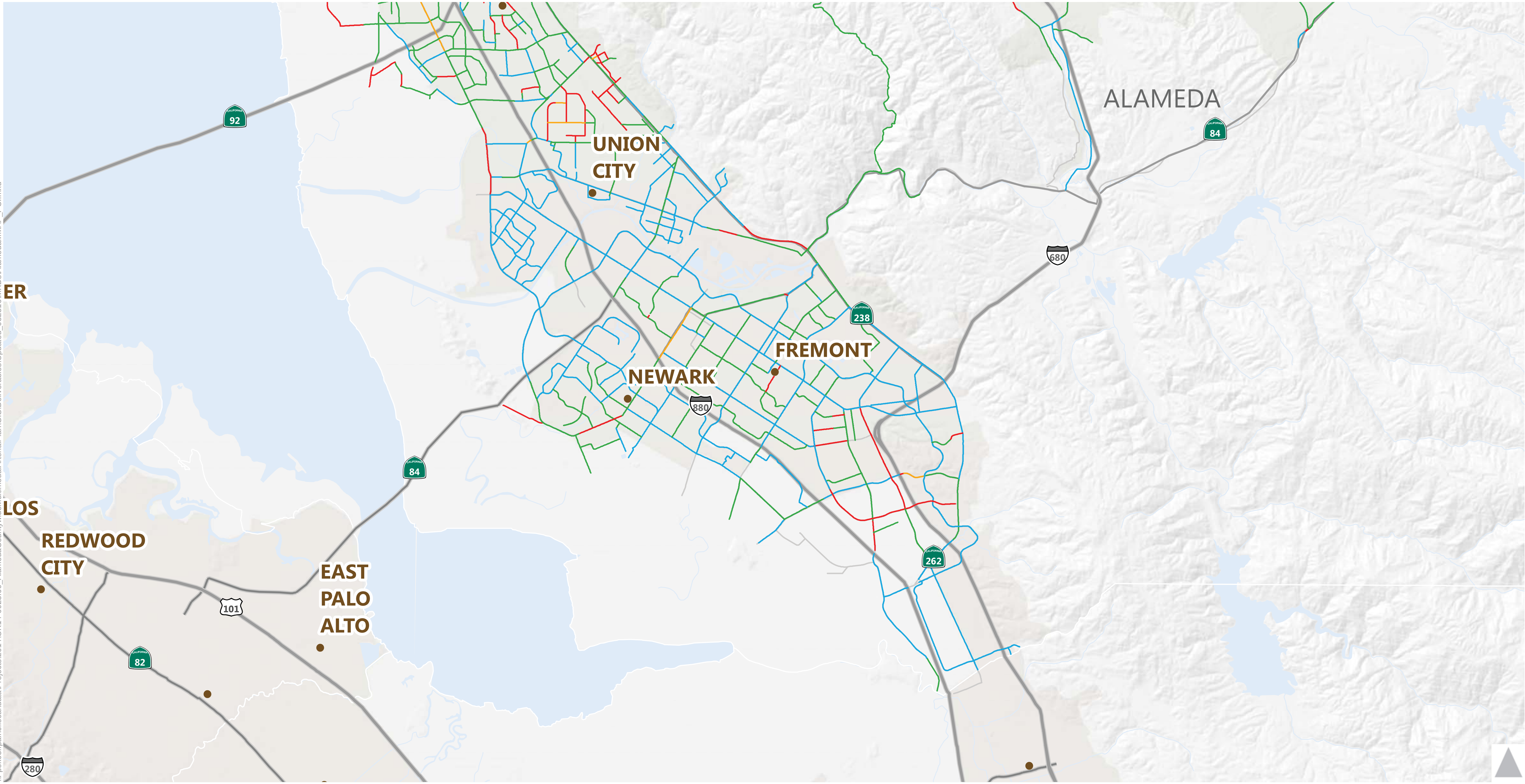


Alameda Countywide Multimodal Arterial Plan

ALAMEDA County Transportation Commission

Figure 1C

Pavement Condition Index (PCI) Ratings - Existing Conditions - Central County



Pavement Condition Index Rating

- At Risk
- Poor
- Good
- Very Good

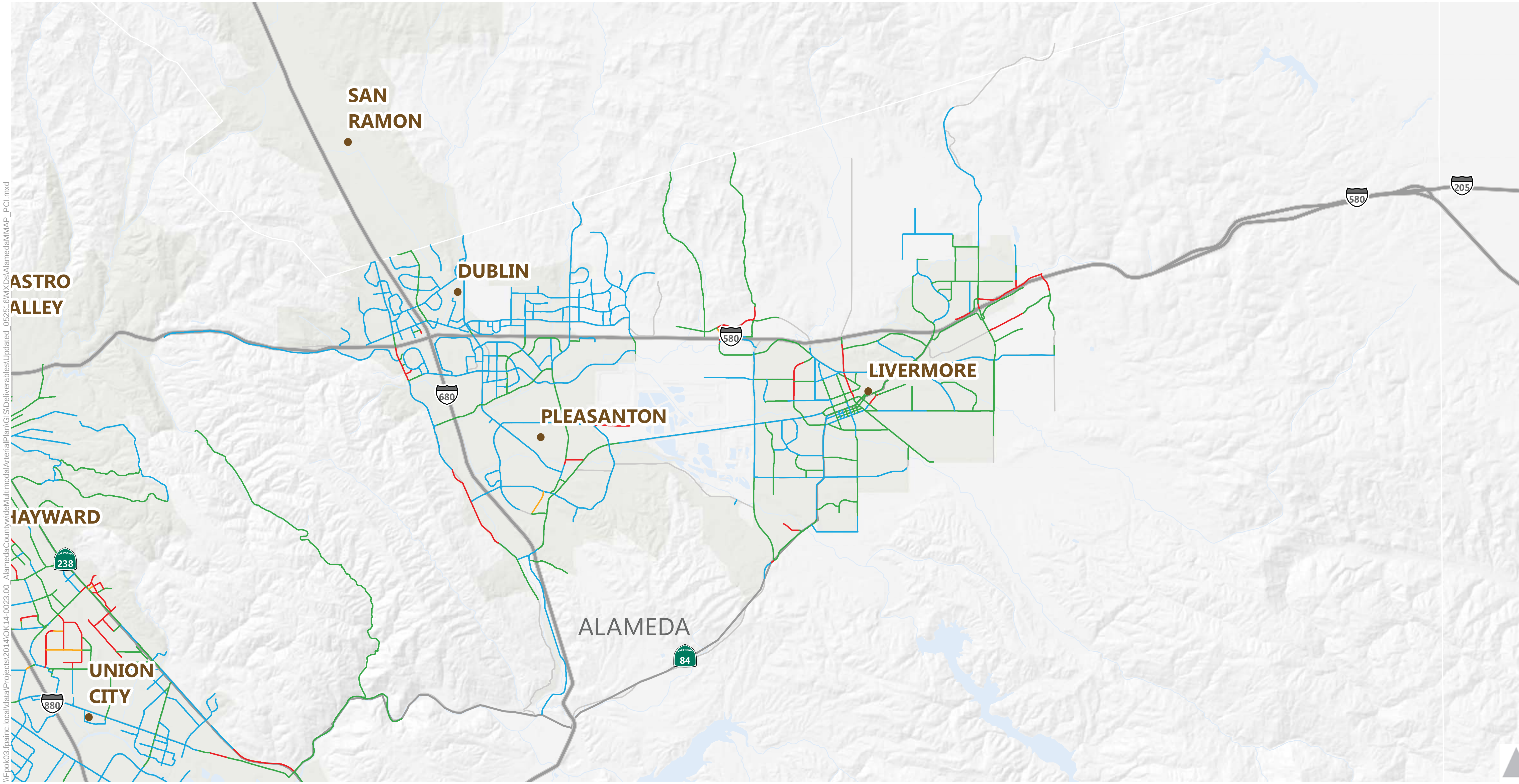
Alameda Countywide Multimodal Arterial Plan

\\Fpok03.fpainc.local\data\Projects\2014\OK14-0023.00_AlamedaCountywideMultimodalArterialPlan\GIS\Deliverables\Updated_052516\MXDs\AlamedaMMAP_PCI.mxd

ALAMEDA County Transportation Commission

Figure 1D

Pavement Condition Index (PCI) Ratings - Existing Conditions - South County



Pavement Condition Index Rating

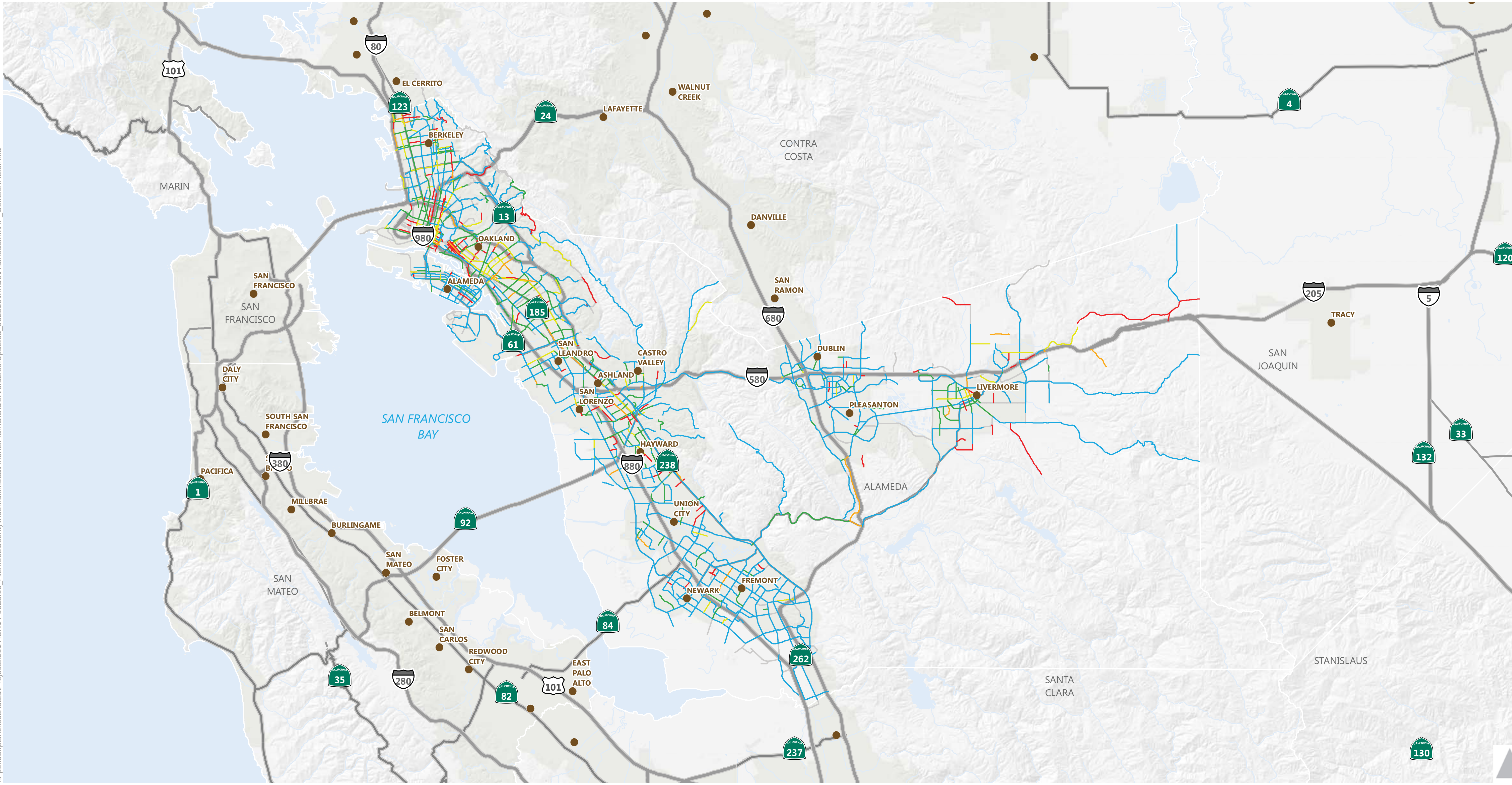
- At Risk
- Poor
- Good
- Very Good

Alameda Countywide Multimodal Arterial Plan

ALAMEDA County Transportation Commission

Figure 1E

Pavement Condition Index (PCI) Ratings - Existing Conditions - East County



\\Fpok03.fpainc.local\data\Projects\2014\OK14-0023.00_AlamedaCountywideMultimodalArterialPlan\GIS\Deliverables\Updated_052516\MXDs\AlamedaMMAP_CollisionRate.mxd

Collision Rates

- < 1.0
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

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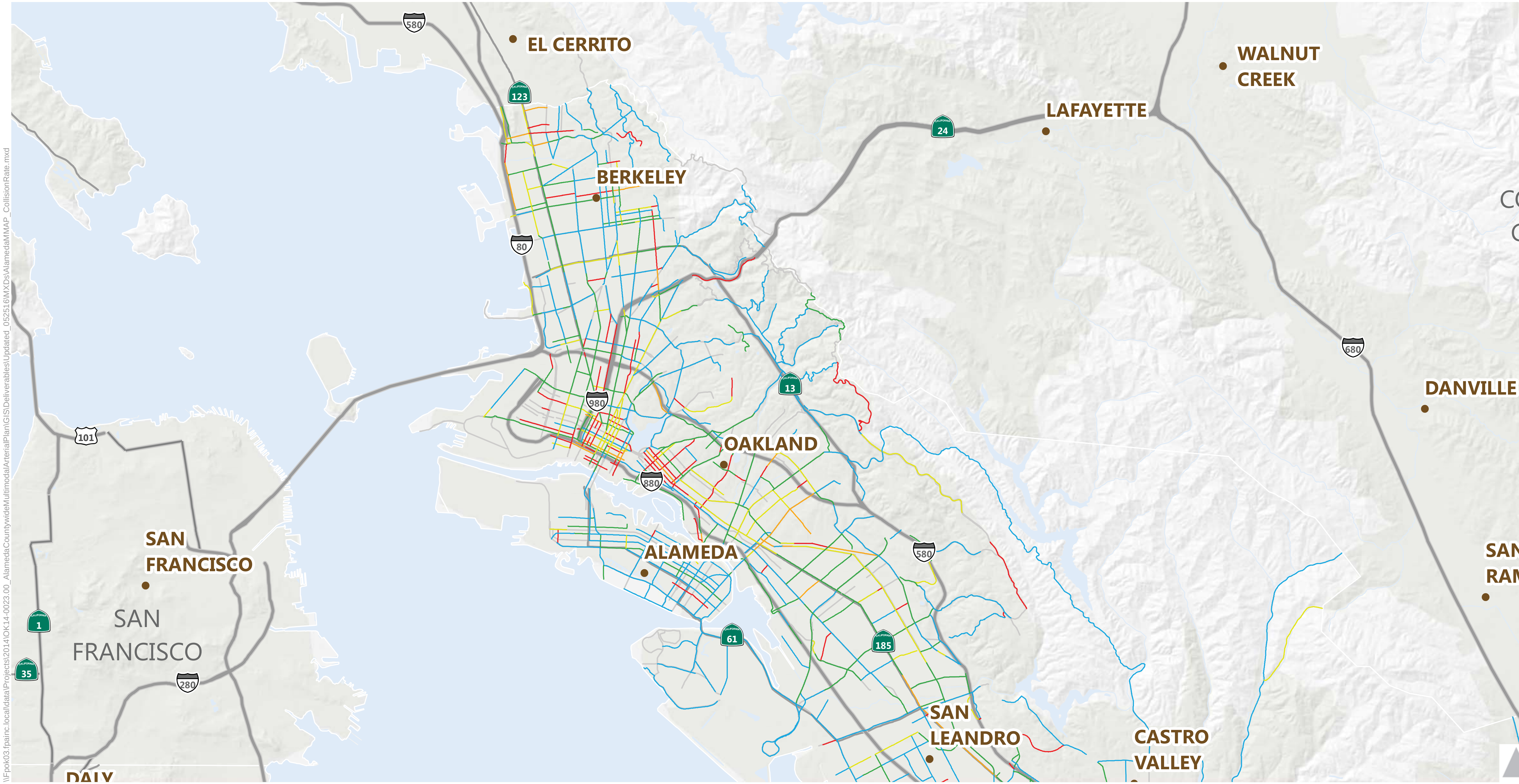
Alameda Countywide Multimodal Arterial Plan

Figure 2A

Collision Rates (2009-2012) - Alameda County



Collision Rates

- < 1.0
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

Alameda Countywide Multimodal Arterial Plan

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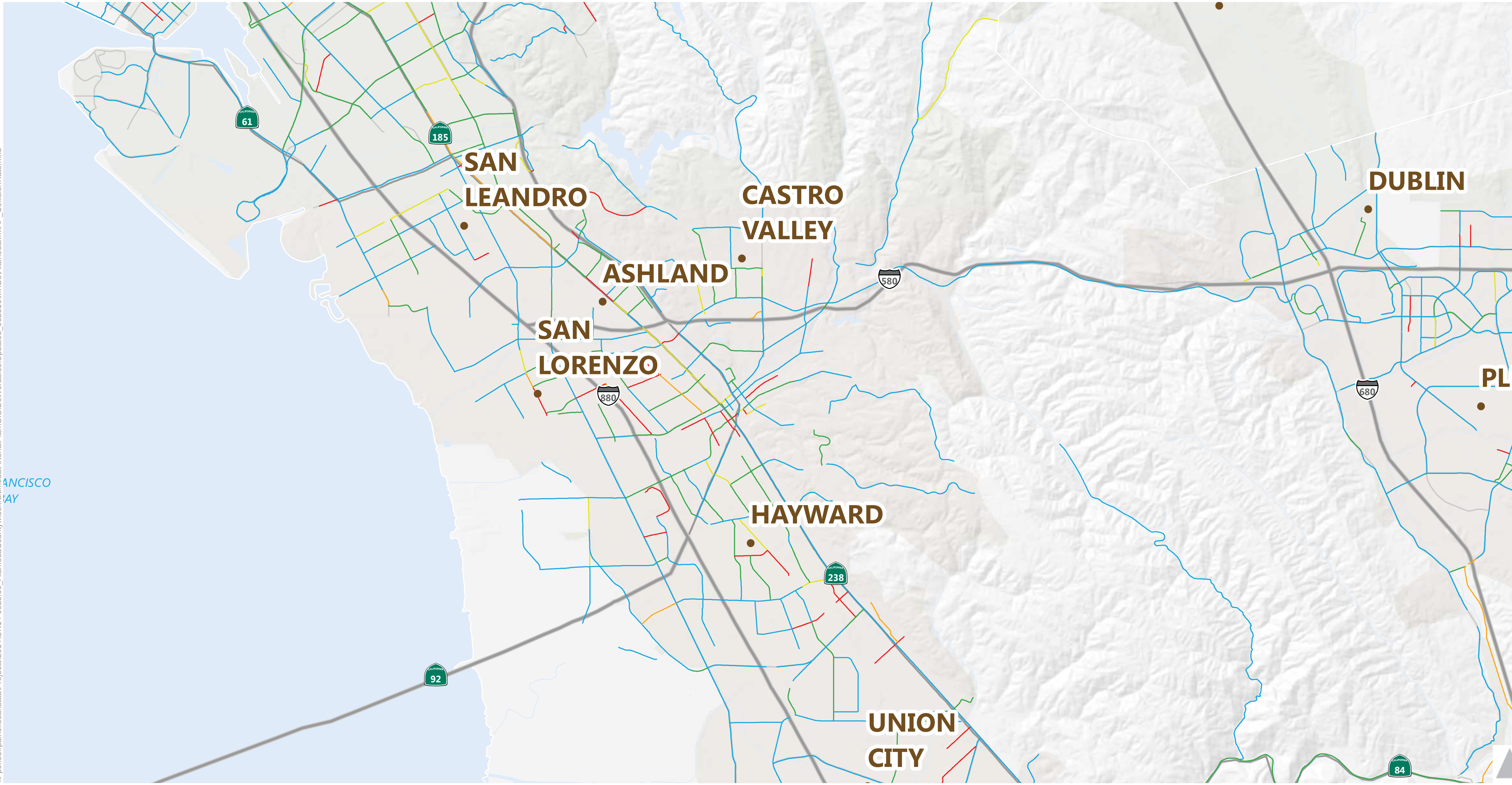
Figure 2B

Collision Rates (2009-2012) - North County



Collision Rates

- < 1.0
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

Alameda Countywide Multimodal Arterial Plan

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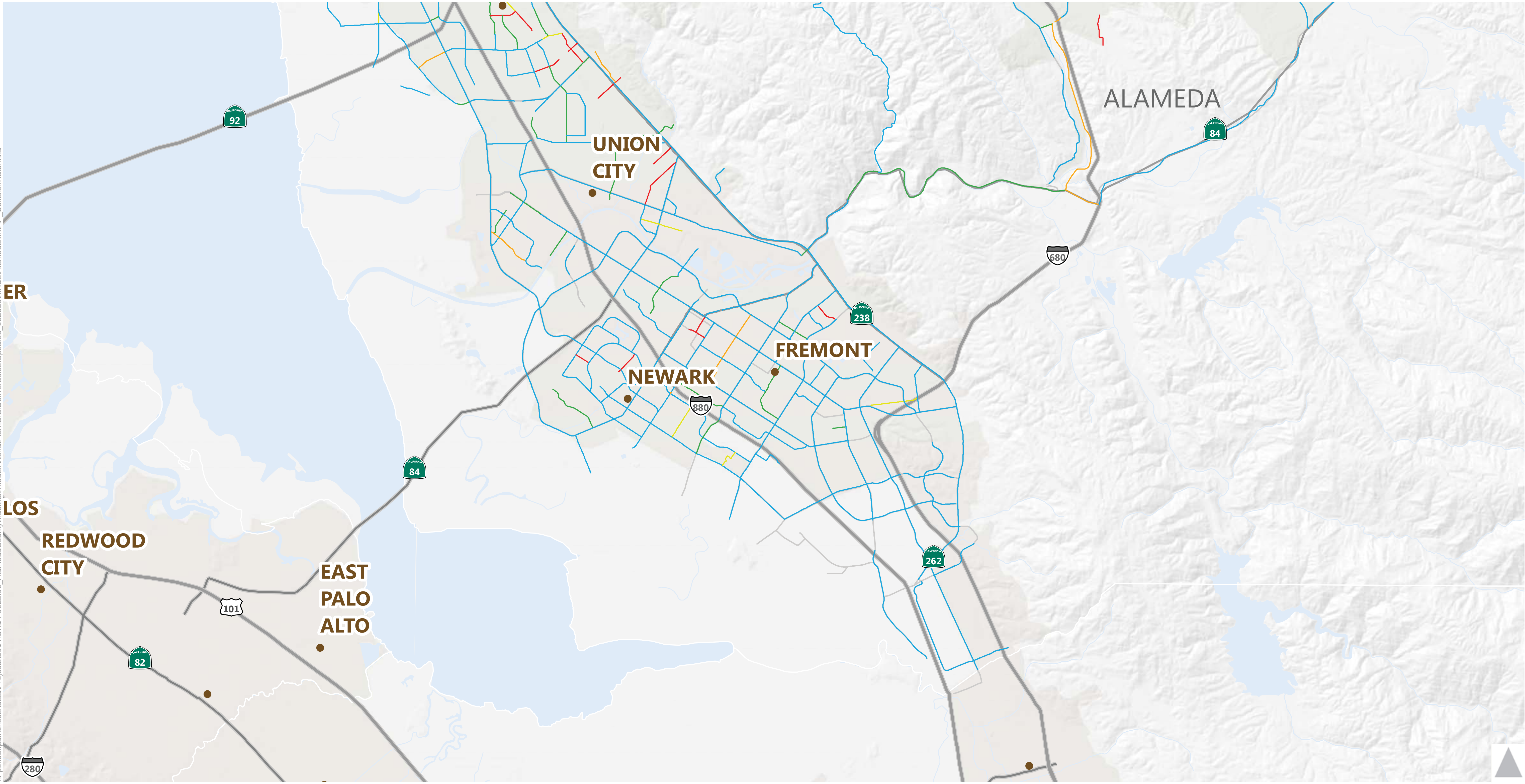
Figure 2C

Collision Rates (2009-2012) - Central County



Collision Rates
- < 1.0
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

\\Fpok03.fpainc.local\data\Projects\2014\OK14-0023.00_AlamedaCountywideMultimodalArterialPlan\GIS\Deliverables\Updated_052516\MXDs\AlamedaMMAP_CollisionRate.mxd

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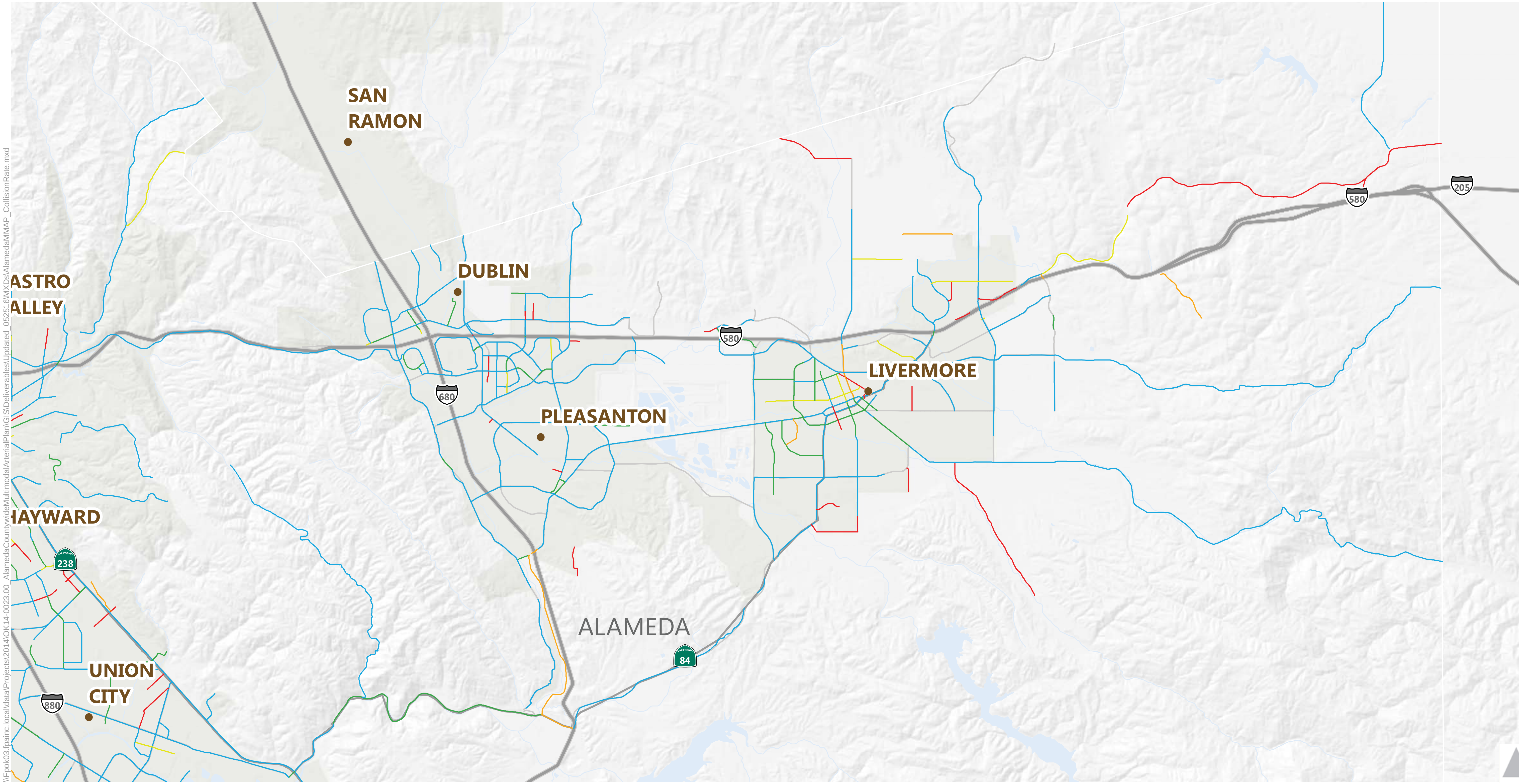
Figure 2D

Collision Rates (2009-2012) - South County



Collision Rates

- < 1.0
- 1 - 2
- 2 - 3
- 3 - 4
- > 4.0

Alameda Countywide Multimodal Arterial Plan

ALAMEDA County Transportation Commission

Figure 2E

Collision Rates (2009-2012) - East County

Appendix 2.2.1
Performance Objectives Memo

MEMORANDUM

Date: June 15, 2015

To: Saravana Suthanthira, Alameda CTC

From: Francisco Martin and Matthew Ridgway, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan – Final Performance Measure Objectives

OK14-0023

The Alameda Countywide Multimodal Arterial Plan's performance measures are derived from the Plan's vision and goals. The performance measures will be utilized to evaluate existing and future year multimodal transportation conditions across the County for the Plan's Study Network[1], which is a broader countywide street network that represents all arterial and collector streets throughout the County using Caltrans' California Road System (CRS) classification. Performance measures were approved by the Alameda CTC Commission on February 26, 2015.

The performance objectives, or thresholds for the performance measures, were developed as a subsequent step after performance measures were approved. The performance objectives will be applied to existing and future year conditions to identify Study Network needs and provide guidance in identifying short-term (year 2020) and long-term (year 2040) improvements to adequately address those needs. Performance measures in combination with the performance objectives will ensure that the proposed short-term and long-term improvements meet the Plan's vision and goals. This memo summarizes the Multimodal Arterial Plan's performance measure planning framework and presents the final performance objectives. The draft performance objectives were presented to ACTAC at the April 9, 2015 meeting and at each of the Planning

[1] The Study Network consists of the arterials and collectors that are part of the California Road System classification that was sent to all Alameda County jurisdictions for review and to support data collection in December 2014.

Area meetings that took place during the week of April 20, 2015. The performance objectives presented in this memo are considered final and will go for ACTAC and Commission approval in September 2015.

A brief summary of the role and utility of various Plan development components is provided in **Table 1**, additional information for each of the components is also provided in the proceeding section.

TABLE 1
ROLE AND UTILITY OF MULTIMODAL ARTERIAL PLAN COMPONENTS

Plan Development Components	Utility	Approval Status
Vision and Goals	The vision lays out the strategic direction for the Plan; goals describe the desired outcome of the Plan.	Approved by Commission on February 26, 2015
Performance Measures	Performance measures assess the existing and future year transportation conditions of the Study Network against the identified goals. These performance measures include three types of measures: Performance Measures; Performance Indicators; and Network Connectivity Checks. • *Performance Measures* – Measures that directly assess the built environment and planning level operations at the facility-specific scale, and thus provide the direct assessment of a roadway facility on Study Network multimodal gaps and needs. • *Performance Indicators* –These are area-wide performance measures and are generally applied after preferred short- and long-term improvements are identified for the Arterial Network to evaluate and to ensure that the preferred improvements achieve the Plan's vision and goals. • *Network Connectivity Checks* - Network connectivity checks are performed as a mapping exercise that evaluates the transit infrastructure, pedestrian comfort, bicycle comfort and truck route accommodation measures for consistency across the respective modal networks.	Approved by Commission on February 26, 2015
Performance Objectives	These are thresholds identified for the performance measures that directly assess the built environment and planning level operations at the facility-specific scale. Performance objectives are applied to the performance measure assessment of existing and future year transportation conditions to determine Study Network gaps, deficiencies and needs. Performance objectives vary depending on the modal priority along a Study Network segment.	Pending Commission Approval – May/June 2015

TABLE 1
ROLE AND UTILITY OF MULTIMODAL ARTERIAL PLAN COMPONENTS

Plan Development Components	Utility	Approval Status
Typologies	Typologies classify the Study Network roads based on their transportation and access functions, and land use characteristics of the roads. They help identify the modal priorities along each Study Network segment. In addition, typologies inform the Arterial Network[1] selection criteria.	Pending Commission Approval – June 2015

1. The Arterial Network is the subset of the Study Network representing *arterials of countywide significance*.

PERFORMANCE MEASURES AND PLANNING FRAMEWORK

The Multimodal Arterial Plan planning framework and how performance measures in combination with performance objectives will be used to identify short and long-term improvements is described below.

TASKS COMPLETED OR IN PROGRESS

1. Performance Measures are derived from the Plan's goals, which are in turn derived from the Plan's vision. The Plan's vision, goals and performance measures were approved by the Commission on February 26, 2015.
2. In late 2014, the project team identified the "Study Network;" this network includes available parallel facilities of other modes (e.g. bike and truck routes). The Study Network will support data collection, assessment of existing and future conditions, and typology development.
3. In February of 2015, the ACTAC and the Commission reviewed the draft criteria to identify Arterials of Countywide Significance (Arterial Network). No changes were requested; therefore, using this set of criteria, the Arterial Network will be developed in July and presented to the ACTAC in August and to the Commission in October for approval. The Arterial Network will be used to develop the list of preferred improvements.
4. Draft roadway typologies[2] were developed for the Study Network. Typologies are descriptive of a roadway's transportation function, land use context, and modal emphasis.

[2] The roadway typology framework is described in a separate memo titled "Alameda CTC Countywide MMAP: Draft Arterial Street Typology Framework Concepts," and will also be presented to ACTAC and at the Planning Area meetings in April.

Modal priority for transit and trucks will be coordinated with the Countywide Transit and Goods Movement Plans that are currently underway. Modal priorities were vetted during the Planning Area meetings in April 2015 and will be brought for ACTAC and Commission approval in September 2015.

5. Modal priorities will inform the performance objectives by segment/corridor as different modal priorities can potentially result in different performance objectives. Performance objectives are described in the following section of this memo.

UPCOMING TASKS

6. The performance objectives will be applied to the performance measure assessment of existing and future year transportation conditions to determine network gaps, deficiencies and needs.
7. Recommended multi-modal transportation improvements will be identified to adequately address short (2020) and long-term (2040) Study Network multimodal needs. Network connectivity checks will be conducted for each mode at this stage to ensure that identified recommended improvements provide an adequate and supportive network for all modes; connectivity checks will be performed as a mapping exercise that evaluates the transit infrastructure, pedestrian comfort, bicycle comfort and truck route accommodation measures for consistency across the respective modal networks. For Study Network segments with multiple modal priorities, preference for recommended improvements will be given to the top identified modal priority; additional improvements will be identified for other lower priority modes wherever possible.
8. The Consultant team will meet with each Alameda County jurisdiction and transit operators individually to review the recommended set of multi-modal transportation improvements; each jurisdiction will have the opportunity to review and refine the set of recommended improvements, which will lead to identifying the preferred set of improvements for the Arterials Network. Since the Arterial Network is the subset of the Study Network, the recommended improvements identified for the Arterial Network will be considered as the preferred set of improvements for the Arterial Network.
9. After preferred improvements are identified, the project team will utilize the following area-wide performance indicators to ensure that the list of identified preferred improvements achieves these various elements of the Plan's vision and goals and the results of these indicators will revise the list of preferred improvements as necessary:
    a. Equity: The benefit to Communities of Concern performance indicator ensures that recommended improvements are equitable throughout the County.

b. Property value index: The property value index ensures that recommended improvements support a strong economy.
c. Demand for active transportation: The demand for active transportation performance indicator will identify the potential mode shift to active transportation modes.
d. VMT per capita and GHG per capita performance indicators: The VMT and GHG per capita indicators will help ensure that recommended improvements have a positive impact on emissions throughout the County.

10. Prioritization criteria[3] will be developed in coordination with stakeholders to prioritize the list of preferred short and long-term improvements to be included in the Final Multimodal Arterial Plan.
11. The project team will develop a set of ITS, climate action, and TDM strategies that are complimentary to the list of preferred short and long-term improvements.

As described above, performance measures and objectives play a critical role in developing the Plan and identifying the preferred set of short and long-term improvements.

APPROVED PERFORMANCE MEASURES

Performance measures will be applied to assess existing and/or future year transportation conditions. These measures also include area-wide performance indicators (non-auto mode share, benefit to Communities of Concern, demand for active transportation, VMT and GHG per capita). These indicators by themselves do not evaluate existing or future conditions to identify gaps or deficiencies, but provide an evaluation of the network or facility for a comparative assessment of the proposed improvements against the Plan's vision and goals. Therefore, these area-wide indicators will be generally applied after preferred short- and long-term improvements are identified for the Arterial Network to evaluate and to ensure that the preferred improvements achieve the Plan's vision and goals. Similarly, facility-specific performance indicators such as operating cost effectiveness, implementation challenge score and property value index will be applied after short- and long-term improvements are identified.

[3] Short and long-term improvement prioritization criteria will be developed and presented to stakeholders later in the Plan development process. All stakeholders will have an opportunity to review and provide feedback on the prioritization criteria before the criteria are finalized.

PROPOSED PERFORMANCE OBJECTIVES

As previously mentioned, modal priorities will inform the performance objectives as different modal priorities can potentially result in different objectives to determine if an arterial study segment is performing adequately to suit the multimodal needs. A particular objective identified for a performance measure related to a mode is the minimum threshold that needs to be met for that measure if that particular mode has the priority on that arterial segment. For example, the Bicycle Comfort Index identifies four different ratings, ranging from Level of Traffic Stress 1 (LTS1) to LTS4 (LTS1 representing "Very Good" comfort level for cyclists). If a Study Network segment is identified as having a bicycle modal priority, the performance measure objective would be to achieve an LTS1 (Very Good) or LTS2 (Good) rating. If the segment is not identified as having a bicycle modal priority, a Bicycle Comfort Index performance objective does not apply and therefore it's assumed that any rating - LTS1, LTS2, LTS3 or LTS4 - is adequate for that specific segment.

Table 2 presents the proposed performance objectives for performance measures that are facility-specific and apply to existing conditions. Performance measures for no objectives were developed are included in the next section of this memo. In order to have a comparable rating system, the scores were translated into an equivalent qualitative rating scale (e.g., very good, good, poor, etc.) for several performance measures. Performance objectives are identified for measures that directly assess the built environment and planning level operations at the facility-specific scale, and thus provide the direct assessment of a roadway facility on Study Network multimodal gaps and needs. The following are those measures, and are related to the "Multimodal" goal.

- 1.1A – Congested Speed
- 1.1B – Reliability
- 1.2A – Transit Travel Speed
- 1.2B – Transit Reliability
- 1.2C – Transit Infrastructure Index
- 1.3 – Pedestrian Comfort Index
- 1.4 – Bicycle Comfort Index
- 1.5 – Truck Route Accommodation Index

All stakeholders had an opportunity to review and refine the draft performance objectives during the April 9, 2015 ACTAC meeting and during the second set of Planning Area meetings held the week of April 20, 2015. The following performance objectives were adjusted based on comments received on the draft objectives:

- 1.1A – Congested Speed objective was adjusted to not apply to transit priority corridors since a transit speed (measure 1.2A) objective is also applied to transit priority corridors.
- 1.2A Transit Travel Speed objective was increased to be greater than 75% of the auto congested speed (measure 1.1A) based on requested changes from AC Transit.
- 1.2B Transit Reliability objective was increased to be greater than a 0.7 PM peak hour-to-non-peak hour transit speed ratio based on requested changes from AC Transit.

This memo presents the final performance objectives to be brought to the ACTAC and Commission for approval in September 2015. The basis for establishing each of the objectives is described below.

TABLE 2
MULTIMODAL ARTERIAL PLAN PERFORMANCE OBJECTIVES

Performance Measure	Application	Modal Objectives[1]				
		Autos	Transit	Pedestrian	Bicycle	Trucks
1.1A – Congested Speed	Facility-Specific Measure, Existing and Future Conditions	Greater than 40% of Posted Speed Limit	*	*	*	Greater than 40% of Posted Speed Limit
1.1B – Reliability	Facility-Specific Measure, Existing and Future Conditions	Reliable	*	*	*	Reliable
1.2A – Transit Travel Speed	Facility-Specific Measure, Existing and Future Conditions	*	Greater than 75% of the Auto Congested Speed (Measure 1.1A)	*	*	*
1.2B – Transit Reliability	Facility-Specific Measure, Existing and Future Conditions	*	Greater than 0.7 *(PM peak hour-to-non-peak hour transit speed ratio)*	*	*	*
1.2C – Transit Infrastructure Index	Facility-Specific Measure, Existing and Future Conditions	*	Medium or High	*	*	*
1.3 – Pedestrian Comfort Index	Facility-Specific Measure, Existing and Future Conditions	**	Medium, High or Excellent	High or Excellent	*	*
1.4 – Bicycle Comfort Index	Facility-Specific Measure, Existing and Future Conditions	**	*	*	High or Excellent	*

TABLE 2
MULTIMODAL ARTERIAL PLAN PERFORMANCE OBJECTIVES

Performance Measure	Application	Modal Objectives[1]				
		Autos	Transit	Pedestrian	Bicycle	Trucks
1.5 – Truck Route Accommodation Index	Facility-Specific Measure, Existing and Future Conditions	*	*	*	*	High

Notes:
1. The asterisk (*) indicates that a performance objective is not applicable for that specific modal priority. Although a performance objective does not apply, it does not imply that the needs assessment will neglect recommended improvements that can better measure performance results and thus enhance the built environment for modes without applicable performance objectives.
2. The double asterisk (**) indicates that that a performance objective is not applicable for that specific modal priority. In addition, sidewalk width reduction or bicycle facility removal will not be considered along auto priority Study Network segments even to meet the set thresholds.

Source: Fehr & Peers, 2015.

EXCEPTIONS FOR IDENTIFYING PERFORMANCE OBJECTIVES

In addition to the facility-specific performance measures, there are a number of performance indicators that will be used later in the project to assure that project vision and goals are met. ***Performance indicators by themselves do not evaluate existing or future conditions to identify a gap or deficiency, but provide a measurement of the network or facility for a comparative assessment of the proposed improvements against the existing conditions.*** Therefore, identifying objectives for indicators are not applicable and therefore not proposed. Similarly, performance objectives are not identified for the network connectivity measures, coordinated technology or collision rates. Network connectivity measure will be conducted as a mapping exercise that evaluates the transit infrastructure, pedestrian comfort, bicycle comfort and truck route accommodation measures for consistency across the respective modal networks. The coordinated technology measure provides an inventory of available and proposed ITS infrastructure along the Study Network, coordinated technology results will be used to inform ITS improvements and strategies recommended as part of the Plan. Collision rates provide a facility-specific assessment of exiting conditions and the results will potentially be used to prioritize short and long-term improvements later in the Plan development process. The following are the indicators and measures for which identifying objectives is not applicable:

- 1.6 – Enhanced Mobility
- 1.7 – Pavement Condition Index
- 2.1 – Benefit to Communities of Concern
- 3.1 – Transit Connectivity
- 3.2 – Pedestrian Connectivity
- 3.3 – Bicycle Connectivity
- 3.4 – Network Connectivity
- 4.1 – Operating Cost Effectiveness
- 4.2 – Implementation Challenge Score
- 4.3 - Coordinated Technology
- 4.4 – Property Value Index
- 5.1 – Collision Rates
- 5.2 – Demand for Active Transportation

BASIS FOR PERFORMANCE OBJECTIVES

Jurisdictions within Alameda County generally do not have adopted performance objectives for the approved performance measures listed in **Table 2**. As a result, the consultant team based performance objectives on previous planning projects that utilized similar measures; if reference projects were not applicable the consultant team applied relevant research to identify appropriate objectives. The basis for each performance objective is described below.

1.1A – Automobile Congested Speed

Automobile congested travel speed will be estimated for Existing and Future Year PM Peak hour conditions. The *2014 Level of Service Monitoring Report* (Alameda CTC, November 2014) applies the HCM 2000 arterial LOS methodology to assess CMP-arterial segment LOS during the PM peak hour. The methodology's LOS thresholds are shown in **Table 3**. According to the methodology, an average speed that is generally greater than 40% of the typical free flow speed corresponds to LOS D or better conditions. Based on this assessment, *the automobile congested speed performance objective is proposed to be greater than 40% of the posted speed limit*. This objective applies to auto and truck priority corridors only.

1.1B – Automobile Reliability

The automobile reliability measure is based on the PM peak hour volume-to-capacity (V/C) assessment, which corresponds to the following measure ratings:

- Reliable (V/C between 0 – 0.8)
- Less Reliable (V/C between 0.8 – 1.0)
- Unreliable (V/C greater than 1.0)

The 1994 HCM provides V/C LOS methodology for arterials; later versions of the HCM provide arterial segment LOS methodologies based on travel speed and not V/C ratio. Based on Table 7-1 in the 1994 HCM, a V/C ratio of 0.79 or lower corresponds to LOS D or better conditions along an arterial with four or more travel lanes. Based on this assessment, *the automobile reliability performance objective is proposed to be lower than a V/C ratio of 0.8, which generally corresponds to LOS D, which is identified to be of rating "Reliable"*. This objective applies to auto and truck priority corridors only.

TABLE 3
ARTERIAL LOS, HCM 2000

Arterial Class	I	II	III	IV
Range of Free Flow Speed (mph)	55 to 45	45 to 35	35 to 30	35 to 25
Typical Free Flow Speed (mph)	50	40	35	30
Level of Service	**Average Travel Speed (mph)**			
A	>42	>35	>30	>25
B	>34-42	>28-35	>24-30	>19-25
C	>27-34	>22-28	>18-24	>13-19
D	>21-27	>17-22	>14-18	>9-13
E	>16-21	>13-17	>10-14	>7-9
F	≤16	≤13	≤10	≤7

Source: Exhibit 15-2, HCM 2000.

1.2A Transit Travel Speed

Transit travel speed will be estimated for Existing and Future Year PM Peak hour conditions utilizing data provided by transit agencies. The *Transit Capacity and Quality of Service Manual* (TCQSM, TRB, 3rd Edition, 2013) was reviewed for applicable performance objectives related to transit speed. No applicable performance objective was identified in the TCQSM. Instead, AC Transit provided their recommended objective based on the average transit speed data along the major corridors. According to AC Transit, *a performance objective that transit travel speed is at least 75% of the auto congested speed* (measure 1.1A) was assumed to be adequate. This objective applies to transit priority corridors only.

1.2B Transit Reliability

The transit reliability metric is estimated by comparing PM peak hour transit travel speed to non-peak hour speed based on data provided by transit agencies. The *Transit Capacity and Quality of Service Manual* (TCQSM, TRB, 3rd Edition) was reviewed for applicable performance objectives related to transit reliability, which for this plan is defined as the PM peak hour-to-non-peak hour transit speed ratio. No applicable performance objective was identified in the TCQSM. Instead, AC Transit provided their recommended objective based on the average transit reliability data along the major corridors. AC Transit suggested *a performance objective that transit reliability should be greater than a PM peak hour-to-non-peak hour transit speed ratio of 0.7*. This objective applies to transit priority corridors only.

1.2C Transit Infrastructure Index

The transit infrastructure index score is based on the following factors: bus stop amenities, bus stop location, and bus stop design. The measure applies a 10-point scoring system that corresponds to the following rating:

- 0 – 5 points = Low
- 6 – 7 points = Medium
- 8 – 10 points = High

The proposed transit infrastructure index objective is based on previous planning projects that utilized a similar measure. For example, Fehr & Peers is currently part of the team developing the *Ashland-Cherryland Business District Specific Plan* in unincorporated Alameda County. Fehr & Peers applied a similar multi-modal performance measure for the specific plan development in which *the objective was to achieve a rating of "Medium" or "High" (at least 6 out of 10 on the scoring system)* along the E. 14th Street/Mission Boulevard transit corridor. The same performance objective is proposed for the Multimodal Arterial Plan development for the transit priority corridors.

1.3 Pedestrian Comfort Index

The pedestrian comfort index score is based on factors such as sidewalk width, presence of buffer between sidewalk and roadway, roadway classification, percent heavy vehicle traffic and land use context. The measure applies a 24-point scoring system that corresponds to the following rating:

- 0 – 7 points = Low
- 8 – 14 points = Medium
- 15 – 20 points = High
- 21 – 24 points = Excellent

The proposed pedestrian comfort index objective is based on previous planning projects that utilized a similar measure. As previously mentioned, Fehr & Peers is currently part of the consultant team developing the *Ashland-Cherryland Business District Specific Plan* in unincorporated Alameda County. Fehr & Peers applied a similar multi-modal performance measure for the specific plan development in which *the objective was to achieve a rating of "High" or "Excellent" (at least 15 out of 24 on the scoring system)* along roadways within the plan area. The same performance objective is proposed for the Multimodal Arterial Plan development and applied to pedestrian priority segments only. A performance objective of Medium, High or Excellent (at least 8 out of 24 on the scoring system) rating is also proposed for transit priority corridors to achieve a minimum pedestrian design standard for transit patrons that walk to and from bus stops.

1.4 Bicycle Comfort Index

The bicycle comfort index is based on the Level of Traffic Stress (LTS) methodology (Mineta Transportation Institute, May 2012) that examines the characteristics of streets and how various aspects can cause stress on bicyclists and affect where they are likely to ride. LTS methodology classifies roadway segments into one of four levels of traffic stress, which are termed as LTS1 through LTS4. Groups of cyclists are categorized by how much stress they will tolerate in different environments:

- LTS1: most children can tolerate and feel safe while bicycling.
- LTS2: the mainstream adult population will tolerate and feel safe while bicycling.
- LTS3: cyclists who are considered "enthused and confident" but still prefer having their own dedicated space for riding will tolerate and feel safe while bicycling.
- LTS4: a level tolerated only by those characterized as "strong and fearless", which comprises just 0.5 percent of the population. The high-stress streets that LTS4 groups will ride are those with high speed limits, multiple travel lanes, limited or non-existent bike lanes and signage, and large distances to cross at intersections.

For simplicity, the LTS results correspond to the following rating:

- LTS1 = Excellent
- LTS2 = High
- LTS3 = Medium
- LTS4 = Low

The proposed bicycle comfort index objective is based on previous planning projects that utilized a similar measure. As previously mentioned, Fehr & Peers is currently part of the consultant team developing the *Ashland-Cherryland Business District Specific Plan* in unincorporated Alameda County. Fehr & Peers applied a similar multi-modal performance measure for the specific plan development in which *the objective was to achieve a rating of "High" or "Excellent"* along roadways within the plan area. The "High" or "Excellent" rating corresponds to an LTS2 or LTS1 score, respectively. A "High" (LTS2) rating implies that the mainstream adult population can tolerate the design of the facility and feel safe while bicycling, a "Excellent" (LTS1) rating implies that most children can tolerate the design of the facility and feel safe while bicycling. The same performance objective is proposed for the Multimodal Arterial Plan development and applied to bicycle priority segments only.

1.5 Truck Route Accommodation Index

The truck route accommodation index score is based on curb lane width; additional consideration for on-street parking will be made only in urban contexts where many businesses are expected to load from the street. The measure applies a four-point scoring system that corresponds to the following rating scores:

- 0-1 point = Low
- 2 points = Medium
- 3 - 4 points = High

One point is assigned if curb lane width is 10 feet or less, two points are assigned if the curb lane width is 11 feet, three points are assigned if the curb lane width is 12 feet or greater. One point is assigned for roadways in urban areas that provide on-street parking; a negative point is assigned if on-street parking is not provided. For purposes of the truck route accommodation index analysis, it is assumed that all jurisdictions within the North and Central County Planning Areas are urban and all jurisdictions within the South and East County Planning Areas are suburban. On-street parking is not considered in the suburban areas since many business typically provide off-street loading facilities for trucks; urban areas generally have limited off-street loading facilities and therefore many trucks are forced to access business by utilizing on-street parking if available. Performance measures similar to the truck route accommodation index have not been applied in other similar planning studies throughout the County; therefore relevant performance objectives are not available.

According to *A Policy on Geometric Design of Highways and Streets* (AASHTO, 2011), the recommended travel lane width ranges between 10 and 12 feet (not including curb, shoulder or on-street parking) for arterials in urban environments. The narrower the lane width, the higher the probability that trucks will off-track into adjacent lane or shoulder. Based on this logic, *a curb lane width of 12 feet or greater is preferred for the majority of truck routes, which corresponds to a "High" rating applying the truck route accommodation index*. This objective applies to truck priority corridors only.

NEXT STEPS

The consultant team and Alameda CTC staff will present the performance objectives for final approval at the September 2015 ACTAC, PPLC and Commission meetings.

Appendix 2.3.1
Needs Assessment Memo

FEHR & PEERS

MEMORANDUM

Date: February 22, 2016

To: Saravana Suthanthira, Alameda CTC

From: Francisco Martin and Matthew Ridgway, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan – Final Needs Assessment

OK14-0023

1. INTRODUCTION

The purpose of this memo is to present the existing and future (Year 2040) transportation conditions of the Countywide Study Network, in addition to identifying Study Network segments with a need for multimodal improvements. The memo describes the existing and planned future transportation infrastructure, including the arterial system, intelligent transportation systems (ITS) equipment, and bicycle, pedestrian, transit and goods movement facilities. The performance measure methods and evaluation of Study Network conditions to determine multimodal improvement needs are also described. The results contained in this memo serve as the basis for identifying proposed improvements, which are summarized in a separate memo.

2. NEEDS ASSESSMENT FRAMEWORK AND APPROACH

2.1 BACKGROUND

The Needs Assessment Evaluation builds on two preceding tasks that were submitted to all jurisdictions within Alameda County for review and comment during November 2015:

- Existing Conditions memo[1] – summarizes existing conditions performance measure evaluations along Study Network segments.
- Arterial Network memo[2] – presents the Arterial Network, which is a subset of the broad Study Network for focused identification and prioritization of improvements.

More information regarding tasks listed above is provided in the respective memos developed for each task.

2.2 APPROACH

The purpose of the Needs Assessment evaluation is to identify Study Network segments with a need for multimodal improvements. The Needs Assessment evaluation was conducted using the following process (outlined in **Exhibit 1**).

Step 1 – Existing Conditions

Existing Conditions data were collected and multimodal performance measures were evaluated along the Arterial Network[3].

Step 2 – Volume and Speed Forecast Development

Future year traffic volume and speed forecasts were developed using the Alameda Countywide Travel Demand Model (Alameda CTC Model) and existing traffic volumes.

Step 3 – Future Year (2020 and 2040) Conditions

Year 2020 and Year 2040 conditions multimodal performance measures were evaluated using data collected for existing conditions, future year traffic volume and forecasts, and assuming planned and funded roadway improvements.

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[1] More information provided in the memo titled *Alameda Countywide Multimodal Arterial Plan – Final Existing Conditions* (Fehr & Peers, December 4, 2015).

[2] More information provided in the memo titled *Alameda Countywide Multimodal Arterial Plan – Final Arterials of Countywide Significance (Arterial Network) Criteria and Map* (Fehr & Peers and CD+A, December 4, 2015).

[3] Readily-available data collected for use on the MAP was gathered from various sources, including data provided by public agency staff, the INRIX database (speed data), the Alameda CTC Travel Demand Model, aerial imagery, and SWITRS database (collision data). The data generally represents 2014 conditions. Detailed information on the data collection process is summarized in the Existing Conditions memo.

Step 4 – Performance Measure Objectives Evaluation

Multimodal performance measure objectives were applied to the existing and future year conditions evaluation to identify Arterial Network segments that do not meet the objectives.

Step 5 – Needs Assessment Evaluation

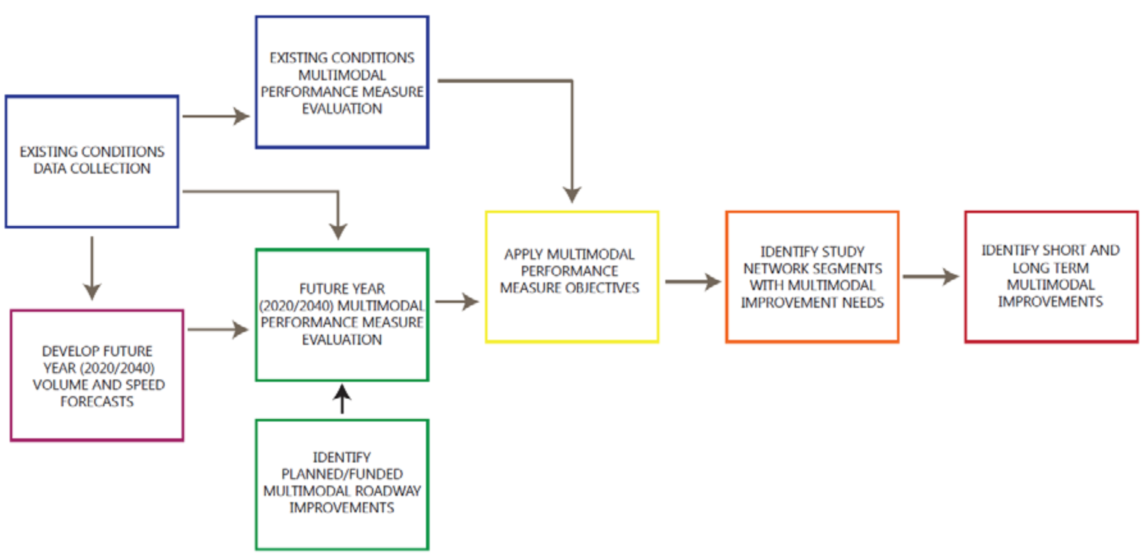
An Arterial Network segment is identified as having a need for improvement if performance of either of the top two modal priorities (developed earlier in the MAP development based on Typology framework) does not meet the performance objective.

Step 6 – Draft Proposed Improvements

Where a need is identified and improvement implementation is feasible, proposed improvements by mode are recommended.

Additional information regarding key components of the Needs Assessment evaluation methodology is provided below.

Exhibit 1 – Needs Assessment Framework



2.2.1 Approved Performance Measure, Objectives and Modal Priority

Approved performance measures and objectives were evaluated along all Study Network segments with available data. A particular objective identified for a performance measure related to a mode is the minimum threshold that needs to be met if that particular mode has a high priority along that Study Network segment. The Needs Assessment evaluation focused on the top two modal priorities along each segment to identify if the performance measure objectives were met[4]. A segment was identified as having a need for improvement if performance objectives were not met for either of the top two modal priorities.

The approved modal priorities inform which performance objectives are utilized to identify if there is a need for improvement along a segment; different modal priorities result in different objectives to determine if an arterial study segment is performing adequately to suit the multimodal needs. For example, the Bicycle Comfort Index identifies four different ratings, ranging from "Low" (Level of Traffic Stress 4) to "Excellent" (Level of Traffic Stress 1). If a Study Network segment was identified as having high bicycle modal priority (or top two in modal priority), the performance measure objective would be to achieve a High or Excellent rating. If the segment is not identified as having high bicycle modal priority, a Bicycle Comfort Index performance objective does not apply and therefore it is assumed that any Bicycle Comfort Index rating is adequate for that segment.

2.2.2 Future Year Volume and Network Assumptions

Year 2020 and 2040 Study Network performance was evaluated using future year traffic volume forecasts developed by Fehr & Peers. Detailed information regarding the forecast development process is summarized in the memo titled *Alameda Countywide Multimodal Arterial Plan Travel Demand Forecasting Results – Draft* (Fehr & Peers, August 21, 2015).

Performance measures were evaluated for future year conditions assuming planned and funded roadway network improvements. The list of funded improvements was primarily obtained from the 2012 *Alameda Countywide Transportation Plan* (Alameda CTC, June 2012).

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[4] Although the Needs Assessment is primarily evaluating improvement needs for the top two modal priorities, proposed improvements were also considered for lower priority modes only if there is enough right-of-way remaining to implement improvements. Presentation of information in the Needs Assessment for the highest two modes is intended to make the evaluation more digestible.

2.3 STUDY SCENARIOS

2.3.1 Study and Arterial Network

The MAP evaluates a 1,200 mile Study Network to understand existing and future roadway conditions and the function of the roads in supporting all modes and assess multimodal needs in a broader context. To identify and prioritize improvements, the MAP focuses on a core and subset, of approximately 510 miles, of the Study Network called the Arterial Network. This core network represents arterials of Countywide Significance and serves as the backbone of multimodal mobility throughout the County.

2.3.2 Analysis Scenarios

The MAP evaluates multimodal performance for Existing, Year 2020 and Year 2040 Conditions. The Year 2020 analysis was based on a single set of standard forecasts. The Year 2040 analysis considered three separate analysis scenarios:

- The **Standard Forecasting Scenario**,
- The **Social and Behavioral Trends Scenario**, which represents a supplemental forecasting scenario accounting for lower vehicle miles of travel (VMT) per capita associated with social and behavioral trends, and
- The **Next Generation Vehicle Scenario**, which represents a supplemental analysis scenario that will account for roadway capacity impacts associated with the expected increase of next generation vehicles within the vehicle fleet in Alameda County.

In addition to the standard forecasts analysis, the MAP evaluates two 2040 scenarios that capture travel behavior trends and impact of next generation vehicles that are not yet reflected in travel demand forecasting models, including the Alameda CTC Model. Current planning tools are mostly based on existing or near-term trends that do not fully capture changes in trends beyond the standard forecasting approach. The Social and Behavioral Trends Scenario analysis examines how volume forecasts generated by the Alameda CTC Model could reasonably change given changes in factors that influence travel behavior, and result in lower VMT. These factors include social and behavioral trends such as an increase in urban living, reduced auto ownership, and shifting lifestyle and generational travel preferences. Social and Behavioral Trends Scenario forecasts assumed the following traffic volume reductions by Planning Area compared to the Standard Forecasting Scenario:

- North County – five percent reduction.
- Central County – five percent reduction.
- South County – 10 percent reduction.
- East County – seven percent reduction.

The Next Generation Vehicle Scenario analysis captures the impact of next-generation vehicles (connected or autonomous in nature) to arterial per lane capacity; Next Generation Vehicle Scenario assumes a 20% increase in arterial capacity. It's important to note that these analysis scenarios are intended as a planning exercise – research on these trends is still in its infancy. For future year scenarios, approximate adjustments to the Standard Forecasting Scenario were used as much as possible in order not to give a false sense of precision. The supplemental analysis is intended to inform jurisdictions on the potential effects that either the Social and Behavioral Trends or Next Generation Vehicles Scenarios may have on future year transportation conditions.

For purposes of the MAP development, the two supplemental forecasting analysis scenarios with variants for demographic, economic, and technologic trends focus only on Year 2040 Conditions. Based on available research, Year 2020 Conditions will likely not have large changes due to these trends as it's too soon for these trends to result in significant changes. Furthermore, this Needs Assessment memo summarizes evaluation results for Existing and Year 2040 Conditions only. Year 2020 results will be used to prioritize short and long-term improvements.

2.3.3 Methodology Limitations

As with any planning-level analysis, assumptions are made to effectively evaluate a roadway network at this scale. The following presents a list of potential methodology limitations to be considered when reviewing Needs Assessment results:

- Cross-sectional measurements were made by utilizing readily-available online aerial imagery.
- Study segment lengths are an average of about 2,200 lineal feet and the representative sample segment (the segment for which analysis is conducted) is generally the most constrained portion of the study segment.
- Automobile and Transit Travel Speed forecasts were estimated by applying the Bureau of Public Roads (BPR) equation. The equation, shown below, estimates future year speed as a function of the Existing Conditions speed and future year volume-to-capacity ratio. Although use of traffic operations models are recommended to estimate future year

speed, the MAP's planning level approach to estimate future year speeds is adequate for an analysis of this scale. Generally, accuracy of speed estimates is lower for a planning level approach compared to estimating speeds using a traffic operations modeling approach.

BPR Equation: $$Future\ Year\ Speed = \frac{\text{Existing Speed}}{[1+0.15(\text{Future Year Volume–to–Capacity Ratio})^4]}$$

Readily-available online aerial imagery was the primary source for collecting cross-sectional measurements; images generally range between a few months to three years old. The majority of cross-sectional data was collected in February 2015. Therefore, if a jurisdiction implemented substantial roadway improvements within the last three years, it is possible that those improvements are not yet shown on readily-available aerial imagery. During the improvement identification phase, Fehr & Peers determined that several roadways were recently improved and the aerial imagery was updated after Existing Conditions cross-sectional measurements were collected in February 2015. Fehr & Peers updated the Year 2020 and 2040 cross-sectional database to reflect recent improvements; however, those updates were not made to the Existing Conditions database. As a result, the Needs Assessment evaluation between Existing and Future Year Conditions may not be consistent along the various segments that were recently improved. Note that the Year 2040 Needs Assessment results, which assume recently improved facilities, are the basis for identifying proposed improvements.

3. PERFORMANCE EVALUATION AND NEEDS ASSESSMENT

This section provides an overview of the performance measure and objectives evaluation for Existing and Year 2040 Conditions. Performance measures were evaluated along the Study Network with readily-available data; the segments were then assessed on whether the objectives are met for the top two modal priorities. A Study Network segment was identified as having a need for improvement if either of the top two prioritized modes did not meet the performance objective.

This memo summarizes the performance and Needs Assessment evaluation at the facility-specific level. After proposed improvements are finalized, the consultant team and Alameda CTC will package proposed improvements into individual projects along Arterial Network corridors later in the Plan development process.

3.1 EXAMPLE NEEDS ASSESSMENT DETERMINATIONS

Table 1 presents an overview of the Needs Assessment approach from development of Typology through determination of multimodal needs along four Study Network segments. Detailed information regarding the Typology and modal priority methodology was previously presented to all jurisdictions for review and comment; the methodology was approved by Alameda CTC and committees in October 2015. As shown in **Table 1**, the land use and Typology overlays provided the basis for identifying modal priorities. If a jurisdiction did not agree with the modal priority identified by applying the approved methodology, they had the option to override the suggested modal priority. The Needs Assessment evaluation focused on the top two modal priorities along each segment to identify if the performance measure objectives were met. A segment was identified as having a need for improvement if performance objectives were not met for either of the top two modal priorities.

TABLE 1
EXAMPLE NEEDS ASSESSEMNT DETERMINATION

Street Segment	Land Use Context Overlay	Street Type	Transit Overlay	Bicycle Overlay	Pedestrian Overlay	Truck Overlay	Modal Priority	Year 2040 Performance Objective Met for High Priority Modes?	Need for Improvement?
San Pablo Avenue between 20th Street and 27th Street (Oakland)	Downtown Mixed Use	Community Connector	Major Corridor	Class 3	Tier 1	None	1. Transit 2. Pedestrian 3. Bicycle 4. Automobile 5. Goods Movement	Transit: • Speed – Objective Not Met • Reliability – Objective Met • Transit Infrastructure Index – Objective Not Met Pedestrian: • Pedestrian Comfort Index – Objective Met	**Yes** – Transit Mode Improvements Needed
W. Tennyson Road between Tampa Avenue and Leidig Court (Hayward)	Residential and Commercial	County Connector	Local Route	Class 2	Tier 3	Tier 3	1. Pedestrian[1] 2. Bicycle 3. Automobile 4. Transit 5. Goods Movement	Pedestrian: • Pedestrian Comfort Index – Objective Not Met Bicycle: • Bicycle Comfort Index – Objective Not Met	**Yes** – Pedestrian and Bicycle Mode Improvements Needed
Paseo Padre Parkway between Peralta Boulevard and Grimmer Boulevard (Fremont)	Downtown Mixed Use	Community Connector	Local Route	Class 2	Tier 2	None	1. Pedestrian 2. Bicycle 3. Transit 4. Automobile 5. Goods Movement	Pedestrian: • Pedestrian Comfort Index – Objective Not Met Bicycle: • Bicycle Comfort Index – Objective Not Met	**Yes** – Pedestrian and Bicycle Mode Improvements Needed
Tesla Road between S. Livermore Avenue and S. Vasco Road (Alameda County)	Rural/Open Space	Community Connector	None	Class 2	None	Tier 3	1. Automobile[3] 2. Goods Movement 3. Bicycle 4. Pedestrian	Automobile: • Speed – Objective Met • Reliability – Objective Not Met Goods Movement: • Truck Infrastructure Index – Objective Met	**Yes** – Automobile Improvements Needed

Notes:
1. Applying the modal priority methodology along W. Tennyson Road in Hayward results in the following priority: Automobile, Goods Movement, Bicycle, Pedestrian and Transit. However, Hayward staff requested that the modal priority for W. Tennyson Road be changed to that listed in the table above.
2. Applying the modal priority methodology along Tesla Road in Alameda County results in the following priority: Goods Movement, Bicycle, Automobile and Pedestrian. However, Alameda County staff requested that the modal priority for Tesla Road be changed to that listed in the table above.

3.2 OVERVIEW OF FINDINGS

Key Needs Assessment findings by mode are presented below.

Transit Mode

The majority of high priority transit segments operate with PM peak hour transit speeds less than 75 percent of the Automobile Congested Speed under Existing Conditions, which do not meet the performance objective. Similarly, the majority segments do not meet the Transit Infrastructure Index objective, which is a measure of bus stop design and provided amenities.

The Transit Reliability objective, which compares the PM peak hour transit speed to non-peak hour transit speed, was met along all high priority transit segments within the South and East County Planning Areas. In contrast, about 30 percent of high priority transit segments in the North and Central County Planning areas did not meet the objective. Overall, the North and Central County Planning Areas have the greatest need for transit improvements compared to the South and East County Planning Areas.

Pedestrian Mode

The majority of high priority pedestrian segments within Alameda County meet the Pedestrian Comfort Index objective under Existing Conditions; about 25 percent of segments do not meet the objective at a countywide level. The Needs Assessment evaluation indicates that the South and East County Planning Areas have the greatest need for pedestrian improvements.

Bicycle Mode

The majority of high priority bicycle segments within Alameda County do not meet the Bicycle Comfort Index objective under Existing Conditions. Although all Planning Areas have a significant need for bicycle improvements, the Central, South and East County Planning Areas have the greatest need for improvements along high priority bicycle segments.

Automobile Mode

In regards to Automobile Congested Speed, the majority of high priority automobile segments operate with automobile speeds greater than 40 percent of the posted speed limit during the PM peak period (4:00 – 6:00 PM) under Existing Conditions, which meets the performance objective. About a third of high priority automobile segments in Alameda County operate at V/C ratios greater than 0.8 during the PM peak hour, which do not meet the Automobile Reliability objective. The Needs Assessment evaluation indicates that the Central County Planning Area has the greatest need for automobile improvements compared to the North, South and East County Planning Areas.

Goods Movement Mode

The majority of high priority goods movement segments within Alameda County provide a curb lane width of 12 feet or greater and thus meet the Truck Route Accommodation Index objective under Existing Conditions. The Needs Assessment evaluation indicates that the North County Planning Area has the greatest need for widening the curb lane width along high priority goods movement segments.

3.3 TRANSIT NEEDS ASSESSMENT EVALUATION

The Existing and Year 2040 transit performance evaluation was primarily based on the following performance measures:

- Transit Travel Speed, the performance objective is to achieve a PM peak hour transit speed greater than 75 percent of the automobile congested speed. The transit network for which PM peak hour transit speed data was collected represents 50% of transit network in Alameda County although it is only about 20 percent, or 240 miles, of the Study Network. **Table 2** presents a countywide summary of transit travel speed for each analysis scenario.
- Transit Reliability, which is a measure of the PM peak hour to non-peak hour transit speed ratio; the performance objective is to achieve a ratio greater than 0.7. Transit reliability was evaluated for about 20 percent, or 240 miles, of the Study Network. **Table 3** presents a countywide summary for this measure.
- Transit Infrastructure Index, which is a measure of typical bus stop design and provided amenities along a Study Network segment; the performance objective is to achieve High rating for Study Network segments along major transit corridors or a minimum Medium rating for segments along crosstown routes. Transit infrastructure index was evaluated for about 30 percent, or 360 miles, of the Study Network. **Table 4** presents a countywide summary for this measure.
- Pedestrian Comfort Index Rating, the performance objective is to achieve a Medium, High or Excellent rating along Study Network segments with high priority transit to

ensure adequate pedestrian access to and from bus stops. More information regarding the pedestrian performance evaluation is presented later in this memo.

The transit performance and Needs Assessment evaluation for Existing and Year 2040 Conditions is summarized below.

TABLE 2
ALAMEDA COUNTYWIDE TRANSIT TRAVEL SPEED SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments Operating Between 20 – 30 MPH	13%	9%
% of Segments Operating Between 10 – 20 MPH	54%	44%
% of Segments Operating Between 5 – 10 MPH	32%	44%
% of Segments Operating Less Than 5 MPH	1%	3%

Notes:
1. Countywide data coverage for Transit Travel Speed is 240 miles.

TABLE 3
ALAMEDA COUNTYWIDE TRANSIT RELIABILITY SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments Operating at Ratio Greater Than 0.8	51%	33%
% of Segments Operating at Ratio Between 0.6 – 0.8	47%	52%
% of Segments Operating at Ratio Between 0.4 – 0.6	2%	13%
% of Segments Operating at Ratio Less Than 0.4	0%	2%

Notes:
1. Countywide data coverage for Transit Reliability is 240 miles.

TABLE 4
ALAMEDA COUNTYWIDE TRANSIT INRASTRUCTURE INDEX SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments with High Rating	11%	16%
% of Segments with Medium Rating	35%	33%
% of Segments with Low Rating	54%	51%

Notes:
1. Countywide data coverage for Transit Travel Speed is 180 miles, which only evaluates segments along major transit corridors or crosstown routes.

3.3.1 Existing Conditions

As shown in the tables above, 87 percent of segments operate at average PM peak hour transit speed less than 20 MPH and 49 percent of the segments operate at a PM peak hour speed to non-peak hour speed ratio less than 0.8. Only 11 percent of transit-serving segments provide bus stop design that results in a High Transit Infrastructure Index rating. **Table 5** presents the performance objective summary for high priority transit segments along the Arterial Network, the resulting Existing Conditions map is provided in **Figure 1**.

As shown in **Table 5**, only 12 miles of high priority transit segments along the Arterial Network operate at a PM peak hour transit speed greater than 75 percent of the automobile speed. However, when compared to the non-peak hour transit speed, 83 miles of Arterial Network segments operate at a PM peak hour transit speed above 70% of the non-peak hour speed. This suggests that PM peak hour transit speeds are considerably lower compared to automobile speeds but not that much lower compared to non-peak hour transit speeds.

The Needs Assessment evaluation also suggests the need for bus stop design improvements as only 17 miles of high priority transit segments along the Arterial Network provide a High Transit Infrastructure Index rating. Most segments that serve major corridor and crosstown bus routes provide a Low or Medium Transit Infrastructure Index rating due to bus stops not providing either of the following design elements:

- Far-side stops,
- Bus bulb-outs, or

- Minimum 80 foot red curb and four foot sidewalks.

The majority of high priority transit segments provide adequate pedestrian facilities.

TABLE 5
ALAMEDA COUNTYWIDE TRANSIT PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objectives Along High Priority Transit Arterial Network Segments[1]		
	Existing	Year 2040 – Standard Forecasting Scenario	Net Difference
Transit Congested Speed	12 mi	21 mi	+9 mi
Transit Reliability	83 mi	56 mi	-27 mi
Transit Infrastructure Index	17 mi	27 mi	+10 mi

Notes:
1. Transit is considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 150 Arterial Network miles have high transit priority.

3.3.2 Year 2040 Conditions – Standard Forecasting Scenario

As shown in **Table 2** and **Table 3**, Transit Travel Speed and Transit Reliability are expected to decrease substantially under Year 2040 – Standard Forecasting Scenario compared to Existing Conditions. The decrease in Transit Travel Speed is primarily due to the increase in traffic demand along mixed flow travel lanes. The East Bay Bus Rapid Transit (BRT) project is assumed to be constructed by Year 2040, which will improve transit operations along Arterial Network segments that will be modified by the project. Overall, 21 miles of high priority transit segments along the Arterial Network are expected to meet the Transit Travel Speed objective, a nine mile increase compared to Existing Conditions, primarily attributed to the East Bay BRT and Line 51 Improvement projects, in addition to lower Automobile Congested Speeds (Transit Travel Speed objective is based on Automobile Congested Speed). In addition, about 56 miles of segments would not meet the Transit Reliability objective, a 27 mile decrease compared to Existing Conditions.

Transit Infrastructure Index results are expected to improve under Year 2040 Conditions due to planned and funded improvements, such as improvements along AC Transit's Line 51 route and the East Bay BRT project. Overall, planned improvements would improve bus stop design along 10 Arterial Network miles.

3.4 PEDESTRIAN NEEDS ASSESSMENT EVALUATION

The Existing and Year 2040 pedestrian performance evaluation was based on the Pedestrian Comfort Index rating. The performance objective is to achieve a High or Excellent rating along Study Network segments with high pedestrian priority. The Pedestrian Comfort Index was evaluated for about 52 percent, or 620 miles, of the Study Network based on available cross section data. **Table 6** presents a countywide summary of automobile congested speed for each analysis scenario.

TABLE 6
ALAMEDA COUNTYWIDE PEDESTRIAN COMFORT INDEX SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments with Excellent Rating	6%	5%
% of Segments with High Rating	54%	51%
% of Segments with Medium Rating	39%	42%
% of Segments with Low Rating	1%	2%

Notes:
1. Countywide data coverage for Pedestrian Comfort Index is 620 miles.

3.4.1 Existing Conditions

The majority of high priority pedestrian segments provide a High or Excellent Pedestrian Comfort Index rating. Higher rated pedestrian facilities are generally provided in the urbanized and downtown areas of jurisdictions. As expected, lower rated pedestrian facilities are provided in rural areas of the County due to the lack of sidewalks and high automobile posted speed limits. North and Central County Planning Areas tend to provide higher rated facilities compared to South and East County. South County shows the greatest percentage of lower rated pedestrian facilities, primarily as a result of sidewalk widths less than six feet along six-lane arterials with high traffic volumes and posted speed limits of 40 MPH or greater. **Table 7** presents the performance objective summary for high priority pedestrian segments, the resulting Existing Conditions Needs Assessment map is provided in **Figure 3**.

As shown in **Table 7**, about 135 miles high priority pedestrian segments along the Arterial Network provide higher rated facilities. In contrast, lower rated facilities can be a result of the following conditions:

- Lack of sidewalks,
- Narrow sidewalk widths,
- High traffic volumes,
- Posted speed limits of 40 MPH or greater,
- Arterials with five or more travel lanes, and/or
- Lack of buffers (landscaped or hardscaped) between sidewalk and adjacent travel lanes.

TABLE 7
ALAMEDA COUNTYWIDE PEDESTRIAN PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objective Along High Priority Pedestrian Arterial Network Segments[1]		
	Existing	Year 2040 – Standard Forecasting Scenario	Net Difference
Pedestrian Comfort Index	135 mi	133 mi	- 2 mi

Notes:
1. Pedestrians are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 207 Arterial Network miles have high pedestrian priority.

3.4.2 Year 2040 – Standard Forecasting Scenario

The majority of segments are expected to continue to provide a High or Excellent Pedestrian Comfort Index rating under Year 2040 Conditions. The primary difference between Existing and Year 2040 Conditions is that traffic volumes are expected to be higher in Year 2040. Higher traffic volumes in Year 2040 can result in a lower Pedestrian Comfort Index rating compared to Existing Conditions. As shown in **Table 7**, 133 miles of high priority pedestrian segments would provide higher rated facilities along the Arterial Network assuming Year 2040 Conditions, a two mile decrease compared to Existing Conditions.

3.5 BICYCLE NEEDS ASSESSMENT EVALUATION

The Existing and Year 2040 bicycle performance evaluation was based on the Bicycle Comfort Index rating. The performance objective is to achieve a High (Level of Traffic Stress 2) or Excellent (Level of Traffic Stress 1) rating along Study Network segments with high bicycle priority. The Bicycle Comfort Index was evaluated for about 56 percent, or 670 miles, of the Study Network based on available cross section data. **Table 8** presents a countywide summary of Bicycle Comfort Index for each analysis scenario.

TABLE 8
ALAMEDA COUNTYWIDE BICYCLE COMFORT INDEX SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments with Excellent Rating	1%	1%
% of Segments with High Rating	14%	14%
% of Segments with Medium Rating	26%	27%
% of Segments with Low Rating With Class 2 Bicycle Lanes Provided	19%	21%
% of Segments with Low Rating Without Class 2 Bicycle Lanes	40%	37%

Notes:
1. Countywide data coverage for Bicycle Comfort Index is 670 miles.

3.5.1 Existing Conditions

The majority of roadway segments in Alameda County provide a Bicycle Comfort Index rating of Medium or Low (LTS 3 or 4), only 15 percent of segments provide a High or Excellent rating (LTS 2 or 1). North and Central County Planning Areas provide higher rated facilities compared to South and East County. A Low or Medium Bicycle Comfort Index rating can be a result of either of the following conditions:

- Lack of dedicated on-street bicycle facilities,
- Lack of buffer separation between Class 2 bicycle lanes and travel lanes, especially along segments that provide four or more travel lanes,

- Posted speed limits of 30 MPH or greater for segments that do not provide dedicated Class 2 bicycle lanes, or 35 MPH or greater for segments that do provide Class 2 bicycle lanes, and/or
- Class 2 bicycle lane plus parking lane widths less than 13.5 feet.

As shown in **Table 8**, providing dedicated on-street Class 2 bicycle lanes can result in a Low rating due to the lack of buffer separation and/or having a posted speed limit of 40 MPH or greater. The majority of segments that provide Class 2 bicycle lanes but result in a Low Bicycle Comfort Index rating are located in the South and East County Planning Areas. In general, not many Class 4 bicycle facilities are provided within the County, which explains the low number of Excellent rated facilities. **Table 9** presents the performance objective summary for high priority bicycle segments, the resulting existing conditions map is provided in **Figure 5**.

TABLE 9
ALAMEDA COUNTYWIDE BICYCLE PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objective Along High Priority Bicycle Arterial Network Segments[1]		
	Existing	Year 2040 – Standard Forecasting Scenario	Net Difference
Bicycle Comfort Index	35 mi	35 mi	0 mi

Notes:
1. Bicycles are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 268 Arterial Network miles have high bicycle priority.

As shown in **Table 9**, only 35 miles of high priority bicycle segments along the Arterial Network provide adequate bicycle facilities under Existing Conditions. This indicates that the bicycle network (along with the transit network) has a great need for improvements throughout the County.

3.5.2 Year 2040 – Standard Forecasting Scenario Conditions

As shown in **Table 8**, the mileage of high priority bicycle segments that provide adequate bicycle facilities along the Arterial Network remains similar between Existing and Year 2040 Conditions. Therefore, the bicycle network is expected to continue to have a great need for improvements in Year 2040.

3.6 AUTOMOBILE NEEDS ASSESSMENT EVALUATION

The Existing and Year 2040 automobile performance evaluation was primarily based on the following performance measures:

- Automobile Congested Speed, the performance objective is to achieve a speed greater than 40 percent of the posted speed limit. PM peak period (4 – 6 PM) speed data was summarized for about 82 percent, or 980 miles, of the Study Network. **Table 10** presents a countywide summary of automobile congested speed for each analysis scenario.
- Automobile Reliability, which is a measure of the PM peak hour volume-to-capacity (V/C) ratio; the performance objective is to achieve a V/C ratio less than 0.8. PM peak hour Automobile Reliability data was summarized for about 53 percent, or 640 miles, of the Study Network. **Table 11** presents a countywide summary for this measure.

The automobile performance and Needs Assessment evaluation for Existing and Year 2040 Conditions is summarized below.

TABLE 10
ALAMEDA COUNTYWIDE AUTOMOBILE CONGESTED SPEED SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments Operating Greater Than 40 MPH	4%	3%
% of Segments Operating Between 30 – 40 MPH	24%	22%
% of Segments Operating Between 20 – 30 MPH	58%	56%
% of Segments Operating Between 10 – 20 MPH	14%	18%
% of Segments Operating Less Than 10 MPH	0%	1%

Notes:
1. Countywide data coverage for Automobile Congested Speed is 980 miles.

TABLE 11
ALAMEDA COUNTYWIDE AUTOMOBILE RELIABILITY SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments Operating at V/C Ratio Less Than 0.8	74%	74%
% of Segments Operating at V/C Ratio Between 0.8 – 1.0	9%	12%
% of Segments Operating at V/C Ratio Greater Than 1.0	17%	14%

Notes:
1. Countywide data coverage for Automobile Reliability is 640 miles.

3.6.1 Existing Conditions

About 86 percent of roadway segments operate at a PM peak period automobile congested speed of 20 miles per hour (MPH) or greater under Existing Conditions. Study Network segments in the North and Central County Planning Areas generally operate at lower speeds during the PM peak period compared to study segments in South and East County. Low PM peak period speeds can be attributed to various factors, including:

- Low automobile posted speed limits,
- High traffic volumes,
- Capacity constraints at intersections, including inefficient signal timings,
- High density of driveways/automobile access points along corridors, and/or
- High volume of pedestrian crossings within urban areas.

About 74 percent of roadway segments operate at a V/C ratio less than 0.8 during the PM peak hour, nine percent operate at a V/C ratio between 0.8 and 1.0 while 17 percent of segments operate over capacity. **Table 12** presents the performance objective summary for high priority automobile Study Network segments, the resulting existing conditions map is shown on **Figure 7**.

As shown in **Table 12**, 231 miles of high priority automobile segments along the Arterial network operate at a congested speed greater than 40 percent of the speed limit during the PM peak period, while 140 miles of Arterial Network segments operate at a V/C ratio less than 0.8 during the PM peak hour.

TABLE 12
ALAMEDA COUNTYWIDE AUTOMOBILE PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objective Along High Priority Automobile Arterial Network Segments[1]		
	Existing	Year 2040 – Standard Forecasting Scenario	Net Difference
Automobile Congested Speed	231 mi	210 mi	-21 mi
Automobile Reliability	140 mi	138 mi	-2 mi

Notes:
1. Automobiles are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 250 Arterial Network miles have high automobile priority.

3.6.2 Year 2040 – Standard Forecasting Scenario

The Year 2040 analysis assumes various planned and funded roadway widening improvements. Roadway widening improvements are expected to increase Automobile Congested Speed and improve Automobile Reliability. Overall, segments under Year 2040 – Standard Forecasting Scenario Conditions are expected to operate at lower automobile speeds during the PM peak period compared to Existing Conditions; resulting in a 21 mile decrease along high priority automobile Arterial Network segments that would meet the Automobile Congested Speed performance objective. As shown in **Table 12**, mileage of high priority automobile Arterial Network segments that meet the Automobile Reliability performance objective would remain similar as Existing Conditions.

3.7 GOODS MOVEMENT NEEDS ASSESSMENT EVALUATION

The Existing and Year 2040 goods movement performance evaluation was based on the Truck Route Accommodation Index rating, which is a measure of the curb lane width. The performance objective is to achieve a High (curb lane width of 12 feet or greater) rating along Study Network segments with high priority goods movement. The Truck Route Accommodation Index was evaluated for about 56 percent, or 670 miles, of the Study Network based on available cross section data. **Table 13** presents a countywide summary of Truck Route Accommodation Index for each analysis scenario.

TABLE 13
ALAMEDA COUNTYWIDE TRUCK ROUTE ACCOMODATION INDEX SUMMARY[1]

Threshold	Existing	Year 2040 – Standard Forecasting Scenario
% of Segments with High Rating	56%	56%
% of Segments with Medium Rating	36%	36%
% of Segments with Low Rating	8%	8%

Notes:
1. Countywide data coverage for Truck Route Accommodation Index is 670 miles.

3.7.1 Existing Conditions

As shown in **Table 13**, the majority of high priority goods movement segments provide a minimum 12 foot curb lane width. A curb lane width of 12 feet or greater is preferred for high priority goods movement segments to minimize the probability that trucks will off-track into the adjacent lane or shoulder. Curb lane widths less than 12 feet are considered inadequate. **Table 14** presents the performance objective summary for high priority goods movement segments, the resulting Existing Conditions Needs Assessment map is provided in **Figure 9**.

As shown in **Table 14**, about 86 miles of high priority goods movement segments along the Arterial Network provide curb lane widths greater than 12 feet. Generally, North County Arterial Network segments provide more segments with curb lane widths less than 12 feet compared to the Central, South and East County.

TABLE 14
ALAMEDA COUNTYWIDE GOODS MOVEMENT PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objective Along High Priority Goods Movement Arterial Network Segments[1]		
	Existing	Year 2040 – Standard Forecasting Scenario	Net Difference
Truck Route Accommodation Index	86 mi	86 mi	0 mi

Notes:
1. Goods movement is considered high priority mode if categorized in the top two prioritized mode along an Arterial Network segment. A total of 135 Arterial Network miles have high goods movement priority.

3.7.2 Year 2040 – Standard Forecasting Scenario Conditions

Figure 10 identifies segments with improvement needs for Study Network segments with high goods movement priority. As shown in **Table 14**, the needs evaluation for Year 2040 Conditions is similar to Existing Conditions since the majority of curb lane widths are expected to be the same between both Existing and Year 2040 Conditions.

3.8 PAVEMENT CONDITION INDEX

The Pavement Condition Index (PCI) was evaluated for Existing Conditions only. The PCI performance objective is to achieve a PCI rating of Good or Very Good. However, PCI was not applied to the Existing Conditions Needs Assessment evaluation. PCI will be utilized later in the MAP development process to prioritize improvements.

PCI was summarized for about 80 percent, or 960 miles, of the Study Network. Of the Study Network segments with available data:

- 35% of segments result in a Very Good PCI rating,
- 41% of segments result in a Good PCI rating,
- 19% of segments result in a At-Risk PCI rating, and
- 5% of segments result in a Poor PCI rating

3.8 COLLISION RATES

Collision Rates were evaluated along the Study Network for Existing Conditions. Existing Collision Rates were summarized for about 71 percent, or 850 miles, of the Study Network. Of the Study Network segments with available data:

- 48% of segments result in an annual collision rate less than 1.0 collision per million vehicle-miles of travel
- 32% of segments result in an annual collision rate between 1.0 and 2.0 collisions per million vehicle-miles of travel
- 8% of segments result in an annual collision rate between 2.0 and 3.0 collisions per million vehicle-miles of travel
- 4% of segments result in an annual collision rate between 3.0 and 4.0 collisions per million vehicle-miles of travel

- 8% of segments result in an annual collision rate greater than 4.0 collisions per million vehicle-miles of travel

Performance measure objectives do not apply to Collision Rates; therefore the Existing Conditions Needs Assessment evaluation did not incorporate the collision rate assessment. Collision Rates will be utilized later in the MAP development process to prioritize improvements.

4. ALTERNATIVE SCENARIOS

The Social and Behavioral Trends and Next Generation Vehicle Scenarios were evaluated as supplemental scenarios to inform Alameda County jurisdictions on how emerging social and technology trends may impact future travel patterns and resulting improvement needs. **Table 15** through **Table 20** compare applicable performance measure results for all three Year 2040 scenarios. Key findings by mode are presented below.

Transit Network Results

As shown in **Table 15** and **Table 16**, both alternative scenarios would result in a substantial increase to Transit Travel Speed and Transit Reliability compared to the Standard Forecasting Scenario, with the highest increase expected for the Next Generation Vehicle Scenario.

Pedestrian Network Results

The primary difference between the Standard Forecasting Scenario and Social and Behavioral Trends Scenario is that traffic volumes are expected to be five to 10 percent lower assuming the latter, which would result in a slight improvement for pedestrians. The Next Generation Vehicle Scenario would not impact the Pedestrian Comfort Index evaluation.

Bicycle Network Results

Neither alternative Scenario would impact the Bicycle Comfort Index evaluation.

Automobile Network Results

As shown in **Table 18** and **Table 19**, both alternative scenarios would result in a substantial improvement to Automobile Congested Speed and Reliability compared to the Standard

Forecasting Scenario, with the highest increase expected for the Next Generation Vehicle Scenario.

Goods Movement Network Results

Neither alternative Scenario would impact the Truck Route Accommodation Index evaluation.

TABLE 15
ALAMEDA COUNTYWIDE TRANSIT TRAVEL SPEED SUMMARY[1]

Threshold	Year 2040 – Standard Forecasting Scenario	Year 2040 – Social and Behavioral Trends Scenario	Year 2040 – Next Generation Vehicle Scenario
% of Segments Operating Between 20 – 30 MPH	9%	10%	11%
% of Segments Operating Between 10 – 20 MPH	44%	49%	50%
% of Segments Operating Between 5 – 10 MPH	44%	39%	38%
% of Segments Operating Less Than 5 MPH	3%	2%	1%

Notes:
1. Countywide data coverage for Transit Travel Speed is 240 miles.

TABLE 16
ALAMEDA COUNTYWIDE TRANSIT RELIABILITY SUMMARY[1]

Threshold	Year 2040 – Standard Forecasting Scenario	Year 2040 – Social and Behavioral Trends Scenario	Year 2040 – Next Generation Vehicle Scenario
% of Segments Operating at Ratio Greater Than 0.8	33%	40%	44%
% of Segments Operating at Ratio Between 0.6 – 0.8	52%	49%	48%
% of Segments Operating at Ratio Between 0.4 – 0.6	13%	10%	8%
% of Segments Operating at Ratio Less Than 0.4	2%	1%	0%

Notes:
1. Countywide data coverage for Transit Reliability is 240 miles.

TABLE 17
ALAMEDA COUNTYWIDE PEDESTRIAN COMFORT INDEX SUMMARY[1]

Threshold	Year 2040 – Standard Forecasting Scenario	Year 2040 – Social and Behavioral Trends Scenario	Year 2040 – Next Generation Vehicle Scenario
% of Segments with Excellent Rating	5%	5%	5%
% of Segments with High Rating	51%	51%	51%
% of Segments with Medium Rating	42%	42%	42%
% of Segments with Low Rating	2%	2%	2%

Notes:
1. Countywide data coverage for Pedestrian Comfort Index is 620 miles.

TABLE 18
ALAMEDA COUNTYWIDE AUTOMOBILE CONGESTED SPEED SUMMARY[1]

Threshold	Year 2040 – Standard Forecasting Scenario	Year 2040 – Social and Behavioral Trends Scenario	Year 2040 – Next Generation Vehicle Scenario
% of Segments Operating Greater Than 40 MPH	3%	4%	4%
% of Segments Operating Between 30 – 40 MPH	22%	24%	25%
% of Segments Operating Between 20 – 30 MPH	56%	57%	57%
% of Segments Operating Between 10 – 20 MPH	18%	15%	14%
% of Segments Operating Less Than 10 MPH	1%	0%	0%

Notes:
1. Countywide data coverage for Automobile Congested Speed is 980 miles.

TABLE 19
ALAMEDA COUNTYWIDE AUTOMOBILE RELIABILITY SUMMARY[1]

Threshold	Year 2040 – Standard Forecasting Scenario	Year 2040 – Social and Behavioral Trends Scenario	Year 2040 – Next Generation Vehicle Scenario
% of Segments Operating at V/C Ratio Less Than 0.8	74%	77%	83%
% of Segments Operating at V/C Ratio Between 0.8 – 1.0	12%	12%	9%
% of Segments Operating at V/C Ratio Greater Than 1.0	14%	11%	8%

Notes:
1. Countywide data coverage for Automobile Reliability is 640 miles.

TABLE 20
ALAMEDA COUNTYWIDE TRANSIT PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objectives Along High Priority Transit, Pedestrian or Automobile Arterial Network Segments		
	Year 2040 – Standard Forecasting Scenario	Year 2040 – Social and Behavioral Trends Scenario	Year 2040 – Next Generation Vehicle Scenario
Transit Congested Speed[1]	21 mi	21 mi	21 mi
Transit Reliability[1]	56 mi	66 mi	69 mi
Pedestrian Comfort Index[2]	133 mi	133 mi	133 mi
Automobile Congested Speed[3]	210 mi	217 mi	221 mi
Automobile Reliability[3]	138 mi	147 mi	166 mi

Notes:
1. Transit is considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 150 Arterial Network miles have high transit priority
2. Pedestrians are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 207 Arterial Network miles have high pedestrian priority.
3. Automobiles are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 250 Arterial Network miles have high automobile priority.

5. CONCLUSIONS

The comprehensive Needs Assessment evaluation presented in this memo provides a thorough multimodal infrastructure review of Alameda County arterials; this is the first time that a multimodal evaluation has been performed at this scale within the County. As such, the evaluation provides an extensive amount of analysis results and conclusions. The main conclusion that can be derived from the results is that out of the five primary modes served by the arterial system, the transit and bicycle networks generally have the greatest need for improvements based on the performance measures that were evaluated for this study. Although all modes have needs for improvements throughout Alameda County, the expectation is that proposed Arterial Network improvements would provide the greatest benefit to transit and bicycle modes while benefiting all other modes.

6. NEXT STEPS

The performance and Needs Assessment evaluation was the basis for identifying proposed improvements along Arterial Network segments. Draft proposed improvements are presented in a separate memo titled *Alameda Countywide Multimodal Arterial Plan – Draft Proposed Improvements* (Fehr & Peers, February 22, 2016). Fehr & Peers and Alameda CTC will meet with each Alameda County jurisdiction between February 29th and March 7th to present the Needs Assessment evaluation and proposed improvements. Please contact Francisco Martin at f.martin@fehrandpeers.com or (510) 587-9422 if you have any questions or comments regarding the information presented in this memo.

Memo Attachments:

Figure 1 – Roadway Segments with Transit Improvement Needs – Existing Conditions

Figure 2 – Roadway Segments with Transit Improvement Needs – 2040 Standard Forecasting Scenario Conditions

Figure 3 – Roadway Segments with Pedestrian Improvement Needs – Existing Conditions

Figure 4 – Roadway Segments with Pedestrian Improvement Needs – 2040 Standard Forecasting Scenario Conditions

Figure 5 – Roadway Segments with Bicycle Improvement Needs – Existing Conditions

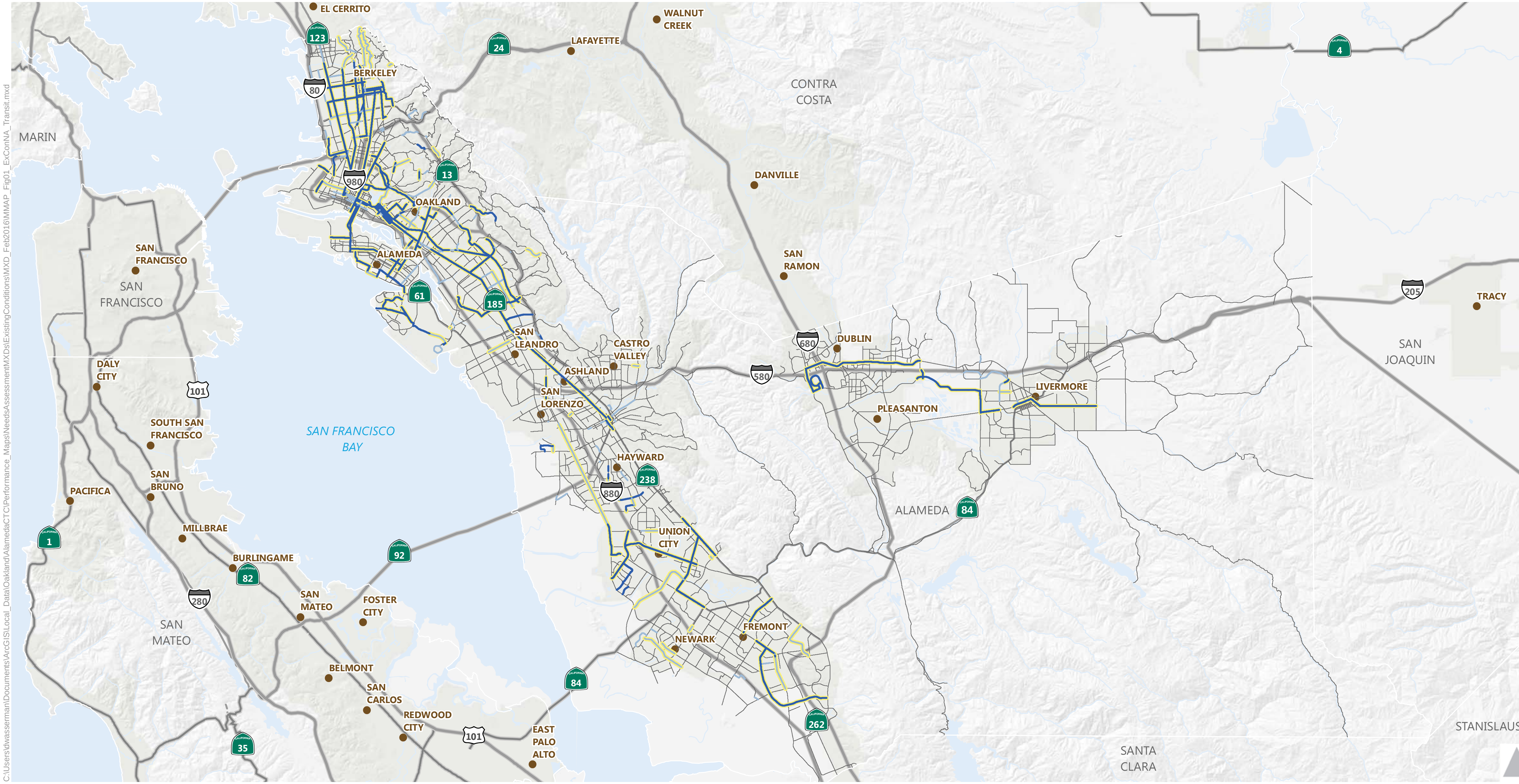
Figure 6 – Roadway Segments with Bicycle Improvement Needs – 2040 Standard Forecasting Scenario Conditions

Figure 7 – Roadway Segments with Vehicle Improvement Needs – Existing Conditions

Figure 8 – Roadway Segments with Vehicle Improvement Needs – 2040 Standard Forecasting Scenario Conditions

Figure 9 – Roadway Segments with Goods Movement Improvement Needs – Existing Conditions

Figure 10 – Roadway Segments with Goods Movement Improvement Needs – 2040 Standard Forecasting Scenario Conditions



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Alameda Countywide Multimodal Arterial Plan

Transit Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 1

Roadway Segments with Transit Improvement Needs
Existing Conditions

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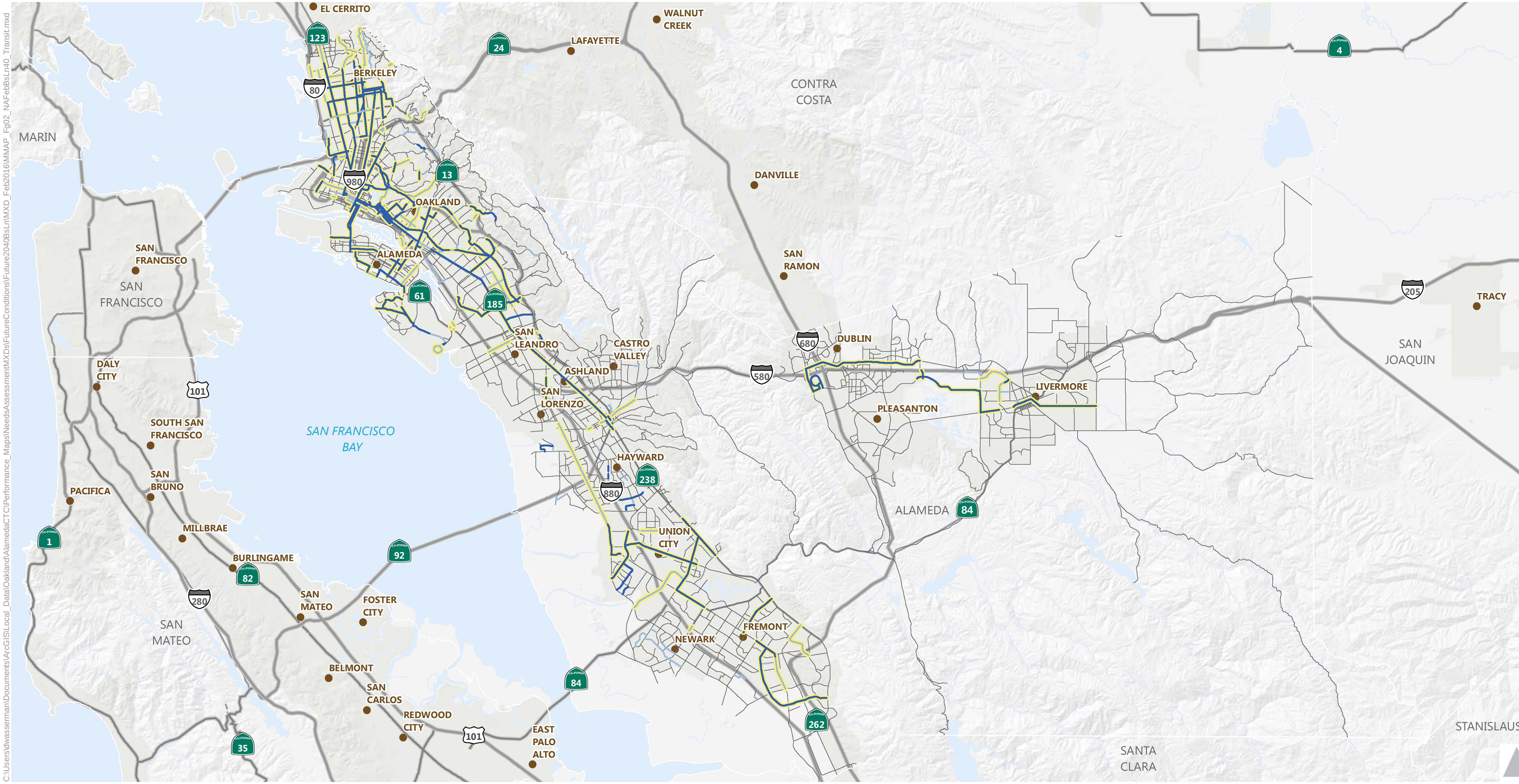


*The transit needs assessment is only evaluated on roadways with transit major corridors and crosstown routes.

Alameda Countywide Multimodal Arterial Plan

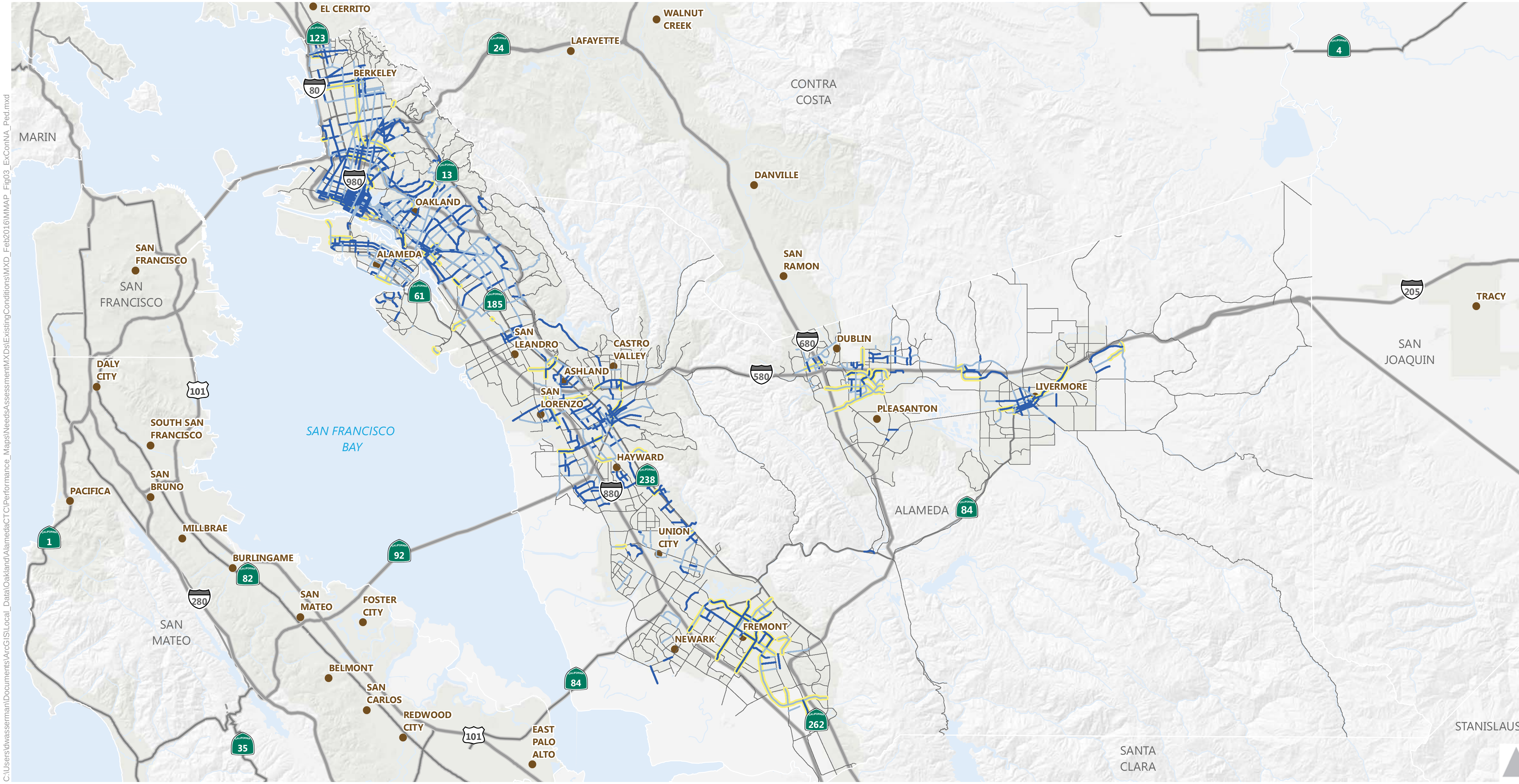
Transit Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 2

Roadway Segments with Transit Improvement Needs
2040 Standard Forecasting Scenario Conditions



Alameda Countywide Multimodal Arterial Plan

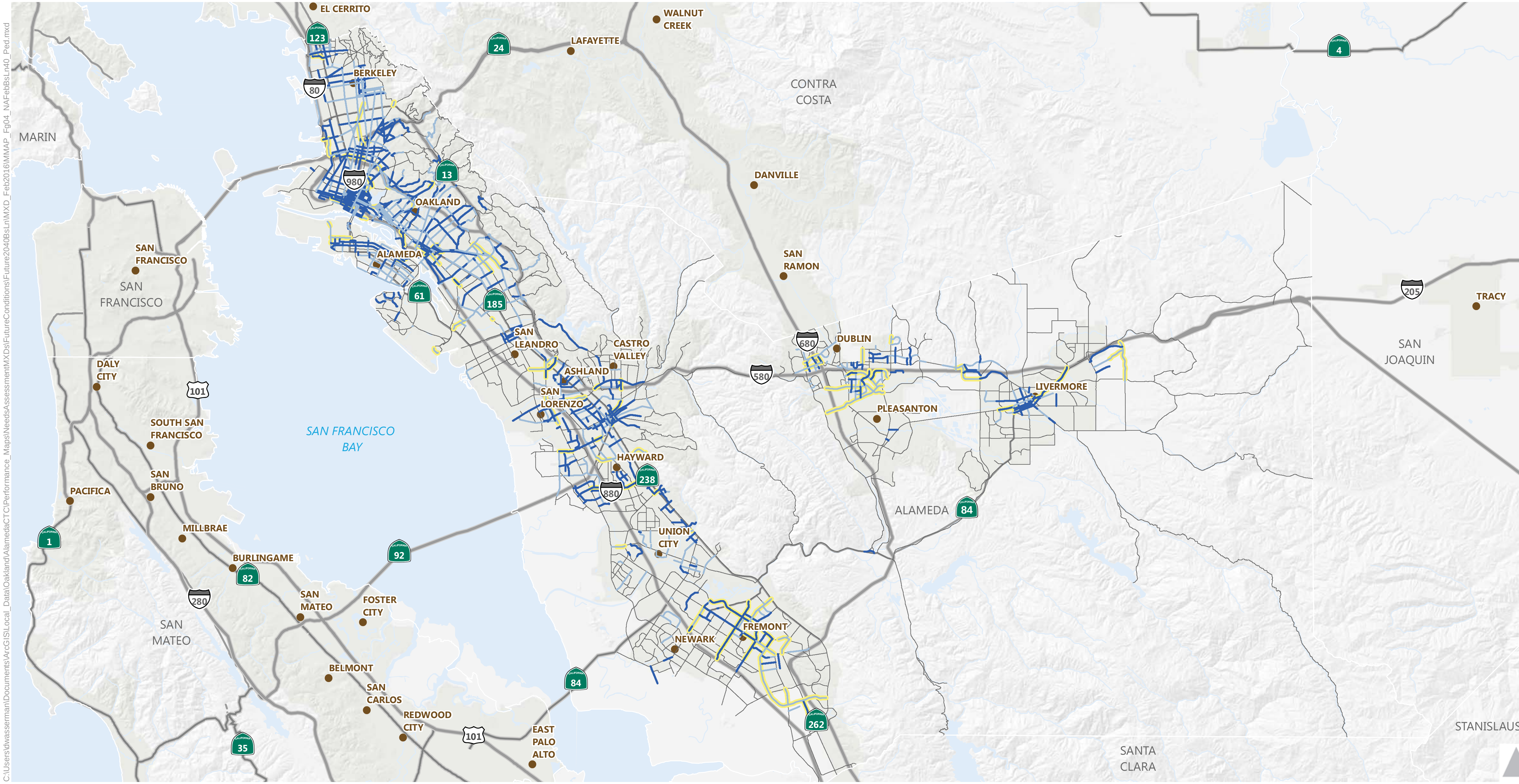
Pedestrian Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 3

Roadway Segments with Pedestrian Improvement Needs
Existing Conditions



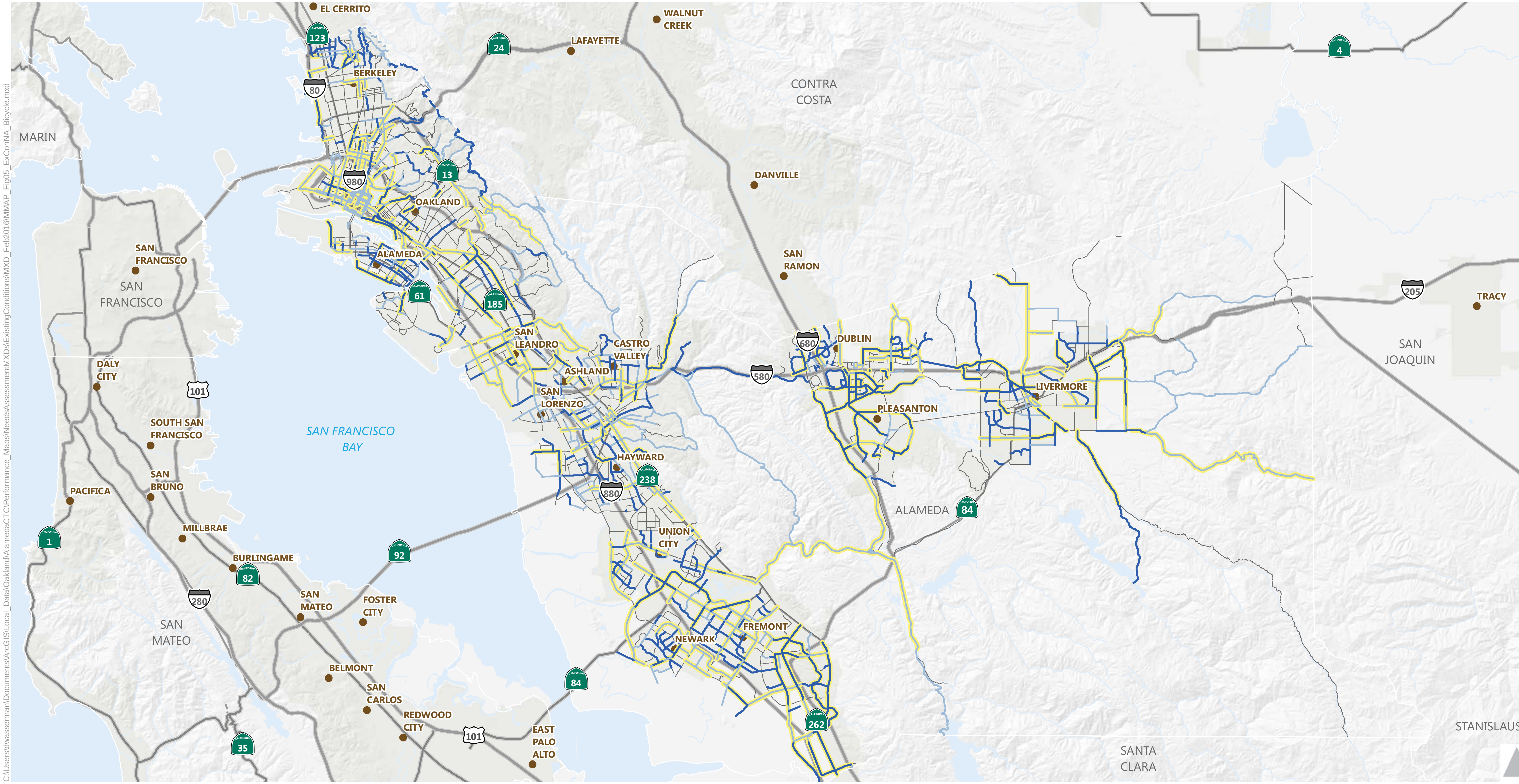
Alameda Countywide Multimodal Arterial Plan

Pedestrian Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

Figure 4

Roadway Segments with Pedestrian Improvement Needs
2040 Standard Forecasting Scenario Conditions



Alameda Countywide Multimodal Arterial Plan

Bicycle Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

Figure 5

Roadway Segments with Bicycle Improvement Needs Existing Conditions

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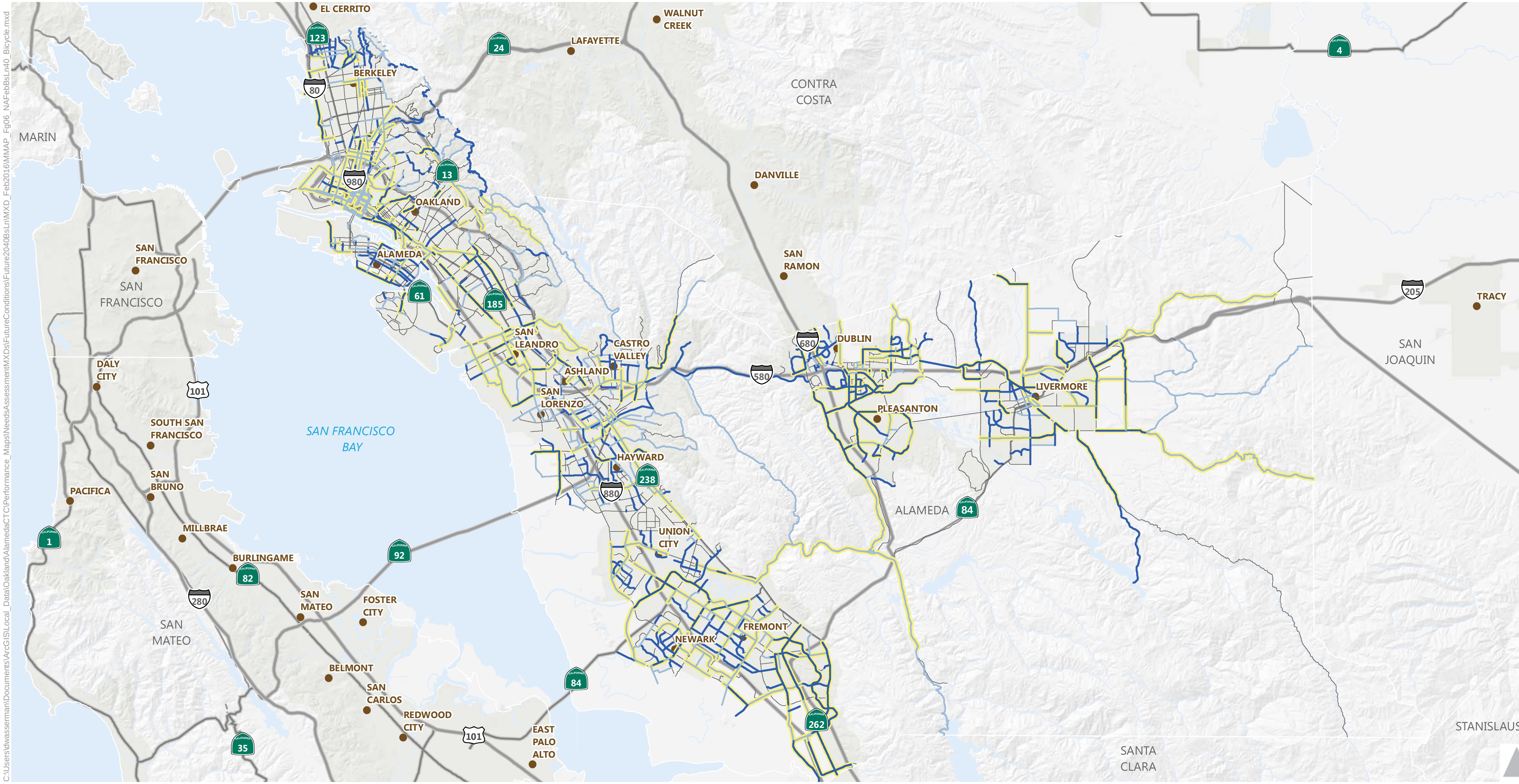


Alameda Countywide Multimodal Arterial Plan

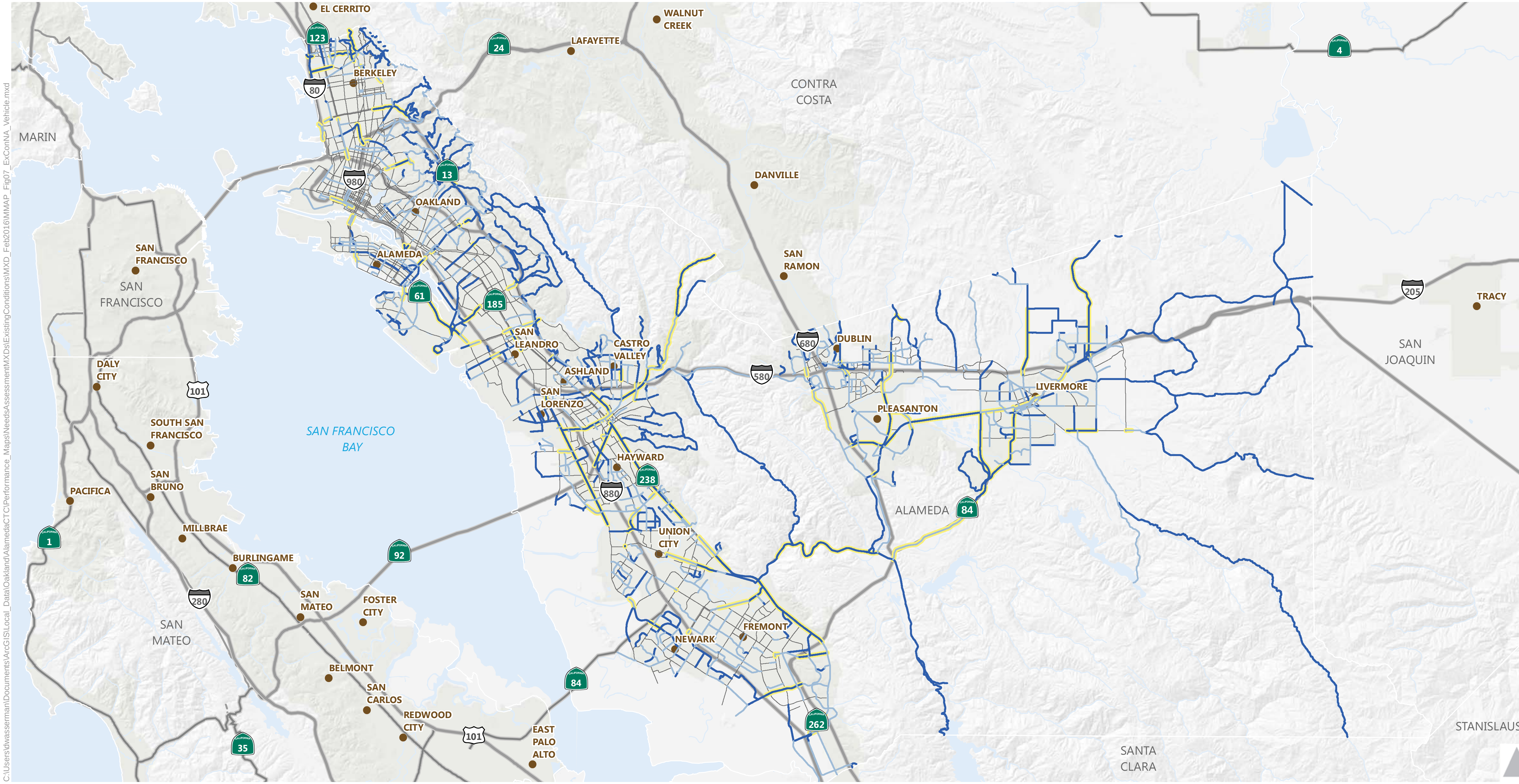
Bicycle Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 6

Roadway Segments with Bicycle Improvement Needs
2040 Standard Forecasting Scenario Conditions



Alameda Countywide Multimodal Arterial Plan

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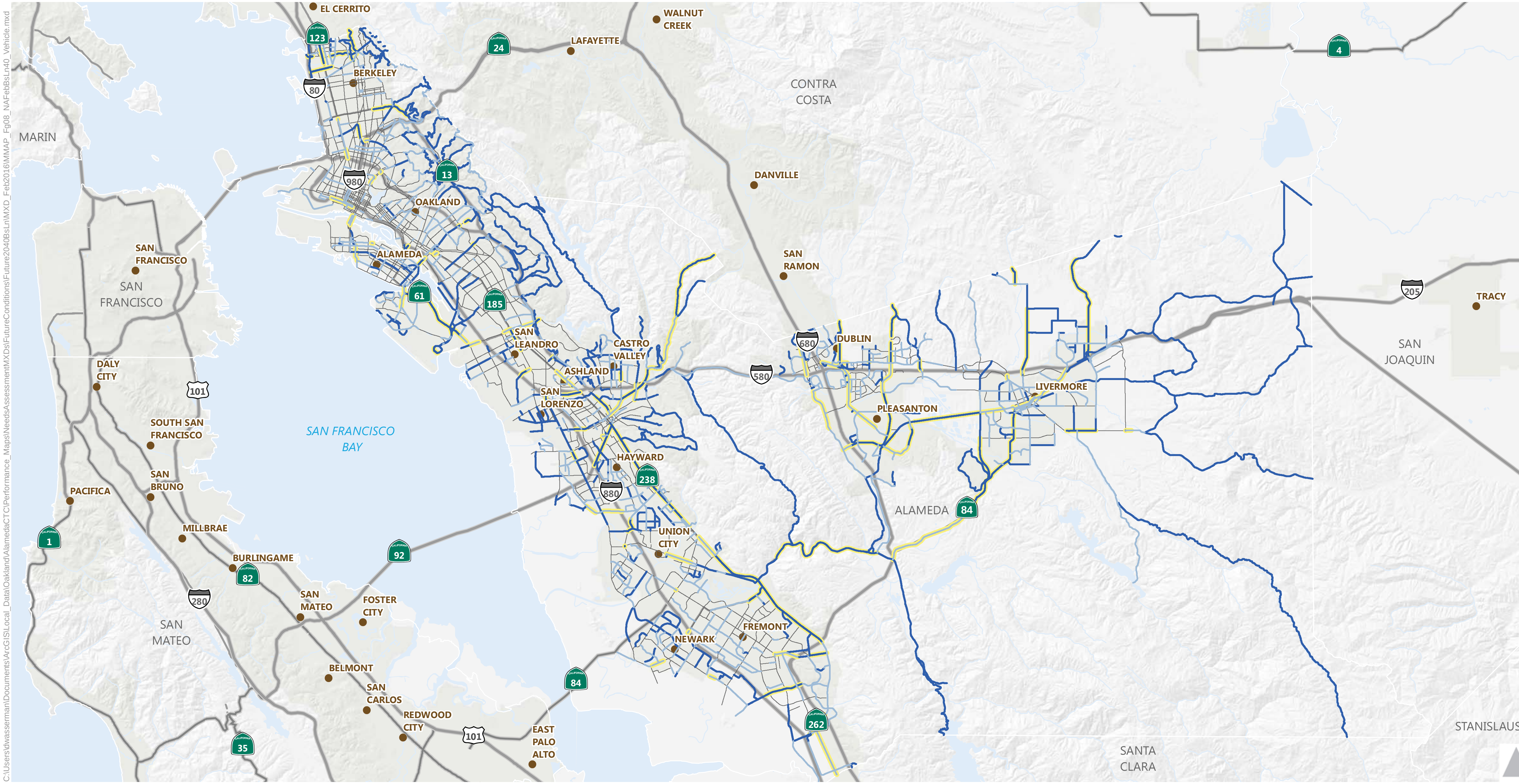
Vehicle Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 7

Roadway Segments with Vehicle Improvement Needs Existing Conditions



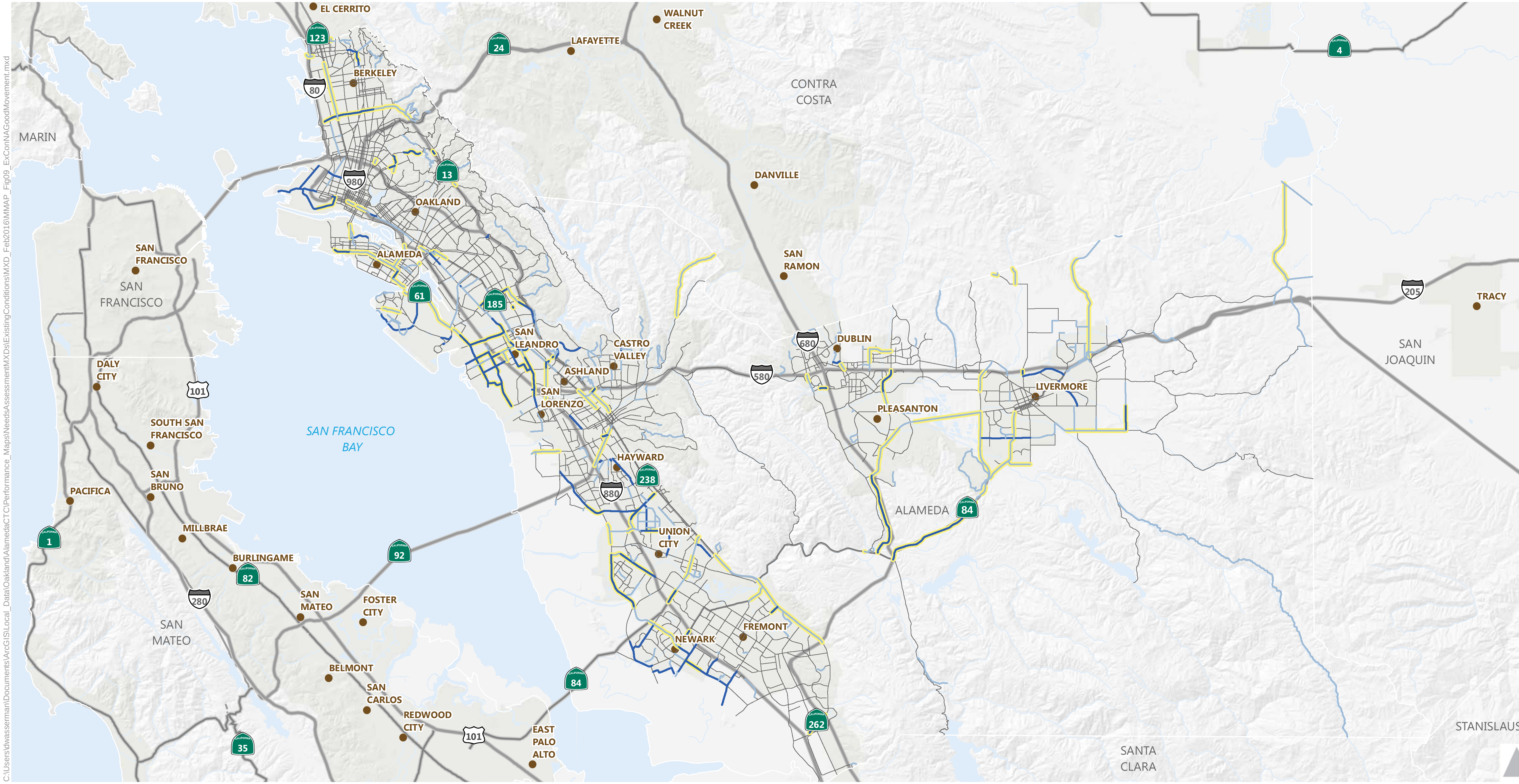
Alameda Countywide Multimodal Arterial Plan

Vehicle Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

Figure 8

Roadway Segments with Vehicle Improvement Needs
2040 Standard Forecasting Scenario Conditions



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Alameda Countywide Multimodal Arterial Plan

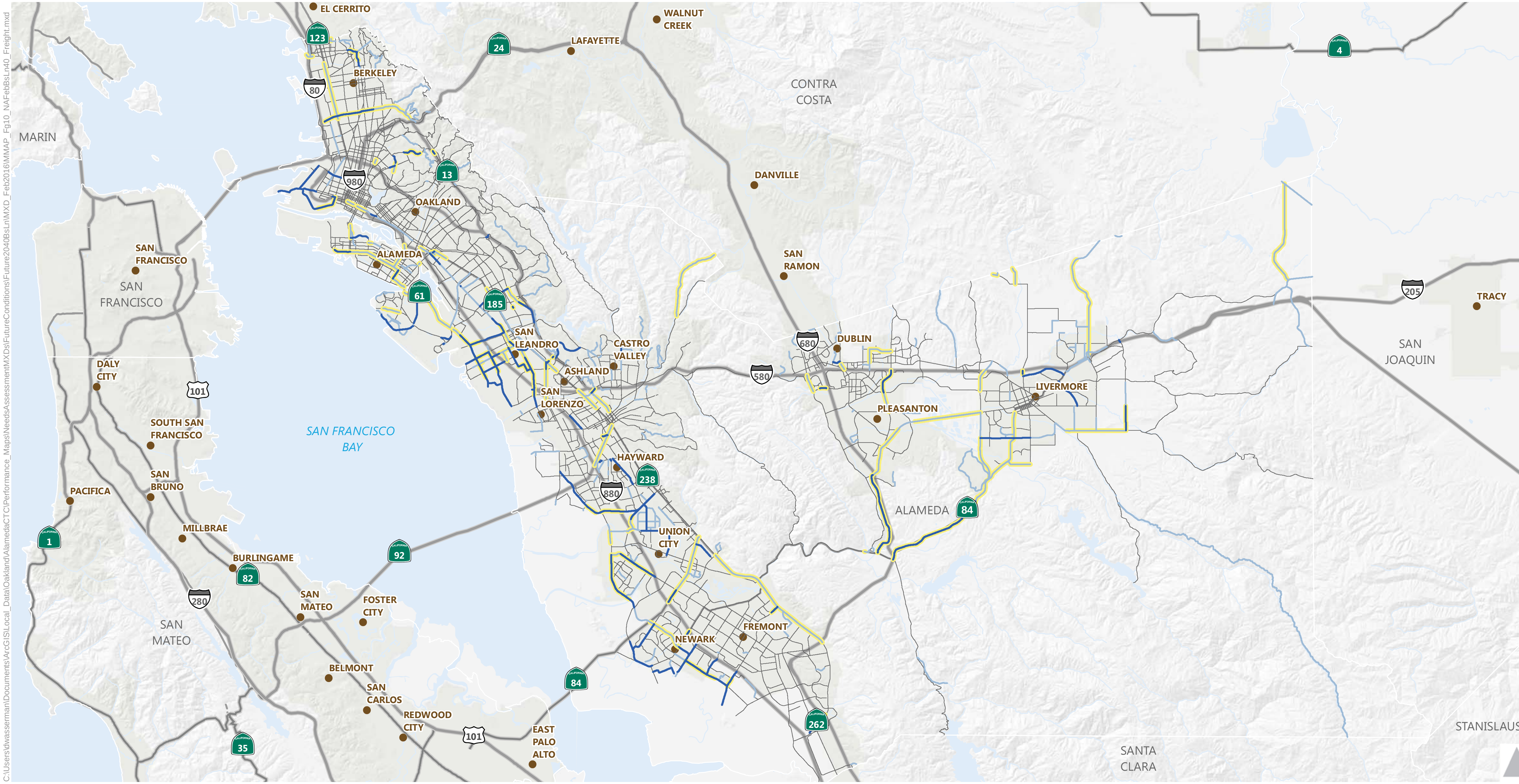
Goods Movement Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 9

Roadway Segments with Goods Movement Improvement Needs
Existing Conditions



Alameda Countywide Multimodal Arterial Plan

Goods Movement Priority Mode

No Improvements Needed	Improvements Needed
#1 Priority	#1 Priority
#2 Priority	#2 Priority

ALAMEDA County Transportation Commission

Figure 10

Roadway Segments with Goods Movement Improvement Needs
2040 Standard Forecasting Scenario Conditions

Appendix 2.3.2
Travel Demand Forecasting Memo

FEHR & PEERS

MEMORANDUM

Date: August 21, 2015

To: Saravana Suthanthira, Alameda CTC

From: Francisco Martin and Mackenzie Watten, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan
Travel Demand Forecasting Results – Final

OK14-0023

1.0 INTRODUCTION

Alameda CTC is leading the development of a Countywide Multimodal Arterial Plan to better understand the existing and future role and function of the countywide arterial system in supporting all modes for all users. To evaluate the future role and conditions of the Study Network, forecasts of future travel behavior are required. These forecasts require the use of multiple data sources, most significantly the Alameda Countywide Travel Demand Model ("Alameda CTC Model"). The *Alameda Countywide Multimodal Arterial Plan – Travel Demand Forecasting Methods White Paper-Final* (Fehr & Peers, June 23, 2015) described the travel behavior forecasting assumptions, methodology, and approach. This memorandum documents the projections of the Plan's multimodal performance measures for the arterial network.

2.0 MULTIMODAL PERFORMANCE MEASURES

The Alameda CTC model is capable of estimating multimodal travel behavior for many locations in Alameda County. It has been calibrated and validated with year 2010 vehicle, transit, and bicycle counts. The Alameda CTC model includes scenario years roughly corresponding to "existing" (year 2010), "near-term" (year 2020), and "long-term" (year 2040).

The full list of performance measures and performance indicators[1] to be estimated as part of the Multimodal Arterial Plan development have been documented in the memo titled *Alameda Countywide Multimodal Arterial Plan – Performance Measures and Evaluation Approach* (Fehr & Peers, January 22, 2015). This memorandum will primarily focus on the two major direct model applications for performance measures: PM peak hour vehicle volume and congested speed (measure 1.1A). The majority of the other performance measures indirectly use vehicle volume and congested speed as inputs.

2.1 EXISTING PERFORMANCE MEASURE CALCULATIONS FROM MODEL

The forecast approach outlined in later sections requires existing observed data as an input. Existing PM peak hour volume count and congested speed data was not available for all the Study Network segments. Observed data provided generally ranged between years from 2012 and 2014. The base year (2010) Alameda CTC model was used to identify PM peak hour volume and speed data for Study Network segments missing observed data.

The existing PM peak hour volume and speed data that was available was used to develop jurisdiction (or planning-area where observed data is not available within a jurisdiction) adjustment factors to apply to the base year model volume and speed forecasts. The PM peak hour adjustment factor calculations take the following form:

$$Existing\ Volume\ Adjustment\ Factor_{Jurisdiction} = Total\ Volume\ from\ Observed\ Data_{Jurisdiction} \div Total\ Volume\ from\ Model\ for\ Segments\ with\ Observed\ Data_{Jurisdiction}$$

$$Existing\ Speed\ Adjustment\ Factor_{Jurisdiction} = Speed\ from\ Observed\ Data_{Jurisdiction} \div\ Speed\ from\ Model\ for\ Segments\ with\ Observed\ Data_{Jurisdiction}$$

Table 1 details the data coverage by each jurisdiction and planning area along with the year of the data provided. The magnitude of coverage varies by jurisdiction. Congested speed data coverage is consistently lower than the count data coverage.

[1] Performance measures assess the existing and future year transportation conditions of the Study Network. Area-wide performance indicators are generally applied after preferred short- and long-term improvements are identified for the Arterial Network (subset of the Study Network that represents *arterials of countywide significance)* to evaluate and to ensure that the preferred improvements achieve the Plan's vision and goals.

Table 1
Observed Data Coverage by Jurisdiction and Planning Area

Jurisdiction/ Planning Area	Study Network Locations	Observed Volume Locations	Volume Coverage	Observed Speed Locations	Speed Coverage	Year of Observed Data
Incorporated Jurisdictions						
Alameda	280	247	89%	30	11%	2014
Albany	58	10	18%	4	7%	2014
Berkeley	386	92	24%	105	28%	2010-2014
Dublin	237	168	71%	19	9%	2014
Emeryville	46	36	79%	1	3%	2012
Fremont	468	287	62%	51	11%	2014
Hayward	447	70	16%	49	11%	2013-2014
Livermore	449	27	7%	54	13%	2013
Oakland	1,500	333	23%	344	23%	2014
Piedmont	18	0	0%	2	12%	2014
Pleasanton	292	260	90%	31	11%	2014
San Leandro	232	24	11%	48	21%	2011
Union City	122	44	37%	9	8%	2013
Unincorporated Areas						
Ashland	61	14	23%	9	15%	2014
Castro Valley	116	38	33%	15	13%	2014
Cherryland	35	0	0%	4	12%	2014
San Lorenzo	36	5	14%	1	3%	2014
Sunol	12	1	9%	1	9%	2014
Unincorporated County	106	33	32%	9	9%	2012-2014
Planning Areas						

Jurisdiction/ Planning Area	Study Network Locations	Observed Volume Locations	Volume Coverage	Observed Speed Locations	Speed Coverage	Year of Observed Data
North	2,288	718	32%	486	22%	-
Central	990	456	47%	105	11%	-
South	711	441	63%	69	10%	-
East	949	151	16%	127	14%	-

Table 2 presents the existing conditions adjustment factors by each jurisdiction and planning area. The volume adjustment factors are usually greater than 1 and the speed adjustment factors are usually less than 1. This result makes sense given that the majority of the observed data was from 2014. One would expect a comparison of the 2014 observed data with the "2010" model data to show the observed data to be higher, and thus require an adjustment factor greater than 1. Additionally the Alameda CTC model development documentation showed that the model was underestimating PM peak hour volumes on the order of 5%.

The inverse relationship makes sense for speed – higher volumes (2014 versus 2010) would cause *lower* congested speeds, in addition model speeds do not account for traffic signal delays or other operational delays that are captured in observed speed data.

Table 2
Existing Conditions Adjustment Factors by Jurisdiction and Planning Area

Jurisdiction/ Planning Area	Study Network Locations	Existing Volume Adjustment Factor	Existing Speed Adjustment Factor
Incorporated Jurisdictions			
Alameda	280	1.14	0.89
Albany	58	1.01	0.87
Berkeley	386	1.09	1.03
Dublin	237	1.09	0.84
Emeryville	46	1.07	0.88
Fremont	468	1.09	0.95
Hayward	447	1.07	0.90

Jurisdiction/ Planning Area	Study Network Locations	Existing Volume Adjustment Factor	Existing Speed Adjustment Factor
Livermore	449	1.04	0.99
Newark	121	1.13	0.88
Oakland	1500	1.04	0.89
Piedmont	18	1.08	0.99
Pleasanton	292	1.07	0.96
San Leandro	232	1.01	0.97
Union City	122	1.11	0.84
Unincorporated Areas			
Ashland	61	0.96	0.87
Castro Valley	116	1.06	1.08
Cherryland	35	1.10	0.85
San Lorenzo	36	0.96	1.02
Sunol	12	1.08	1.00
Unincorporated County	106	1.13	1.09
Planning Areas			
North	2,288	1.08	0.93
Central	990	1.08	0.98
South	711	1.10	0.92
East	949	1.05	0.96

For Study Network segments without available peak hour data, the adjusted peak hour data pivoting from the base year Alameda CTC model was calculated as follows:

$$\begin{aligned} &Existing\ Adjusted\ Model\ Volume_{Facility} \\ &\quad = Base\ Year\ Raw\ Model\ Volume_{Facility} \\ &\quad \times Existing\ Volume\ Adjustment\ Factor_{Jurisdiction} \end{aligned}$$

$$\begin{aligned} Existing\ Adjusted\ Model\ Speed_{Facility} \\ &= Base\ Year\ Raw\ Model\ Speed_{Facility} \\ &\times Existing\ Speed\ Adjustment\ Factor_{Jurisdiction} \end{aligned}$$

These adjustments were applied to the 2010 base year model, calibrating them to observed data that generally ranges between years 2012 and 2014. For the purposes of this study it is assumed that the adjusted existing conditions volume and speed data still represent year 2010 conditions. This represents a conservative assumption as most of the data represents post 2010 conditions.

Figure 1 displays the existing volumes for all Study Network segments. **Figure 2** displays the existing speeds for all Study Network segments.

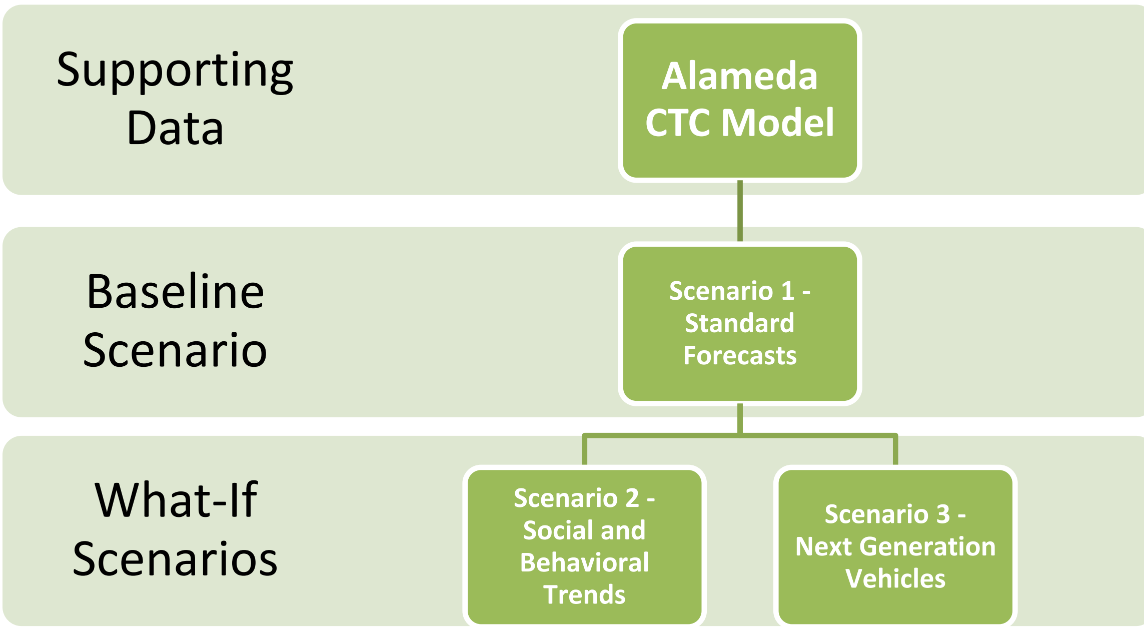
3.0 FORECAST SCENARIOS

To evaluate how well the arterials are performing to meet the established Plan goals, multimodal performance measures will be estimated for future year conditions along the Study Network. This plan will focus on "near-term" (year 2020) and "long-term" (year 2040) scenario years. The year 2020 analysis will be based on a single set of standard forecasts. The year 2040 analysis will consider three separate analysis scenarios:

- Scenario 1 will provide a **standard forecasting analysis** scenario,
- Scenario 2 will provide a supplemental forecasting scenario accounting for lower vehicle miles of travel (VMT) per capita associated with **social and behavioral trends** and the future of mobility, and
- Scenario 3 will account for roadway capacity impacts associated with the expected increase of **next generation vehicles** within the vehicle fleet in Alameda County. This scenario will not influence travel demand but will influence transportation operations. As such it will use the travel estimates from the standard forecasting scenario (Scenario 1 above).

Scenarios 2 and 3 will start with the standard baseline forecasts as developed as part of Scenario 1 and adjust according to factors described below. **Figure 3** presents a flowchart illustrating the relationship between the three scenarios.

Figure 3 – Scenario Flowchart



3.1 SCENARIO 1 – STANDARD FORECASTS

The standard forecasts scenario used the latest Alameda CTC model as received "off-the-shelf" from Alameda CTC without additional edits or adjustments to model parameters.

Study Network volume forecasts for scenario year 2040 were developed by deriving Alameda CTC Model growth rates between the base year (2010) and year 2040 model volumes and applying the growth rates to existing conditions data by jurisdiction. **Table 3** presents the PM peak hour volume growth factors by jurisdiction and planning area.

Table 3
PM Peak Hour Volume Growth (2010-2040) Factors by Jurisdiction and Planning Area

Jurisdiction/ Planning Area	Study Network Locations	Volume Growth Factor
Incorporated Jurisdictions		
Alameda	280	1.09
Albany	58	1.31
Berkeley	386	1.16

Jurisdiction/ Planning Area	Study Network Locations	Volume Growth Factor
Dublin	237	1.61
Emeryville	46	1.53
Fremont	468	1.21
Hayward	447	1.33
Livermore	449	1.32
Newark	121	1.24
Oakland	1,500	1.38
Piedmont	18	1.07
Pleasanton	292	1.23
San Leandro	232	1.43
Union City	122	1.20
Unincorporated Areas		
Ashland	61	1.62
Castro Valley	116	1.19
Cherryland	35	1.61
San Lorenzo	36	1.25
Sunol	12	1.62
Unincorporated County	106	1.58
Planning Areas		
North	2,288	1.31
Central	990	1.33
South	711	1.21
East	949	1.36

For Study Network segments the 2040 PM peak hour volume was then calculated as follows:

$$2040\ Forecasted\ Volume\ _{Facility}\ = Existing\ Volume_{Facility} \times 2040\ Growth\ Factor_{jurisdiction}$$

Figure 5 presents the 2040 PM peak hour volume standard forecasts for all Study Network segments.

For Study Network segments the 2020 PM peak hour volume was then calculated via interpolation as follows:

$$2020\ Forecasted\ Volume\ _{Facility} = Existing\ Volume_{Facility} + \left(\frac{\left(2040\ Forecasted\ Volume\ _{Facility} - \ Existing\ Volume_{Facility}\right)}{(2040 - 2010)}\right) \times (2020 - 2010)$$

Figure 4 presents the 2020 PM peak hour volume forecasts for all Study Network segments. The estimated of growth to 2020 and 2040 closely match the growth estimated for Alameda County screenlines in the Alameda CTC model development documentation.

Congested speed forecasts were estimated using the forecasted volumes calculated above in conjunction with the Bureau of Public Roads (BPR) speed equation. This was assessed to be a more accurate approach to forecast speed as opposed to using the congested speed estimated in the travel model itself, as it is a function of the volume in the model.

The BPR congested speed equation is:

$$Future\ Year\ Speed = \frac{\text{Existing Speed}}{[1 + 0.15(\text{Future Year Volume} - \text{to} - \text{Capacity Ratio})^4]}$$

For 2020 and 2040 the forecasted speeds were calculated at each facility using the congested speed function above.

Figures 6 and 7 present the 2020 and 2040 congested speed for all Study Network segments respectively.

3.2 SCENARIO 2 – SOCIAL AND BEHAVIORAL TRENDS

Recent research has indicated that social and behavioral trends such as an increase in urban living, less auto ownership, and shifting lifestyle and generational travel preferences may significantly change relative to current planning thought. These factors influence travel behavior and could result in lower vehicle volumes and VMT. This forecast scenario prepares forecasts for scenario year 2040 assuming certain social and behavioral trends in Alameda County. Please refer to the *Alameda Countywide Multimodal Arterial Plan – Travel Demand Forecasting Methods White Paper-Final* (Fehr & Peers, June 23, 2015) in **Attachment A** for more details.

Table 4 presents the PM peak hour volume and VMT adjustment factors applied for Scenario 2 to account for social and behavioral trends.

Table 4
Scenario 2 PM Peak Hour Volume and VMT Adjustment Factors

Planning Area	Adjustment Factor Applied to Scenario 1
North	-5%
Central	-5%
South	-10%
East	-7%

For Study Network segments the 2040 PM peak hour volume for Scenario 2 was then calculated as follows:

$$2040\ Scenario\ 2\ Forecasted\ Volume\ _{Facility} = 2040\ Scenario\ 1\ Forecasted\ Volume_{Facility} \times Adjustment\ Factor_{Planning\ Area}$$

Figure 8 presents the 2040 PM peak hour volume forecasts for all Study Network segments for Scenario 2.

Congested speed forecasts were estimated using the Scenario 2 forecasted volumes in conjunction with the Alameda CTC travel demand model volume delay function. This was assessed to be a more accurate approach to forecast speed as opposed to using the congested speed estimated in the travel model itself, as it is a function of the unadjusted model volume. For 2040 Scenario 2 the forecasted speeds were calculated using the congested speed function described above.

Figure 9 presents the 2040 congested speeds for all Study Network segments for scenario 2.

3.2 SCENARIO 3 – NEXT GENERATION VEHICLES

Next generation vehicles such as self-driving or autonomous vehicles (AVs), are already being road tested in several states and will be available for sale within five to 10 years. Research has shown that AVs affect performance of transportation network elements based on their relative proportion to other types of vehicles. This scenario analyzes the likely penetration of AVs in Alameda County and how that will affect the performance of the transportation network.

Scenario 3 will assume that the Study Network contains 20% more capacity (vehicles per hour per lane) than the standard forecast Scenario 1 to account for the significant fleet penetration (50-85%) of next generation vehicles. It is assumed that the Scenario 3 long-term (year 2040) volume forecasts will be the same as Scenario 1 forecasts, the only difference between both scenarios is that Scenario 3 assumes 20% higher Study Network capacity than Scenario 1.

The 20% higher Study Network capacity will be assessed in the performance measure evaluation, not within the Alameda CTC Model. Therefore, the increased capacity will affect the PM peak hour congested speed (measure 1.1A) and reliability (measure 1.1B) calculations for Scenario 3, all other Scenario 3 performance measure calculations will be the same as Scenario 1 results.

For 2040 Scenario 3 the forecasted speeds were calculated using the congested speed function described in Section 3.1 above. **Figure 10** presents the Scenario 3 year 2040 congested speeds along the Study Network.

4.0 NEXT STEPS

Once short-term (2020) and long-term (2040) volume and speed forecasts are approved, the consultant team will utilize the data to assess future year transportation conditions by applying approved performance measures. Please contact Francisco Martin at 510-587-9422 if you have any questions or comments.

Attachments:

Figure 1 – PM Peak Hour Two-Way Vehicle Volume, Existing Conditions
Figure 2 – PM Peak Hour Two-Way Congested Speed, Existing Conditions
Figure 4 – PM Peak Hour Two-Way Vehicle Volume, Year 2020 Conditions
Figure 5 – PM Peak Hour Two-Way Vehicle Volume, Year 2040 Conditions-Scenario 1
Figure 6 – PM Peak Hour Two-Way Congested Speed, Year 2020 Conditions
Figure 7 – PM Peak Hour Two-Way Congested Speed, Year 2040 Conditions-Scenario 1
Figure 8 – PM Peak Hour Two-Way Vehicle Volume, Year 2040 Conditions-Scenario 2
Figure 9 – PM Peak Hour Two-Way Congested Speed, Year 2040 Conditions-Scenario 2
Figure 10 – PM Peak Hour Two-Way Congested Speed, Year 2040 Conditions-Scenario 3

Attachment A – Alameda Countywide Multimodal Arterial Plan – Travel Demand Forecasting Methods White Paper – Final

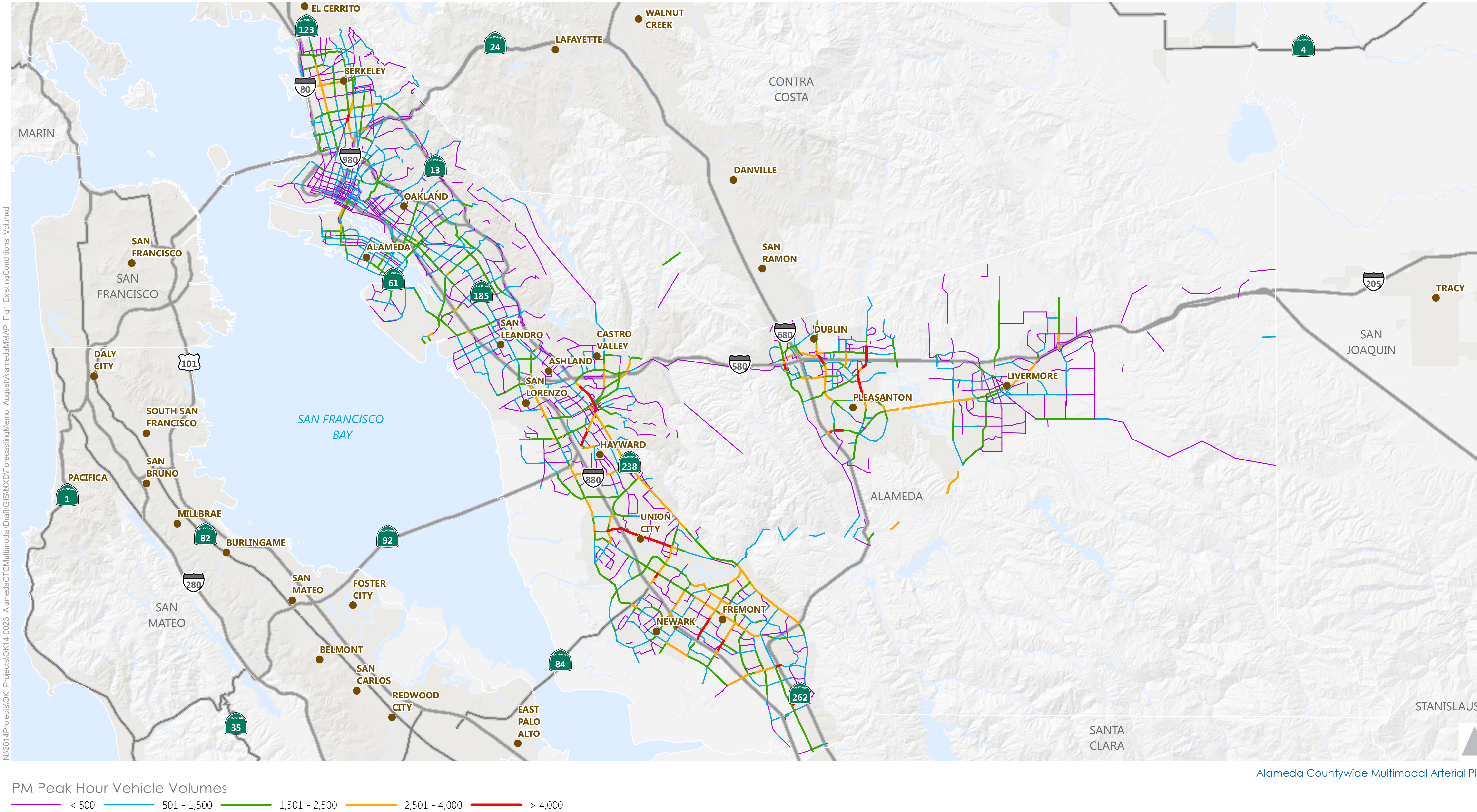


Figure 1

PM Peak Hour Two-Way Vehicle Volume
Existing Conditions

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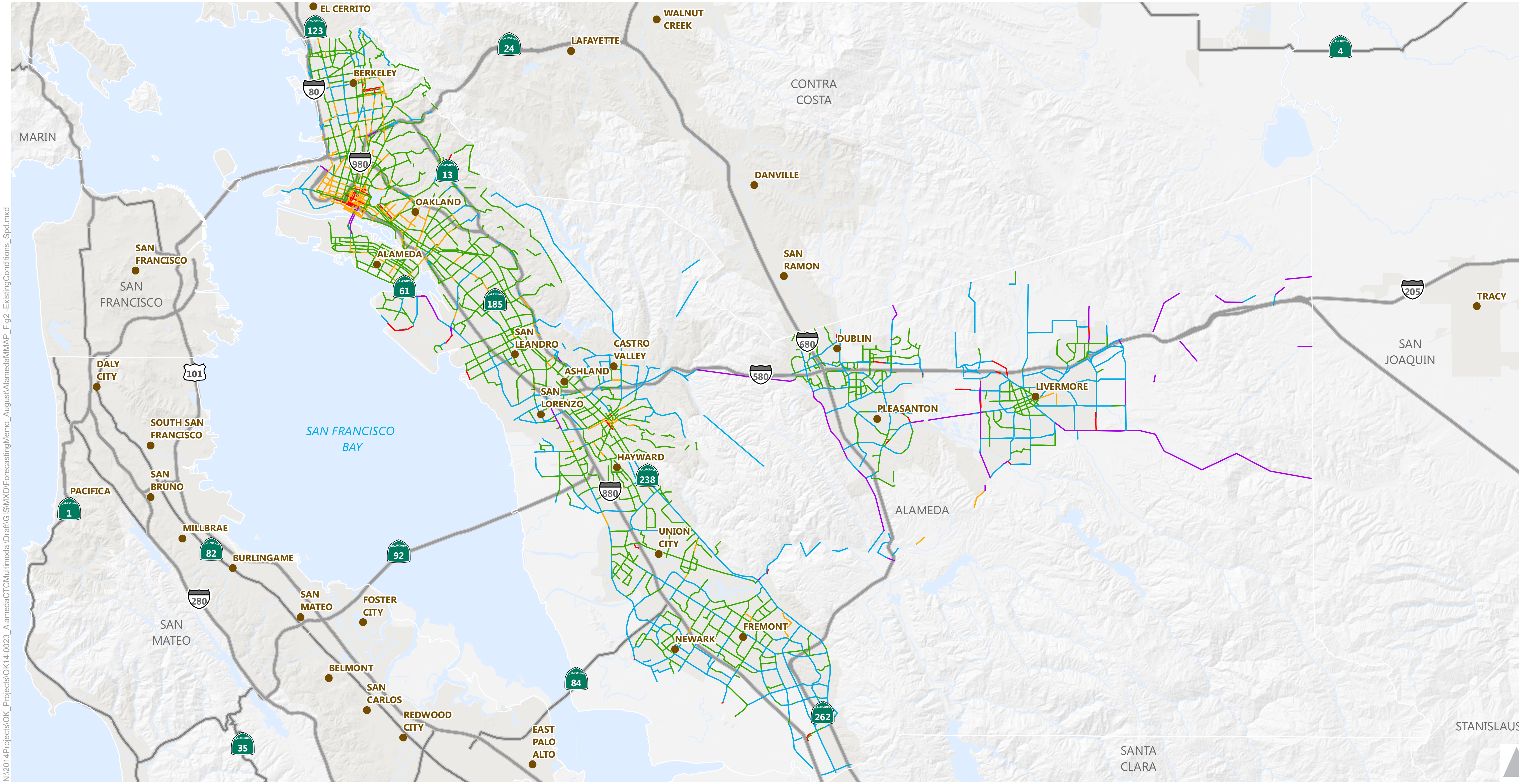


Alameda Countywide Multimodal Arterial Plan

PM Peak Hour Congested Speed

< 10 | 10 - 20 | 20 - 30 | 30 - 40 | > 40 (MPH)

ALAMEDA County Transportation Commission

Figure 2

PM Peak Hour Two-Way Congested Speed
Existing Conditions

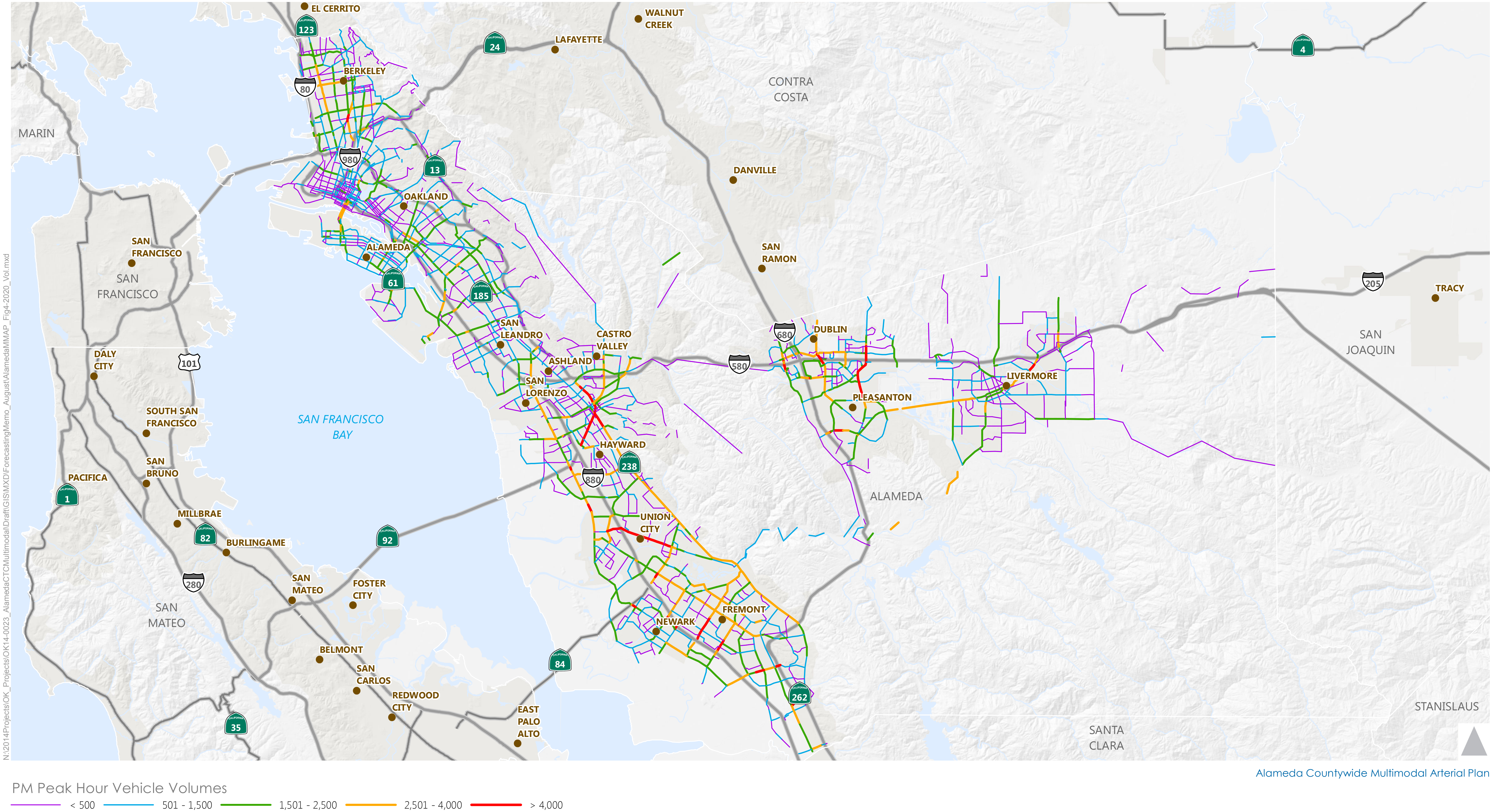
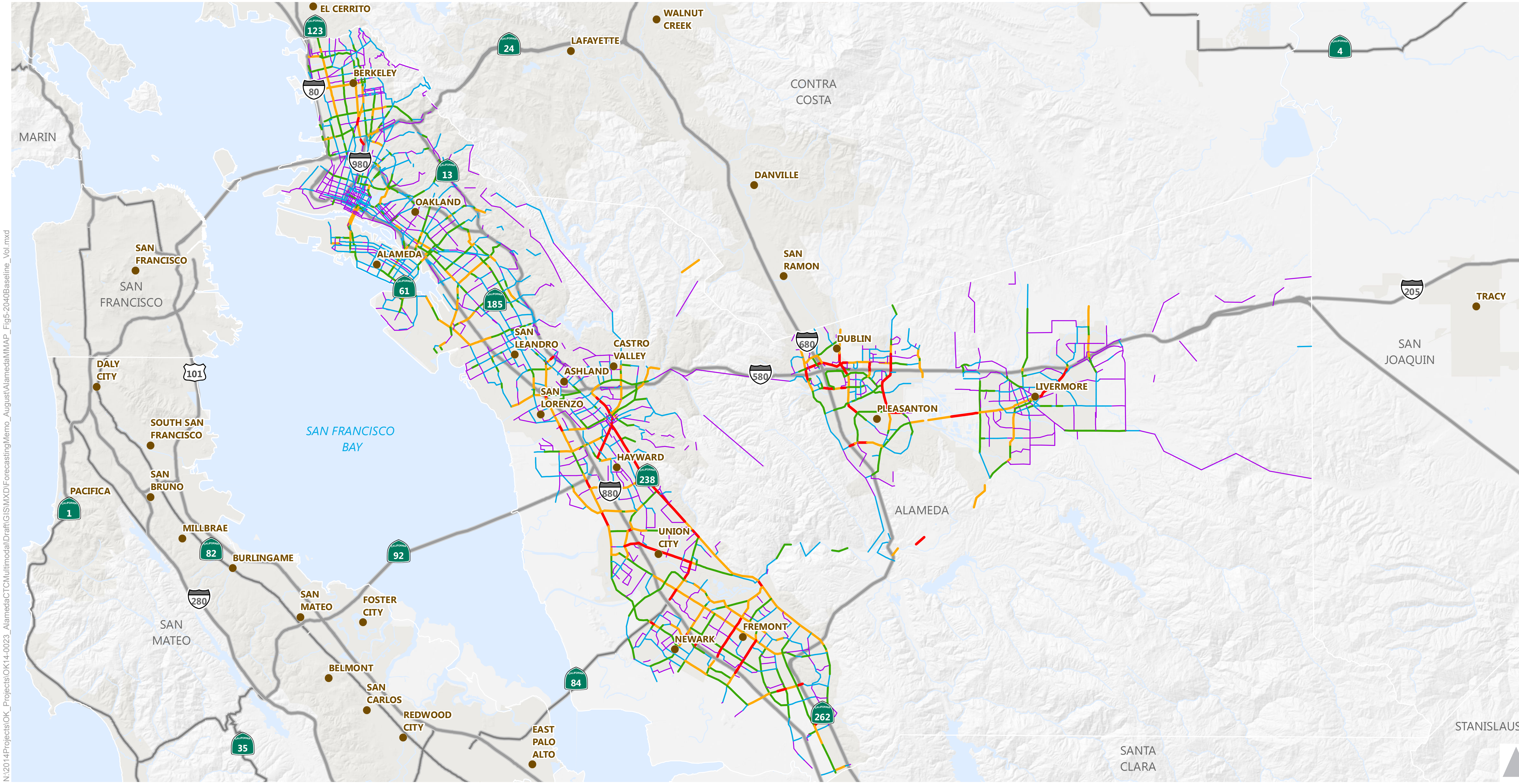


Figure 4

PM Peak Hour Two-Way Vehicle Volume

Year 2020 Conditions



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Alameda Countywide Multimodal Arterial Plan

PM Peak Hour Vehicle Volumes

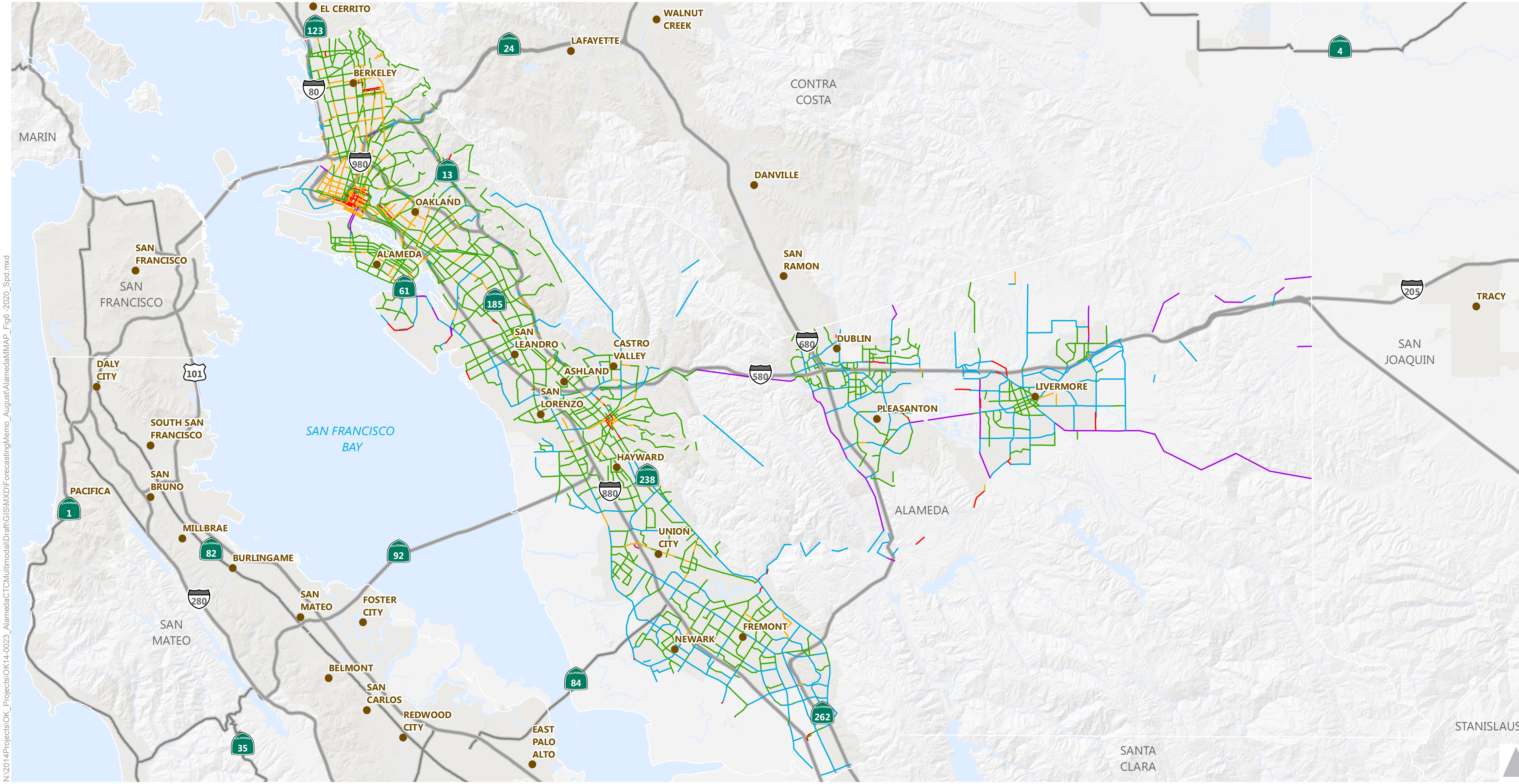
< 500 | 501 - 1,500 | 1,501 - 2,500 | 2,501 - 4,000 | > 4,000

Figure 5

PM Peak Hour Two-Way Vehicle Volume

Year 2040 Conditions - Scenario1

ALAMEDA County Transportation Commission



Alameda Countywide Multimodal Arterial Plan

PM Peak Hour Congested Speed

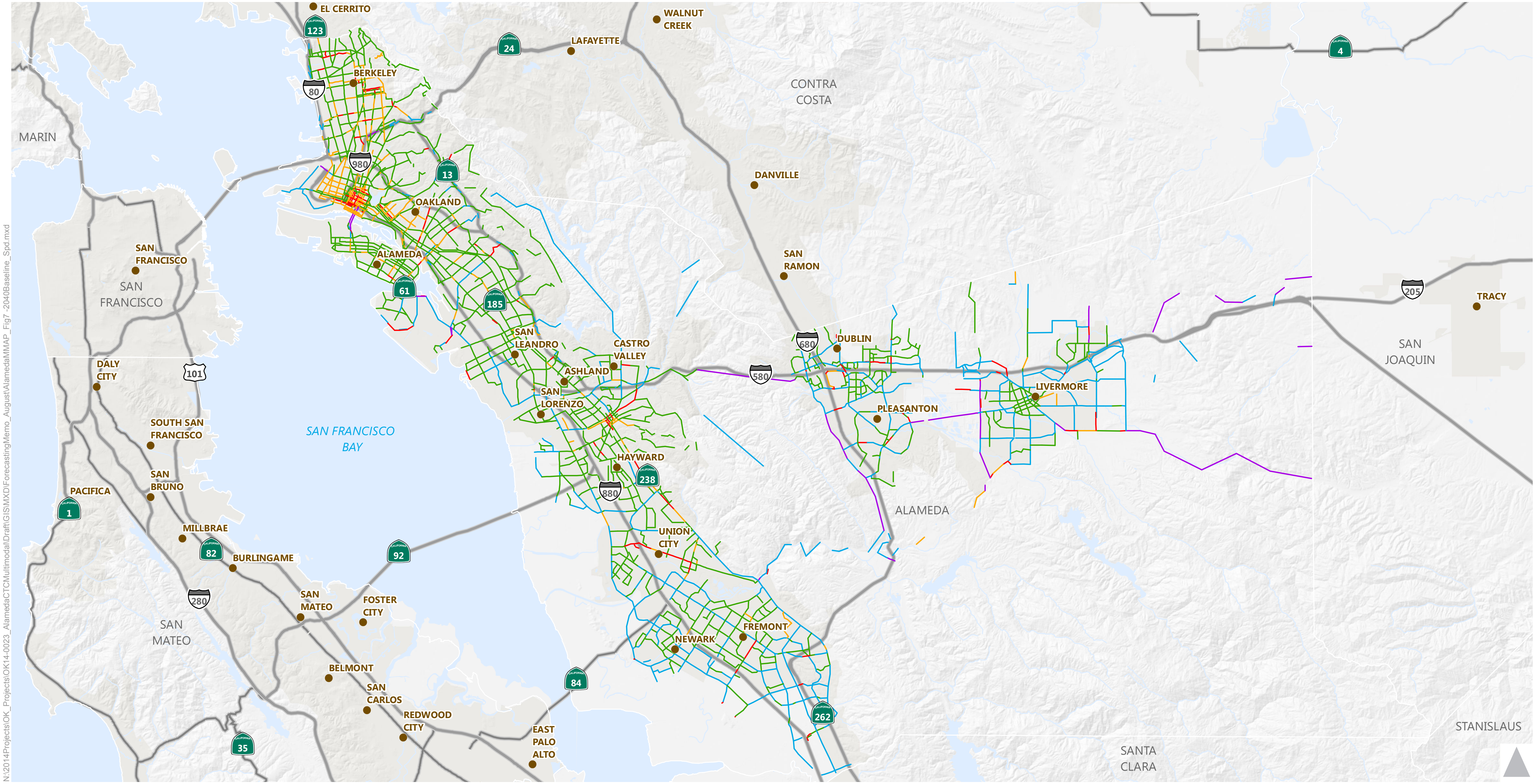
< 10 | 10 - 20 | 20 - 30 | 30 - 40 | > 40 (MPH)

ALAMEDA County Transportation Commission

Figure 6

PM Peak Hour Two-Way Congested Speed

Year 2020 Conditions



Alameda Countywide Multimodal Arterial Plan

PM Peak Hour Congested Speed

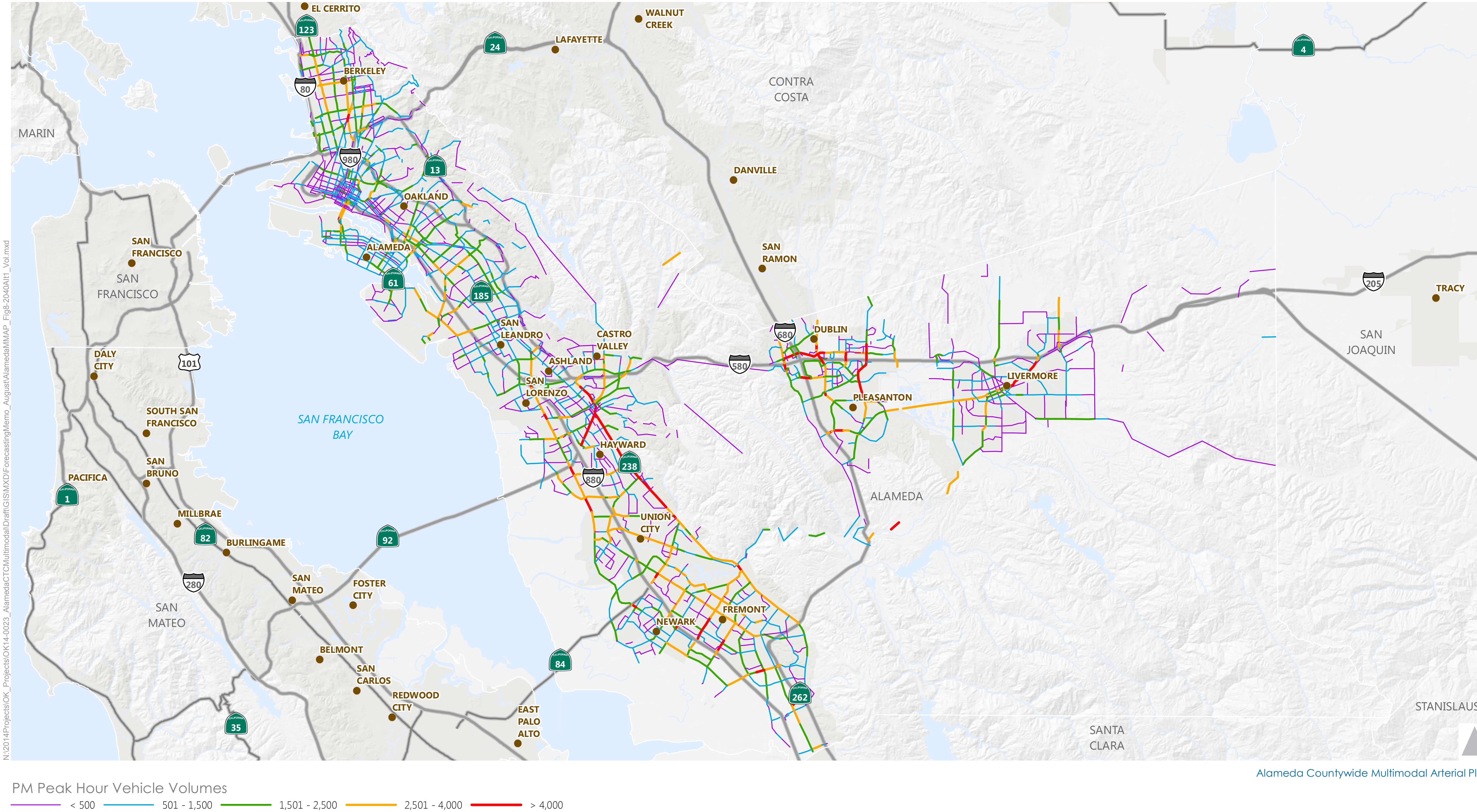
< 10 | 10 - 20 | 20 - 30 | 30 - 40 | > 40 (MPH)

Figure 7

PM Peak Hour Two-Way Congested Speed

Year 2040 Conditions - Scenario 1

ALAMEDA County Transportation Commission



Alameda Countywide Multimodal Arterial Plan

Figure 8

PM Peak Hour Two-Way Vehicle Volume

Year 2040 Conditions - Scenario 2

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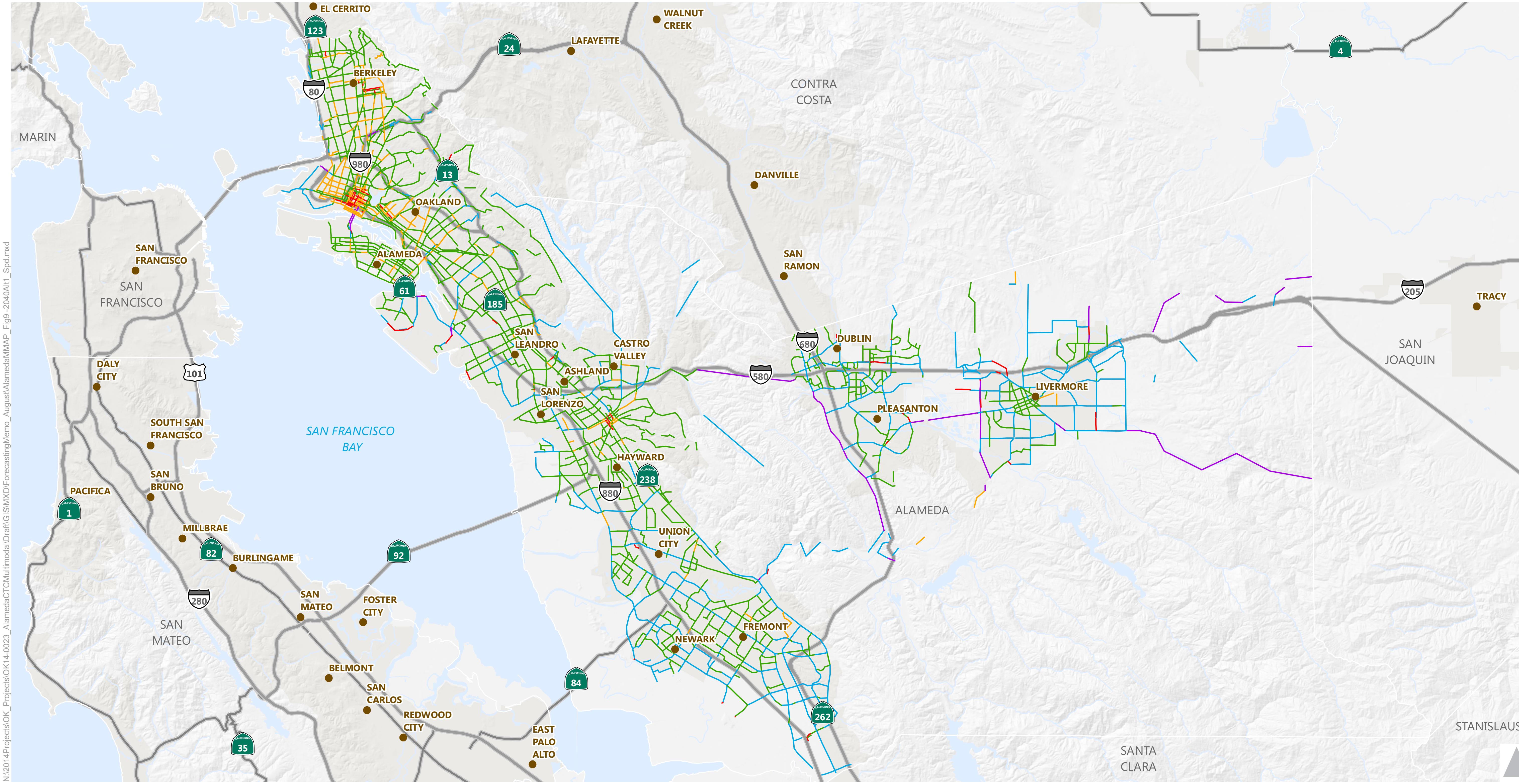

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Alameda Countywide Multimodal Arterial Plan

PM Peak Hour Congested Speed

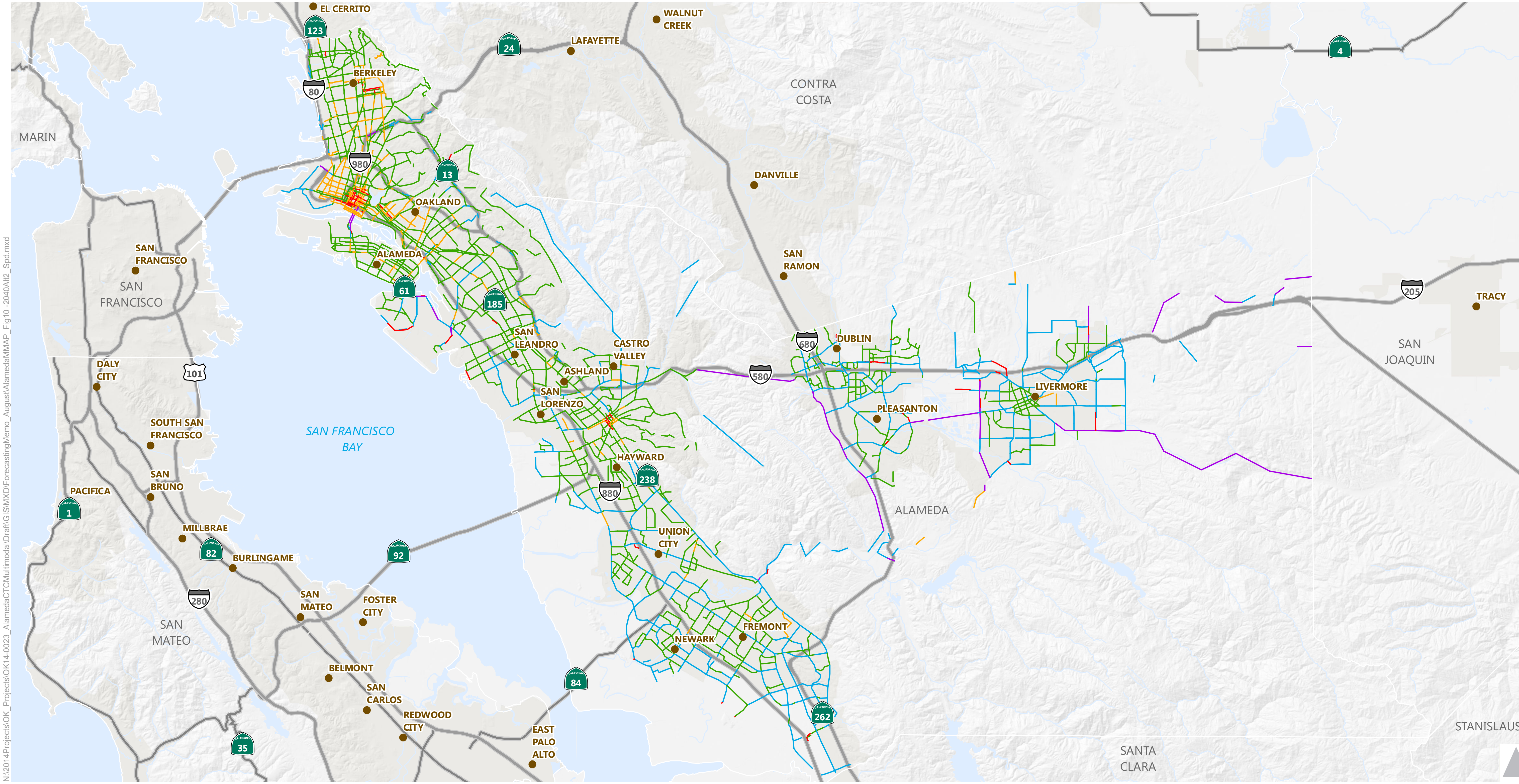
< 10 | 10 - 20 | 20 - 30 | 30 - 40 | > 40 (MPH)

ALAMEDA County Transportation Commission

Figure 9

PM Peak Hour Two-Way Congested Speed

Year 2040 Conditions - Scenario 2



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Alameda Countywide Multimodal Arterial Plan

PM Peak Hour Congested Speed
< 10 | 10 - 20 | 20 - 30 | 30 - 40 | > 40 (MPH)

ALAMEDA County Transportation Commission

Figure 10

PM Peak Hour Two-Way Congested Speed

Year 2040 Conditions - Scenario 3

FEHR PEERS

ATTACHMENT A

Alameda Countywide Multimodal Arterial Plan – Travel Demand Forecasting Methods White Paper - Final

FEHR & PEERS

MEMORANDUM

Date: June 23, 2015

To: Saravana Suthanthira, Alameda CTC

From: Francisco Martin and Mackenzie Watten, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan
Travel Demand Forecasting Methods White Paper – Final

OK14-0023

1.0 INTRODUCTION

Alameda CTC is leading the development of a Countywide Multimodal Arterial Plan to better understand the existing and future role and function of the countywide arterial system in supporting all modes for all users. This Plan will provide a framework for the integrated management of major arterial corridors and will identify a priority list of short- and long-term multimodal improvements and strategies.

To evaluate the future role and conditions of the Study Network, forecasts of future travel behavior are required. These forecasts require the use of multiple data sources, most significantly the Alameda Countywide Travel Demand Model ("Alameda CTC Model"). This white paper describes the travel behavior forecasting assumptions, methodology, and approach.

The white paper first briefly describes the Alameda CTC Model. Then it provides forecast details for the Plan's multimodal performance measures, including those directly and indirectly forecasted using the Alameda CTC Model. The paper then details the three scenarios for which forecasts will be prepared. The first scenario, the Standard Baseline Forecasts Scenario, represents forecasts using current and approved travel behavior projections consistent with *Plan Bay Area* as represented by the Alameda CTC Model.

The other two scenarios represent "what-if" scenarios to evaluate the Study Network if travel behavior and technological trends significantly change in the future. The second scenario, the Social and Behavior Trends Scenario, examines how trends in demographics may change travel behavior. The third scenario, the Next Generation Vehicles Scenario, considers the implications of emerging technology on arterial capacity. These "what-if" scenarios incorporate travel behavior trends not fully captured by the Alameda CTC Model and require off model adjustments.

2.0 ALAMEDA CTC MODEL

The Alameda CTC Model is a collection of mathematical models that represent the Bay Area's land use and transportation networks that allows the Alameda CTC to anticipate and forecast the potential impacts of local land development decisions, transportation network infrastructure planning, and transportation land use and network policy on the major transportation infrastructure in the County. The model is periodically updated to be consistent with the most recent land use and socio-economic database as prepared by ABAG and transportation infrastructure investments as approved in the MTC's Regional Transportation Plan, and travel behavior assumptions as prepared by the Metropolitan Transportation Commission's (MTC) regional travel demand model.

The most recent Alameda CTC model update was completed in July 2014 and includes land use and transportation network assumptions to reflect MTC's *Plan Bay Area*. Additionally, the model was updated with numerous features that will benefit the Multimodal Arterial Plan:

- The model was updated to contain more detail in transit rich corridors, near transit stations, and in designated Priority Development Areas (PDAs)
- Enhancements to more accurately model bicycle trips through bicycle network infrastructure coding and a distinct bicycle trip assignment application
- Validation of the model to updated year 2010 traffic, transit, and bicycle counts
- Inclusion of transit park-and-ride vehicles in the highway assignment

The Alameda CTC model includes scenario years roughly corresponding to "existing" (year 2010), "near-term" (year 2020), and "long-term" (year 2040).

3.0 MULTIMODAL PERFORMANCE MEASURES

The Alameda CTC model is capable of estimating multimodal travel behavior for many locations in Alameda County. It has been calibrated and validated with year 2010 traffic vehicle, transit, and bicycle counts.

The full list of performance measures and performance indicators[1] to be estimated as part of the Multimodal Arterial Plan development have been documented in the January 22, 2015 memo titled *Alameda Countywide Multimodal Arterial Plan – Performance Measures and Evaluation Approach*.

3.1 PERFORMANCE MEASURES CALCULATED FROM MODEL

Some of proposed performance measures and indicators will be directly and indirectly estimated using the Alameda CTC model. Direct calculation implies that the performance measure is calculated using Alameda CTC model; indirect calculation implies that an Alameda CTC model output will be used as an input to calculate a specific performance measure. Please refer to the *Alameda Countywide Multimodal Arterial Plan – Performance Measures and Evaluation Approach* memo for more detail. Performance measures and indicators were approved by the Commission on February 26, 2015.

In addition to the performance measures directly estimated from the model, the model will be used indirectly in other performance measure and indicator calculations. For example, pedestrian and bicycle comfort indices will not be directly estimated by the model, but use vehicle volume forecasts directly estimated from the model as an input.

[1] Performance measures assess the existing and future year transportation conditions of the Study Network. Area-wide performance indicators are generally applied after preferred short- and long-term improvements are identified for the Arterial Network (subset of the Study Network that represents *arterials of countywide significance)* to evaluate and to ensure that the preferred improvements achieve the Plan's vision and goals.

3.1.1 Existing Performance Measure Calculations from Model

Existing PM peak hour volume count and travel speed data was not available for all the Study Network segments. The base year (2010) Alameda CTC model will be used with adjustments as described below. to identify PM peak hour volume and speed data for Study Network segments missing observed data.

The existing PM peak hour volume and speed data that is available will be used to develop jurisdiction (or planning-area where observed data is not available within a jurisdiction) adjustment factors to apply to the base year model volume and speed forecasts. The PM peak hour adjustment factor calculation will take the following form:

$$Existing\ Volume\ Calibration\ Factor_{Jurisdiction}$$
$$= Total\ Volume\ from\ Available\ Count\ Data_{Jurisdiction}$$
$$\div Total\ Volume\ from\ Model\ for\ Segments\ with\ Available\ Count\ Data_{jurisdiction}$$

For Study Network segments without available PM peak hour volume data, the adjusted PM peak hour volume from the base year Alameda CTC model will be calculated as follows:

$$Existing\ Calibrated\ Model\ Volume_{Facility}$$
$$= Base\ Year\ Raw\ Model\ Volume_{Facility}$$
$$\times Existing\ Volume\ Calibration\ Factor_{jurisdiction}$$

The Alameda CTC Model is used to directly calculate adjusted PM peak hour traffic volumes for Study Network segments without available observed data. The adjusted PM peak hour volumes are then used as inputs to calculate the following performance measures (an indirect model application) for existing conditions:

- 1.1B – Reliability
- 1.3 – Pedestrian Comfort Index
- 1.4 – Bicycle Comfort Index
- 5.1 – Collision Rates

Adjusted PM peak hour automobile speed (measure 1.1A) for Study Network segments without available observed speed data will be calculated using a similar process as the adjusted volume calculation described above. Existing PM peak hour transit speed (measure 1.2A) and transit reliability (measure 1.2B) will not be estimated using the Alameda CTC Model since AC Transit and LAVTA provided existing transit speed and reliability data for the majority of their transit network.

Transit speed and reliability will not be evaluated for Study Network segments in which transit operators did not provide data for.

The Alameda CTC Model can also be utilized to directly estimate non-auto transportation mode share (measure 1.6), vehicle miles of travel (VMT) per capita (measure 5.3) and greenhouse gas (GHG) emissions per capita (measure 5.4) for existing conditions.

3.2 PERFORMANCE MEASURES NOT CALCULATED FROM MODEL

The following performance measures or indicators will be evaluated as part of the Multimodal Arterial Plan development but will not be directly or indirectly calculated from the Alameda CTC Model:

- 1.2C Transit Infrastructure Index
- 1.5 Truck Route Accommodation Index
- 1.7 Pavement Condition Index
- 2.1 Benefit to Communities of Concern
- 3.1 Transit Connectivity
- 3.2 Pedestrian Connectivity
- 3.3 Bicycle Connectivity
- 3.4 Network Connectivity
- 4.1 Operating Cost Effectiveness
- 4.2 Implementation Challenge Score
- 4.3 Coordinated Technology

4.0 FORECAST SCENARIOS

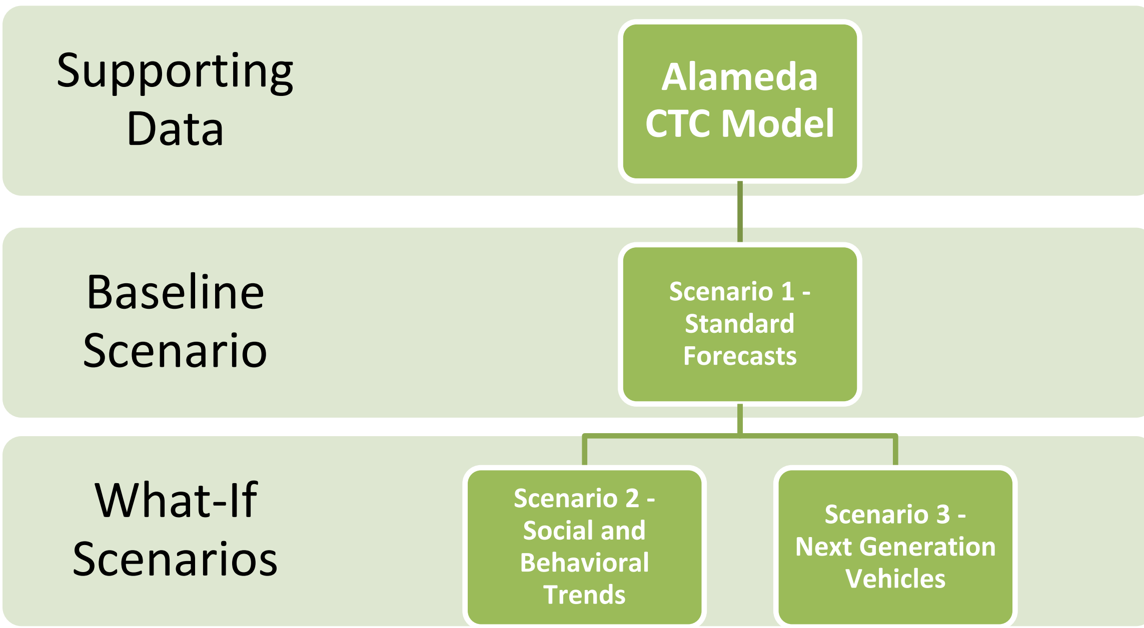
To evaluate how well the arterials are performing to meet the established Plan goals, multimodal performance measures will be estimated for future year conditions along the Study Network. This plan will focus on "near-term" (year 2020) and "long-term" (year 2040) scenario years. The year 2020 analysis will be based on a single set of standard forecasts. The year 2040 analysis will consider three separate analysis scenarios:

- Scenario 1 will provide a **standard forecasting analysis** scenario,
- Scenario 2 will provide a supplemental forecasting scenario accounting for lower VMT per capita associated with **social and behavioral trends** and the future of mobility, and
- Scenario 3 will account for roadway capacity impacts associated with the expected increase of **next generation vehicles** within the vehicle fleet in Alameda County. This scenario will not influence travel demand but will influence transportation operations. As

such it will use the travel estimates from the standard forecasting scenario (Scenario 1 above).

Scenarios 2 and 3 will start with the standard baseline forecasts as developed as part of Scenario 1 and adjust according to factors described below. **Figure 1** presents a flowchart illustrating the relationship between the three scenarios.

Figure 1 – Scenario Flowchart



4.1 SCENARIO 1 – STANDARD FORECASTS

The standard forecasts scenario will use the latest Alameda CTC model as received "off-the-shelf" from Alameda CTC without additional edits or adjustments to model parameters. PM peak hour volumes are generally higher than AM peak hour volumes throughout the County, therefore the Arterial Plan development process focuses on the PM peak hour only; AM peak hour forecasts will not be developed. Alameda CTC generally conducts their Congestion Management Program (CMP) Level of Service (LOS) monitoring by focusing on PM peak hour operations along the CMP network, which sets the precedent for focusing on the PM peak hour only as part of the Arterial Plan development approach.

Study Network volume forecasts for scenario year 2040 will be developed by deriving Alameda CTC Model growth rates between the base year (2010) and year 2040 model volumes and applying the growth rates to existing observed and adjusted volumes. The growth rates will be estimated for each jurisdiction and used to estimate year 2040 forecasts within the respective jurisdiction.

Year 2020 Study Network volume forecasts will be estimated using linear interpolation between existing and year 2040 volume forecasts. Interpolation will be used to ensure that the Project avoids scenarios where 2020 volume forecasts are unreasonably different (e.g., lower) than 2040 volume forecasts. The 2020 version of the Alameda CTC model will be reviewed at a Planning Area level to ensure that the linear interpolation assumed is reasonable.

4.1.1 Future Year (2020 and 2040) Performance Measure Calculations from Model

The Alameda CTC Model will be used to estimate year 2020 and 2040 Study Network PM peak hour volume forecasts. Future year volume forecasts will then be used as inputs to calculate the following performance measures (an indirect model application) for year 2020 and 2040:

- 1.1B – Reliability
- 1.3 – Pedestrian Comfort Index
- 1.4 – Bicycle Comfort Index
- 5.1 – Collision Rates

Future year PM peak hour automobile congested speed (measure 1.1A) will be estimated by applying a standard time delay function, which is typically incorporated into travel demand models to calculate congested travel speeds. The travel delay function will utilize existing peak hour speeds and the future year volume forecasts to estimate year 2020 and 2040 PM peak hour congested speed (measure 1.1A), which is an indirect model application.

Future year PM peak hour transit speed (measure 1.2A) will be estimated by applying the existing conditions PM peak hour transit speed-to- automobile speed ratio to the 2020 and 2040 PM peak hour automobile congested speed (measure 1.1A) estimate. Year 2020 and 2040 transit reliability (measure 1.2B) will be estimated by utilizing year 2020 and 2040 PM peak hour transit speed (measure 1.2A) estimates. Therefore, both the transit speed and transit reliability measures are indirectly estimated from the Alameda CTC Model for future year conditions.

The Alameda CTC Model can also be utilized to directly estimate non-auto transportation mode share (measure 1.6), demand for active transportation (measure 5.2), vehicle miles of travel (VMT) per capita (measure 5.3) and greenhouse gas (GHG) emissions per capita (measure 5.4) for year 2020 and 2040 conditions.

4.1.2 "What-if" Scenarios - Trends Beyond Standard Forecasts

In addition to the standard forecasts analysis, the Multimodal Arterial Plan will prepare two unique scenarios that capture travel behavior trends and impact of next generation vehicles based on the latest research that are not reflected yet in the standard travel demand forecasting models including ABAG/MTC planning or the Alameda CTC Model.

The current planning tools are mostly based on existing or near-term trends that do not fully capture changes in trends beyond the standard forecasting approach. The first alternative forecasting analysis will examine how volume forecasts generated by the Alameda CTC Model could reasonably change given changes in factors that influence travel behavior, and result in lower VMT. These factors include social and behavioral trends such as an increase in urban living, less auto ownership, and shifting lifestyle and generational travel preferences as explained in the sections below. The second alternative analysis scenario that captures the impact of next-generation vehicles (connected or autonomous in nature) will utilize the standard forecast estimates and estimate the impact of next-generation vehicles to arterial per lane capacity. It's important to note that these analysis scenarios are intended as a planning exercise – research on these trends is still in its infancy and there are a number of assumptions that will be used to quantify effects to the countywide Study Network. As such, approximate adjustments will be used as much as possible to not give a false sense of precision.

For purposes of this Plan development, the two supplemental forecasting analysis scenarios with variants for demographic, economic, and technologic trends will focus on the "long-term" (year 2040) scenario. Based on available research, "near-term" (year 2020) scenario will likely not have large changes due to these trends.

The following sections will describe each "what-if" scenario, the national research on the trends, the local context of those trends, and proposed assumptions for applications of the local context to the what-if" scenario.

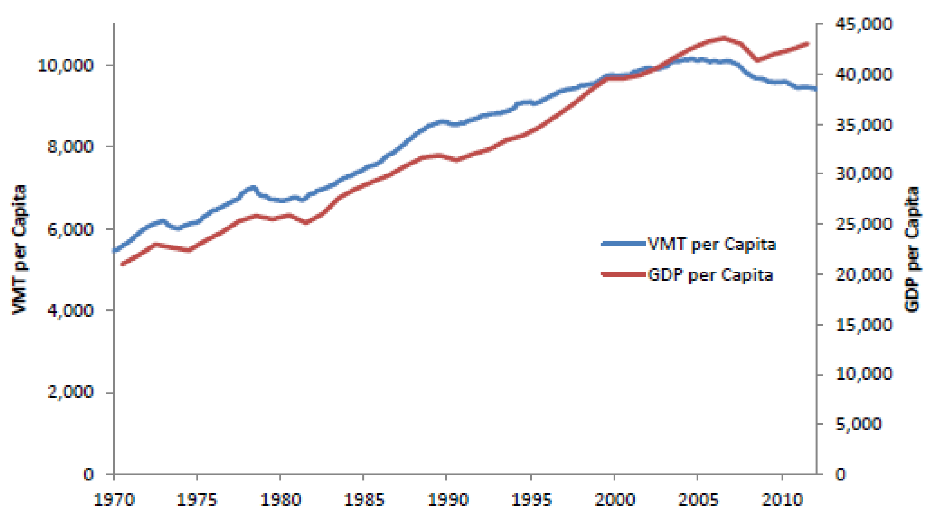
4.2 SCENARIO 2 – SOCIAL AND BEHAVORIAL TRENDS

Recent research has indicated that social and behavioral trends such as an increase in urban living, less auto ownership, and shifting lifestyle and generational travel preferences may significantly change relative to current planning thought. These factors influence travel behavior and could result in lower VMT. This scenario analyzes how existing planning tools such as the Alameda CTC Model currently reflect these trends, and to what extent future conditions would change if further changes were assumed.

4.2.1 National Research

As shown in **Figure 2**, after 50 years of steady growth, total national vehicle miles traveled (VMT) per capita leveled off in 2004 and declined by eight percent between 2004 and 2012[2]. Research has focused on the reasons for the decline and whether the leveling and subsequent drop in VMT will be temporary or the beginning of a sustained downward trend. Research has narrowed the possible reasons for the decline to macroeconomic factors, technology and social networking, and shifting lifestyle and generational trends that influence society's transportation priorities.

Figure 2 – Annual VMT and GDP per Capita 1970-2012



Source: Federal Highway Administration Office of Highway Policy Information; World Bank.

[2] Federal Highway Administrative Office of Highway Policy Information, 2012.

4.2.1.1 Macroeconomic factors

The economic decline of the Great Recession around 2008 does not fully explain the VMT decline observed. Driving began to plateau in 2004, at least three years before the onset of the recession. In the meantime, GDP per capita continued to climb until the onset of the Great Recession[3]. Although the macroeconomic decline reversed in 2010, VMT per capita has continued to decline. Factors to explain this include lower vehicle ownership (by nearly five percent between 2006 and 2011)[4], declining employment rate (approximately five percent between 2000 and 2012)[5], decrease in median household income (10 percent decrease between 2000 and 2012)[6], and a shift from housing development in suburban or urban fringe areas to infill ("previously developed") areas near city centers and inner ring suburbs[7].

4.2.1.2 Technology and social networking

Some of the "conventional" wisdom on the reasons for VMT decline has been overstated. Internet shopping accounts for only 10 percent of all purchases, and only 80 percent of internet purchases generated additional VMT due to delivery vehicles. Telecommuting effects are still small: only 4.3 percent of employees worked from home in 2010, as compared with 3.5 percent in 1970. Many studies have found that connected applications and the sharing economy tended to be associated with only slight changes in travel demand (both increase and decrease). Information and communications technologies appear to be as a complement to travel and not a substitute for it.[8]

4.2.1.3 Shifting lifestyle and generational trends

A large amount of research has been focused on the shifting lifestyle of generational trends between Baby Boomers (those born between 1946 and 1964) and Millennials (those born between 1983 and 2000). These two groups represent the two largest age cohorts alive today. Millennials are transitioning into adult life in a poor job market while Baby Boomers are

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[3] World Bank, 2012.
[4] Cohn, D'Vera. "Data show a dent in Americans' love for cars." *Pew Research Center*. 1 July 2013. http://www.pewresearch.org/fact-tank/2013/07/01/data-show-a-dent-in-americans-love-for-cars/
[5] Bureau of Labor Statistics, 2012.
[6] U.S. Census Bureau, 2012.
[7] Thomas, J. "Residential Construction Trends in America's Metropolitan Regions," U.S. Environmental Protection Agency, January 2009 and January 2010.
[8] Volpe National Transportation Systems Center. "Driven to Extremes – Has Growth in Automobile Use Ended?" FHWA Office of Highway Policy Information, May 2013.

transitioning into their golden years and experiencing issues retiring due to devaluation of various assets.

Baby Boomers are expected to be more active and mobile than the present senior population, just as the present senior population is more mobile than the generation before them. Aligning with overall trends, per capita VMT declined by nearly 10 percent between 2001 and 2009 for Baby Boomers. Car mode share declined between 2001 and 2009 for both Baby Boomers and seniors aged 75 and older.[9]

Millennials have entered their adult lives during the onset of the Great Recession. Research has shown that economic factors have had a strong influence on their travel decisions. Younger generations travel fewer miles and make fewer trips than was the case for previous generations at the same stage in their lives. [10]

Car ownership is down overall – adults between the ages of 21 and 34 bought just 27 percent of all new vehicles sold in the US, down from a peak of 38 percent in 1985. Surveys of Millennials indicate a strong preference towards living in medium or big cities, where land use and social scenes tend to be more dynamic with a mixture of activities and socioeconomic groups.[11]

4.2.1.4 National Research Conclusion

The national research above indicates that VMT growth will slow significantly and may even stabilize at pre-2000 VMT per capita levels. **Putting the above factors together this white paper forecasts that VMT per capita (nationally), which grew by 17 percent between 1990 and 2004 and declined by eight percent between 2004 and 2012, will remain static or decline and will be between 90% and 95% of the 2012 VMT per capita, even through 2040**. This estimate is based on the national research listed above and may be different given local context (see next section). Additionally this research is in its infancy and should be considered approximate assumptions and for the sake of high level planning. Further research and monitoring of trends may adjust these assumptions.

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[9] National Household Travel Survey (NHTS), 2009.
[10] Blumenberg E., Taylor B., Ralph K., Wander M., Brumbaugh S. "*What's Youth Got to Do with It? Exploring the Travel Behavior of Teens and Young Adults.*" (2013) University of California Transportation Center.
[11] Lachmann M., Leanne B., Deborah L. "*Generation Y: Shopping and Entertainment in the Digital Age.*" Urban Land Institute, 2013.

4.2.2 Local Context

The research reviewed above is national in scope and may not directly apply to Alameda County. The current planning projections produced by ABAG, MTC, and Alameda CTC already partially account for the demographic trends described above. This has been accounted for in the standard forecasting scenario (Scenario 1 above). This scenario will explore how trends may go above and beyond that which has been projected for the purposes of creating a "what-if" scenario.

The regional Sustainability Community Strategy (SCS) prepared by MTC and ABAG for the Bay Area, *Plan Bay Area*, includes sections on "Aging Baby Boomers Expected to Change Travel and Development Patterns" and "Demand for Multi-Unit Housing in Urban Areas Close to Transit Expected to Increase". Clearly, trends in demographics and travel behavior are expected and accounted for in regional planning projections. Review of demographics from the Alameda CTC model (which implements the MTC/ABAG SCS) at a Planning Area and PDA area level reflects these trends.

Table 1 presents the percentage of growth from 2010 to 2040 located in PDA areas by Planning Area. Consistent with the national research[12], there is a shift towards growth in urban environments in Alameda County.

Table 1
Percentage of Growth (2010 to 2040) in PDA by Planning Area (Alameda CTC Model)

Planning Area	% Growth in PDA		
	Total HH	Total Pop	Total Emp
North	91%	88%	84%
Central	77%	72%	55%
South	78%	75%	56%
East	60%	55%	36%
Total	*81%*	*77%*	*65%*

[12] Thomas, J. "Residential Construction Trends in America's Metropolitan Regions," U.S. Environmental Protection Agency, January 2009 and January 2010.

Table 2 presents the household vehicle ownership distribution by Planning Area from the Alameda CTC model. Consistent with the national research[13], there is a shift towards less auto ownership in Alameda County.

Table 2
Household Vehicle Ownership Distribution by Planning Area (Alameda CTC Model)

Planning Area	Scenario Year 2010			Scenario Year 2040			Growth (percent points)		
	0-Vehicle	1-Vehicle	2+-Vehicle	0-Vehicle	1-Vehicle	2+-Vehicle	0-Vehicle	1-Vehicle	2+-Vehicle
North	19%	44%	37%	26%	42%	32%	7%	-2%	-6%
Central	9%	36%	55%	12%	38%	50%	3%	2%	-5%
South	6%	27%	67%	7%	29%	64%	2%	2%	-4%
East	4%	24%	71%	6%	27%	67%	2%	3%	-5%
Total	12%	36%	51%	17%	37%	46%	*5%*	*0%*	*-5%*

Table 3 presents the household worker distribution by Planning Area from the Alameda CTC model. Consistent with the national research[14], there is a shift towards less workers per household in Alameda County, which means there will tend to be reduced number of trips and reduced VMT.

Table 3
Household Worker Distribution by Planning Area (Alameda CTC Model)

Planning Area	Scenario Year 2010			Scenario Year 2040			Growth		
	0-Worker	1-Worker	2+-Worker	0-Worker	1-Worker	2+-Worker	0-Worker	1-Worker	2+-Worker
North	32%	38%	30%	36%	36%	27%	4%	-1%	-3%
Central	25%	40%	35%	29%	39%	31%	4%	-1%	-3%
South	16%	37%	47%	19%	37%	45%	2%	0%	-2%
East	19%	34%	47%	19%	35%	46%	0%	0%	0%
Total	26%	38%	37%	29%	37%	34%	*3%*	*-1%*	*-2%*

[13] Lachmann M., Leanne B., Deborah L. "*Generation Y: Shopping and Entertainment in the Digital Age.*" Urban Land Institute, 2013.
[14] Bureau of Labor Statistics, 2012.

Changes in other factors mentioned in the national research, including goods and service delivery, telecommuting, social networking, and internet shopping, is likely not directly accounted for in the Alameda CTC Model. The research indicated a change in plus or minus two percent VMT per capita for the various factors – this will be incorporated into the adjustment factors listed in the next section.

Detailed tables detailing the trends described above, cross classified by Planning Area and PDA are presented at the end of this memo.

4.2.3 Scenario 2 Conclusion

As mentioned previously, the factors listed above are byproducts of land use, built environment, and multimodal options available. It's clear that the Bay Area planning projections partially include the trends described by the national research. The projections differ to the degree already captured in model by Planning Area.

The national research indicates that VMT per capita will remain static or decline and will be between 90% and 95% of the 2012 VMT per capita, even through 2040. Based on the evaluation of trends in social, demographics and travel behavior in each Planning Area as detailed in tables 2 to 4, the project team determined qualitatively the degree these trends have been already captured in the model for 2040 as high, medium, and low, as shown in **Table 4**.

Based on the research that states that there will be a 5% to 10% reduction of VMT per capita over the 2012 levels, an additional adjustment factor was identified for each of the Planning Areas based on the degree to which the research trends were already captured. As the North and Central Planning Areas were identified to have a high amount of trends already captured, a reduction of downward adjustment factor of 5% was identified for VMT reduction. The South and East Planning Areas were identified to have a low amount of trends already captured, and thus higher downward adjustment factors were identified.

Considering that the South Planning Area will have a direct mass transit connection to Silicon Valley, a major regional employment center, it is expected to have higher VMT reduction (10%). The East Planning Area with the proposed transit improvements will have a VMT reduction (7%) that is comparable to the South Planning Area and higher than the North and Central Planning Areas.

Table 4 also presents these adjustment factors to be applied to Scenario 1 Year 2040 vehicle volume forecasts to develop Scenario 2 2040 vehicle volume forecasts. Study Network vehicle volume forecasts are used as inputs into various future year performance measure calculations, as described in Section 4.1.1 above. These factors reflect the incremental change in travel behavior (relative to the partially captured model factors) due to demographics and the future of mobility. These factors combined with the model projections create a 2040 scenario consistent with the national research of 90% to 95% of the 2012 VMT per capita.

Table 4
Scenario 2 Traffic Volume Adjustment Factors

Planning Area	Degree Already Captured in Model				Adjustment Factor Applied to Scenario 1 (Year 2040 Only)
	Shift to PDAs	Vehicle Ownership	Labor Participation	Other Factors (Goods Delivery, Social Networking, etc.)	Proposed Adjustment Factor
North	High	High	High	None	-5%
Central	Medium	Medium	High	None	-5%
South	Medium	Medium	Medium	None	-10%
East	Low	Medium	Low	None	-7%

These adjustment factors are approximate to represent the nature of the national research and the concept of a "what-if" scenario. Performance measures and indicators listed in **Table 1** will be estimated for Scenario 2 using a similar process as Scenario 1 calculations described in Section 4.1.1.

4.3 SCENARIO 3 – NEXT GENERATION VEHICLES

Next generation vehicles such as self-driving or autonomous vehicles (AVs), are already being road tested in several states and will be available for sale within five to 10 years. Research has shown that AVs affect performance of transportation network elements based on their relative proportion to other types of vehicles. This scenario analyzes the likely penetration of AVs in Alameda County and how that will affect the performance of the transportation network.

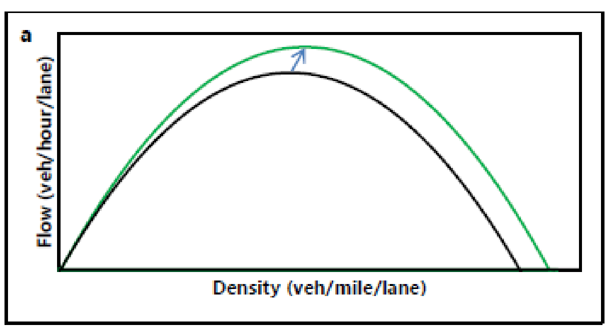
4.3.1 National Research

The research is varied by facility type – those locations with fewer conflicts (such as freeways and highways) will be the first to receive benefits as market penetration grows. Multimodal arterials would likely require substantial market penetration of AVs before noticeable impacts on roadway capacity are observed. The research has narrowed its focus to the effect of AVs on roadway capacity, VMT, and parking.

4.3.1.1 Effect on Roadway Capacity

AVs present an opportunity for increased roadway capacity due to their potential to minimize following distances between vehicles and improve time negotiating merging and intersection right-of-way. In the short-term (year 2020), AVs will have negligible impacts to roadway capacity. In the long term (year 2040), when AVs reach almost significant amounts (50-85%[15]) of penetration of the fleet, operating efficiencies will begin to improve. Some research indicates per-lane highway roadway capacities could improve by up to 50%. As shown on **Figure 3**, **research on capacity improvements for non-highway roadway facilities is more limited, but early research indicates capacity improvements on the order of 20%[16] with significant amounts (50-85%) of penetration of the fleet. These assumptions appear conservative and therefore reasonable to use for this alternative scenario.**

Figure 3 – Potential Flow Capacity Shift with Autonomous Vehicles



Source: Caltrans PATH program

[15] Patcharinee Tientrakool, Ya-Chi Ho, and Nicholas F. Maxemchuk. "Highway Capacity Benefits from Using Vehicle-to-Vehicle Communication and Sensors for Collision Avoidance." Vehicle Technology Conference (VTC Fall). San Francisco, California, September 2011.

[16] Steven E. Shladover. "Highway Capacity Increases from Automated Driving." California PATH Program, July 2012.

4.3.1.2 Effect on VMT

A number of complex factors with varying levels of interaction will affect changes to travel behavior patterns, resulting in either an increase or decrease in overall vehicle-miles traveled (VMT). Research has also shown that the increase in AVs can lead to more travel/VMT[17], while others indicate that AVs may increase travel/VMT[18] [19].

Given the uneven results and lack of research on the topic, the next generation vehicle scenario will not consider the effect on VMT.

4.3.1.3 Effect on Parking

AVs will have automatic parking capabilities that move a vehicle from a traffic lane into a parking space by performing a parallel, perpendicular or angle parking maneuver. AVs and their automated parking capabilities can potentially affect the need to provide on-street parking for arterial segments that have right-of-way constraints and would thus make it difficult to provide on-street parking. Automatic parking will allow passengers to be dropped off at destinations that do not provide off-street parking or adjacent on-street parking spaces and AVs would then have the capability to park itself at an on-street parking space within a few blocks of the passenger's destination.

4.3.2 Local Context

The national research on next generation vehicles is limited and mostly still at research in nature. As such, there is no local context to provide except that there are test facilities either available or being opened across the region for testing next generation vehicles. The facilities included in the national research (highways and arterials) are likely similar to the type of facilities that exist in a mature urban environment like Alameda County.

4.3.3 Scenario 3 Conclusion

The research above indicates that the improved driver experience provided by AVs could produce as much as a 50 percent increase for highway facilities and roughly 20 percent for non-highway

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[17] http://www.autonews.com/article/20130612/OEM11/130619945/for-some-driving-is-more-stressful-than-skydiving#
[18] http://trb.metapress.com/content/j81w2542q372x2p5/
[19] http://www.nzta.govt.nz/resources/research/reports/469/docs/469.pdf

facilities[20] in operating efficiency and capacity utilization, in addition to better on-street parking demand management.

These rates vary by facility types where AVs would be permitted, the multimodal options available as well as AV market penetration. Although the net operational improvements to arterials may not significantly reduce the need to expand infrastructure to keep pace with population growth, the benefit of AVs on the road would most likely take the form of increased mobility for all, increased safety, reduced incident-related congestion, and reduced environmental costs per VMT.

Based on the research described above, Scenario 3 will assume that the Study Network contains 20% more capacity (vehicles per hour per lane) than the standard forecast Scenario 1 to account for the significant fleet penetration (50-85%) of next generation vehicles. These adjustment factors are approximate to represent the nature of the national research and the concept of a "what-if" scenario. These adjustments are intended for a high level planning study.

As part of Scenario 3, Fehr & Peers will not conduct a new Alameda CTC Model run assuming 20% higher capacity along arterials or any capacity adjustments along freeways. It is assumed that the Scenario 3 future year (2020 and 2040) volume forecasts will be the same as Scenario 1 forecasts, the only difference between both scenarios is that Scenario 3 assumes 20% higher Study Network capacity than Scenario 1. The 20% higher Study Network capacity will be assessed in the performance measure evaluation, not within the Alameda CTC Model. Therefore, the increased capacity will affect the PM peak hour congested speed (measure 1.1A) and reliability (measure 1.1B) calculations for Scenario 3, all other Scenario 3 performance measure calculations will be the same as Scenario 1 results.

Please contact Francisco Martin at 510-587-9422 if you have any questions or comments.

Attachments:
Demographic and Future of Mobility Trends Capture in Model: Full Detail

[20] Steven E. Shladover. "Highway Capacity Increases from Automated Driving." California PATH Program, July 2012.

Growth by Planning Area

All Planning Areas

Planning Area	2010			2040			Growth		
	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP
North	247,345	618,495	316,745	328,378	836,168	444,864	81,033	217,673	128,119
Central	123,482	367,390	124,352	149,463	449,340	171,302	25,981	81,950	46,950
South	104,301	325,896	124,019	130,813	417,993	171,193	26,512	92,097	47,174
East	71,252	202,753	119,131	100,717	276,537	172,814	29,465	73,784	53,683
Total	*546,380*	*1,514,534*	*684,247*	*709,371*	*1,980,038*	*960,173*	*162,991*	*465,504*	*275,926*

All Planning Areas

PDA	2010			2040			Growth		
	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP
Regional Center	12,952	23,459	97,173	28,663	50,608	130,395	15,711	27,149	33,222
City Center	34,067	83,293	68,869	58,094	139,740	101,730	24,027	56,447	32,861
Mixed-Use Corridor	96,275	242,129	58,453	114,488	294,133	76,006	18,213	52,004	17,553
Urban Neighborhood	49,325	133,585	30,267	63,270	176,602	47,943	13,945	43,017	17,676
Transit Neighborhood	45,729	140,723	30,065	54,647	171,802	39,650	8,918	31,079	9,585
Suburban Center	16,401	51,218	71,654	37,067	101,650	103,144	20,666	50,432	31,490
Transit Town Center	45,990	136,363	40,001	76,160	235,522	75,814	30,170	99,159	35,813
Sub-Total PDA	*300,739*	*810,770*	*396,482*	*432,389*	*1,170,057*	*574,682*	*131,650*	*359,287*	*178,200*
Non-PDA	245,641	703,764	287,765	276,982	809,981	385,491	31,341	106,217	97,726
				% Growth in PDAs			81%	77%	65%

Growth by Planning Area

North

	2010			2040			Growth		
	TOTHH	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**
North	247,345	618,495	316,745	328,378	836,168	444,864	81,033	217,673	128,119
Central									
South									
East									
Total	*247,345*	*618,495*	*316,745*	*328,378*	*836,168*	*444,864*	*81,033*	*217,673*	*128,119*

North

	2010			2040			Growth		
	TOTHH	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**
Regional Center	12,952	23,459	97,173	28,663	50,608	130,395	15,711	27,149	33,222
City Center	11,039	21,329	35,060	21,314	41,636	50,877	10,275	20,307	15,817
Mixed-Use Corridor	80,390	196,675	49,326	93,981	233,932	60,956	13,591	37,257	11,630
Urban Neighborhood	46,786	125,613	29,702	57,185	157,322	46,808	10,399	31,709	17,106
Transit Neighborhood	4,159	10,192	7,844	5,120	12,855	8,760	961	2,663	916
Suburban Center	0	0	0	0	0	0	0	0	0
Transit Town Center	22,837	65,958	23,316	45,328	137,768	51,648	22,491	71,810	28,332
Sub-Total PDA	*178,163*	*443,226*	*242,421*	*251,591*	*634,121*	*349,444*	*73,428*	*190,895*	*107,023*
Non-PDA	69,182	175,269	74,324	76,787	202,047	95,420	7,605	26,778	21,096
				% Growth in PDAs			91%	88%	84%

Growth by Planning Area

Central

	2010			2040			Growth		
	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP
North									
Central	123,482	367,390	124,352	149,463	449,340	171,302	25,981	81,950	46,950
South									
East									
Total	*123,482*	*367,390*	*124,352*	*149,463*	*449,340*	*171,302*	*25,981*	*81,950*	*46,950*

Central

	2010			2040			Growth		
	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP	TOTHH	TOTPOP	TEMP
Regional Center	0	0	0	0	0	0	0	0	0
City Center	10,708	27,559	14,382	17,537	44,155	23,080	6,829	16,596	8,698
Mixed-Use Corridor	15,885	45,454	9,127	20,507	60,201	15,050	4,622	14,747	5,923
Urban Neighborhood	2,539	7,972	565	6,085	19,280	1,135	3,546	11,308	570
Transit Neighborhood	17,615	54,163	12,344	21,040	65,494	19,897	3,425	11,331	7,553
Suburban Center	0	0	0	0	0	0	0	0	0
Transit Town Center	5,694	16,347	3,887	7,274	21,255	6,884	1,580	4,908	2,997
Sub-Total PDA	*52,441*	*151,495*	*40,305*	*72,443*	*210,385*	*66,046*	*20,002*	*58,890*	*25,741*
Non-PDA	71,041	215,895	84,047	77,020	238,955	105,256	5,979	23,060	21,209
				% Growth in PDAs			77%	72%	55%

Growth by Planning Area

South

	2010			2040			Growth		
	TOTHH	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**
North									
Central									
South	104,301	325,896	124,019	130,813	417,993	171,193	26,512	92,097	47,174
East									
Total	*104,301*	*325,896*	*124,019*	*130,813*	*417,993*	*171,193*	*26,512*	*92,097*	*47,174*

South

	2010			2040			Growth		
	TOTHH	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	12,320	34,405	19,427	19,243	53,949	27,773	6,923	19,544	8,346
Mixed-Use Corridor	0	0	0	0	0	0	0	0	0
Urban Neighborhood	0	0	0	0	0	0	0	0	0
Transit Neighborhood	23,955	76,368	9,877	28,487	93,453	10,993	4,532	17,085	1,116
Suburban Center	3,541	10,966	16,528	6,605	20,702	28,954	3,064	9,736	12,426
Transit Town Center	17,459	54,058	12,798	23,558	76,499	17,282	6,099	22,441	4,484
Sub-Total PDA	*57,275*	*175,797*	*58,630*	*77,893*	*244,603*	*85,002*	*20,618*	*68,806*	*26,372*
Non-PDA	47,026	150,099	65,389	52,920	173,390	86,191	5,894	23,291	20,802
				% Growth in PDAs			78%	75%	56%

Growth by Planning Area

East

	2010			2040			Growth		
	TOTHH	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**
North									
Central									
South									
East	71,252	202,753	119,131	100,717	276,537	172,814	29,465	73,784	53,683
Total	*71,252*	*202,753*	*119,131*	*100,717*	*276,537*	*172,814*	*29,465*	*73,784*	*53,683*

East

	2010			2040			Growth		
	TOTHH	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**	**TOTHH**	**TOTPOP**	**TEMP**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	0	0	0	0	0	0	0	0	0
Mixed-Use Corridor	0	0	0	0	0	0	0	0	0
Urban Neighborhood	0	0	0	0	0	0	0	0	0
Transit Neighborhood	0	0	0	0	0	0	0	0	0
Suburban Center	12,860	40,252	55,126	30,462	80,948	74,190	17,602	40,696	19,064
Transit Town Center	0	0	0	0	0	0	0	0	0
Sub-Total PDA	*12,860*	*40,252*	*55,126*	*30,462*	*80,948*	*74,190*	*17,602*	*40,696*	*19,064*
Non-PDA	58,392	162,501	64,005	70,255	195,589	98,624	11,863	33,088	34,619
				% Growth in PDAs			60%	55%	36%

Household Vehicle Ownership

All Planning Areas

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North	46,684	108,165	92,390	85,817	138,221	104,103	39,133	30,056	11,713
Central	10,876	44,803	67,794	17,928	57,142	74,794	7,052	12,339	7,000
South	5,960	28,258	70,073	9,537	38,145	83,128	3,577	9,887	13,055
East	3,116	17,221	50,887	6,315	27,216	67,179	3,199	9,995	16,292
Total	*66,636*	*198,447*	*281,144*	*119,597*	*260,724*	*329,204*	*52,961*	*62,277*	*48,060*

All Planning Areas

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center	5,934	5,785	1,231	17,316	9,206	2,142	11,382	3,421	911
City Center	5,779	14,787	13,500	14,832	24,355	18,900	9,053	9,568	5,400
Mixed-Use Corridor	18,002	43,643	34,599	25,446	51,452	37,420	7,444	7,809	2,821
Urban Neighborhood	8,529	23,095	17,709	13,575	29,394	20,302	5,046	6,299	2,593
Transit Neighborhood	3,383	15,320	27,024	5,157	19,639	29,849	1,774	4,319	2,825
Suburban Center	961	4,239	11,189	3,543	11,254	22,279	2,582	7,015	11,090
Transit Town Center	6,962	18,732	20,273	17,798	29,945	28,356	10,836	11,213	8,083
Sub-Total PDA	*49,550*	*125,601*	*125,525*	*97,667*	*175,245*	*159,248*	*48,117*	*49,644*	*33,723*
Non-PDA	17,086	72,846	155,619	21,930	85,479	169,956	4,844	12,633	14,337
					% Growth in PDAs		91%	80%	70%

Household Vehicle Ownership

North

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North	46,684	108,165	92,390	85,817	138,221	104,103	39,133	30,056	11,713
Central									
South									
East									
Total	*46,684*	*108,165*	*92,390*	*85,817*	*138,221*	*104,103*	*39,133*	*30,056*	*11,713*

North

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center	5,934	5,785	1,231	17,316	9,206	2,142	11,382	3,421	911
City Center	2,702	5,601	2,738	7,738	9,118	4,456	5,036	3,517	1,718
Mixed-Use Corridor	15,782	36,833	27,750	21,804	42,520	29,487	6,022	5,687	1,737
Urban Neighborhood	8,392	22,383	16,017	12,774	27,354	17,061	4,382	4,971	1,044
Transit Neighborhood	514	1,833	1,811	706	2,305	2,109	192	472	298
Suburban Center	0	0	0	0	0	0	0	0	0
Transit Town Center	5,246	11,351	6,215	15,184	19,775	10,310	9,938	8,424	4,095
Sub-Total PDA	*38,570*	*83,786*	*55,762*	*75,522*	*110,278*	*65,565*	*36,952*	*26,492*	*9,803*
Non-PDA	8,114	24,379	36,628	10,295	27,943	38,538	2,181	3,564	1,910
				% Growth in PDAs			94%	88%	84%

Household Vehicle Ownership

Central

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North									
Central	10,876	44,803	67,794	17,928	57,142	74,794	7,052	12,339	7,000
South									
East									
Total	*10,876*	*44,803*	*67,794*	*17,928*	*57,142*	*74,794*	*7,052*	*12,339*	*7,000*

Central

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	1,523	4,875	4,308	3,978	8,131	5,430	2,455	3,256	1,122
Mixed-Use Corridor	2,220	6,810	6,849	3,642	8,932	7,933	1,422	2,122	1,084
Urban Neighborhood	137	712	1,692	801	2,040	3,241	664	1,328	1,549
Transit Neighborhood	1,689	7,064	8,858	2,583	8,952	9,509	894	1,888	651
Suburban Center	0	0	0	0	0	0	0	0	0
Transit Town Center	624	2,394	2,674	1,020	3,190	3,060	396	796	386
Sub-Total PDA	*6,193*	*21,855*	*24,381*	*12,024*	*31,245*	*29,173*	*5,831*	*9,390*	*4,792*
Non-PDA	4,683	22,948	43,413	5,904	25,897	45,621	1,221	2,949	2,208
				% Growth in PDAs			83%	76%	68%

Household Vehicle Ownership

South

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North									
Central									
South	5,960	28,258	70,073	9,537	38,145	83,128	3,577	9,887	13,055
East									
Total	*5,960*	*28,258*	*70,073*	*9,537*	*38,145*	*83,128*	*3,577*	*9,887*	*13,055*

South

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	1,554	4,311	6,454	3,116	7,106	9,014	1,562	2,795	2,560
Mixed-Use Corridor	0	0	0	0	0	0	0	0	0
Urban Neighborhood	0	0	0	0	0	0	0	0	0
Transit Neighborhood	1,180	6,423	16,355	1,868	8,382	18,231	688	1,959	1,876
Suburban Center	152	865	2,522	366	1,820	4,420	214	955	1,898
Transit Town Center	1,092	4,987	11,384	1,594	6,980	14,986	502	1,993	3,602
Sub-Total PDA	*3,978*	*16,586*	*36,715*	*6,944*	*24,288*	*46,651*	*2,966*	*7,702*	*9,936*
Non-PDA	1,982	11,672	33,358	2,593	13,857	36,477	611	2,185	3,119
				% Growth in PDAs			83%	78%	76%

Household Vehicle Ownership

East

	2010			2040			Growth		
	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh
North									
Central									
South									
East	3,116	17,221	50,887	6,315	27,216	67,179	3,199	9,995	16,292
Total	*3,116*	*17,221*	*50,887*	*6,315*	*27,216*	*67,179*	*3,199*	*9,995*	*16,292*

East

	2010			2040			Growth		
	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh
Regional Center	0	0	0	0	0	0	0	0	0
City Center	0	0	0	0	0	0	0	0	0
Mixed-Use Corridor	0	0	0	0	0	0	0	0	0
Urban Neighborhood	0	0	0	0	0	0	0	0	0
Transit Neighborhood	0	0	0	0	0	0	0	0	0
Suburban Center	809	3,374	8,667	3,177	9,434	17,859	2,368	6,060	9,192
Transit Town Center	0	0	0	0	0	0	0	0	0
Sub-Total PDA	*809*	*3,374*	*8,667*	*3,177*	*9,434*	*17,859*	*2,368*	*6,060*	*9,192*
Non-PDA	2,307	13,847	42,220	3,138	17,782	49,320	831	3,935	7,100
				% Growth in PDAs			74%	61%	56%

Household Vehicle Ownership - Percentages

All Planning Areas

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North	19%	44%	37%	26%	42%	32%	7%	-2%	-6%
Central	9%	36%	55%	12%	38%	50%	3%	2%	-5%
South	6%	27%	67%	7%	29%	64%	2%	2%	-4%
East	4%	24%	71%	6%	27%	67%	2%	3%	-5%
Total	*12%*	*36%*	*51%*	*17%*	*37%*	*46%*	*5%*	*0%*	*-5%*

All Planning Areas

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center	46%	45%	10%	60%	32%	7%	15%	-13%	-2%
City Center	17%	43%	40%	26%	42%	33%	9%	-1%	-7%
Mixed-Use Corridor	19%	45%	36%	22%	45%	33%	4%	0%	-3%
Urban Neighborhood	17%	47%	36%	21%	46%	32%	4%	0%	-4%
Transit Neighborhood	7%	34%	59%	9%	36%	55%	2%	2%	-4%
Suburban Center	6%	26%	68%	10%	30%	60%	4%	4%	-8%
Transit Town Center	15%	41%	44%	23%	39%	37%	8%	-1%	-7%
Sub-Total PDA	*16%*	*42%*	*42%*	*23%*	*41%*	*37%*	*6%*	*-1%*	*-5%*
Non-PDA	7%	30%	63%	8%	31%	61%	1%	1%	-2%
				% Growth in PDAs					

Household Vehicle Ownership - Percentages

North

	2010			2040			Growth		
	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh
North	19%	44%	37%	26%	42%	32%	7%	-2%	-6%
Central									
South									
East									
Total	*19%*	*44%*	*37%*	*26%*	*42%*	*32%*	*7%*	*-2%*	*-6%*

North

	2010			2040			Growth		
	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh	0-veh	1-veh	2+-veh
Regional Center	46%	45%	10%	60%	32%	7%	15%	-13%	-2%
City Center	24%	51%	25%	36%	43%	21%	12%	-8%	-4%
Mixed-Use Corridor	20%	46%	35%	23%	45%	31%	4%	-1%	-3%
Urban Neighborhood	18%	48%	34%	22%	48%	30%	4%	0%	-4%
Transit Neighborhood	12%	44%	44%	14%	45%	41%	1%	1%	-2%
Suburban Center									
Transit Town Center	23%	50%	27%	34%	44%	23%	11%	-6%	-4%
Sub-Total PDA	*22%*	*47%*	*31%*	*30%*	*44%*	*26%*	*8%*	*-3%*	*-5%*
Non-PDA	12%	35%	53%	13%	36%	50%	2%	1%	-3%
					% Growth in PDAs				

Household Vehicle Ownership - Percentages

Central

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North									
Central	9%	36%	55%	12%	38%	50%	3%	2%	-5%
South									
East									
Total	*9%*	*36%*	*55%*	*12%*	*38%*	*50%*	*3%*	*2%*	*-5%*

Central

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center									
City Center	14%	46%	40%	23%	46%	31%	8%	1%	-9%
Mixed-Use Corridor	14%	43%	43%	18%	44%	39%	4%	1%	-4%
Urban Neighborhood	5%	28%	67%	13%	34%	53%	8%	6%	-13%
Transit Neighborhood	10%	40%	50%	12%	43%	45%	3%	2%	-5%
Suburban Center									
Transit Town Center	11%	42%	47%	14%	44%	42%	3%	2%	-5%
Sub-Total PDA	*12%*	*42%*	*47%*	*17%*	*43%*	*40%*	*5%*	*1%*	*-6%*
Non-PDA	7%	32%	61%	8%	33%	59%	1%	1%	-2%
					% Growth in PDAs				

Household Vehicle Ownership - Percentages

South

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North									
Central									
South	6%	27%	67%	7%	29%	64%	2%	2%	-4%
East									
Total	*6%*	*27%*	*67%*	*7%*	*29%*	*64%*	*2%*	*2%*	*-4%*

South

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center									
City Center	13%	35%	52%	16%	37%	47%	4%	2%	-6%
Mixed-Use Corridor									
Urban Neighborhood									
Transit Neighborhood	5%	27%	68%	7%	29%	64%	2%	3%	-4%
Suburban Center	4%	24%	71%	6%	28%	67%	1%	3%	-4%
Transit Town Center	6%	29%	65%	7%	30%	64%	1%	1%	-2%
Sub-Total PDA	*7%*	*29%*	*64%*	*9%*	*31%*	*60%*	*2%*	*2%*	*-4%*
Non-PDA	4%	25%	71%	5%	26%	69%	1%	1%	-2%
					% Growth in PDAs				

Household Vehicle Ownership - Percentages

East

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
North									
Central									
South									
East	4%	24%	71%	6%	27%	67%	2%	3%	-5%
Total	*4%*	*24%*	*71%*	*6%*	*27%*	*67%*	*2%*	*3%*	*-5%*

East

	2010			2040			Growth		
	0-veh	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**	**0-veh**	**1-veh**	**2+-veh**
Regional Center									
City Center									
Mixed-Use Corridor									
Urban Neighborhood									
Transit Neighborhood									
Suburban Center	6%	26%	67%	10%	31%	59%	4%	5%	-9%
Transit Town Center									
Sub-Total PDA	*6%*	*26%*	*67%*	*10%*	*31%*	*59%*	*4%*	*5%*	*-9%*
Non-PDA	4%	24%	72%	4%	25%	70%	1%	2%	-2%
					% Growth in PDAs				

Household Worker Distribution

All Planning Areas

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North	78,722	93,663	74,844	118,768	119,534	89,866	40,046	25,871	15,022
Central	31,100	49,654	42,733	44,142	58,841	46,891	13,042	9,187	4,158
South	17,203	38,326	48,754	24,236	48,103	58,470	7,033	9,777	9,716
East	13,418	24,398	33,436	18,919	34,973	46,823	5,501	10,575	13,387
Total	*140,443*	*206,041*	*199,767*	*206,065*	*261,451*	*242,050*	*65,622*	*55,410*	*42,283*

All Planning Areas

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	7,253	3,922	1,775	17,533	7,496	3,643	10,280	3,574	1,868
City Center	10,716	12,168	11,173	18,750	21,320	18,027	8,034	9,152	6,854
Mixed-Use Corridor	28,045	37,939	30,252	36,822	43,968	33,531	8,777	6,029	3,279
Urban Neighborhood	15,424	19,365	14,546	20,891	24,242	18,125	5,467	4,877	3,579
Transit Neighborhood	9,556	17,666	18,507	12,899	20,773	20,971	3,343	3,107	2,464
Suburban Center	2,992	5,205	8,200	6,425	11,831	18,811	3,433	6,626	10,611
Transit Town Center	13,645	17,164	15,157	24,932	27,228	23,953	11,287	10,064	8,796
Sub-Total PDA	*87,631*	*113,429*	*99,610*	*138,252*	*156,858*	*137,061*	*50,621*	*43,429*	*37,451*
Non-PDA	52,812	92,612	100,157	67,813	104,593	104,989	15,001	11,981	4,832
				% Growth in PDAs			77%	78%	89%

Household Worker Distribution

North

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North	78,722	93,663	74,844	118,768	119,534	89,866	40,046	25,871	15,022
Central									
South									
East									
Total	*78,722*	*93,663*	*74,844*	*118,768*	*119,534*	*89,866*	*40,046*	*25,871*	*15,022*

North

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	7,253	3,922	1,775	17,533	7,496	3,643	10,280	3,574	1,868
City Center	5,175	3,470	2,391	8,777	7,531	5,007	3,602	4,061	2,616
Mixed-Use Corridor	23,852	31,501	25,010	30,831	35,882	27,104	6,979	4,381	2,094
Urban Neighborhood	14,981	18,387	13,425	19,795	21,957	15,423	4,814	3,570	1,998
Transit Neighborhood	1,261	1,592	1,304	1,714	1,935	1,471	453	343	167
Suburban Center	0	0	0	0	0	0	0	0	0
Transit Town Center	8,988	8,275	5,546	18,203	15,390	11,687	9,215	7,115	6,141
Sub-Total PDA	*61,510*	*67,147*	*49,451*	*96,853*	*90,191*	*64,335*	*35,343*	*23,044*	*14,884*
Non-PDA	17,212	26,516	25,393	21,915	29,343	25,531	4,703	2,827	138
				% Growth in PDAs			88%	89%	99%

Household Worker Distribution

Central

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North									
Central	31,100	49,654	42,733	44,142	58,841	46,891	13,042	9,187	4,158
South									
East									
Total	*31,100*	*49,654*	*42,733*	*44,142*	*58,841*	*46,891*	*13,042*	*9,187*	*4,158*

Central

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	3,284	4,322	3,099	6,154	6,835	4,556	2,870	2,513	1,457
Mixed-Use Corridor	4,193	6,438	5,242	5,991	8,086	6,427	1,798	1,648	1,185
Urban Neighborhood	443	978	1,121	1,096	2,285	2,702	653	1,307	1,581
Transit Neighborhood	4,610	7,154	5,855	6,408	8,245	6,384	1,798	1,091	529
Suburban Center	0	0	0	0	0	0	0	0	0
Transit Town Center	1,643	2,322	1,731	2,333	2,894	2,044	690	572	313
Sub-Total PDA	*14,173*	*21,214*	*17,048*	*21,982*	*28,345*	*22,113*	*7,809*	*7,131*	*5,065*
Non-PDA	16,927	28,440	25,685	22,160	30,496	24,778	5,233	2,056	-907
				% Growth in PDAs			60%	78%	122%

Household Worker Distribution

South

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North									
Central									
South	17,203	38,326	48,754	24,236	48,103	58,470	7,033	9,777	9,716
East									
Total	*17,203*	*38,326*	*48,754*	*24,236*	*48,103*	*58,470*	*7,033*	*9,777*	*9,716*

South

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	2,257	4,376	5,683	3,819	6,954	8,464	1,562	2,578	2,781
Mixed-Use Corridor	0	0	0	0	0	0	0	0	0
Urban Neighborhood	0	0	0	0	0	0	0	0	0
Transit Neighborhood	3,685	8,920	11,348	4,777	10,593	13,116	1,092	1,673	1,768
Suburban Center	523	1,282	1,736	1,032	2,262	3,313	509	980	1,577
Transit Town Center	3,014	6,567	7,880	4,396	8,944	10,222	1,382	2,377	2,342
Sub-Total PDA	*9,479*	*21,145*	*26,647*	*14,024*	*28,753*	*35,115*	*4,545*	*7,608*	*8,468*
Non-PDA	7,724	17,181	22,107	10,212	19,350	23,355	2,488	2,169	1,248
				% Growth in PDAs			65%	78%	87%

Household Worker Distribution

East

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North									
Central									
South									
East	13,418	24,398	33,436	18,919	34,973	46,823	5,501	10,575	13,387
Total	*13,418*	*24,398*	*33,436*	*18,919*	*34,973*	*46,823*	*5,501*	*10,575*	*13,387*

East

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	0	0	0	0	0	0	0	0	0
City Center	0	0	0	0	0	0	0	0	0
Mixed-Use Corridor	0	0	0	0	0	0	0	0	0
Urban Neighborhood	0	0	0	0	0	0	0	0	0
Transit Neighborhood	0	0	0	0	0	0	0	0	0
Suburban Center	2,469	3,923	6,464	5,393	9,569	15,498	2,924	5,646	9,034
Transit Town Center	0	0	0	0	0	0	0	0	0
Sub-Total PDA	*2,469*	*3,923*	*6,464*	*5,393*	*9,569*	*15,498*	*2,924*	*5,646*	*9,034*
Non-PDA	10,949	20,475	26,972	13,526	25,404	31,325	2,577	4,929	4,353
				% Growth in PDAs			53%	53%	67%

Household Worker Distribution - Percentages

All Planning Areas

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North	32%	38%	30%	36%	36%	27%	4%	-1%	-3%
Central	25%	40%	35%	29%	39%	31%	4%	-1%	-3%
South	16%	37%	47%	19%	37%	45%	2%	0%	-2%
East	19%	34%	47%	19%	35%	46%	0%	0%	0%
Total	*26%*	*38%*	*37%*	*29%*	*37%*	*34%*	*3%*	*-1%*	*-2%*

All Planning Areas

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	56%	30%	14%	61%	26%	13%	5%	-4%	-1%
City Center	31%	36%	33%	32%	37%	31%	1%	1%	-2%
Mixed-Use Corridor	29%	39%	31%	32%	38%	29%	3%	-1%	-2%
Urban Neighborhood	31%	39%	29%	33%	38%	29%	2%	-1%	-1%
Transit Neighborhood	21%	39%	40%	24%	38%	38%	3%	-1%	-2%
Suburban Center	18%	32%	50%	17%	32%	51%	-1%	0%	1%
Transit Town Center	30%	37%	33%	33%	36%	31%	3%	-2%	-2%
Sub-Total PDA	*29%*	*38%*	*33%*	*32%*	*36%*	*32%*	*3%*	*-1%*	*-1%*
Non-PDA	22%	38%	41%	24%	38%	38%	3%	0%	-3%
					% Growth in PDAs				

Household Worker Distribution - Percentages

North

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North	32%	38%	30%	36%	36%	27%	4%	-1%	-3%
Central									
South									
East									
Total	*32%*	*38%*	*30%*	*36%*	*36%*	*27%*	*4%*	*-1%*	*-3%*

North

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center	56%	30%	14%	61%	26%	13%	5%	-4%	-1%
City Center	47%	31%	22%	41%	35%	23%	-6%	4%	2%
Mixed-Use Corridor	30%	39%	31%	33%	38%	29%	3%	-1%	-2%
Urban Neighborhood	32%	39%	29%	35%	38%	27%	3%	-1%	-2%
Transit Neighborhood	30%	38%	31%	33%	38%	29%	3%	-1%	-3%
Suburban Center									
Transit Town Center	39%	36%	24%	40%	34%	26%	1%	-2%	1%
Sub-Total PDA	*35%*	*38%*	*28%*	*39%*	*36%*	*26%*	*4%*	*-2%*	*-2%*
Non-PDA	25%	38%	37%	29%	38%	33%	4%	0%	-3%
					% Growth in PDAs				

Household Worker Distribution - Percentages

Central

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North									
Central	25%	40%	35%	29%	39%	31%	4%	-1%	-3%
South									
East									
Total	*25%*	*40%*	*35%*	*29%*	*39%*	*31%*	*4%*	*-1%*	*-3%*

Central

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center									
City Center	31%	40%	29%	35%	39%	26%	4%	-1%	-3%
Mixed-Use Corridor	26%	41%	33%	29%	39%	31%	3%	-1%	-2%
Urban Neighborhood	17%	38%	44%	18%	38%	44%	1%	-1%	0%
Transit Neighborhood	26%	41%	33%	30%	39%	30%	4%	-1%	-3%
Suburban Center									
Transit Town Center	29%	41%	30%	32%	40%	28%	3%	-1%	-2%
Sub-Total PDA	*27%*	*40%*	*33%*	*30%*	*39%*	*31%*	*3%*	*-1%*	*-2%*
Non-PDA	24%	40%	36%	29%	39%	32%	5%	-1%	-4%
				% Growth in PDAs					

Household Worker Distribution - Percentages

South

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North									
Central									
South	16%	37%	47%	19%	37%	45%	2%	0%	-2%
East									
Total	*16%*	*37%*	*47%*	*19%*	*37%*	*45%*	*2%*	*0%*	*-2%*

South

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center									
City Center	18%	36%	46%	20%	36%	44%	2%	1%	-2%
Mixed-Use Corridor									
Urban Neighborhood									
Transit Neighborhood	15%	37%	47%	17%	37%	46%	1%	0%	-1%
Suburban Center	15%	36%	49%	16%	34%	50%	1%	-2%	1%
Transit Town Center	17%	38%	45%	19%	38%	43%	1%	0%	-2%
Sub-Total PDA	*17%*	*37%*	*47%*	*18%*	*37%*	*45%*	*1%*	*0%*	*-1%*
Non-PDA	16%	37%	47%	19%	37%	44%	3%	0%	-3%
					% Growth in PDAs				

Household Worker Distribution - Percentages

East

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
North									
Central									
South									
East	19%	34%	47%	19%	35%	46%	0%	0%	0%
Total	*19%*	*34%*	*47%*	*19%*	*35%*	*46%*	*0%*	*0%*	*0%*

East

	2010			2040			Growth		
	0-worker	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**	**0-worker**	**1-worker**	**2+-workers**
Regional Center									
City Center									
Mixed-Use Corridor									
Urban Neighborhood									
Transit Neighborhood									
Suburban Center	19%	31%	50%	18%	31%	51%	-1%	1%	1%
Transit Town Center									
Sub-Total PDA	*19%*	*31%*	*50%*	*18%*	*31%*	*51%*	*-1%*	*1%*	*1%*
Non-PDA	19%	35%	46%	19%	36%	45%	1%	1%	-2%
				% Growth in PDAs					

Median Household Income

All Planning Areas

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
North	247,345	10,839,466,303	43,823	328,378	12,986,234,633	39,547	81,033	2,146,768,330	-10%
Central	123,482	5,564,957,973	45,067	149,463	6,383,768,616	42,711	25,981	818,810,643	-5%
South	104,301	6,437,394,757	61,719	130,813	7,708,979,484	58,931	26,512	1,271,584,727	-5%
East	71,252	4,901,785,590	68,795	100,717	6,685,365,027	66,378	29,465	1,783,579,437	-4%
Total	*546,380*	*27,743,604,623*	*50,777*	*709,371*	*33,764,347,760*	*47,598*	*162,991*	*6,020,743,137*	*-6%*

All Planning Areas

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
Regional Center	12,952	320,447,688	24,741	28,663	693,535,118	24,196	15,711	373,087,430	-2%
City Center	34,067	1,444,820,596	42,411	58,094	2,290,231,822	39,423	24,027	845,411,226	-7%
Mixed-Use Corridor	96,275	3,870,840,891	40,206	114,488	4,354,480,197	38,034	18,213	483,639,306	-5%
Urban Neighborhood	49,325	1,748,470,194	35,448	63,270	2,178,029,900	34,424	13,945	429,559,706	-3%
Transit Neighborhood	45,729	2,264,730,903	49,525	54,647	2,602,577,947	47,625	8,918	337,847,044	-4%
Suburban Center	16,401	1,085,471,869	66,183	37,067	2,389,685,371	64,469	20,666	1,304,213,502	-3%
Transit Town Center	45,990	1,891,683,001	41,132	76,160	2,915,092,896	38,276	30,170	1,023,409,895	-7%
Sub-Total PDA	*300,739*	*12,626,465,142*	*41,985*	*432,389*	*17,423,633,251*	*40,296*	*131,650*	*4,797,168,109*	*-4%*
Non-PDA	245,641	15,117,139,481	61,542	276,982	16,340,714,509	58,996	31,341	1,223,575,028	-4%
					% Growth in PDAs				

Median Household Income

North

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
North	247,345	10,839,466,303	43,823	328,378	12,986,234,633	39,547	81,033	2,146,768,330	-10%
Central									
South									
East									
Total	*247,345*	*10,839,466,303*	*43,823*	*328,378*	*12,986,234,633*	*39,547*	*81,033*	*2,146,768,330*	*-10%*

North

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
Regional Center	12,952	320,447,688	24,741	28,663	693,535,118	24,196	15,711	373,087,430	-2%
City Center	11,039	368,792,710	33,408	21,314	672,498,888	31,552	10,275	303,706,178	-6%
Mixed-Use Corridor	80,390	3,250,747,254	40,437	93,981	3,591,850,252	38,219	13,591	341,102,998	-5%
Urban Neighborhood	46,786	1,606,439,661	34,336	57,185	1,859,290,115	32,514	10,399	252,850,454	-5%
Transit Neighborhood	4,159	182,517,247	43,885	5,120	213,343,980	41,669	961	30,826,733	-5%
Suburban Center	0	0		0	0		0	0	
Transit Town Center	22,837	635,416,410	27,824	45,328	1,289,147,654	28,440	22,491	653,731,244	2%
Sub-Total PDA	*178,163*	*6,364,360,970*	*35,722*	*251,591*	*8,319,666,007*	*33,068*	*73,428*	*1,955,305,037*	*-7%*
Non-PDA	69,182	4,475,105,333	64,686	76,787	4,666,568,626	60,773	7,605	191,463,293	-6%
				% Growth in PDAs					

Median Household Income

Central

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
North									
Central	123,482	5,564,957,973	45,067	149,463	6,383,768,616	42,711	25,981	818,810,643	-5%
South									
East									
Total	*123,482*	*5,564,957,973*	*45,067*	*149,463*	*6,383,768,616*	*42,711*	*25,981*	*818,810,643*	*-5%*

Central

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
Regional Center	0	0		0	0		0	0	
City Center	10,708	409,513,118	38,244	17,537	629,056,936	35,870	6,829	219,543,818	-6%
Mixed-Use Corridor	15,885	620,093,637	39,036	20,507	762,629,945	37,189	4,622	142,536,308	-5%
Urban Neighborhood	2,539	142,030,533	55,940	6,085	318,739,785	52,381	3,546	176,709,252	-6%
Transit Neighborhood	17,615	681,871,941	38,710	21,040	782,962,020	37,213	3,425	101,090,079	-4%
Suburban Center	0	0		0	0		0	0	
Transit Town Center	5,694	224,203,002	39,375	7,274	276,768,170	38,049	1,580	52,565,168	-3%
Sub-Total PDA	*52,441*	*2,077,712,231*	*39,620*	*72,443*	*2,770,156,856*	*38,239*	*20,002*	*692,444,625*	*-3%*
Non-PDA	71,041	3,487,245,742	49,088	77,020	3,613,611,760	46,918	5,979	126,366,018	-4%
					% Growth in PDAs				

Median Household Income

South

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
North									
Central									
South	104,301	6,437,394,757	61,719	130,813	7,708,979,484	58,931	26,512	1,271,584,727	-5%
East									
Total	*104,301*	*6,437,394,757*	*61,719*	*130,813*	*7,708,979,484*	*58,931*	*26,512*	*1,271,584,727*	*-5%*

South

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
Regional Center	0	0		0	0		0	0	
City Center	12,320	666,514,768	54,100	19,243	988,675,998	51,378	6,923	322,161,230	-5%
Mixed-Use Corridor	0	0		0	0		0	0	
Urban Neighborhood	0	0		0	0		0	0	
Transit Neighborhood	23,955	1,400,341,715	58,457	28,487	1,606,271,947	56,386	4,532	205,930,232	-4%
Suburban Center	3,541	232,878,176	65,766	6,605	430,634,481	65,198	3,064	197,756,305	-1%
Transit Town Center	17,459	1,032,063,589	59,114	23,558	1,349,177,072	57,270	6,099	317,113,483	-3%
Sub-Total PDA	*57,275*	*3,331,798,248*	*58,172*	*77,893*	*4,374,759,498*	*56,164*	*20,618*	*1,042,961,250*	*-3%*
Non-PDA	47,026	3,105,596,509	66,040	52,920	3,334,219,986	63,005	5,894	228,623,477	-5%
				% Growth in PDAs					

Median Household Income

East

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
North									
Central									
South									
East	71,252	4,901,785,590	68,795	100,717	6,685,365,027	66,378	29,465	1,783,579,437	-4%
Total	*71,252*	*4,901,785,590*	*68,795*	*100,717*	*6,685,365,027*	*66,378*	*29,465*	*1,783,579,437*	*-4%*

East

	2010			2040			Growth		
	TOTHH	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**	**TOTHH**	**MHHINC**	**MHHINC/HH**
Regional Center	0	0		0	0		0	0	
City Center	0	0		0	0		0	0	
Mixed-Use Corridor	0	0		0	0		0	0	
Urban Neighborhood	0	0		0	0		0	0	
Transit Neighborhood	0	0		0	0		0	0	
Suburban Center	12,860	852,593,693	66,298	30,462	1,959,050,890	64,311	17,602	1,106,457,197	-3%
Transit Town Center	0	0		0	0		0	0	
Sub-Total PDA	*12,860*	*852,593,693*	*66,298*	*30,462*	*1,959,050,890*	*64,311*	*17,602*	*1,106,457,197*	*-3%*
Non-PDA	58,392	4,049,191,897	69,345	70,255	4,726,314,137	67,274	11,863	677,122,240	-3%
					% Growth in PDAs				

Appendix 3.1.1
Improvements Memo

MEMORANDUM

Date: June 20, 2016

To: Saravana Suthanthira, Alameda CTC

From: Francisco Martin and Matthew Ridgway, Fehr & Peers

Subject: Alameda Countywide Multimodal Arterial Plan – Final Proposed Improvements

OK14-0023

1. INTRODUCTION

The Alameda Countywide Multimodal Arterial Plan (MAP) is currently in its final states of developments development by Alameda CTC and the Fehr & Peers consultant team. The primary goal of the MAP is to identify and prioritize a list of short and long-term multimodal transportation infrastructure improvements based on multimodal needs to accommodate population and travel demand growth within Alameda County. This memo presents final proposed multimodal improvements for the Arterial Network. The memo briefly describes the Needs Assessment evaluation and how that analysis provided the basis for identifying recommended improvements. Draft proposed improvements were discussed with each Alameda County jurisdictions, AC Transit, LAVTA and Caltrans during one-on-one and small group meetings that took place from February 29th through March 7th earlier this year. Proposed improvements have been updated incorporating comments and are presented in this memorandum (Attachments - Figures 1 through 5). They will be packaged into short and long-term improvements in the next and final steps of the MAP.

2. MULTIMODAL IMPROVEMENTS FRAMEWORK AND APPROACH

2.1 BACKGROUND

The proposed improvement process builds on the Needs Assessment results, which are summarized in the memo titled *Alameda Countywide Multimodal Arterial Plan – Final Needs Assessment* (Fehr & Peers, February 22, 2016). The Needs Assessment evaluation identifies Arterial Network segments with a need for multimodal improvements. The Needs Assessment evaluation was conducted using the following process (outlined in **Exhibit 1**).

Step 1 – Existing Conditions

Existing Conditions data were collected and multimodal performance measures were evaluated along the Arterial Network.

Step 2 – Volume and Speed Forecast Development

Future year traffic volume and speed forecasts were developed using the Alameda Countywide Travel Demand Model (Alameda CTC Model) and existing traffic volumes.

Step 3 – Future Year (2020 and 2040) Conditions

Year 2020 and Year 2040 conditions multimodal performance measures were evaluated using data collected for existing conditions, future year traffic volume and forecasts, and assuming planned and funded roadway improvements.

Step 4 – Performance Measure Objectives Evaluation

Multimodal performance measure objectives were applied to the existing and future year conditions evaluation to identify Arterial Network segments that do not meet the objectives.

Step 5 – Needs Assessment Evaluation

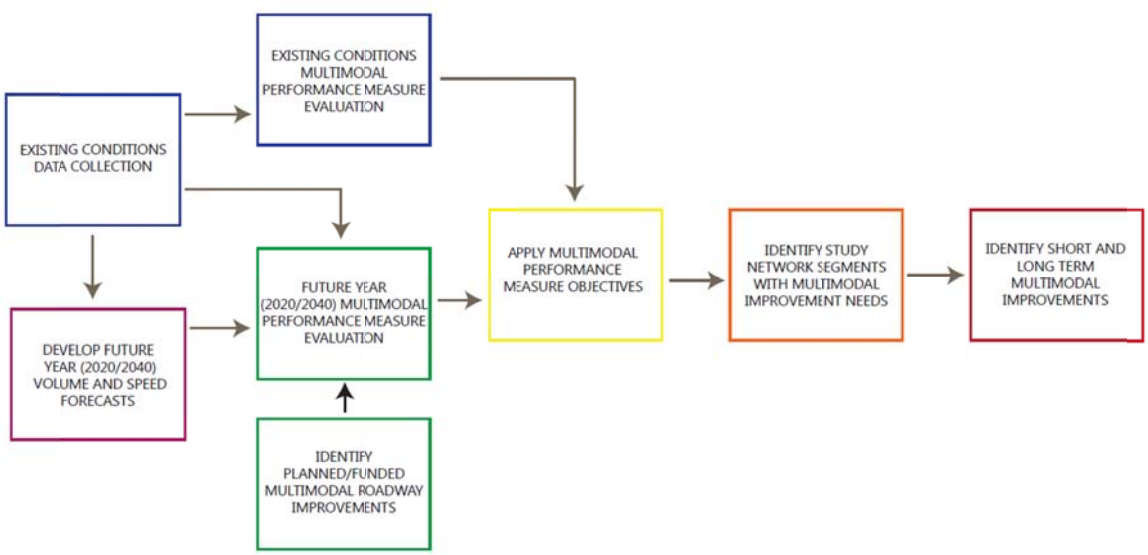
An Arterial Network segment is identified as having a need for improvement if performance of either of the top two modal priorities (developed earlier in the MAP development based on Typology framework) does not meet the performance objective.

Step 6 – Proposed Improvements

Where a need is identified and improvement implementation is feasible, proposed improvements by mode are recommended.

The Needs Assessment evaluation was informed by the Typology and modal priority tasks completed earlier in the MAP development process. MAP Typology was developed in coordination with the *Alameda Countywide Transit Plan, AC Transit Major Corridor Study, Alameda Countywide Goods Movement Plan, Alameda Countywide Bicycle and Pedestrian Plan* and with local jurisdictions who informed the bicycle Typology based on their local bicycle plans. Local jurisdictions also validated the modal priorities that were applied during the Needs Assessment evaluation.

Exhibit 1 – Needs Assessment Framework



2.1.1 Study and Arterial Network

The MAP evaluates a 1,200 mile Study Network to understand existing and future roadway conditions and the function of large network of countywide arterials in supporting all modes, and assess multimodal needs in a broader context. To identify and prioritize improvements, the MAP focuses on a core and subset, of approximately 510 miles, of the Study Network called the Arterial Network. This core network represents arterials of Countywide Significance and serves as the backbone of multimodal mobility throughout the County.

2.1.2 Needs Assessment Analysis Scenarios

The MAP evaluates multimodal performance for Existing, Year 2020 and Year 2040 Conditions. The Existing and Year 2020 Needs Assessment evaluation results will be used later in the MAP development process to prioritize proposed improvements into short and long-term projects.

The Year 2040 analysis considered three separate analysis scenarios:

- The **Standard Forecasting Scenario** – the focus scenario for improvements
- Supplemental Scenarios:
    - The **Social and Behavioral Trends Scenario**, which accounts for lower vehicle miles of travel (VMT) per capita associated with social and behavioral trends, and
    - The **Next Generation Vehicle Scenario**, which accounts for roadway capacity impacts associated with the expected increase of next generation/autonomous vehicles.

Proposed recommendations were developed based on the Needs Assessment evaluation for the Year 2040 Standard Forecasting Scenario. The Social and Behavioral Trends and Next Generation Vehicle Scenarios were evaluated as supplemental scenarios to inform Alameda County jurisdictions on how the emerging social and technology trends may impact future travel patterns and resulting improvement needs.

2.2 GIS TOOL DEVELOPMENT

A powerful geographic information system cross-sectional tool (GIS Tool) was developed to perform the Needs Assessment and inform the identification of proposed improvements. The majority of data collected for MAP development including Arterial Network Typology and modal priorities are saved in a geospatial database, which allows the GIS Tool to run various analyses to assess the Arterial Network's multimodal performance. The GIS Tool also integrates with the CityEngine software package, which has the capabilities to automate development of 3-D street cross-section renderings. The GIS Tool has the following capabilities:

- Assess multimodal performance for all study scenarios
- Identify Arterial Network segments that do not meet multimodal performance objectives for all modes
- Input total roadway right-of-way (ROW) based on aerial image or data provided by jurisdictions
- Quantify the portion of the roadway ROW that could be repurposed by assuming the National Association of City Transportation Officials (NACTO) minimum cross-sectional elements: 10 foot travel lanes (11 foot curb lanes for bus and truck routes), 10 foot median, seven foot parking lanes (if provided) and five foot bicycle lanes (if provided)[1]
- Identify potential Arterial Network segments suitable for ROW reallocation to improve high priority pedestrian and bicycle segments
- Identify potential Arterial Network segments suitable for ROW reallocation to provide dedicated on-street transit only lanes along high priority transit segments
- Identify potential bicycle facility improvements by facility (class) type
- Integration with the CityEngine software, which has the capability of automating the creation of cross-sectional graphics for each analysis scenario
- Quantify performance measure benefits assuming implementation of proposed improvements

As listed above, the GIS Tool has various capabilities, all of which were used by the Fehr & Peers team to identify potential improvements to address the Arterial Network's multimodal needs.

2.3 MULTIMODAL IMPROVEMENTS METHODOLOGY

Improvements are proposed along Arterial Network segments identified as having a need for improvements for the top two priority modes. This did not preclude jurisdictions from identifying improvements for other modes during their review of draft improvements. The general process for identifying improvements is summarized below.

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[1] The MAP adopted the NACTO Street Design Guide's cross sectional element minimums for its national based research that incorporate innovative street designs that accommodate multimodal needs.

Step 1 – Needs Assessment Determination

Identify Arterial Network segments that do not meet the performance measure objective of top two priority modes.

Step 2 – GIS Tool Determinations

Determine Available Right-of-Way

Available right-of-way is the critical element in defining improvements that can be made on a particular roadway segment to better support and accommodate any modal needs. Using aerial imagery, the project team estimated available right-of-way on all Arterial Network roadways. This information was input into the project's GIS tool and used to estimate the portion of roadway that could be repurposed to better accommodate the priority modes assuming the following NACTO minimums:

- 10' travel lanes (11' curb lanes for bus and truck routes in all jurisdictions; 11' travel lanes in Livermore and Alameda County per their request)
- 10' median (where provided)
- 8' parking lanes (where provided)
- 5' bike lanes (where provided)

Potential repurposing would also involve narrowing individual elements of the cross-section, by reducing the width of a 13-foot travel lane or a median, for example. Some jurisdictions requested that the team also consider parking removal in order to provide additional right-of-way that could be used to accommodate other modes.

For roadway segments where performance objectives for the priority modes are not being met or are not forecast to be met in the future and where Step 2 revealed the potential for excess right-of-way, the project team used the GIS tool to identify improvements that would require additional right-of-way. The tool then identified potential modal improvements that would allow these segments to best meet the plan's performance objectives for the top two priority modes and could be implemented within available right-of-way. The tool was able to suggest various improvements for each mode, based on priority, to each roadway segment where there is excess width (right-of-way); however, the tool does not have the human professional judgment required to iterate, where possible, to arrive at the set of improvements that provide the highest possible tier facilities of the two priority modes (see Section 1.4) considering synergies while accommodating both modes. The GIS Tool identified the following set of suggested improvements by mode based on available right-of-way

Travel Lane Repurposing

Where transit, pedestrian or bicycle were identified as the top two modal priorities, the GIS Tool suggested travel lane repurposing only if the automobile volume-to-capacity ratio after lane removal would be less than:

- 0.8 if automobiles were considered top modal priority,
- 1.0 if automobiles were considered second priority,
- 1.2 if automobiles were considered third priority, or
- Any value if automobiles were considered fourth of fifth priority.

For example, if bicycles were considered top priority and automobiles second, the GIS Tool would recommend removing a mixed-flow travel lane if the resulting volume-to-capacity ratio would be less than 1.0.

Transit

The GIS Tool suggested the following transit network improvements:

- Dedicated transit lanes if the study segment is part of a Major Corridor, the travel lane repurposing criteria described above would be met and there is sufficient right-of-way to implement minimum 12' transit only lanes in each direction, and
- Bus stop curb extensions where there is on-street parking.

The project team identified Rapid Bus improvements manually for Major Corridors to be consistent with AC Transit's Major Corridor Study. The team identified Enhanced Bus improvements manually for high priority transit segments that are not part of a Major Corridor.

Pedestrians

The GIS Tool suggested the following pedestrian network improvements:

- Adding sidewalks where they are not present,

- Widening existing sidewalks to six feet in residential areas where existing sidewalks are less than six feet wide,
- Widening existing sidewalks to nine feet in commercial areas where existing sidewalks are less than nine feet wide,
- Curb extensions where there is no on-street parking,
- Streetscape improvements along segments with painted or raised medians, and
- Implementing high-visibility crosswalks.

Although not automated by the GIS Tool, the project team manually identified pedestrian-scale lighting improvements on segments with high pedestrian priority near transit hubs, downtown areas and major commercial areas.

Bicycles

The GIS Tool suggested the following bicycle network improvements:

- Minimum five-foot Class 2 bicycle lanes where available right-of-way ranged from 10 to 13 feet for two-way streets or from five to six feet for one-way streets,
- Minimum five-foot Class 2 enhanced buffered bicycle lanes with two foot buffers where available right-of-way ranged from 14 to 15 feet for two-way streets or at least seven feet for one-way streets,
- Minimum five-foot Class 4 protected bicycle lanes with three foot buffers where available right-of-way was greater than 16 feet for two-way streets, or greater than eight feet for one-way streets, and
- Class 3 bicycle routes along segments without available right-of-way to implement dedicated on-street bicycle lanes. Class 3 enhanced bicycle boulevard improvements are also proposed for collector segments with 25 MPH speed limits and one lane in each direction, that are parallel to nearby arterials.

Proposed Class 1 multi-use path improvements were based on stakeholder input, rather than the GIS Tool.

Automobiles

The GIS Tool identified study segments that did not meet the automobile mode's congested speed and/or reliability performance objectives. The project team then applied their professional judgement to identify appropriate automobile network improvements that would enhance traffic management along these congested segments.

Goods Movement

The GIS Tool suggested minimum 12-foot curb lane widths in each direction along goods movement network routes where there is sufficient right-of-way.

Step 3 – Manually Identify Facility-Specific Improvements based on GIS Tool Determinations

Based on results from Step 1 and Step 2, identify improvements that could be implemented within the available ROW to improve the performance of the top priority mode. Repeat this process for the second priority mode. For example if: the highest priorities were bicycle then transit, neither mode met its performance objectives, and the GIS Tool determined that there was enough ROW available to implement Class 4 protected bicycle lanes, then the proposed improvement would be to implement Class 4 protected bicycle lanes. If after assuming this improvement the bicycle performance objectives were met and there were additional ROW available, transit improvements could be recommended.

Improvements for reach mode were identified on the 510 miles of Arterial Network segments with that specific mode as one of two top priority modes. The table below shows the mileage of roadway segments where each mode is a top priority.

Mode	High Priority Mileage
Transit	150 miles
Pedestrian	207 miles
Bicycle	268 miles
Automobile	250 miles
Goods Movement	135 miles

If ROW is not available to accommodate the first priority mode or the second priority mode (after the first priority mode's recommendations have been accommodated), other improvements that do not require ROW are considered; such as optimizing bus stop locations and spacing, implementing ITS improvements, adding bulbouts and high-visibility crosswalks for pedestrians, and the feasibility of bike boulevards on parallel roads. Improvements identified during this step were primarily improvements to address the needs of the high priority modes along each Arterial Network segment.

Step 4 – Perform Network Connectivity Checks

Fehr & Peers reviewed proposed improvements after completion of Step 3 to identify potential Arterial Network gaps for each mode. Additional multimodal improvements were identified for lower priority modes during this step in an effort to develop a complete and connected network for each mode:

- **Transit Network**: Improvements were proposed along Arterial Network segments beyond those that the transit agencies recommended for the Major Corridors.
- **Pedestrian Network**: Improvements were proposed to enhance pedestrian connectivity to transit around major transit hubs (e.g. BART stations) and along transit Major Corridors with recommended transit-only lane improvements.
- **Bicycle Network**: Improvements were identified along lower priority bicycle segments that are key to building a countywide bicycle network. The Network Connectivity checks also included a review of Class 1 multiuse trails, such as the Bay Trail, East Bay Greenway and Iron Horse Trail, and non-arterial Class 3 Enhanced (bike boulevard) bikeways, such as the Berkeley Bike Boulevard system, that parallel Arterial Network segments.
- **Auto Network**: ITS improvements were identified along segments with low auto priority but are key segments to managing traffic demand along Arterial Network corridors. ITS improvements were also identified along high priority transit segments that may have low auto priority.
- **Goods Movement Network**: Curb lane widenings were proposed along the goods movement network regardless of the goods movement priority along those specific segments.

Step 5 – Quantify Benefits of Proposed Improvements

Fehr & Peers quantified the performance measures assuming proposed improvements and the percentage of each modal network that meets performance objectives with and without the improvements.

Step 6 – Evaluate Remaining Arterial Network Needs

Finally, Fehr & Peers identified the remaining Arterial Network multimodal needs after implementation of proposed improvements.

Please refer to **Table 1** and **Table 2** below to better understand the improvement identification process; **Table 1** provides an overview of the Needs Assessment evaluation process and **Table 2** summarizes how improvements were identified based on the Needs Assessment results.

Draft proposed improvements were discussed with each Alameda County jurisdiction, AC Transit, LAVTA and Caltrans during one-on-one and small group meetings that took place from February 29th through March 7th earlier this year. Final improvements were identified after incorporating the comments provided by stakeholder agencies on the draft proposed improvements.

2.3.1 Methodology Limitations

The following presents a list of potential methodology limitations to be considered when reviewing proposed improvements:

- Cross-sectional measurements were made by utilizing online aerial imagery. Therefore, the actual available ROW may likely to be different and in many cases more ROW may be available than what was measured in the aerial imagery. It also means that the improvements proposed is very likely to be conservative given the actual ROW availability in many places, particularly for roads outside of the downtown areas.
- Study segment lengths are an average of about 2,200 lineal feet and the representative sample segment (the segment for which analysis is conducted) is generally the most constrained portion of the study segment.
- While recommending improvements to meet the respective performance objective, only existing curb-to-curb dimensions were considered to offer cost effective improvement options.
- Proposed transit improvements do not address the transit vehicle fleet as the MAP is focused on the street environment.
- Especially as it relates to bikeways, the MAP considers parallel non-arterial bikeways such as trails and bike boulevards in its network connectivity assessment. These facilities are assumed to provide a high-quality, low-stress cycling experience, but are not analyzed.

- Proposed automobile improvements are limited to Intelligent Transportation Systems (ITS) improvements. Transportation system management (TSM) improvements, such as access management, lengthening of turn pockets and provision of turn lanes are suggested to improve automobile operations along Arterial Network segments with poor automobile operations. However, facility-specific TSM or capital improvements are not proposed as part of the MAP.
- Existing on-street parking was assumed to be retained under the standard forecasting scenario. Some jurisdictions (Berkeley, Oakland, Emeryville and, to a limited extent, Hayward) requested that the team consider parking removal in order to provide additional right-of-way that could be used by priority and other modes.

TABLE 1
EXAMPLE NEEDS ASSESSMENT DETERMINATION

Street Segment	Land Use Context Overlay	Street Type	Transit Overlay	Bicycle Overlay	Pedestrian Overlay	Truck Overlay	Modal Priority	Year 2040 Performance Objective Met for High Priority Modes?	Need for Improvement?
San Pablo Avenue between 20th Street and 27th Street (Oakland)	Downtown Mixed Use	Community Connector	Major Corridor	Class 3	Tier 1	None	1. Transit 2. Pedestrian 3. Bicycle 4. Automobile 5. Goods Movement	Transit: • Speed – Objective Not Met • Reliability – Objective Met • Transit Infrastructure Index – Objective Not Met Pedestrian: • Pedestrian Comfort Index – Objective Met	**Yes** – Transit Mode Improvements Needed
W. Tennyson Road between Tampa Avenue and Leidig Court (Hayward)	Residential and Commercial	County Connector	Local Route	Class 2	None	Tier 3	1. Pedestrian[1] 2. Bicycle 3. Automobile 4. Transit 5. Goods Movement	Pedestrian: • Pedestrian Comfort Index – Objective Not Met Bicycle: • Bicycle Comfort Index – Objective Not Met	**Yes** – Pedestrian and Bicycle Mode Improvements Needed
Paseo Padre Parkway between Peralta Boulevard and Grimmer Boulevard (Fremont)	Downtown Mixed use	Community Connector	Local Route	Class 2	Tier 2	None	1. Pedestrian 2. Bicycle 3. Transit 4. Automobile 5. Goods Movement	Pedestrian: • Pedestrian Comfort Index – Objective Not Met Bicycle: • Bicycle Comfort Index – Objective Not Met	**Yes** – Pedestrian and Bicycle Mode Improvements Needed
Tesla Road between S. Livermore Avenue and S. Vasco Road (Alameda County)	Rural/Open Space	Community Connector	None	Class 2	None	Tier 3	1. Automobile[2] 2. Goods Movement 3. Bicycle 4. Pedestrian	Automobile: • Speed – Objective Met • Reliability – Objective Not Met Goods Movement: • Truck Infrastructure Index – Objective Met	**Yes** – Automobile Improvements Needed

Notes:
1. Applying the modal priority methodology along W. Tennyson Road in Hayward results in the following priority: Automobile, Goods Movement, Bicycle, Pedestrian and Transit. However, Hayward staff requested that the modal priority for W. Tennyson Road be changed to that listed in the table above.
2. Applying the modal priority methodology along Tesla Road in Alameda County results in the following priority: Goods Movement, Bicycle, Automobile and Pedestrian. However, Alameda County staff requested that the modal priority for Tesla Road be changed to that listed in the table above.

TABLE 2
EXAMPLE IMPROVEMENT DETERMINATION

Street Segment	Proposed Improvements	Year 2040 Performance Measure Results for High Priority Modes – Before Improvements	Year 2040 Performance Measure Results for High Priority Modes – After Improvements	Year 2040 Performance Objectives Met for High Priority Mode – After Improvements	Additional Need for Improvement After Implementation of Proposed Improvements?
San Pablo Avenue between 20th Street and 27th Street (Oakland)	Transit: • Dedicated transit lanes Pedestrian[1]: • High-visibility crosswalks • Pedestrian scale lighting	Transit: • Speed = 17.5 MPH • Reliability = 0.86 • Transit Infrastructure Index = Low Pedestrian: • Pedestrian Comfort Index = High	Transit: • Speed = 25 MPH • Reliability = 0.90 • Transit Infrastructure Index = High Pedestrian: • Pedestrian Comfort Index = High	Transit: • Speed – Objective Met • Reliability – Objective Met • Transit Infrastructure Index – Objective Met Pedestrian: • Pedestrian Comfort Index – Objective Met	**No**
W. Tennyson Road between Tampa Avenue and Leidig Court (Hayward)	Pedestrian: • High-visibility crosswalks • Landscaped buffers between sidewalk and travel lanes • Pedestrian scale lighting • Curb bulbouts Bicycle: • Class 4 protected bicycle lanes	Pedestrian: • Pedestrian Comfort Index = Medium Bicycle: • Bicycle Comfort Index = Medium	Pedestrian: • Pedestrian Comfort Index = High Bicycle: • Bicycle Comfort Index = Excellent	Pedestrian: • Pedestrian Comfort Index – Objective Met Bicycle: • Bicycle Comfort Index – Objective Met	**No**
Paseo Padre Parkway between Peralta Boulevard and Grimmer Boulevard (Fremont)	Pedestrian: • Widen sidewalk • Provide high-visibility crosswalks • Provide pedestrian scale lighting Bicycle: • Class 4 protected bicycle lanes	Pedestrian: • Pedestrian Comfort Index = Medium (10) Bicycle: • Bicycle Comfort Index = Medium	Pedestrian: • Pedestrian Comfort Index = Medium (14) Bicycle: • Bicycle Comfort Index = Excellent	Pedestrian: • Pedestrian Comfort Index – Objective Not Met Bicycle: • Bicycle Comfort Index – Objective Met	**Yes** – Additional Pedestrian Improvements Needed[2]

TABLE 2
EXAMPLE IMPROVEMENT DETERMINATION

Street Segment	Proposed Improvements	Year 2040 Performance Measure Results for High Priority Modes – Before Improvements	Year 2040 Performance Measure Results for High Priority Modes – After Improvements	Year 2040 Performance Objectives Met for High Priority Mode – After Improvements	Additional Need for Improvement After Implementation of Proposed Improvements?
Tesla Road between S. Livermore Avenue and S. Vasco Road (Alameda County)	Automobile: • Improvements not proposed[3] Goods Movement: • Improvements not proposed[4]	Automobile: • Speed = 30 MPH • Reliability = 1.32 Goods Movement: • Truck Route Accommodation Index = High	Automobile: • Speed = 30 MPH • Reliability = 1.32 Goods Movement: • Truck Route Accommodation Index = High	Automobile: • Speed – Objective Not Met • Reliability – Objective Not Met Goods Movement: • Truck Route Accommodation Index – Objective Met	**Yes** – Automobile Improvements Needed

Notes:
1. Although pedestrian performance measure was High before improvements, MAP proposed pedestrian improvements as a part of implementing dedicated transit lanes.
2. Pedestrian performance improved along Paseo Padre Parkway with proposed improvements; however, implementation of proposed improvements would not meet the performance objective due to the segment being 4 to 6 lanes wide with a 35 MPH posted speed limit. Additional improvements, such as reducing the number of lanes to four lanes along the entire segment and/or reducing posted limits would result in the segment meeting the pedestrian performance objective; however, these additional improvements are not proposed as part of the MAP.
3. Due to the rural nature of the Tesla Road in unincorporated Alameda County, ITS improvements were not recommended. Additional improvements, such as widening Tesla Road from two to four lanes, may potentially improve the automobile performance. However, roadway widenings to provide additional travel lanes were not considered as part of the Multimodal Arterial Plan.
4. Improvement not proposed because roadway segment meets performance objective for that specific mode under Year 2040 baseline conditions.

3. PROPOSED IMPROVEMENTS

This section presents an overview of the type of multimodal improvements that were considered during the improvement identification process. Proposed multimodal improvements are shown in the following figures:

- **Figure 1** – Transit Network Proposed Improvements
- **Figure 2** – Bicycle Network Proposed Improvements
- **Figure 3** – Pedestrian Network Proposed Improvements
- **Figure 4** – Automobile Network Proposed Improvements
- **Figure 5** – Goods Movement Network Proposed Improvements

3.1 PROPOSED TRANSIT NETWORK IMPROVEMENTS

Transit network improvements were primarily considered along AC Transit and LAVTA major corridors. Considered improvements are grouped into the following three categories:

- **Enhanced Bus Improvements** – Enhanced Bus services are designed around on-street improvements that reduce travel time, improve passenger comfort and increase operational efficiency. Improvements under this category include:
  - Bus stop consolidation
  - Traffic signal optimization (not including transit priority detection)
  - Far-side bus stop relocation at intersections
  - Minimum 80 feet red curb at bus stops
  - American with Disabilities Act (ADA) compliant bus stops (minimum eight foot by five foot landing area)
  - Providing curb extensions (bulbouts) at bus stops, where feasible
  - Bus stop amenity enhancements, such as bus shelters, benches, wayfinding and real-time arrival information
- **Rapid Bus Improvements** – Rapid Bus improvements include those for the Enhanced Bus category, in addition to the following improvements:
  - Transit signal priority (TSP)
  - Queue jump lanes or queue bypass lanes at intersections, where feasible

- **Dedicated Transit Lane Improvements** – Dedicated transit lanes (also referred to as Bus Rapid Transit – BRT) is a system of improvements that build upon the features of Enhanced and Rapid Bus that, when combined, make riding the bus similar to riding light-rail. In addition to providing a high quality bus riding experience, dedicated transit lane systems focus on supporting transit-oriented development around stations, maximizing comfort of passengers and improving station access. Dedicated transit lane improvements include those for the Enhanced and Rapid Bus (with the exception of queue jump or bypass lanes) categories, in addition to the following improvements:
  - Level boarding platforms (median or curb side) so boarding is faster and easier
  - Dedicated on-street transit only lanes to improve transit speed and reliability
  - Pedestrian enhancements, such as bulbouts, pedestrian-scale lighting and high-visibility crosswalks

Example designs of improvements considered for the transit network are shown in **Exhibit 2**. Proposed transit network improvements are shown in **Figure 1**. Fehr & Peers referred to the AC Transit *Major Corridor Study* (MCS) to quantify the benefits of proposed improvements to Transit Travel Speed and Transit Reliability. Based on the information provided in the MCS, the following maximum increases to Transit Travel Speed were assumed:

- Enhanced Bus improvements – 10 percent increase in Transit Travel Speed
- Rapid Bus improvements – 23 percent increase in Transit Travel Speed
- Dedicated transit lane improvements – 42 percent increase in Transit Travel Speed

Exhibit 2 – Example Transit Network Improvement Designs

Existing AC Transit Rapid Bus stop (Image source: AC Transit)

Far-Side Bus Stop with Bulbout, ADA Compliant Loading Platform, Bus Shelter, Bench and Class 4 Protected Bicycle Lane
(Image source: *San Pablo Avenue Specific Plan*)

BRT Station (Image source: AC Transit)

3.1.1 Consistency with AC Transit's Major Corridor Study

AC Transit is currently developing the *Major Corridor Study* (MCS) to identify improvements to major corridors throughout the North, Central and South Planning Areas. Preliminary MCS recommendations were provided by AC Transit in November 2015. Considering the planning work already under taken and that a continuous network is key for transit performance, MCS recommendations were given priority during the improvement identification process undertaken as part of the MAP development. The AC Transit MCS recommended dedicated transit lanes along the following corridors; however, the respective jurisdictions did not agree with the proposed dedicated transit lanes and requested Rapid Bus improvements instead:

- E.14th/Mission Boulevard between Davis Street and Decoto Road
- Decoto Road between Mission Boulevard and Fremont Boulevard
- Fremont Boulevard between Decoto Road and Walnut Avenue
- Walnut Avenue between Fremont Boulevard and Civic Center Drive

In addition to the AC Transit corridors listed above, dedicated transit lanes were initially proposed along the Dublin Boulevard corridor in the City of Dublin, however LAVTA and City of Dublin staff did not agree with the initial recommendation and requested Rapid Bus improvements instead.

Transit improvements are also proposed along high priority transit segments in MAP that are not part of the AC Transit or LAVTA's major corridor network, such as:

- Stanley Boulevard, Railroad Avenue, Maple Street and East Avenue in Livermore and Alameda County[2]
- Foothill Road, Stoneridge Mall Road, Owens Drive, W. Las Positas Boulevard and Santa Rita Road in Pleasanton[1]
- Fremont Boulevard in Fremont
- Dyer Street and Whipple Avenue in Union City
- 73rd Avenue, Hegenberger Road, Market Street, Pleasant Valley Avenue, 51st Street and Martin Luther King Jr. Way in Oakland

[2] Proposed transit improvements in East County are consistent with the preliminary Rapid Bus route map provided by LAVTA on March 3, 2016. The preliminary Rapid Bus map may have different route alignments than the bus system changes approved by the LAVTA Board of Directors on May 4, 2016.

- Ashby Avenue, Sacramento Street, Martin Luther King Jr. Way, 7th Street and Dwight Way in Berkeley

Alameda CTC is concurrently developed the *Alameda Countywide Transit Plan*, which evaluates a larger transit network, including BART, Ferry and other inter-regional service enhancements than what is considered for evaluation in the MAP. AC Transit's MCS focuses primarily on identifying transit network recommended improvements along existing major corridor routes that operate along the MAP Arterial Network.

3.1.2 Benefits of Proposed Transit Improvements

Proposed transit network improvements are shown in **Figure 1**, the following is a summary of proposed improvements:

- 21 miles of dedicate transit lane improvements
- 82 miles of Rapid Bus improvements
- 39 miles of Enhanced Bus improvements

As discussed above, proposed improvements along the major corridor network are generally consistent with the MCS, with the exception of the corridors listed above. In addition to AC Transit's major corridors, Fehr & Peers is proposing improvements to LAVTA major corridors in East County and non-major corridors in North and South County. Fehr & Peers evaluated the Year 2040 Study Network performance assuming implementation of proposed transit network improvements. **Table 3** presents a summary of Transit Travel Speed before and after proposed improvements; **Table 4** presents a summary of Transit Reliability; **Table 5** presents a summary of Transit Infrastructure Index; and **Table 6** presents a summary of the performance measure objective evaluation.

As shown in **Table 6**, proposed improvements would result in a 24 mile increase in Arterial Network segments that meet the Transit Travel Speed performance objective and a 46 mile and 100 mile increase in segments that meet the Transit Reliability and Transit Infrastructure Index objectives, respectively.

TABLE 3
ALAMEDA COUNTYWIDE TRANSIT TRAVEL SPEED SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
% of Segments Operating Between 20 – 30 MPH	9%	17%	8%
% of Segments Operating Between 10 – 20 MPH	44%	51%	7%
% of Segments Operating Between 5 – 10 MPH	44%	30%	-14%
% of Segments Operating Less Than 5 MPH	3%	2%	-1%

Notes:
1. Countywide data coverage for Transit Travel Speed is 240 miles.

TABLE 4
ALAMEDA COUNTYWIDE TRANSIT RELIABILITY SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
% of Segments Operating at Ratio Greater Than 0.8	33%	58%	25%
% of Segments Operating at Ratio Between 0.6 – 0.8	52%	32%	-20%
% of Segments Operating at Ratio Between 0.4 – 0.6	13%	9%	-4%
% of Segments Operating at Ratio Less Than 0.4	2%	1%	-1%

Notes:
1. Countywide data coverage for Transit Reliability is 240 miles.

TABLE 5
ALAMEDA COUNTYWIDE TRANSIT INRASTRUCTURE INDEX SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
% of Segments with High Rating	16%	74%	58%
% of Segments with Medium Rating	33%	8%	-25%
% of Segments with Low Rating	51%	18%	-33%

Notes:
1. Countywide data coverage for Transit Infrastructure Index is 240 miles.

TABLE 6
ALAMEDA COUNTYWIDE TRANSIT PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Objective Along High Priority Transit Arterial Network Segments[1]		
	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
Transit Travel Speed	21 mi	45 mi	+24 mi
Transit Reliability	56 mi	112 mi	+56 mi
Transit Infrastructure Index	27 mi	127 mi	+100 mi

Notes:
1. Transit is considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 150 Arterial Network miles have high transit priority.

3.2 PEDESTRIAN NETWORK RECOMMENDATIONS

Considered pedestrian network improvements are categorized as follows:

- **Sidewalk Enhancements** – Improvements include widening existing sidewalks or implementing new sidewalks where missing. Generally, providing a minimum six foot sidewalk width is recommended (nine feet is the desired minimum).

- **Curb Bulbouts** – Curb extensions for pedestrian crossings at intersections or mid-block locations to reduce crossing distance and automobile turning speeds, which results in an improvement to pedestrian safety and comfort.
- **Crosswalk Enhancements** – Implement high-visibility crosswalk treatments to increase visibility of pedestrian crossing paths and discourage drivers from encroaching into crosswalks.
- **Streetscape Enhancements** – Implement landscaped buffers between sidewalks and travel lanes and/or raised landscape medians to improve pedestrian comfort.
- **Pedestrian Scale Lighting** – Implementing pedestrian scale lighting can alert drivers to the presence of pedestrians and enhance personal safety. Pedestrian scale lighting poles are generally closer to the ground and spaced closely together to create an even lighting of the sidewalk.

Example facilities considered for pedestrian network improvements are shown in **Exhibit 3**. As summarized in the Needs Assessment evaluation, the majority of Arterial Network segments with high pedestrian priority provide facilities with a High Pedestrian Comfort Index rating, thus meeting the pedestrian performance objective. Although pedestrian improvements were prioritized for Arterial Network segments that have high pedestrian priority and do not meet the objective, improvements were also proposed along segments that meet the performance objective under Existing Conditions to enhance pedestrian connectivity along corridors with dedicated transit lanes and around major transit stations as pedestrian improvements can also enhance the transit experience and encourage an increase in transit mode share.

Given the scale of the network evaluated in the MAP, it was not possible to assess the adequacy of pedestrian crossings of arterials. There has been significant evolution of design practices and standards for unsignalized pedestrian crossings including new traffic control devices such as the Rapid Rectangular Flashing Beacon and the Pedestrian Hybrid Beacon. Where Arterial Network segments are designated as high pedestrian priority, unsignalized crossing controls, which do not impact ROW, are recommended.

As shown in **Figure 2**, Fehr & Peers identified Arterial Network segments with high pedestrian and bicycle priority and low automobile priority (modal priority three, four or five) where additional ROW reallocation within the curb-to-curb travel way (e.g. travel lane removal) should be considered to improve pedestrian and bicycle performance.

Exhibit 3 – Example Pedestrian Facility Improvements

Streetscape Enhancements – Landscaped Buffer and Median (Image source: Fehr & Peers)

Pedestrian Scale Lighting (Image source: Fehr & Peers)

High-Visibility Crosswalks (Image source: NACTO)

Overhead Flashing Beacon – High-Visibility Crosswalk
(Image source: Fehr & Peers)

Rectangular Rapid Flashing Beacon – High-Visibility Crosswalk (Image source: Fehr & Peers)

Curb Bulbouts (Image source: NACTO)

3.2.1 Benefits of Proposed Pedestrian Network Improvements

Proposed pedestrian network improvements are shown in **Figure 2**, the following is a summary of proposed improvements:

- 81 miles of sidewalk enhancements (including 40 miles of new sidewalk)
- 81 miles of curb bulbout improvements
- 233 miles of crosswalk enhancements
- 60 miles of streetscape enhancements
- 130 miles of pedestrian scale lighting improvements

Fehr & Peers evaluated the Year 2040 Study Network performance assuming implementation of proposed pedestrian network improvements. **Table 7** presents a summary of Pedestrian Comfort Index before and after proposed improvements and **Table 8** presents a summary of the performance measure objective evaluation. As shown in **Table 8**, proposed improvements would result in a 55 mile increase in Arterial Network segments that meet the Pedestrian Comfort Index objective.

Proposed bicycle network improvements, presented in Section 3.3, can also enhance pedestrian safety and comfort. For example, proposed Class 4 protected bicycle lanes would provide a buffer between the sidewalk and travel lanes, which improves the Pedestrian Comfort Index rating.

TABLE 7
ALAMEDA COUNTYWIDE PEDESTRIAN COMFORT INDEX SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
% of Segments with Excellent Rating	5%	11%	6%
% of Segments with High Rating	51%	53%	2%
% of Segments with Medium Rating	42%	36%	-6%
% of Segments with Low Rating	2%	0%	-2%

Notes:
1. Countywide data coverage for Pedestrian Comfort Index is 620 miles.

TABLE 8
ALAMEDA COUNTYWIDE PEDESTRIAN PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Objective Along High Priority Pedestrian Arterial Network Segments[1]		
	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
Pedestrian Comfort Index	133 mi	188 mi	+55 mi

Notes:
1. Pedestrians are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 207 Arterial Network miles have high pedestrian priority.

3.3 PROPOSED BICYCLE NETWORK IMPROVEMENTS

Bicycle facilities are categorized as follows:

- **Class 1 Bikeway/Multi-Use Path** – These facilities are located off-street and can serve both bicyclists and pedestrians. Class I paths are generally eight to 12 feet wide excluding shoulders and are generally paved.
- **Class 2 Bicycle Lanes** – These facilities provide a dedicated area for bicyclists within the paved street width through the use of striping and signage. Minimum five foot bicycle lane widths are generally recommended.
- **Class 2 Enhanced Buffered Bicycle Lanes** – Similar facility as Class 2 bicycle lanes with the addition of a striped buffer separating the bicycle lane and travel lane. Minimum five foot bicycle lane and two foot buffer widths are generally recommended.
- **Class 3 Bicycle Routes** – These facilities are found along streets that do not provide sufficient width for dedicated bicycle lanes and are also provided on low-volume streets that have no bicycle lanes. The street is designated as a bicycle route through the use of signage and striping informing drivers to share the street with bicyclists.
- **Class 3 Enhanced Bicycle Boulevards** – Similar to Class 3 Bicycle Routes, however Bicycle Boulevards are generally designated along low-speed, low-volume streets optimized for bicycle traffic.
- **Class 4 Protected Bicycle Lanes** - Similar facility as Class 2 Enhanced buffered bicycle lanes with the addition of a vertical buffer separating the bicycle lane and travel lane. Vertical separation can include: on-street parking, flexible pylons, planters or curb

separation. Minimum five foot bicycle lane and three foot buffer widths are generally recommended (two foot buffers were considered along constrained segments).

Example facilities considered for bicycle network improvements are shown in **Exhibit 4**. As discussed above, the Needs Assessment evaluation was the basis for identifying bicycle network improvements along high priority segments. The bicycle Typology developed in coordination with all jurisdictions was used to identify improvements. For example, if the bicycle Typology identified a Class 2 bicycle lane along an Arterial Network segment, an effort was made to determine if, Class 2 Enhanced or Class 4 facilities could be implemented along that segment depending on available right-of-way. The baseline bicycle network and proposed network improvements are shown in **Figure 3**.

Exhibit 4 – Considered Bicycle Facility Improvements

Class 2 Bicycle Lanes (Image source: NACTO)

Class 2 Enhanced Buffered Bicycle Lanes (Image source: NACTO)

Class 3 Bicycle Routes (Image source: NACTO)

Class 3 Enhanced Bicycle Boulevards (Image source: NACTO)

Class 4 Protected Bicycle Lanes (Image source: NACTO)

The following is a list of key highlights regarding proposed bicycle network improvements:

- Many South and East County arterials provide Class 2 bicycle lanes under existing conditions; however, due to high travel speeds (35 MPH or greater), these facilities generally result in a Low Bicycle Comfort Index rating. Many of the existing Class 2 bicycle lanes can be upgraded to Class 4 protected bicycle lanes by re-striping and narrowing travel lanes and/or parking lanes to provide a minimum two to three foot buffer.
- Central County arterials generally lack dedicated on-street bicycle facilities compared to arterials in all other planning areas. In addition, right-of-way is generally constrained along the Arterial Network in Central County. Additional considerations, such as removing on-street parking, would be necessary if Central County jurisdictions are to provide a complete bicycle network.
- North County jurisdictions typically provide several dedicated on-street facilities (typically Class 2 bicycle lanes) under Existing Conditions. As a result, the focus of identifying improvements was to enhance existing facilities to provide buffer separation between bicycle lanes and travel lanes, in addition to identifying improvements that would provide a complete bicycle network throughout North County.
- As shown in **Figure 3**, Class 1 multi-use paths are considered adequate parallel routes along Arterial Network segments with not enough available right-of-way to implement dedicated on-street facilities. For example, the baseline network assumes implementation of a Class 1 bikeway along the BART track alignment between Oakland and Hayward, also known as the East Bay Greenway, which provides a parallel facility to the East 14th Street/Mission Boulevard corridor in North and Central County.

3.3.1 Benefits of Proposed Bicycle Network Improvements

Proposed bicycle network improvements are shown in **Figure 3**, the following is a summary of proposed improvements:

- 34 miles of Class 2 bicycle lane improvements
- 12 miles of Class 2 buffered bicycle lane improvements
- 37 miles of Class 3 bicycle route improvements
- 25 miles of Class 3 bicycle boulevard improvements
- 144 miles of Class 4 protected bicycle lane improvements

Fehr & Peers evaluated the Year 2040 Study Network performance assuming implementation of proposed bicycle network improvements. **Table 9** presents a summary of Bicycle Comfort Index before and after proposed improvements and **Table 10** presents a summary of the performance measure objective evaluation. As shown in **Table 10**, proposed improvements would result in a 111 mile increase in Arterial Network segments that meet the Bicycle Comfort Index objective.

TABLE 9
ALAMEDA COUNTYWIDE BICYCLE COMFORT INDEX SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
% of Segments with Excellent Rating	1%	29%	28%
% of Segments with High Rating	14%	12%	-2%
% of Segments with Medium Rating	27%	23%	-4%
% of Segments with Low Rating With Class 2 Bicycle Lanes Provided	21%	12%	-9%
% of Segments with Low Rating Without Class 2 Bicycle Lanes	37%	24%	-13%

Notes:
1. Countywide data coverage for Bicycle Comfort Index is 670 miles.

TABLE 10
ALAMEDA COUNTYWIDE BICYCLE PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Objective Along High Priority Bicycle Arterial Network Segments[1]		
	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
Bicycle Comfort Index	35 mi	146 mi	+111 mi

Notes:
1. Bicycles are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 268 Arterial Network miles have high bicycle priority.

3.4 PROPOSED AUTOMBILE NETWORK IMPROVEMENTS

Proposed automobile improvements are limited to ITS improvements. Iteris performed an analysis of the ITS element of the MAP and developed an ITS framework and memorandum, which is being finalized. Based on this work, ITS infrastructure improvements are grouped into the following three categories:

- **Low Level of ITS Infrastructure** – generally corresponds to the ability to remotely monitor and manage field devices from a central location (e.g., TMC). Traffic signals along a corridor are interconnected and allow communication back to a TMC where there is a central system to actively manage field devices.
- **Medium Level of ITS Infrastructure** – corresponds to everything described above plus the additional ability to visually monitor and/or react to traffic conditions in real time from a central location. This includes having devices such as closed-circuit television (CCTV) cameras, adaptive signal timing controls, and/or transit signal priority controls.
- **High Level of ITS Infrastructure** – corresponds to everything described above plus the additional ability to actively inform and influence traffic flow in real-time from a central location. This includes devices such as changeable message signs or any connected vehicle (vehicle to infrastructure) capabilities.

Proposed ITS improvements are shown in **Figure 4**.

3.4.1 Benefits of Proposed Automobile Network Improvements

The following is a summary of proposed ITS improvements:

- 51 miles of Medium Level ITS improvements
- 175 miles of High Level ITS improvements

At its most basic level, the primary objective for ITS infrastructure improvements is to increase average automobile and transit speed. Quantifying the percent increase in speed directly resulting from implementation of ITS strategies is not easily accomplished. At this time, there is not enough readily-available data to quantify the percent increase in travel speed associated with implementing improvements in either of the three ITS infrastructure improvement categories. The performance measure analysis results presented in this memo do not account for improvement in automobile and transit travel speed expected from proposed ITS improvements. Therefore, performance measure analysis *after* proposed improvements is not presented in this section. **Table 11** presents a summary of Automobile Congested Speed before proposed improvements. **Table 12** presents a summary of Automobile Reliability and **Table 13** presents a summary of the performance measure objective evaluation.

As discussed in Section 3.1, dedicated transit lane improvements are proposed along various segments of the transit major corridor network. It is assumed that travel lanes would be converted to transit only lanes along select Arterial Network segments with high transit priority. Converting a travel lane to a transit only lane would decrease Automobile Congested Speed and increase the volume-to-capacity ratio along Arterial Network segments with high transit priority. Implementation of proposed ITS infrastructure improvements are expected to increase Automobile Congested Speed, however, the increase in speed is not quantified at this time.

TABLE 11
ALAMEDA COUNTYWIDE AUTOMOBILE CONGESTED SPEED SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements
% of Segments Operating Greater Than 40 MPH	3%
% of Segments Operating Between 30 – 40 MPH	22%
% of Segments Operating Between 20 – 30 MPH	56%
% of Segments Operating Between 10 – 20 MPH	18%
% of Segments Operating Less Than 10 MPH	1%

Notes:
1. Countywide data coverage for Automobile Congested Speed is 980 miles. This assessment does not yet account for potential increases in Automobile Congested Speed as a result of implementing proposed ITS infrastructure improvements.

TABLE 12
ALAMEDA COUNTYWIDE AUTOMOBILE RELIABILITY SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements
% of Segments Operating at V/C Ratio Less Than 0.8	74%
% of Segments Operating at V/C Ratio Between 0.8 – 1.0	12%
% of Segments Operating at V/C Ratio Greater Than 1.0	14%

Notes:
1. Countywide data coverage for Automobile Reliability is 640 miles.
Source: Fehr & Peers, 2016.

TABLE 13
ALAMEDA COUNTYWIDE AUTOMOBILE PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objective Along High Priority Automobile Arterial Network Segments[1]
	Year 2040 Conditions – Without Proposed Improvements
Automobile Congested Speed	210 mi
Automobile Reliability	138 mi

Notes:
1. Automobiles are considered high priority mode if they are categorized in the top two prioritized mode along an Arterial Network segment. A total of 250 Arterial Network miles have high automobile priority.

3.4.2 Alternative Scenario Considerations

The Social and Behavioral Trends and Next Generation Vehicle Scenarios were evaluated as supplemental scenarios to inform Alameda County jurisdictions on how emerging social and technology trends may impact future travel patterns and resulting improvement needs. As presented in the Needs Assessment memo, an increase in the next generation vehicle fleet could improve Automobile Congested Speed and Reliability throughout Alameda County. Based on research conducted by Fehr & Peers, a 20 percent increase in arterial capacity may be possible with significant next generation vehicle fleet penetration by Year 2040. The increased capacity could offset the potential decrease in Automobile Congested Speed due to BRT or road diet improvements proposed as part of the MAP.

Next generation vehicles could also minimize the need for on-street parking along the Arterial Network. Fully autonomous vehicles are expected to have the capability to drop-off users at their destination and drive off to park several blocks away. Providing on-street parking along the Arterial Network may not be critical if fully autonomous vehicles can drop-off/pick-up users curbside regardless of where and how far the vehicles park. As a result, jurisdictions could consider removing on-street parking along the Arterial Network and repurposing the right-of-way to implement a variety of multimodal improvements.

3.4.3 Additional Automobile Network Improvement Considerations

Intersection operations were not evaluated as part of the MAP due to the scale of this study. While increased capacity improvements, such as roadway or intersection widening, were not considered as part of the MAP, the study has identified a list of additional transportation systems management recommendations that could improve automobile operations along segments that operate with high congestion and delay during peak hours:

- Access management strategies, such as driveway consolidation and turn-restrictions
- Lengthening of turn pockets
- Provision of turn lanes
- Time-of-day parking restrictions (e.g. prohibiting on-street parking during peak periods to utilize the parking lane as an additional travel lane)
- Signal timing optimization

3.5 GOODS MOVEMENT NETWORK RECOMMENDATIONS

Widening curb lane widths to provide a minimum of 12 feet was the primary improvement considered along Arterial Network segments with high goods movement priority. Proposed goods movement network improvements are shown in **Figure 5**. Alameda CTC's *Alameda Countywide Goods Movement Plan* recommends a comprehensive set of goods movement strategies including needed general infrastructure improvements.

A few Alameda County jurisdictions requested not to widen the curb lane to 12' even if it is a priority Tier 2 or 3 truck route network. For those roads, on-street truck parking was not considered as part of the Truck Route Accommodation Index evaluation. South and East County jurisdictions do not typically provide on-street parking along the Arterial Network as the majority of truck deliveries are made via off-street loading facilities. Jurisdictions did not want to be penalized for not providing on-street truck parking along the Arterial Network segments with available off-street loading facilities.

3.5.1 Benefits of Proposed Goods Movement Network Improvements

Fehr & Peers evaluated the Year 2040 Study Network performance assuming implementation of proposed goods movement network improvements. **Table 14** presents a summary of Truck Route Accommodation Index before and after proposed improvements; **Table 15** presents a summary of the performance measure objective evaluation. As shown in **Table 15**, proposed improvements would result in a 22 mile increase in Arterial Network segments that meet the Truck Route Accommodation Index objective.

TABLE 14
ALAMEDA COUNTYWIDE TRUCK ROUTE ACCOMODATION INDEX SUMMARY[1]

Threshold	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
% of Segments with High Rating	55%	59%	+4%
% of Segments with Medium Rating	37%	34%	-3%
% of Segments with Low Rating	8%	7%	-1%

Notes:
1. Countywide data coverage for Truck Route Accommodation Index is 670 miles.

TABLE 15
ALAMEDA COUNTYWIDE GOODS MOVEMENT PERFORMANCE OBJECTIVE EVALUATION

Performance Measure Objective	Segment Miles That Meet Performance Objective Along High Priority Goods Movement Arterial Network Segments[1]		
	Year 2040 Conditions – Without Proposed Improvements	Year 2040 Conditions – With Proposed Improvements	Net Difference
Truck Route Accommodation Index	83 mi	105 mi	+22 mi

Notes:
1. Goods movement is considered high priority mode if categorized in the top two prioritized mode along an Arterial Network segment. A total of 135 Arterial Network miles have high goods movement priority.

5. NEXT STEPS

Fehr & Peers and Alameda CTC will present final proposed improvements to the Committees and Commission in June 2016 for approval as part of the Draft MAP. Please contact Francisco Martin at f.martin@fehrandpeers.com if you have any questions regarding the information presented in this memo.

Memo Attachments:

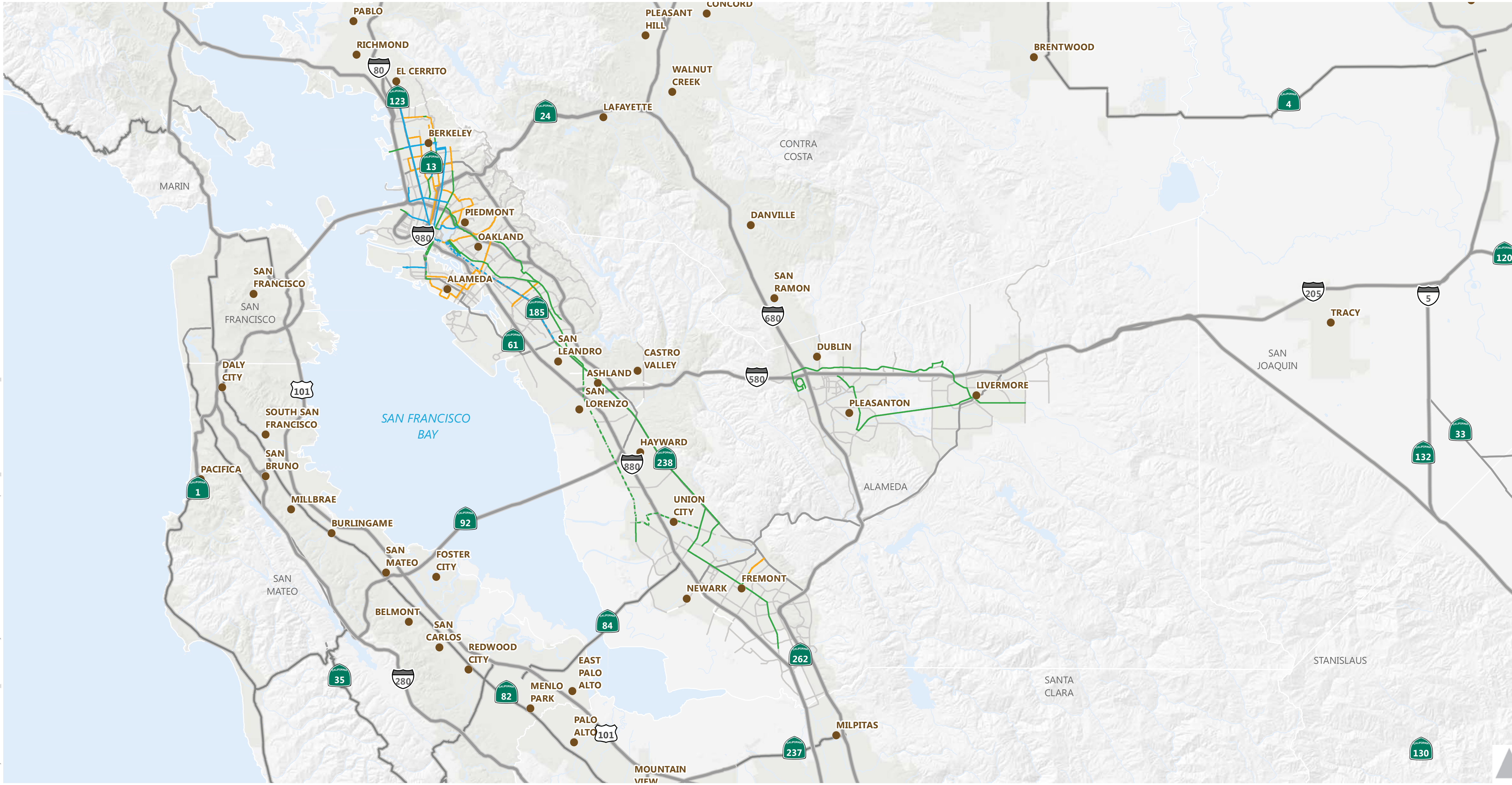
Figure 1 – Transit Network Proposed Improvements

Figure 2 – Pedestrian Network Proposed Improvements

Figure 3 – Bicycle Network Proposed Improvements

Figure 4 – ITS Network Proposed Improvements

Figure 5 – Goods Movement Network Proposed Improvements



Legend

Proposed Transit Network Improvements

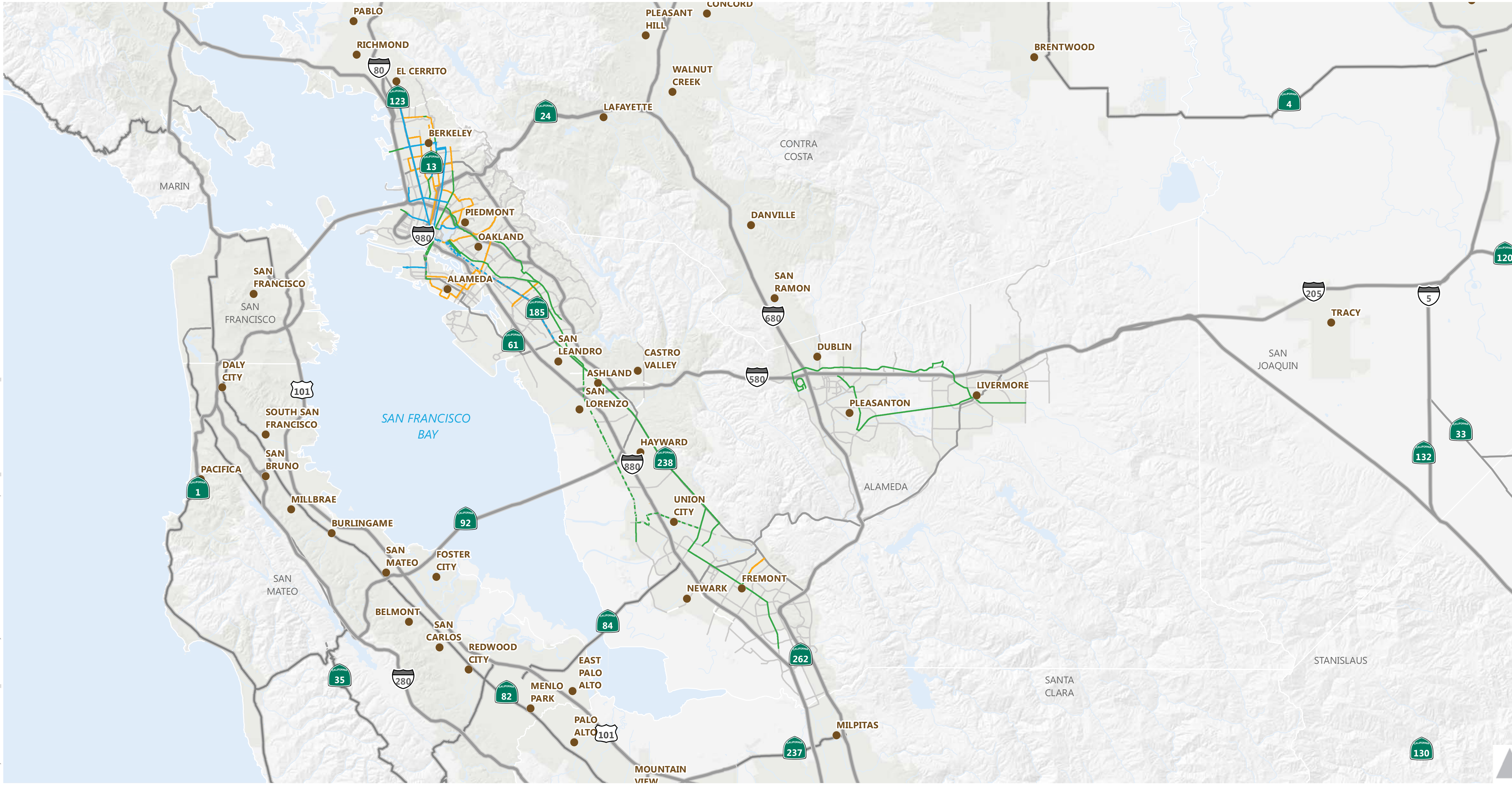
- Enhanced Bus Improvements
- Rapid Bus Improvements
- Dedicated Transit Lane Improvements
- Baseline Rapid Route
- Baseline BRT Routes

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 1A

Transit Network Proposed Improvements - Alameda County



Legend

Proposed Transit Network Improvements

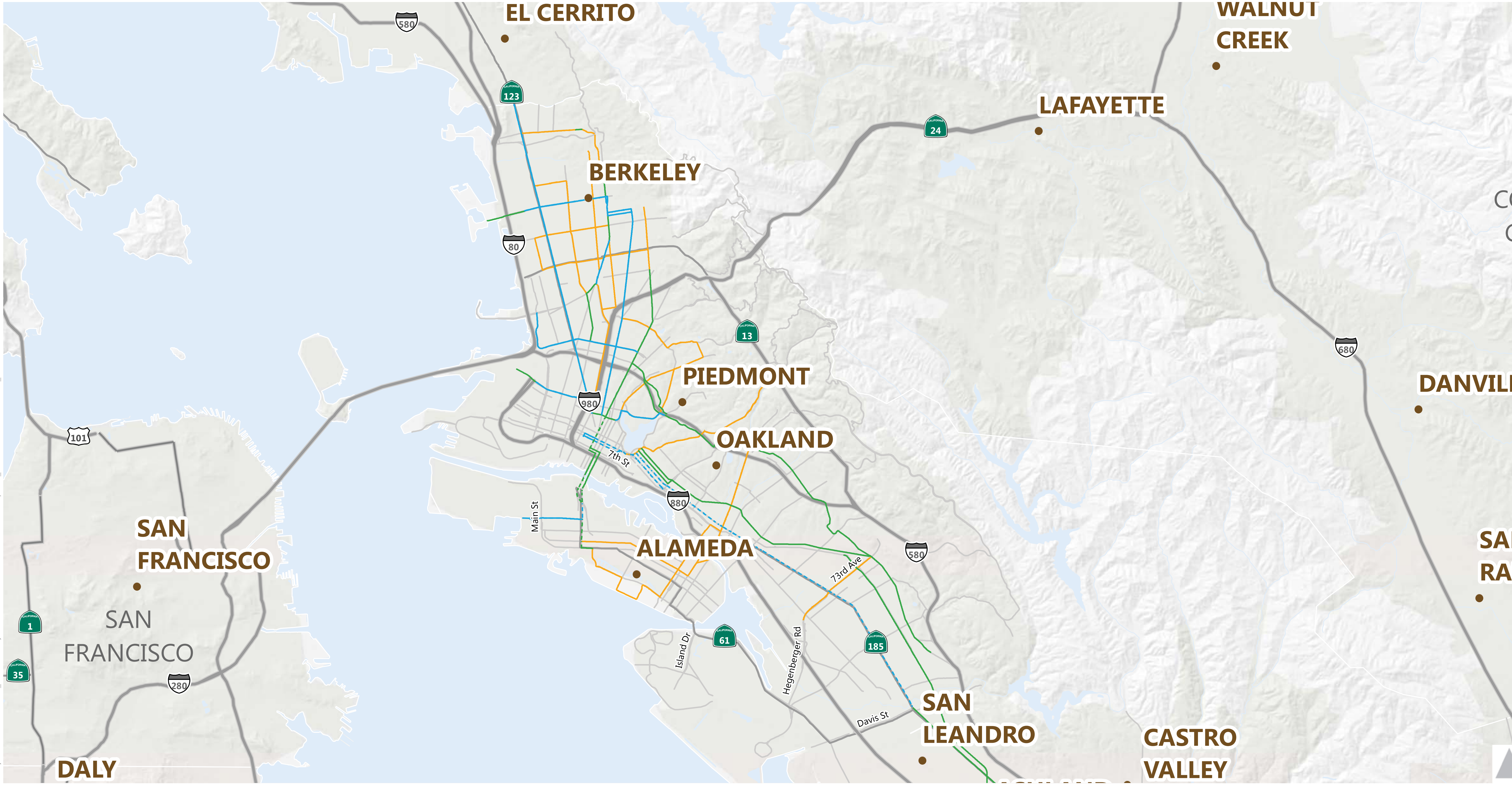
- Enhanced Bus Improvements
- Rapid Bus Improvements
- Dedicated Transit Lane Improvements
- Baseline Rapid Route
- Baseline BRT Routes

Alameda Countywide Multimodal Arterial Plan

Figure 1A

ALAMEDA County Transportation Commission

Transit Network Proposed Improvements - Alameda County



Legend

Proposed Transit Network Improvements

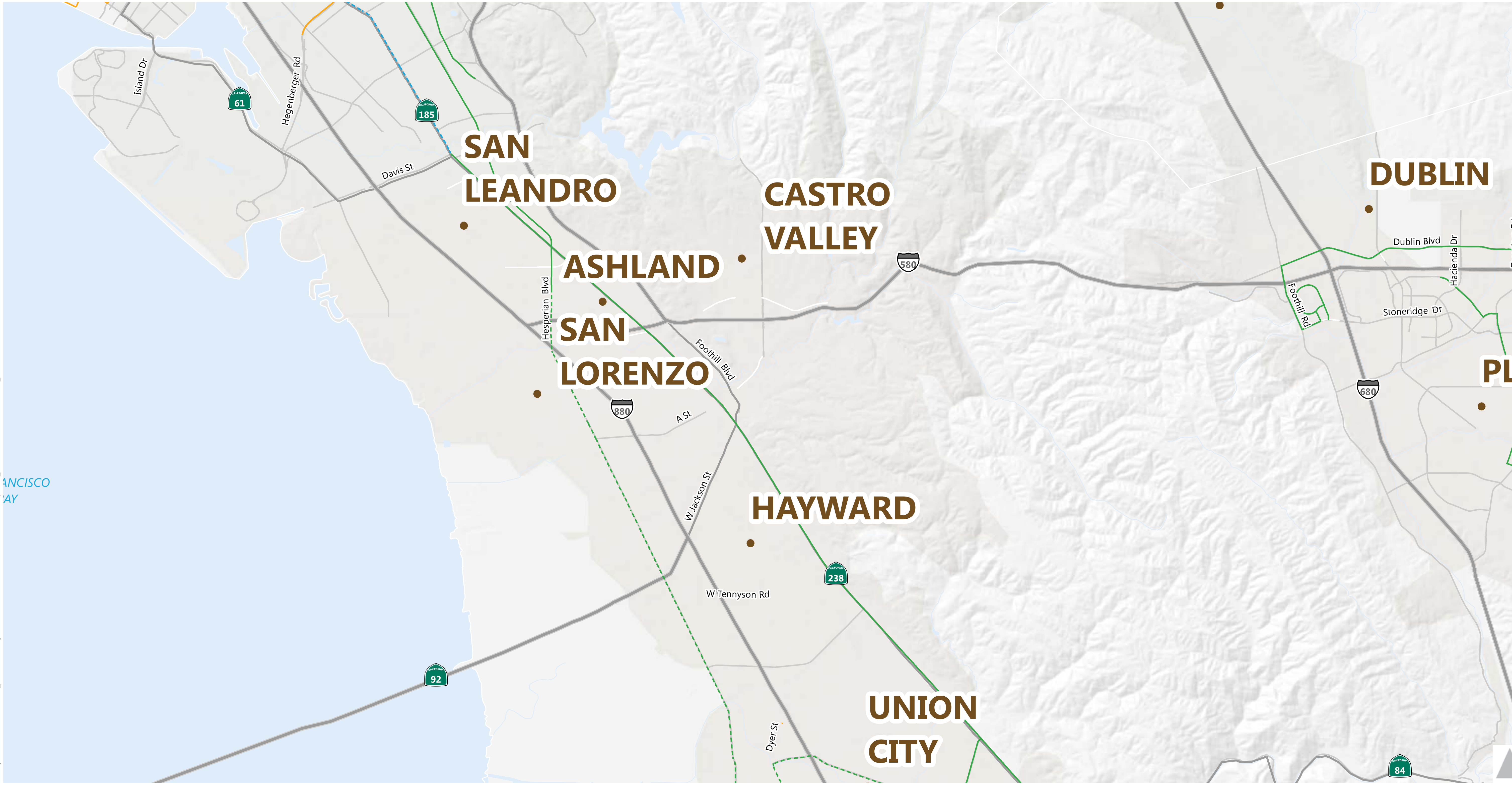
- Enhanced Bus Improvements
- Rapid Bus Improvements
- Dedicated Transit Lane Improvements
- Baseline Rapid Route
- Baseline BRT Routes

Alameda Countywide Multimodal Arterial Plan

Figure 1B

ALAMEDA County Transportation Commission

Transit Network Proposed Improvements - North County



Legend

Proposed Transit Network Improvements

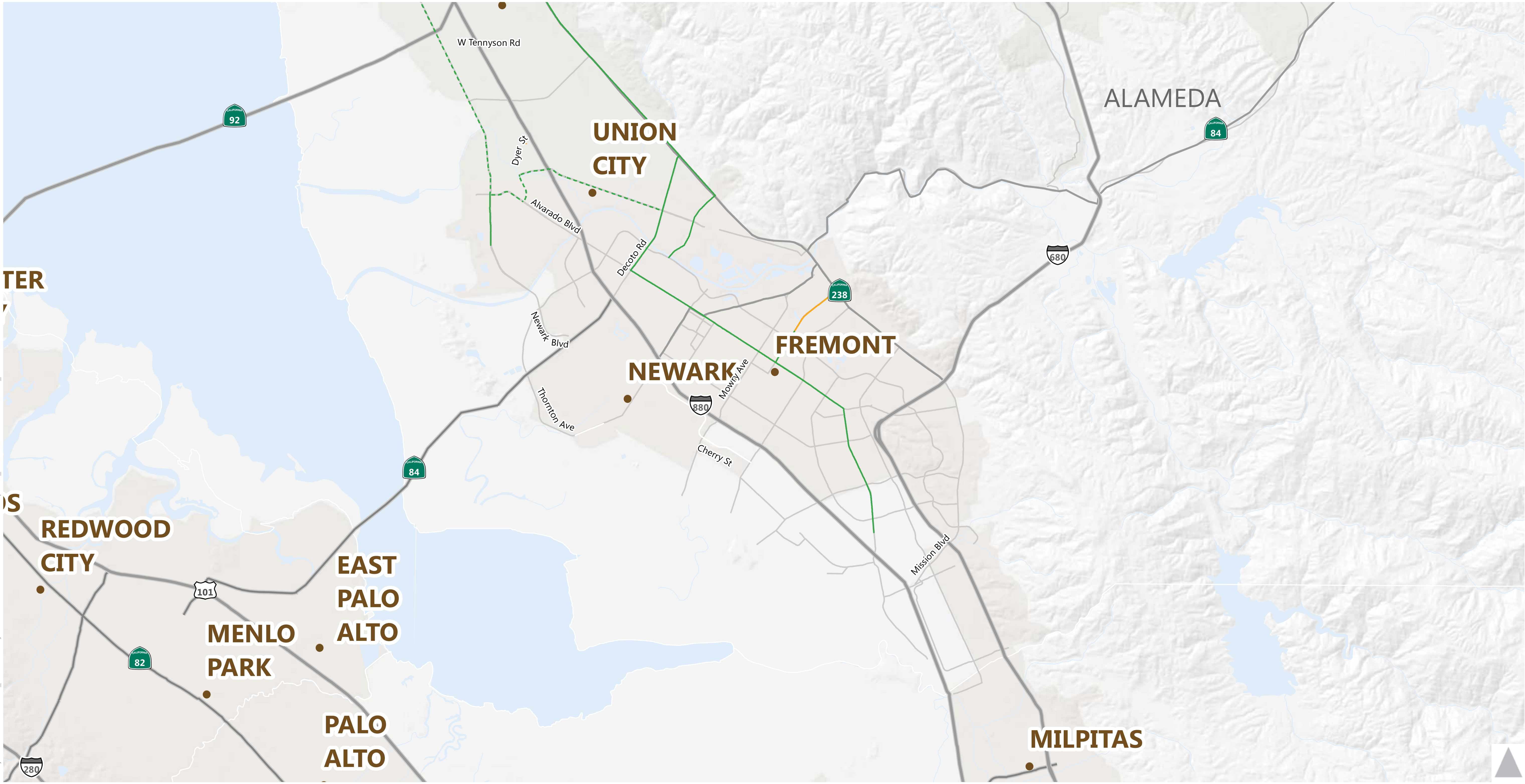
- Enhanced Bus Improvements
- Rapid Bus Improvements
- Dedicated Transit Lane Improvements
- Baseline Rapid Route
- Baseline BRT Routes

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 1C

Transit Network Proposed Improvements - Central County



Legend

Proposed Transit Network Improvements

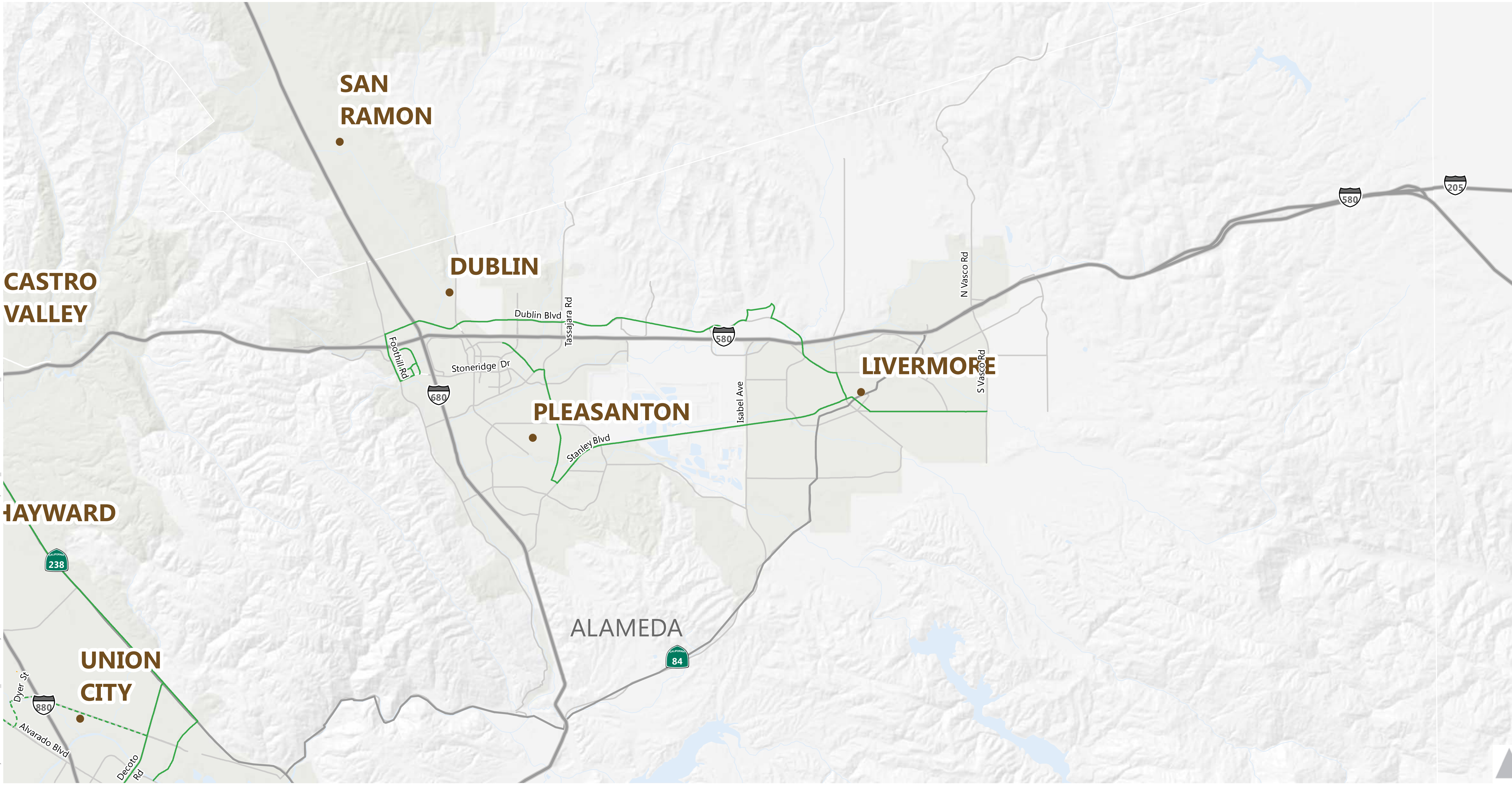
- Enhanced Bus Improvements
- Rapid Bus Improvements
- Dedicated Transit Lane Improvements
- Baseline Rapid Route
- Baseline BRT Routes

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 1D

Transit Network Proposed Improvements - South County



Legend

Proposed Transit Network Improvements

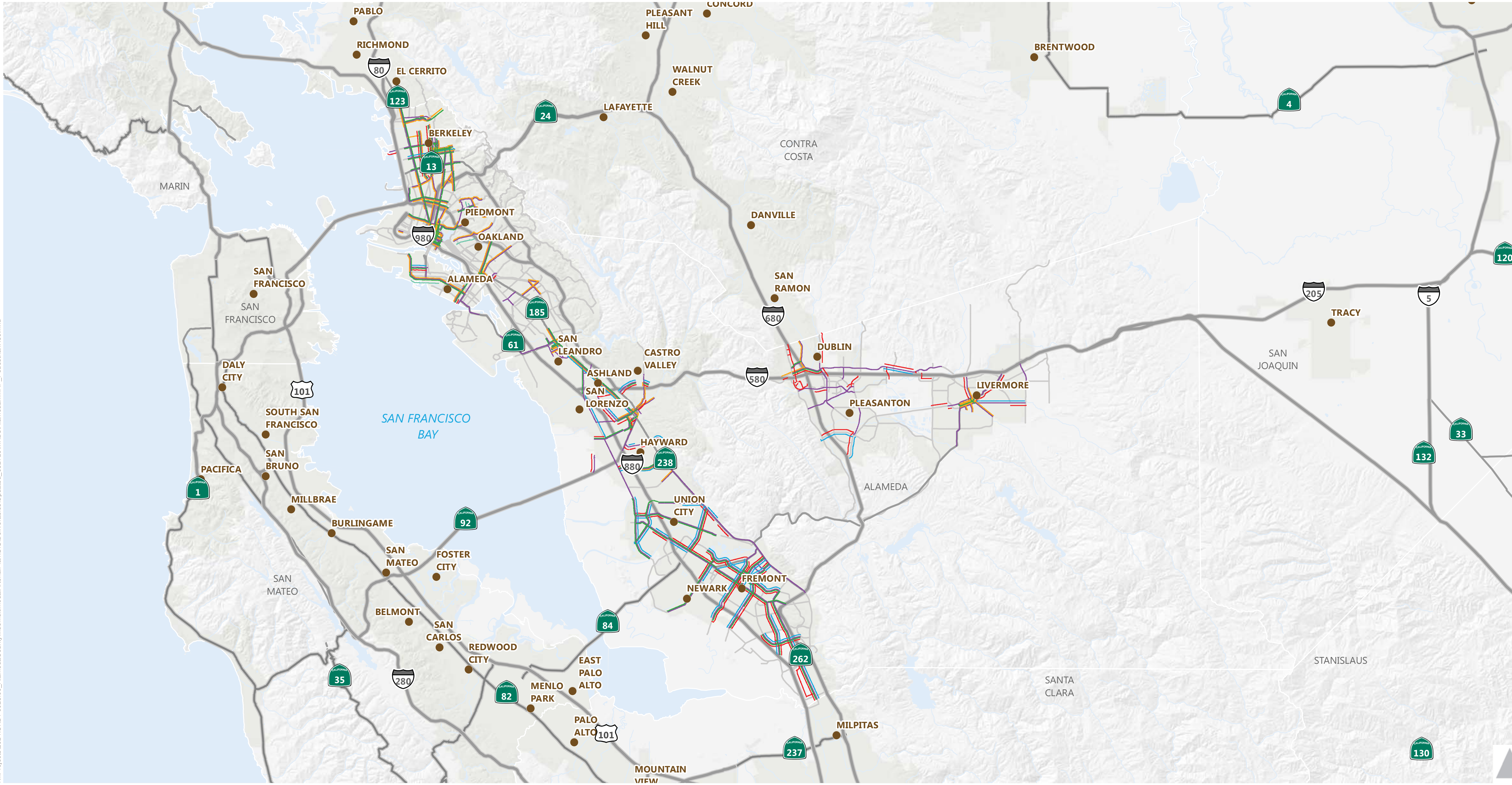
- Enhanced Bus Improvements
- Rapid Bus Improvements
- Dedicated Transit Lane Improvements
- Baseline Rapid Route
- Baseline BRT Routes

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 1E

Transit Network Proposed Improvements - East County



Legend

Proposed Pedestrian Network Improvements

- Sidewalk Enhancements
- Curb Bulbouts
- Pedestrian Scale Lighting
- Streetscape Enhancements
- Crosswalk Enhancements
- Travel Lane Removal (Road Diet)

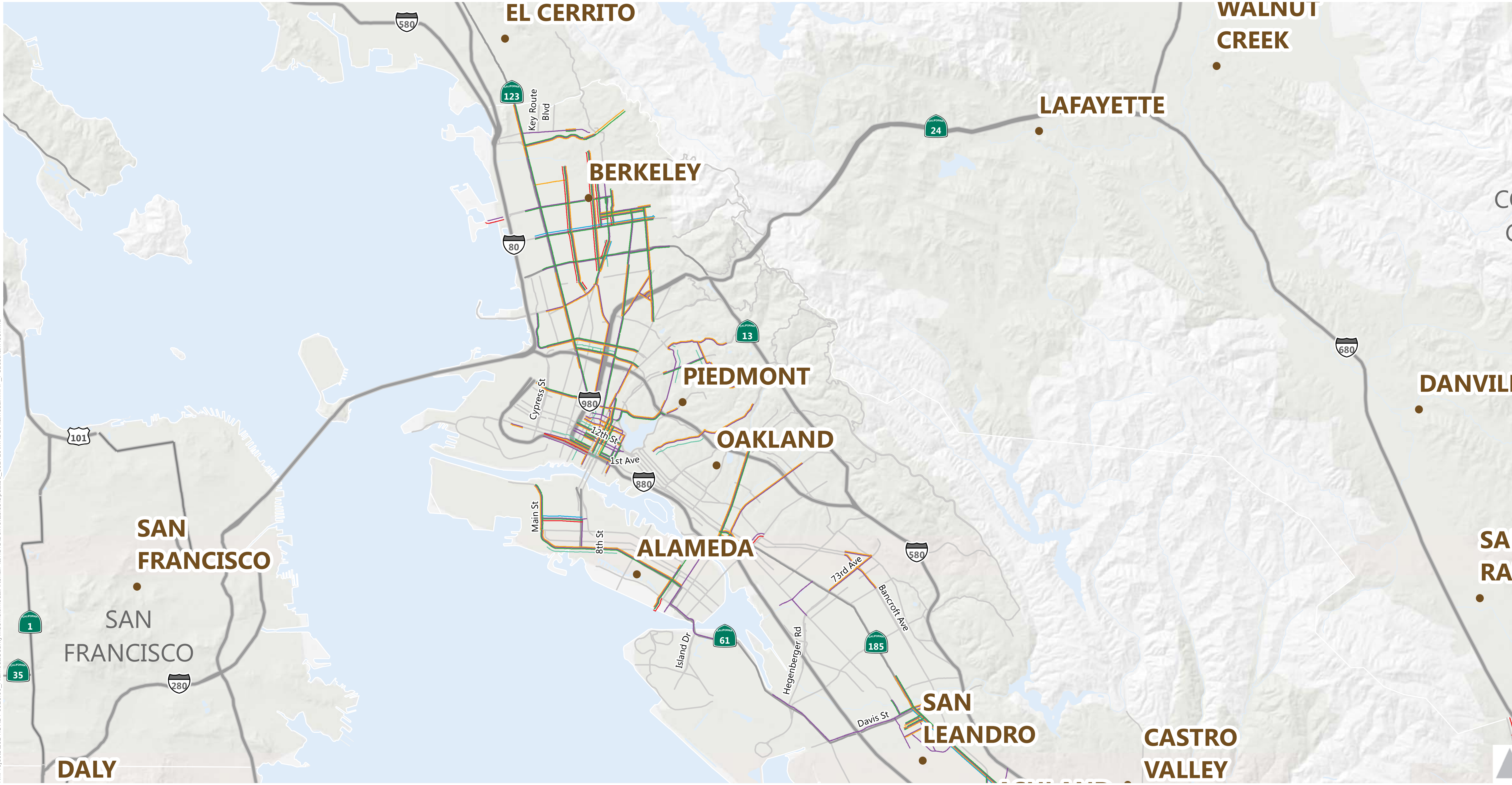
Alameda Countywide Multimodal Arterial Plan

Note: Existing, planned and funded improvements are not shown on the map for ease of reading.

Figure 2A

ALAMEDA County Transportation Commission

Pedestrian Network Proposed Improvements - Alameda County



Legend

Proposed Pedestrian Network Improvements

- Sidewalk Enhancements
- Curb Bulbouts
- Pedestrian Scale Lighting
- Streetscape Enhancements
- Crosswalk Enhancements
- Travel Lane Removal (Road Diet)

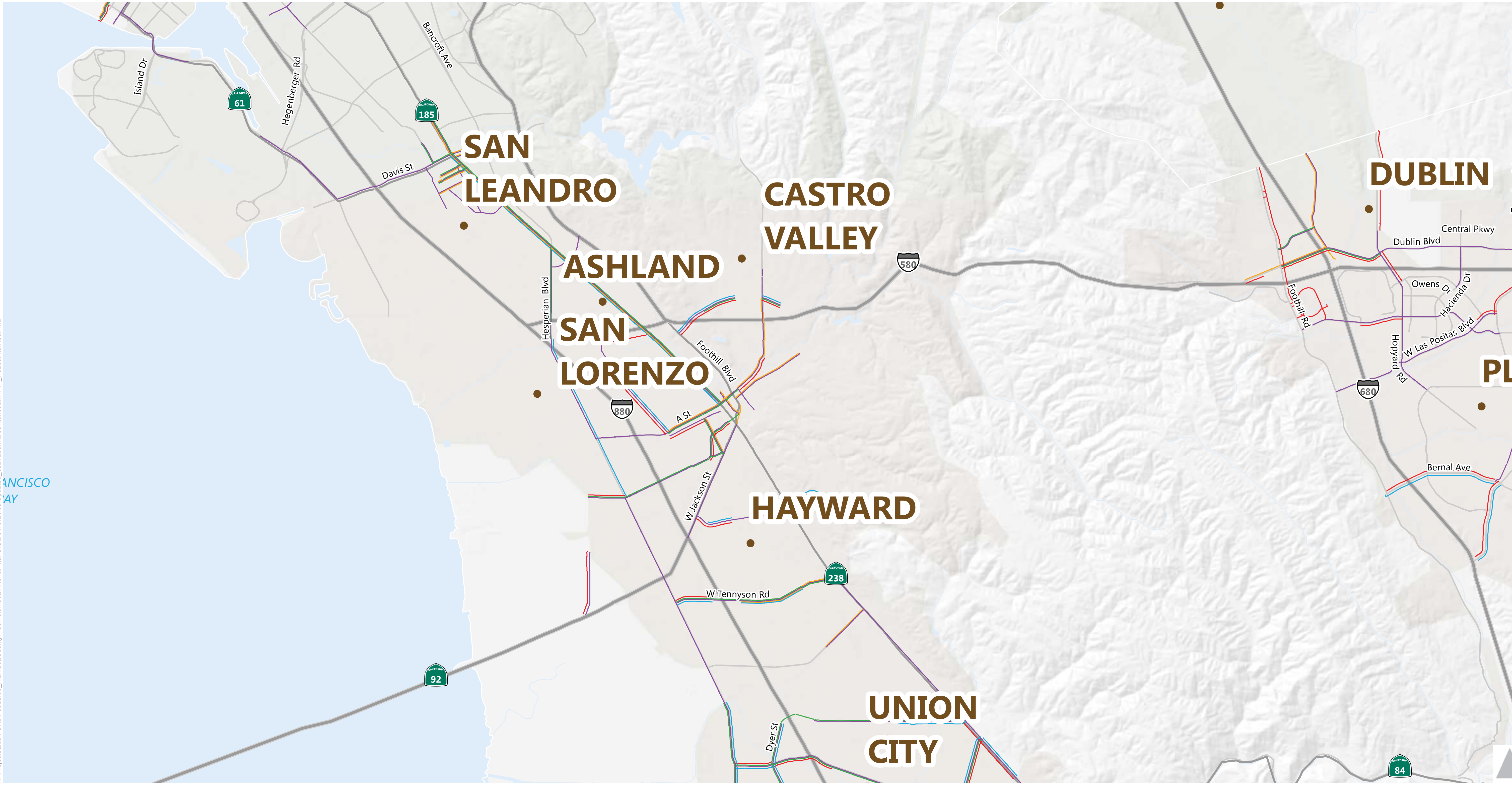
Alameda Countywide Multimodal Arterial Plan

Note: Existing, planned and funded improvements are not shown on the map for ease of reading.

Figure 2B

ALAMEDA County Transportation Commission

Pedestrian Network Proposed Improvements - North County



Legend

Proposed Pedestrian Network Improvements

- Sidewalk Enhancements
- Curb Bulbouts
- Pedestrian Scale Lighting
- Streetscape Enhancements
- Crosswalk Enhancements
- Travel Lane Removal (Road Diet)

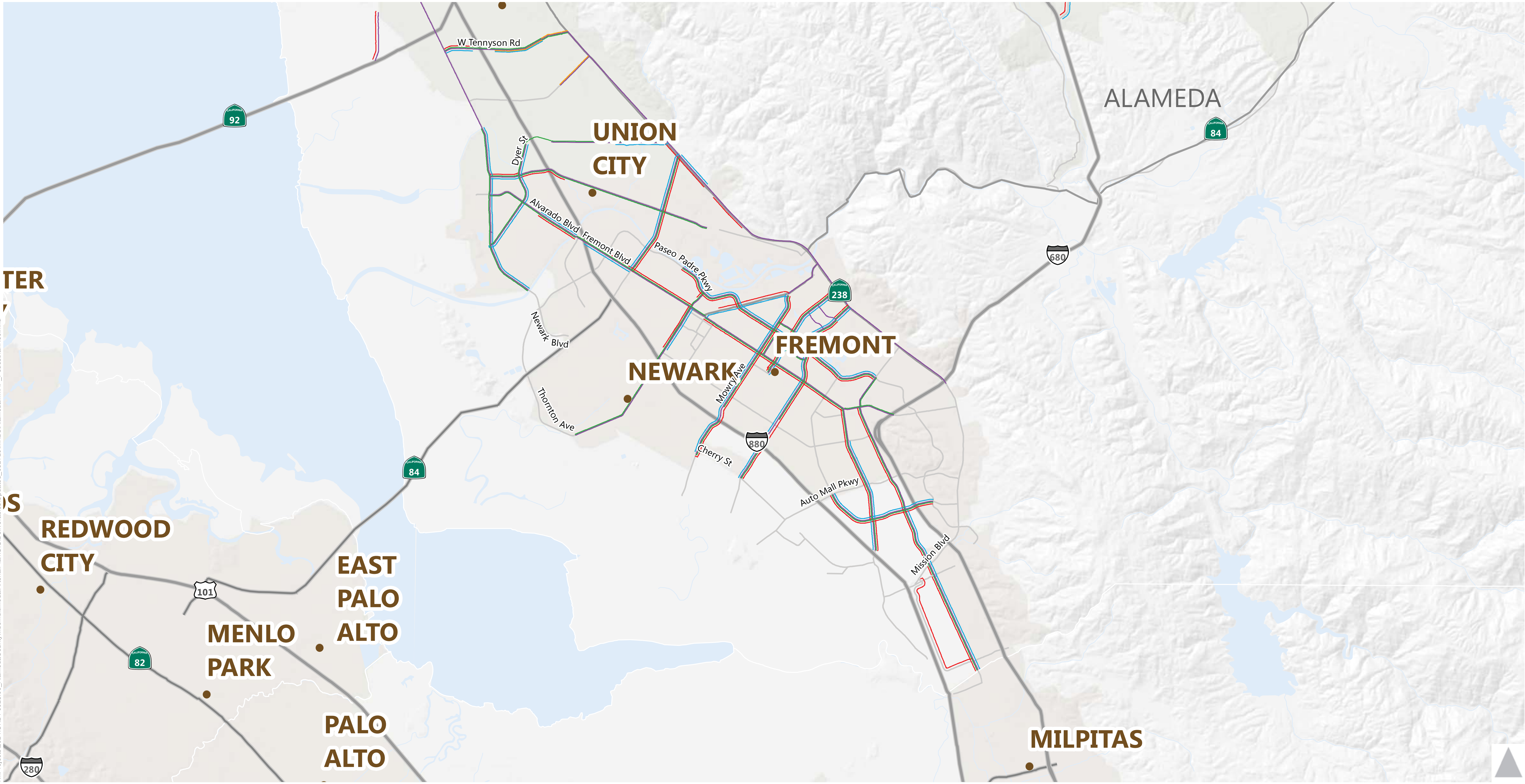
Alameda Countywide Multimodal Arterial Plan

Note: Existing, planned and funded improvements are not shown on the map for ease of reading.

Figure 2C

ALAMEDA County Transportation Commission

Pedestrian Network Proposed Improvements - Central County



Legend

Proposed Pedestrian Network Improvements

- Sidewalk Enhancements
- Curb Bulbouts
- Pedestrian Scale Lighting
- Streetscape Enhancements
- Crosswalk Enhancements
- Travel Lane Removal (Road Diet)

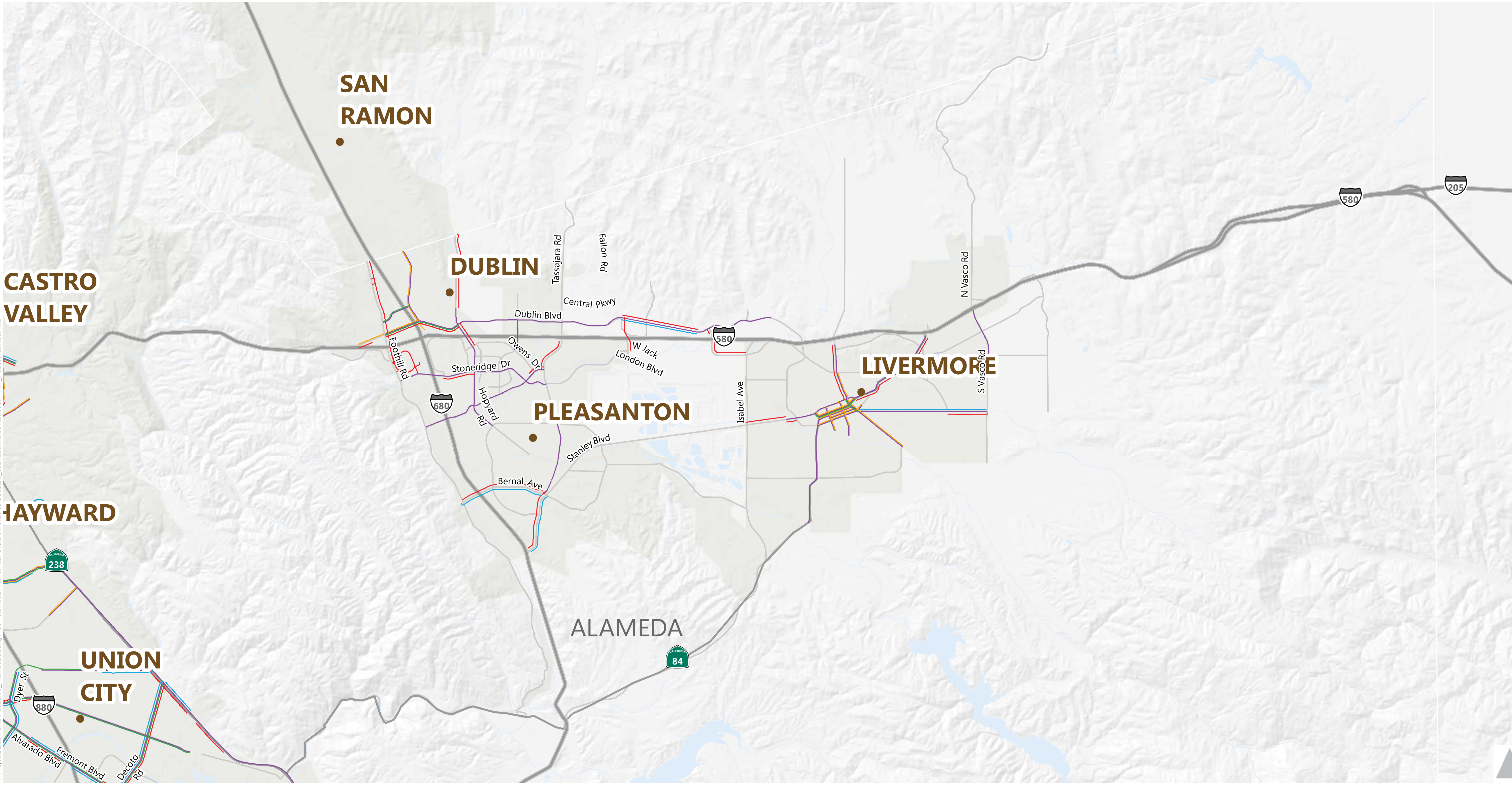
Alameda Countywide Multimodal Arterial Plan

Note: Existing, planned and funded improvements are not shown on the map for ease of reading.

ALAMEDA County Transportation Commission

Figure 2D

Pedestrian Network Proposed Improvements - South County



Legend

Proposed Pedestrian Network Improvements

- Sidewalk Enhancements
- Curb Bulbouts
- Pedestrian Scale Lighting
- Streetscape Enhancements
- Crosswalk Enhancements
- Travel Lane Removal (Road Diet)

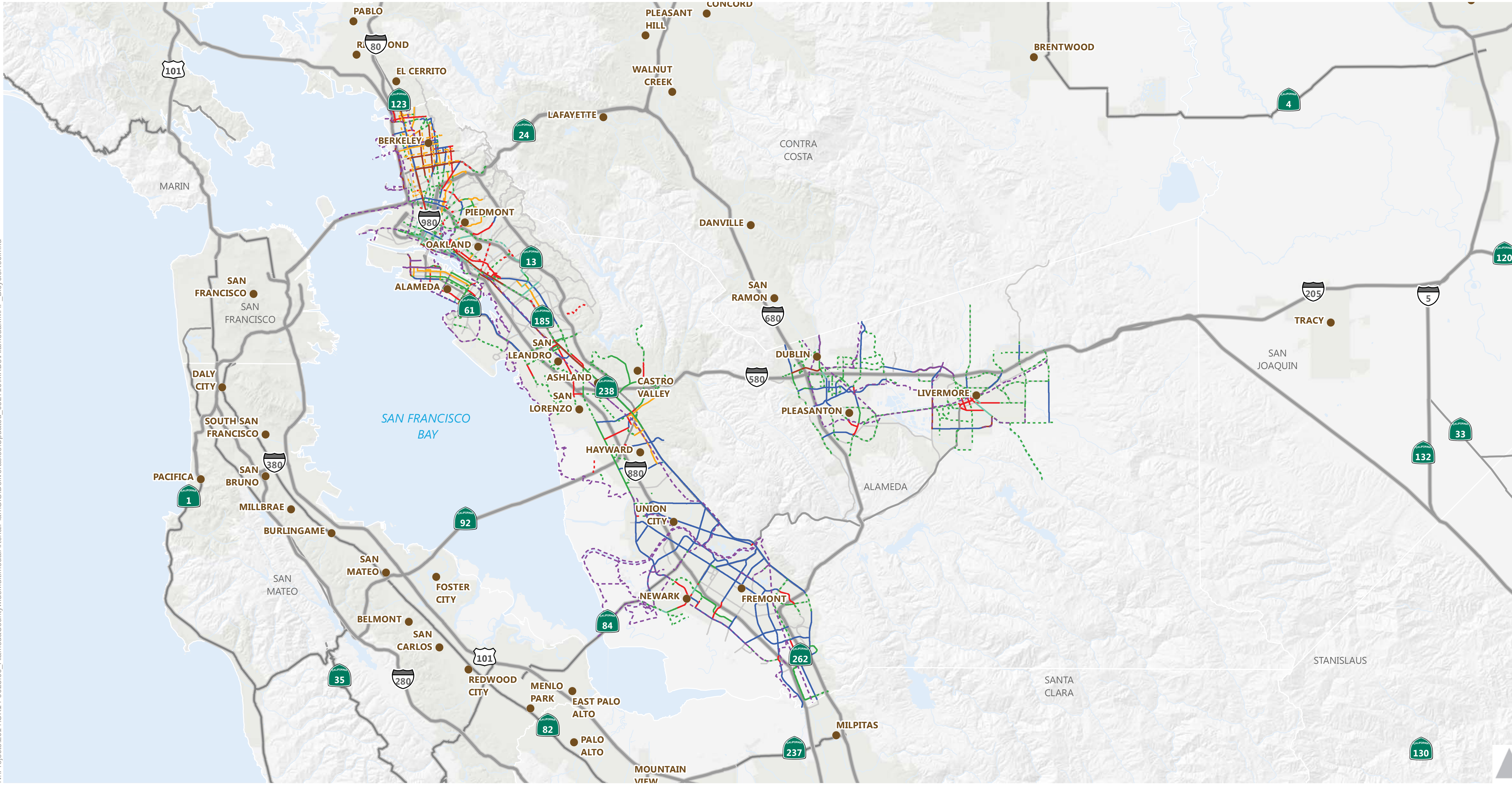
Alameda Countywide Multimodal Arterial Plan

Note: Existing, planned and funded improvements are not shown on the map for ease of reading.

Figure 2E

ALAMEDA County Transportation Commission

Pedestrian Network Proposed Improvements - East County



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Legend

Proposed Bicycle Network Improvements
- Class 1
- Class 2 Enhanced
- Class 2
- Class 3 Enhanced
- Class 3
- Class 4
- Parallel Facility Available

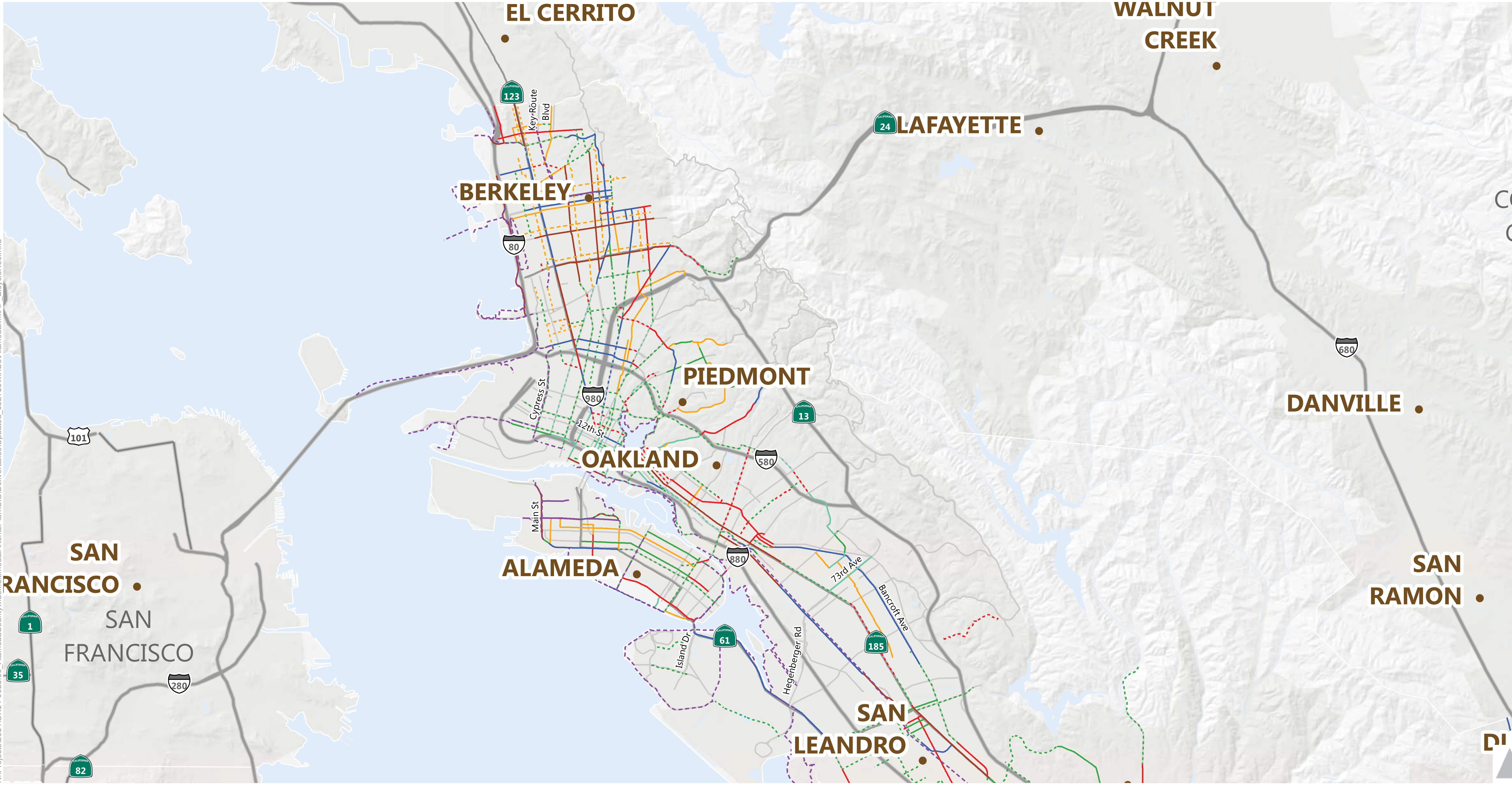
Baseline Bicycle Network
- Class 1
- Class 2 Enhanced
- Class 2
- Class 3 Enhanced
- Class 3
- Class 4

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 3A

Bicycle Network Proposed Improvements - Alameda County



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Legend

Proposed Bicycle Network Improvements
- Class 1
- Class 2 Enhanced
- Class 2
- Class 3 Enhanced
- Class 3
- Class 4
- Parallel Facility Available

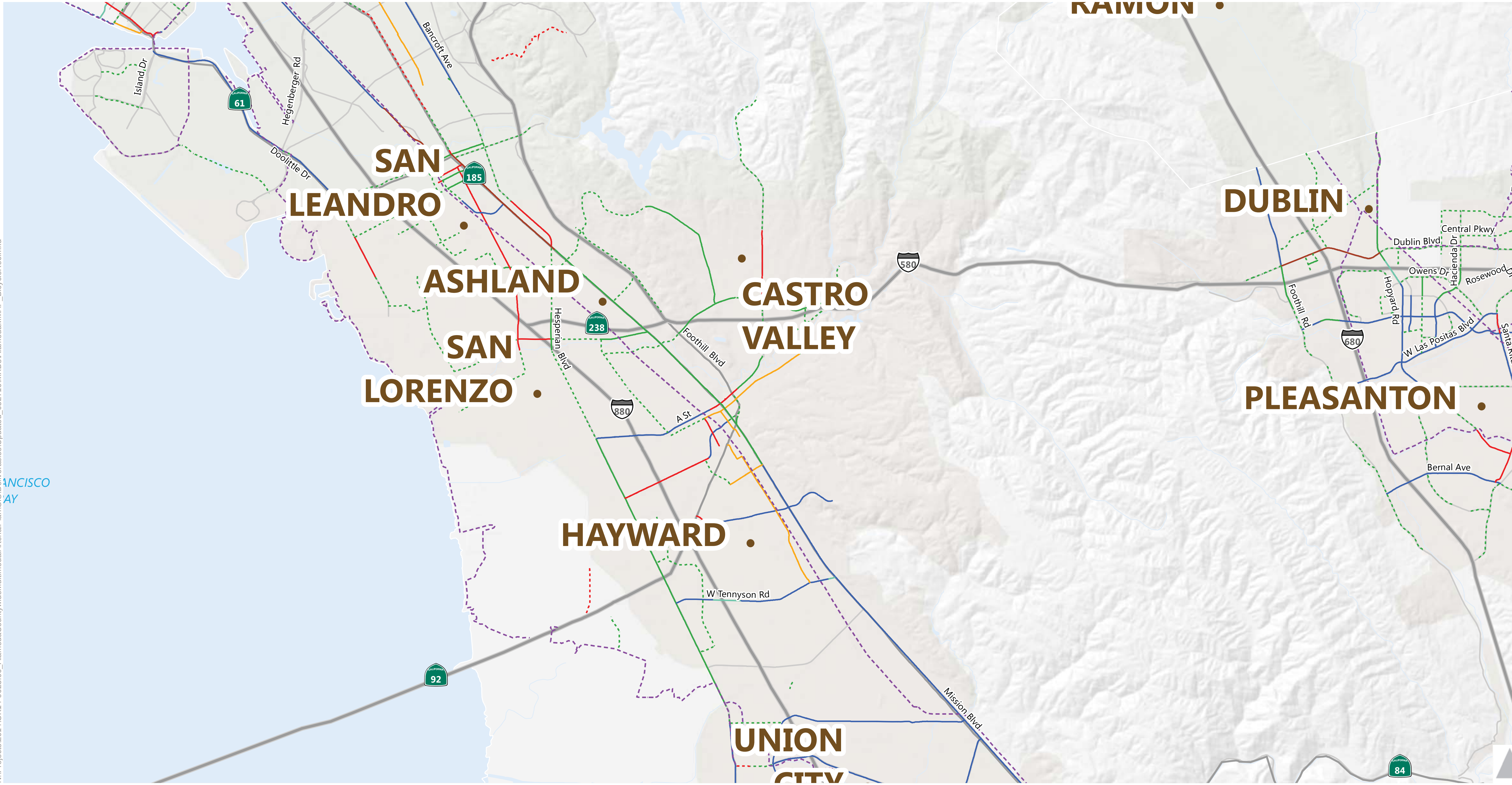
Baseline Bicycle Network
- Class 1
- Class 2 Enhanced
- Class 2
- Class 3 Enhanced
- Class 3
- Class 4

Alameda Countywide Multimodal Arterial Plan

Figure 3B

ALAMEDA County Transportation Commission

Bicycle Network Proposed Improvements - North County



Legend

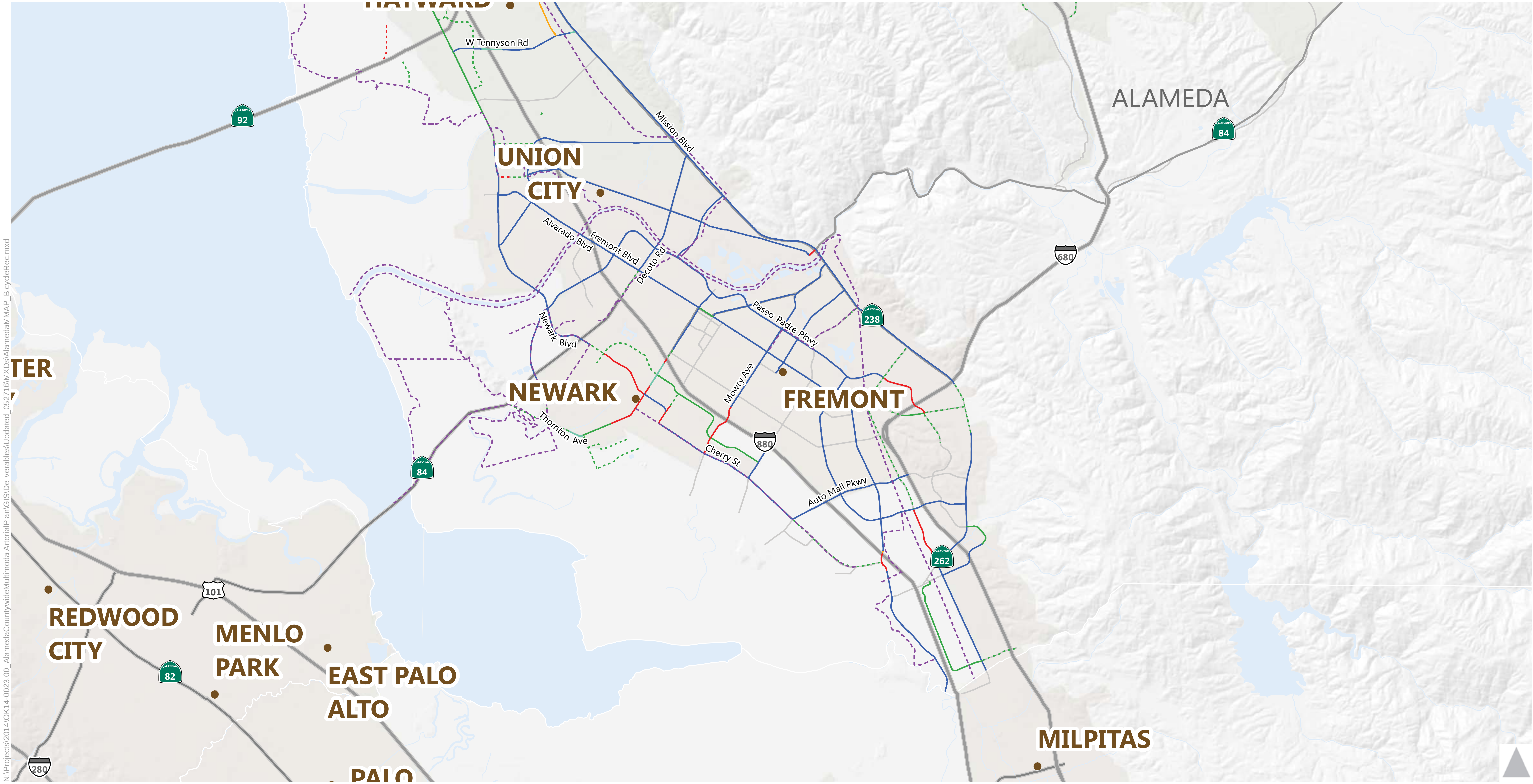
Proposed Bicycle Network Improvements		Baseline Bicycle Network	
Class 1	Class 3 Enhanced	Class 1	Class 3 Enhanced
Class 2 Enhanced	Class 3	Class 2 Enhanced	Class 3
Class 2	Class 4	Class 2	Class 4
	Parallel Facility Available		

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 3C

Bicycle Network Proposed Improvements - Central County

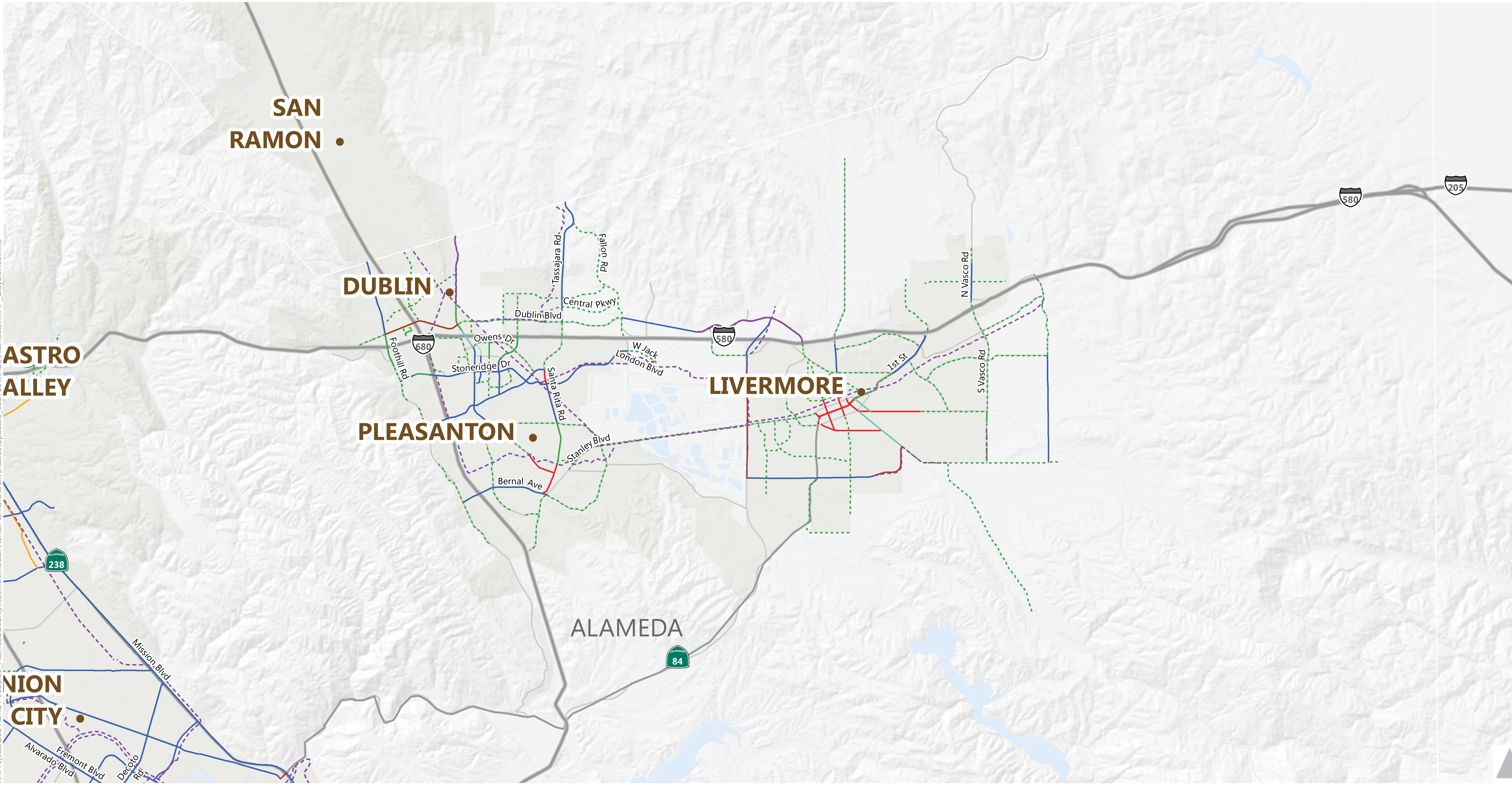


Legend

Proposed Bicycle Network Improvements		Baseline Bicycle Network	
Class 1	Class 3 Enhanced	Class 1	Class 3 Enhanced
Class 2 Enhanced	Class 3	Class 2 Enhanced	Class 3
Class 2	Class 4	Class 2	Class 4
	Parallel Facility Available		

Figure 3D

Bicycle Network Proposed Improvements - South County



Legend

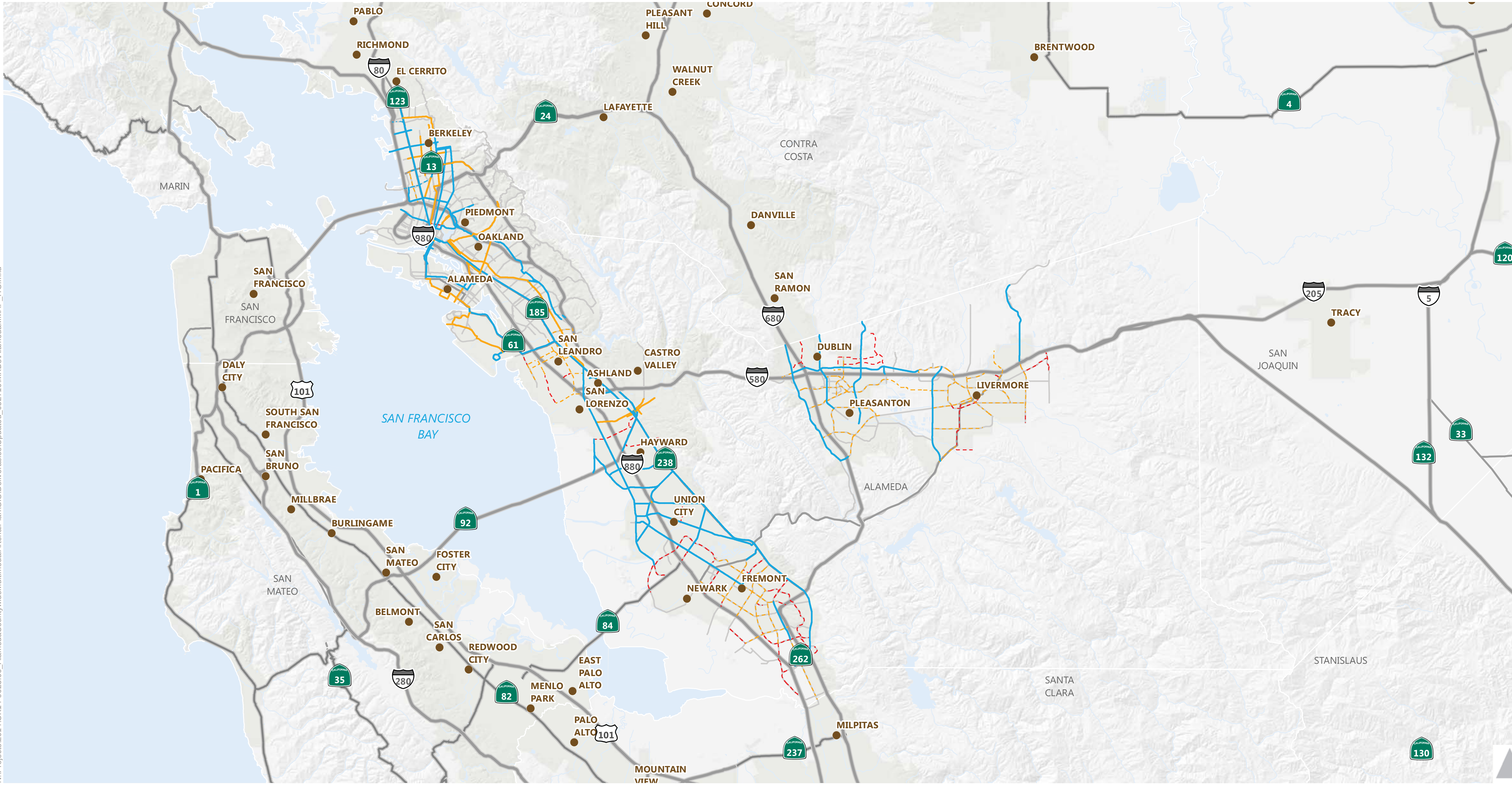
Proposed Bicycle Network Improvements
- Class 1
- Class 2 Enhanced
- Class 2
- Class 3 Enhanced
- Class 3
- Class 4
- Parallel Facility Available

Baseline Bicycle Network
- Class 1
- Class 2 Enhanced
- Class 2
- Class 3 Enhanced
- Class 3
- Class 4

ALAMEDA County Transportation Commission

Figure 3E

Bicycle Network Proposed Improvements - East County



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Legend

Proposed ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

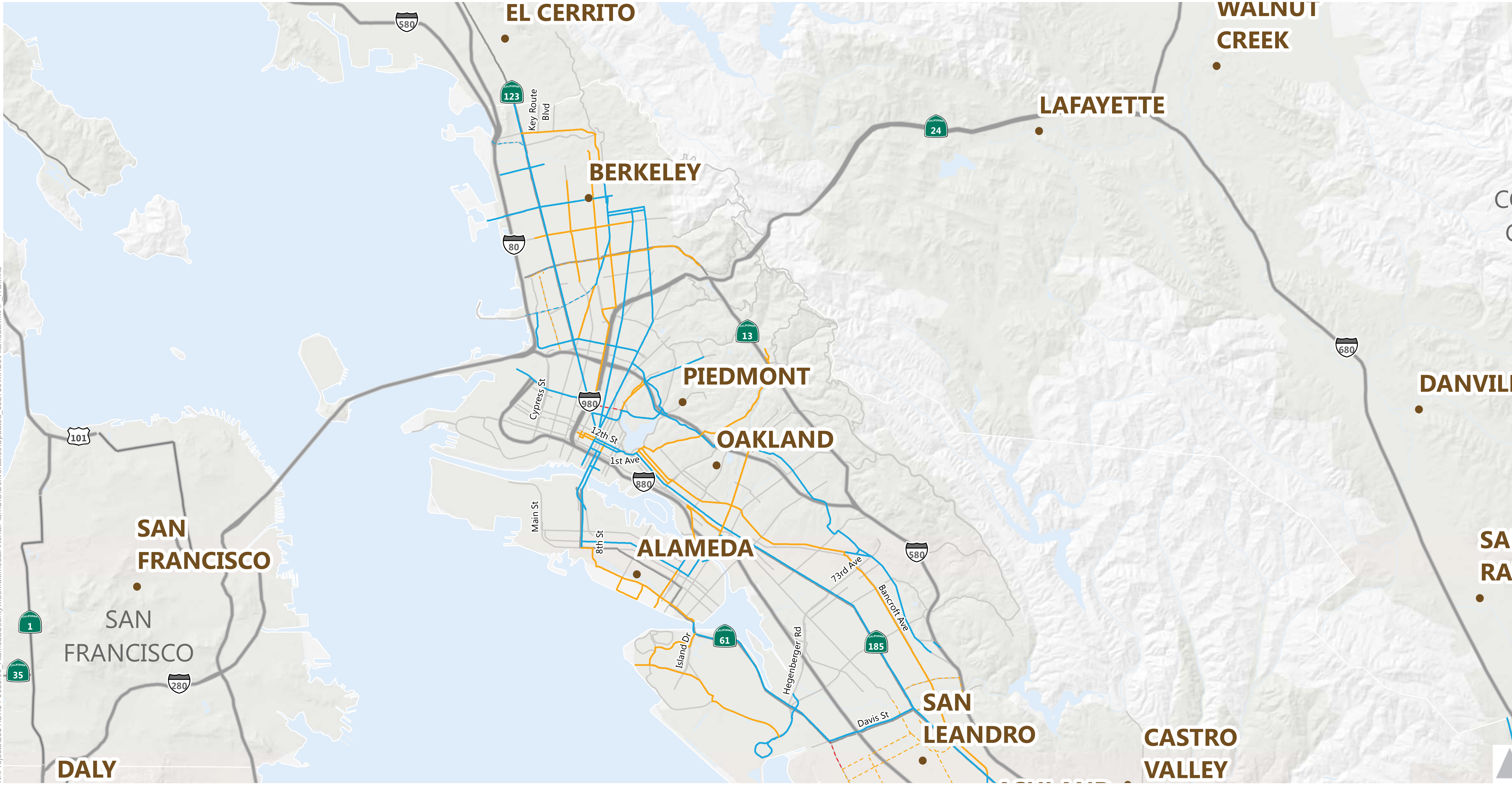
Baseline ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 4A

ITS Network Proposed Improvements - Alameda County



N:\Projects\2014\OK14-0023.00_AlamedaCountywideMultimodalArterialPlan\GIS\Deliverables\Updated_052716\MXDs\AlamedaMMAP_ITS.mxd

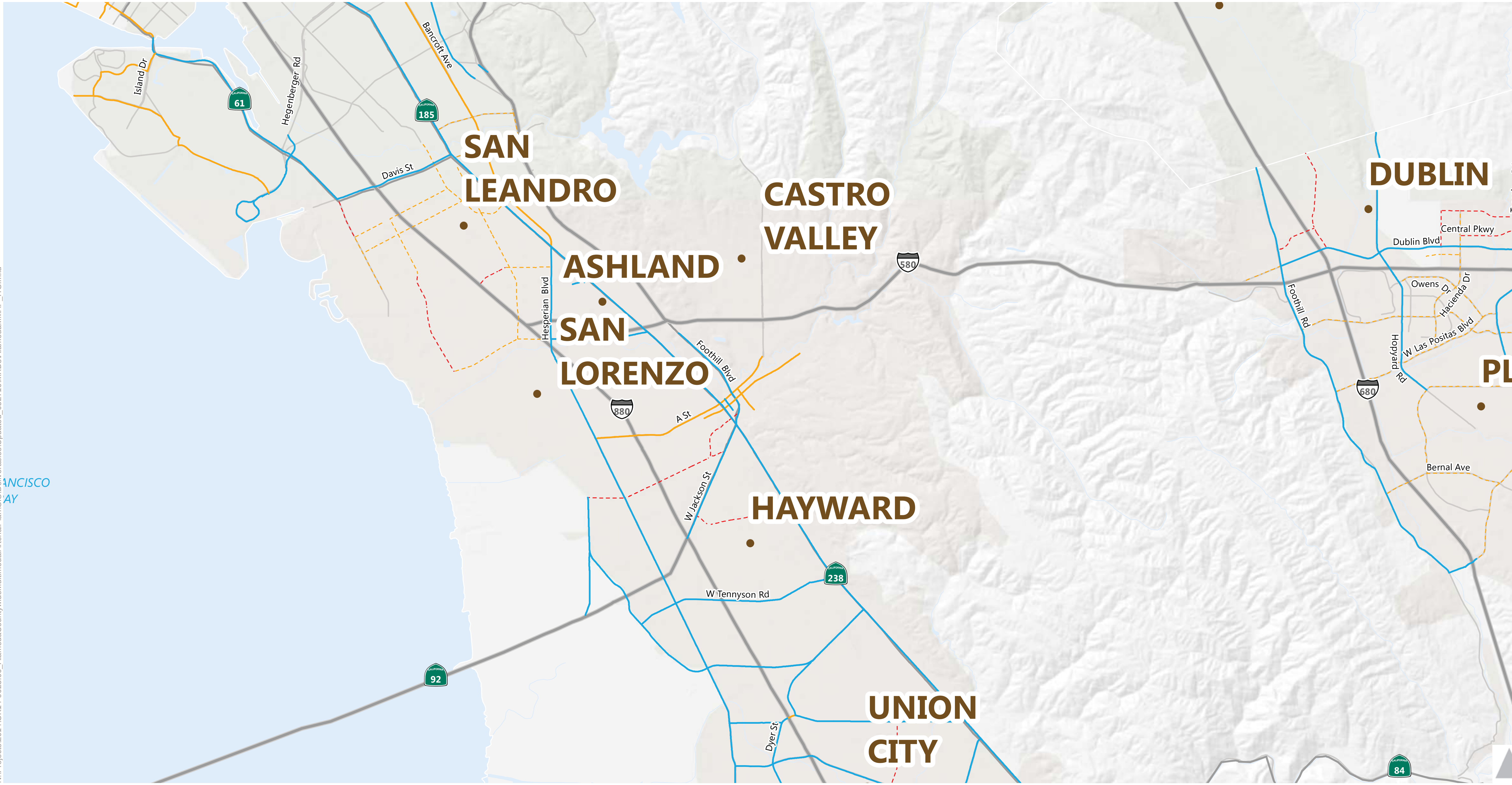
Legend

Proposed ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

Baseline ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

Figure 4B

ITS Network Proposed Improvements - North County



Legend

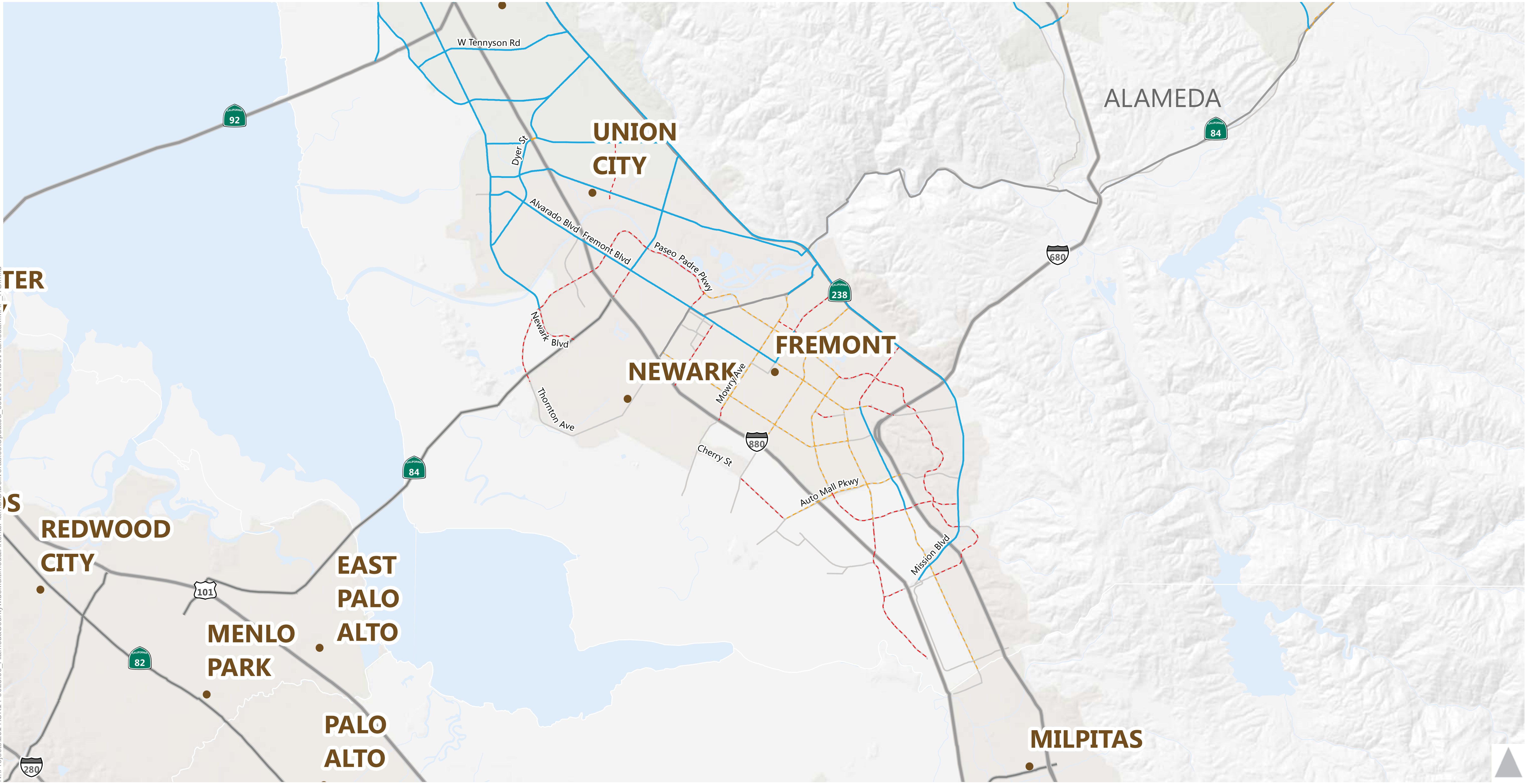
Proposed ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

Baseline ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

Figure 4C

ALAMEDA County Transportation Commission

ITS Network Proposed Improvements - Central County



Legend

Proposed ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

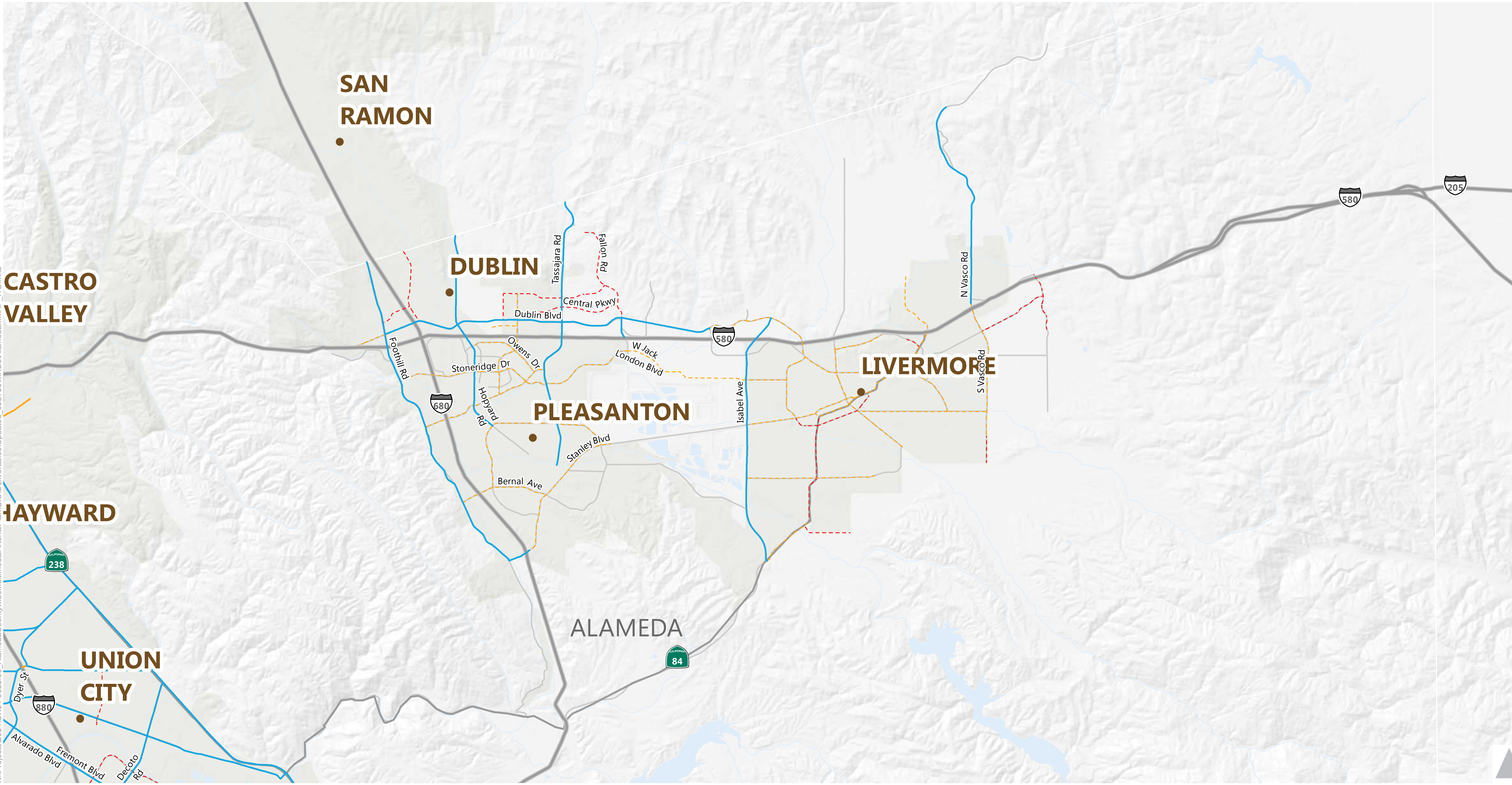
Baseline ITS Infrastructure
- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Figure 4D

ITS Network Proposed Improvements - South County



Legend

Proposed ITS Infrastructure

- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

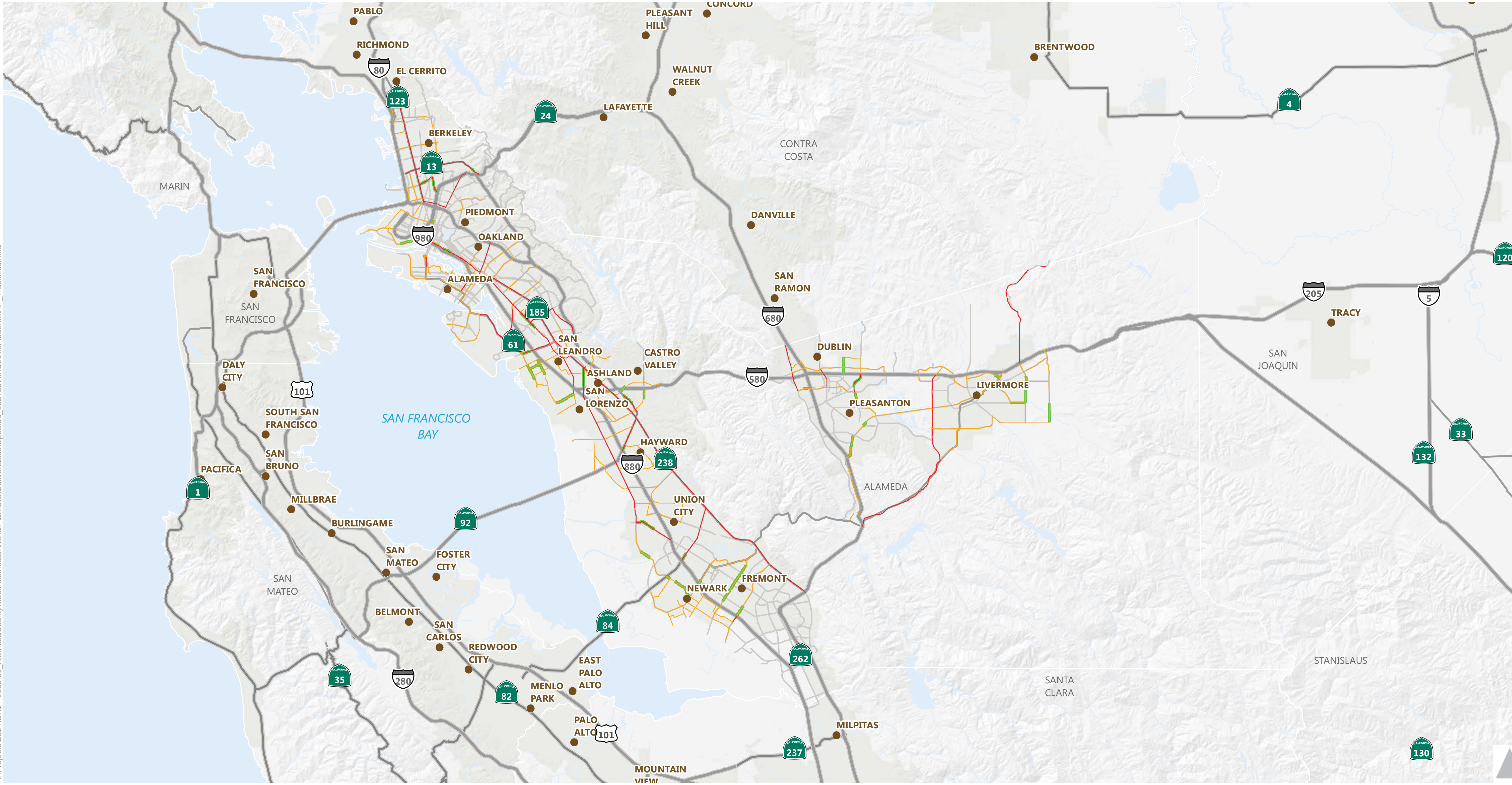
Baseline ITS Infrastructure

- High Level of ITS Infrastructure
- Medium Level of ITS Infrastructure
- Low Level of ITS Infrastructure

Figure 4E

ALAMEDA County Transportation Commission

ITS Network Proposed Improvements - East County



Legend

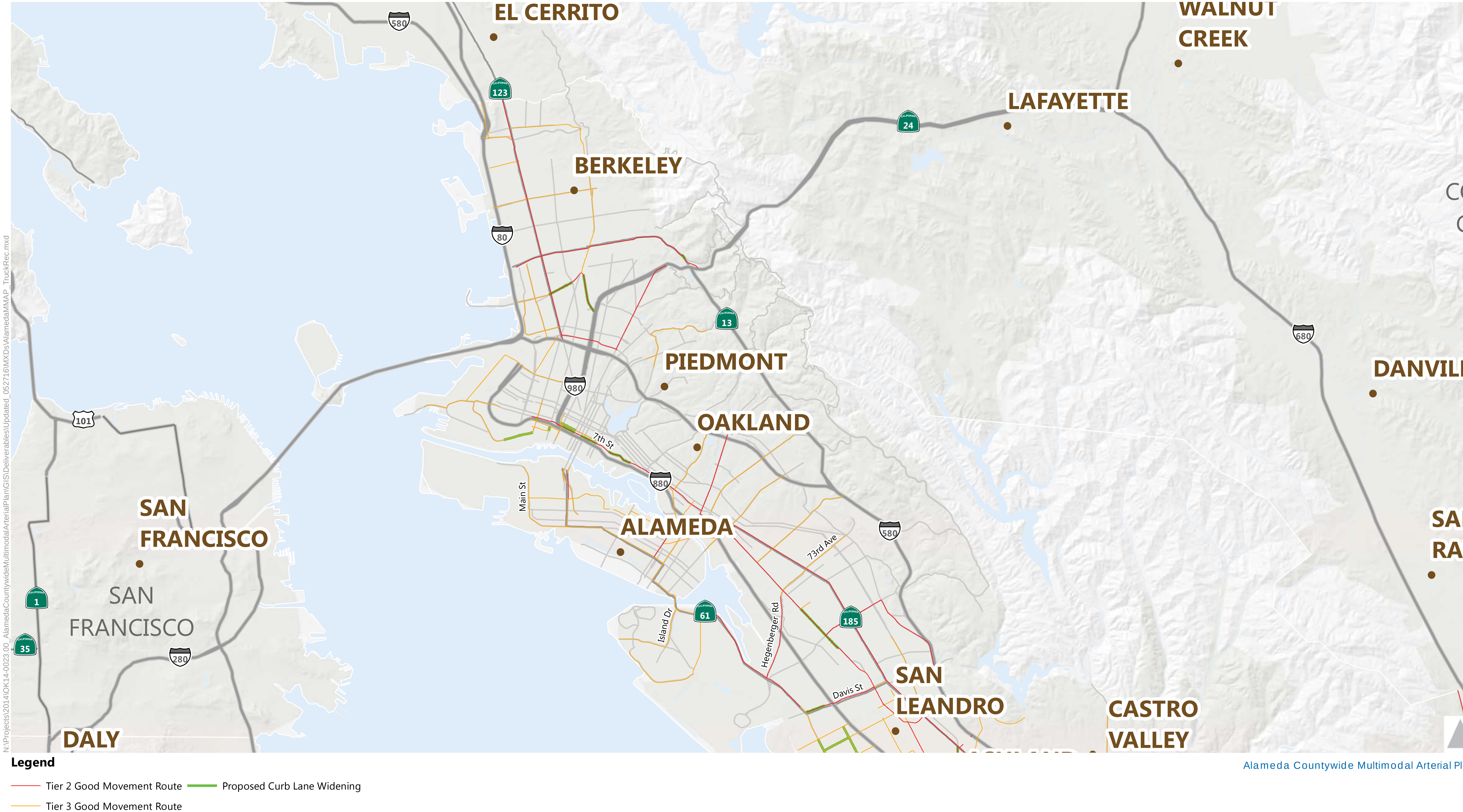
- Tier 2 Good Movement Route
- Tier 3 Good Movement Route
- Proposed Curb Lane Widening

Alameda Countywide Multimodal Arterial Plan

Figure 5A

ALAMEDA County Transportation Commission

Goods Movement Network Proposed Improvements - Alameda County

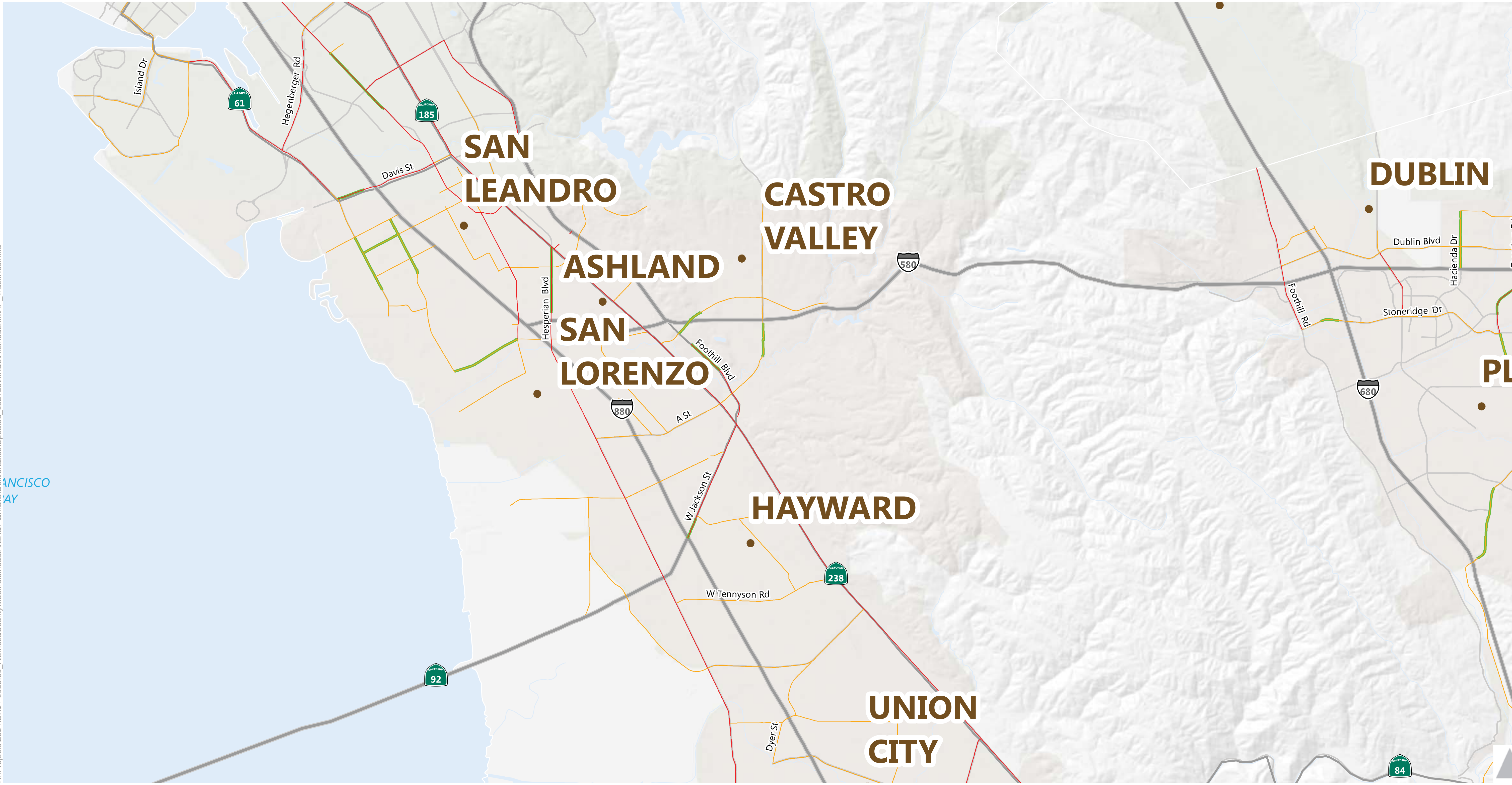


Alameda Countywide Multimodal Arterial Plan

Figure 5B

ALAMEDA County Transportation Commission

Goods Movement Network Proposed Improvements - North County



Legend

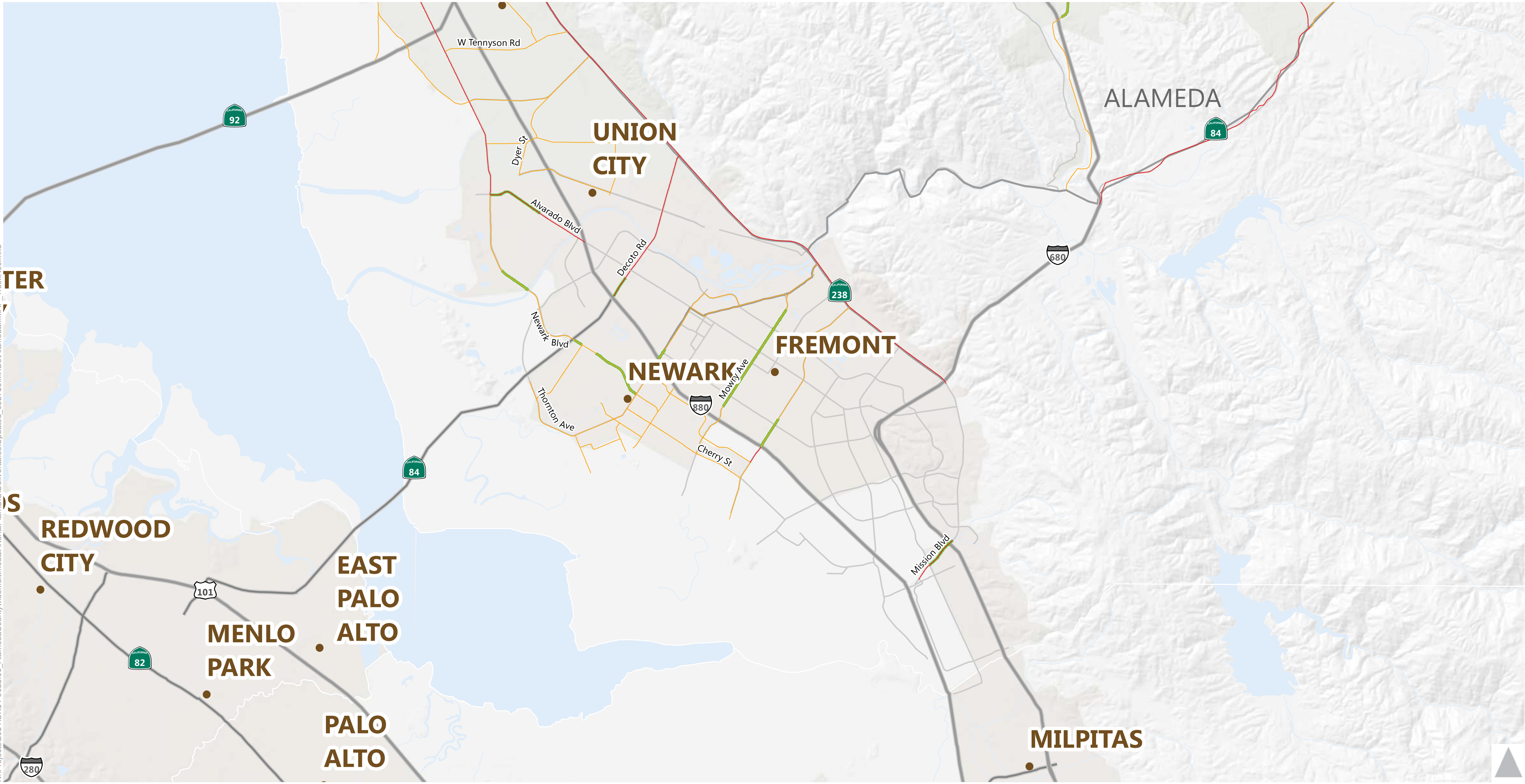
- Tier 2 Good Movement Route
- Tier 3 Good Movement Route
- Proposed Curb Lane Widening

Alameda Countywide Multimodal Arterial Plan

Figure 5C

ALAMEDA County Transportation Commission

Goods Movement Network Proposed Improvements - Central County



Legend

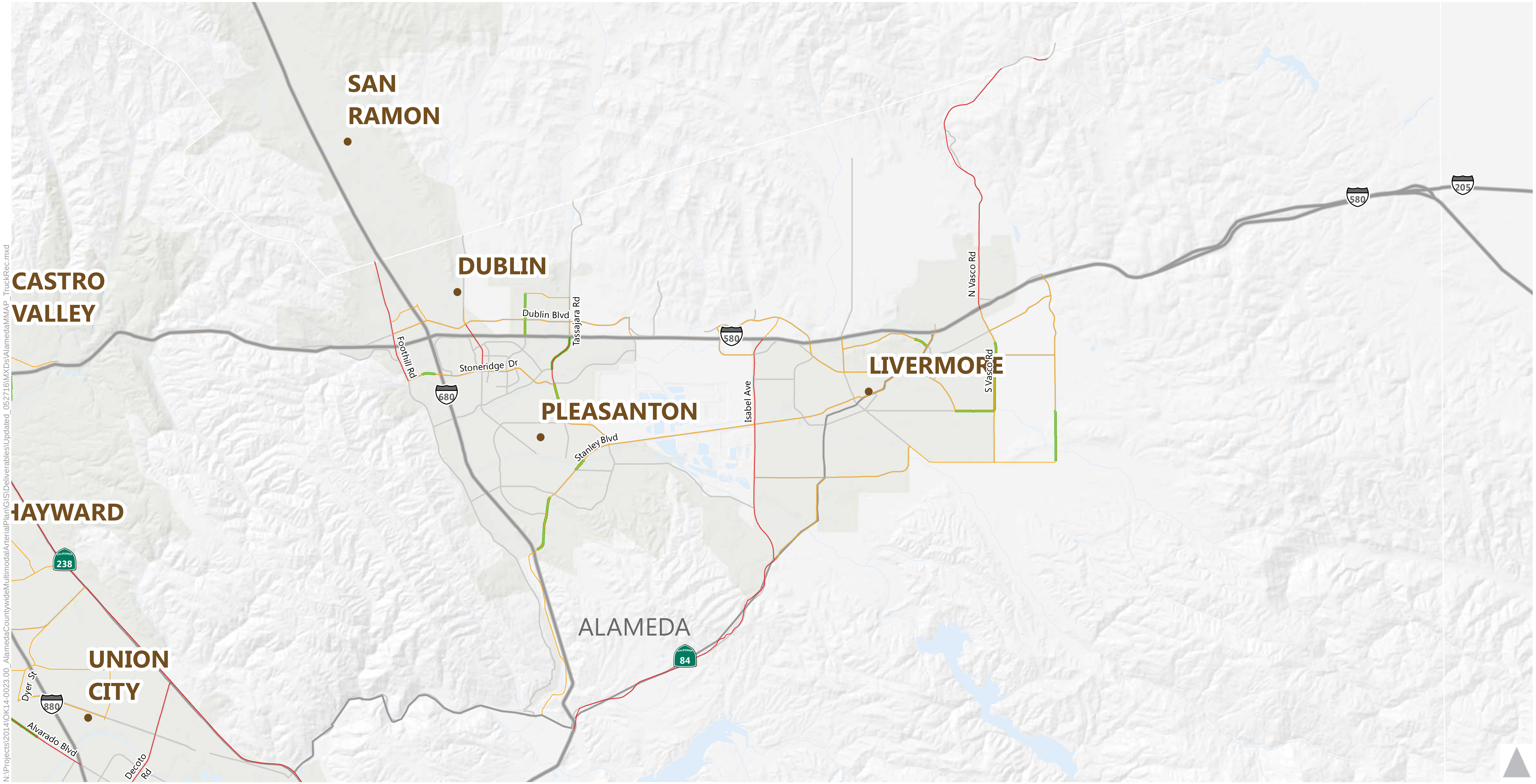
Tier 2 Good Movement Route
Proposed Curb Lane Widening
Tier 3 Good Movement Route

Alameda Countywide Multimodal Arterial Plan

Figure 5D

ALAMEDA County Transportation Commission

Goods Movement Network Proposed Improvements - South County



Legend

- Tier 2 Good Movement Route
- Proposed Curb Lane Widening
- Tier 3 Good Movement Route

Alameda Countywide Multimodal Arterial Plan

Figure 5E

ALAMEDA County Transportation Commission

Goods Movement Network Proposed Improvements - East County

Appendix 3.5.1
ITS Memo

TECHNICAL MEMORANDUM

To:	Francisco Martin	**From:**	Richard Shinn
	Fehr & Peers		David Huynh
			Iteris, Inc.
			2150 Shattuck Ave., Ste. 601
			Berkeley, CA 94704
Date:	May 20, 2016		
RE:	Alameda County Multimodal Arterial Plan – Traffic Management Coordination Strategies, Policies & Best Practices Technical Memorandum		

1 | Introduction

Project Overview

Alameda CTC is developing a Countywide Multimodal Arterial Plan that will provide a framework for identifying, prioritizing, and implementing proposed improvements that will address needs of all modes on the County's arterial roadways. As a basis to identifying these improvements, the Multimodal Arterial Plan evaluates the existing performance of Alameda County's arterial roadways to gain a better understanding of how these roadways currently serve multimodal users throughout the County. Based on this understanding, the Multimodal Arterial Plan can assess multimodal needs of users across the county, which will ultimately feed into identifying the appropriate improvements to address multimodal needs on the arterial roadways countywide.

Technical Memorandum Overview

The purpose of this memo is to review and document the existing ITS conditions and to outline ITS strategies, policies, and best practices to achieve Alameda CTC's goals for improved mobility, travel reliability, and modal connectivity on the arterial network as well as agency needs. The focus of this document are the automobile and transit modes only. With respect to other modes, some auto and transit focused ITS strategies may also benefit bicyclists and pedestrians. ITS strategies such as bicycle detectors and pedestrian count-down signals are aimed at those modes however they are not included in this document's recommendations. This document will present ITS improvement recommendations for the 510-mile Arterial Network which represent arterials of Countywide significance and serve as the backbone of multimodal mobility throughout the county. ITS recommendations will only focus on arterial network segments that were identified in the Arterial Plan's needs assessment as having an improvement need for automobiles and/or transit priority corridors. Finally, Next Generation vehicle technologies and their impact on the ITS infrastructure will be addressed at a high level in addition to the other recommended strategies and technologies. This document will discuss potential changes in technology and infrastructure that would need to be considered for implementation within the public right-of-way to accommodate and support Next Generation vehicles.

2 | Existing Conditions Summary

In November 2014, the project team and Alameda CTC finalized the vision and goals that will serve as a guide for prioritizing investments and designing projects and programs, including ITS, to address important transportation issues in the county and region. The coordinated technology measure assesses the level of ITS infrastructure along the Study Network. The measure is based on a zero to three point scale based on the level of ITS investment defined by the built infrastructure. Existing levels of ITS infrastructure are identified based on the following general categories:

- **Level 0** - No ITS infrastructure in place. Generally, traffic signals along a corridor are not interconnected and there's no communications back to a central location (e.g., transportation management center, or TMC) to remotely monitor or manage traffic signals.
- **Level 1 -** Low level of ITS infrastructure that generally corresponds to the ability to remotely monitor and manage field devices from a central location (e.g., TMC). Traffic signals along a corridor are interconnected and allow communication back to a TMC where there is a central system to actively manage field devices.
- **Level 2 -** Medium level of ITS infrastructure that corresponds to everything described above plus the additional ability to visually monitor and/or react to traffic conditions in real time from a central location. This includes having devices such as closed-circuit television (CCTV) cameras, adaptive signal timing controls, and/or transit signal priority controls.
- **Level 3** - High level of ITS infrastructure that corresponds to everything described above plus the additional ability to actively inform and influence traffic flow in real-time from a central location. This includes devices such as changeable message signs or any connected vehicle (vehicle to infrastructure) capabilities.

Existing conditions data was collected for 1,200 miles of major arterials called "Study Network" for the MAP. The Arterial Network of 510 miles mentioned above is a core and subset of this Study Network. Coordinated technology was summarized for about 75 percent, or 386 miles, of the Arterial Network as ITS infrastructure data was not readily available for the remaining 25 percent. Of the Arterial Network segments with data coverage, the majority of segments provide low or no ITS infrastructure. The inventory of ITS infrastructure levels is based on data provided by jurisdictions in addition to a review of the projects included in the 2011 Bay Area ITS Architecture, soon to be completed 2016 Bay Area ITS Architecture as well as the consultant team's knowledge of the countywide ITS infrastructure network.

Of the Arterial Network segments with available data:

- 10% of segments provide High level of ITS infrastructure,
- 29% of segments provide Medium level of ITS infrastructure,
- 46% of segments provide Low level of ITS infrastructure, and
- 15% of segments do not provide any ITS infrastructure.

Major ITS Programs and Infrastructure

The following summarizes major ITS program investments currently or soon to be in operation within Alameda County.

- **I-80 Integrated Corridor Management (ICM) Program:** This project is slated to be operational in Summer 2016. Within Alameda County, this project covers the cities of Albany, Berkeley, Emeryville, and Oakland. The arterial and transit portions of the program is along San Pablo

Avenue and the major arterials that connect I-80 and San Pablo Avenue with a focus on improving operation through the use of ITS enhancements. ITS elements implemented along arterials within the program include CCTV cameras for roadway monitoring, signal controller upgrades and communications to traffic signals for traffic responsive signal operations, trailblazer signs for incident management, and transit signal priority for enhanced transit performance.

- **San Pablo Avenue Smart Corridor:** Part of the East Bay Smart Corridors program. This program has been in place since the early 2000's and focused on the implementation of ITS elements along the San Pablo Avenue corridor within Alameda County limits. ITS elements deployed as part of the program included CCTV cameras for roadway monitoring, equipment for emergency vehicle preemption (EVP) and transit signal priority (TSP) operations, and signal coordination. Communications was primarily provided through leased-lines from telecom companies. To a large extent, the ITS enhancements provided under this program are being folded into the I-80 ICM project.
- **International Boulevard/Telegraph Avenue/East 14th Street (INTEL) Smart Corridor:** Part of the East Bay Smart Corridors program and similar to the San Pablo Avenue Smart Corridor, this program has also been in place since the early 2000's. ITS elements deployed as part of the program included CCTV cameras for roadway monitoring, equipment for emergency vehicle preemption (EVP) and transit signal priority (TSP) operations, and signal coordination. Communications was primarily provided through leased-lines from telecom companies.
- **I-880 ICM Program**: This program runs the length of Interstate 880 in Alameda County and seeks to manage traffic that naturally diverts from the freeway due to major incidents on I-880. The arterial incident management portion of the project proposes to initially install ITS equipment on arterial streets along the I-880 Corridor in the cities of Oakland and San Leandro. As of this writing the initial segment will be implemented by 2017. In the long term, the corridor is slated to expand to extend into Santa Clara County and include the length of the interstate. Project components include trailblazer signs, cameras, detection stations, signal coordination and communications improvements.
- **Interstate 580/680 Tri-Valley Smart Corridor Program:** This program has been in place since the early 2000's and focused on the implementation of ITS elements within the Tri-Valley cities of Dublin, Pleasanton, and Livermore. ITS elements deployed as part of the program included new central signal systems in each city, fiber optic communications, and CCTV cameras for roadway monitoring. A key element of the ITS enhancement included center-to-center communications where the fiber optic network interconnects each city's Traffic Management Center allowing for the sharing of video and data between each city.
- **I-580 ICM Program**: Currently in the initial planning stages, this program covers I-580 from I-238 in Castro Valley to the Alameda County-San Joaquin County line. Similar to the I-880 ICM, this program seeks to manage traffic that naturally diverts from the freeway due to major incidents on I-580 in the cities of Pleasanton, Dublin, Livermore and unincorporated Alameda County.
- **Webster Street Smart Corridor**: The project is located along the Webster Street corridor at six intersections between Central Avenue and the Alameda ingress and egress of the Webster/Posey tubes (State Route 260); as well as Constitution Way in the City of Alameda. It also includes signal timing work at the intersection of Harrison and 7th Streets in Oakland. The project will implement an Intelligent Transportation System (ITS) to improve safety and operations of transit and vehicular modes; enhancing mobility and safety in this vital corridor which connects the City of Alameda to I-880 and the City of Oakland. The project includes implementation of an Emergency Vehicle Preemption (EVP) system to improve emergency response time for fire departments, implementation of a Transit Signal Priority

(TSP) system to promote transit use and implementation of an Advanced Traveler Information System (ATIS) to inform public of street, freeway and tunnel conditions in real-time.

- **East Bay Bus Rapid Transit:** The limits of this project spans between downtown Oakland and the San Leandro BART station, within the cities of Oakland and San Leandro and expected to be operational in 2017. ITS elements deployed as part of this project primarily consist of transit signal priority along the project corridor consisting of: Broadway, 11th/12th Streets, E. 12th Street, International Boulevard, East 14th Street, Davis Street, and San Leandro Boulevard.
- **Next Generation Arterial Operations Program**: MTC's NextGen AOP was initiated in 2014 as a pilot program to assist local agencies in implementing advanced technologies to better manage and operate their arterials. The NextGen AOP explores and implements the benefits of advanced technologies that can improve travel time and travel time reliability for autos and transit vehicles along arterials, as well as improve the safety of motorists, transit riders, pedestrians, and bicyclists. These technologies may include adaptive signal control systems, transit signal priority, real-time traffic monitoring, and other innovative operational strategies. Three of the four selected pilot deployments are located in Alameda and include:

  - **City of Fremont:** Implementation of an adaptive signal control system and real-time traffic monitoring for 9 intersections along a 2.2 mile section of Fremont Boulevard.
  - **AC Transit Line 97:** Implementation of an adaptive signal control system for 34 intersections along the Hesperian Blvd. portion of the corridor between the cities of San Leandro and Hayward and implementation of transit signal priority for 61 intersections along the entire project corridor between the cities of San Leandro and Union City.
  - **LAVTA/City of Dublin:** Implementation of an adaptive signal control system for 16 intersections along the 2.9 miles stretch of Dublin Blvd. The new adaptive signal control will work with the existing transit signal priority system to improve corridor operations and performance.

Local ITS Infrastructure

In general, agencies within Alameda County with the highest level of ITS infrastructure are located in the central, east, and south portions of the county. **Table 1** provides a high level summary of the ITS infrastructure utilized by local agencies in the County. These agencies generally have a dedicated communications infrastructure to support ITS-related operations such as a centralized monitoring and control of the local roadways. This baseline of ITS infrastructure, especially a communications network, enables for easier expansion of other ITS-related improvements since the supporting infrastructure needed is already in place. These agencies have a history of strong local support and funding of ITS related improvements.

Agencies in the north portion of the county tend to have a lower level of ITS infrastructure. What ITS infrastructure that does exist is generally isolated to ITS elements installed as part of larger regional initiatives such as the San Pablo Smart Corridor or I-80 ICM programs. As such, ITS infrastructure in these agencies are typically limited to the roadway corridors encompassed by these regional programs. For example, in the cities of Albany, Berkeley, and Emeryville, the existing ITS infrastructure is focused on San Pablo Avenue and the east-west roadways (Buchanan St., Gilman St., University Ave., Ashby Ave. and Powell St.) connecting I-80 and San Pablo Avenue that are part of the I-80 ICM.

Table 1 - Existing ITS Infrastructure

JURISDICTION	Central Signal System (Tier – 1)	High Bandwidth Communications (Tier 2)	Visual Monitoring (Tier – 2)	Route Guidance (Tier – 3)	Transit Priority (Tier – 2)	Adaptive Signal Operations (Tier – 2)
Alameda						
Albany			X	X	X	
Berkeley			X	X	X	
Emeryville			X	X	X	
Oakland		X		X	X	
Piedmont						
San Leandro	X	X	X		X (2)	X (1)
Hayward	X	X	X		X (2)	X
Dublin	X	X	X		X	X (1)
Pleasanton	X	X	X			
Livermore	X	X	X			
Union City	X				X (2)	
Fremont	X	X	X			X (1)
Newark						
Alameda County					X (2)	X (1)
Caltrans			X	X	X	

(1) Adaptive signal operations will be implemented in San Leandro, Alameda County, Dublin, and Fremont as part of MTC's Next Generation Arterial Operations Program.

(2) Transit signal priority will be implemented in San Leandro, Hayward, Union City, and Alameda County as part as part of AC Transit's Line 97 project funded through MTC's Transit Performance Initiative and Next Generation Arterial Operations Program.

3 | Arterial Network Needs

The vision, goals and supportive principles discussed in Section 1 of this document were used to create performance objectives/needs which will be used to develop strategies for satisfying those needs. The focus of this section is to identify the needs of different modes estimated through the Needs Assessment step that can be at least partially satisfied through the deployment of Intelligent Transportation System (ITS) strategies.

The *Alameda Countywide Multimodal Arterial Plan – Final Needs Assessment* technical memorandum prepared by Fehr & Peers dated February 22, 2016 presented performance measures/objectives and needs for several modes of transportation transit, pedestrian, bicycle, automobile and goods movement. Given that the focus of this document is automobile and transit modes only, Iteris identified which needs for those two modes could be at least partially satisfied by ITS strategies. With respect to other modes, some auto and transit focused ITS strategies may also benefit freight, bicyclists and pedestrians. ITS strategies such as bicycle detectors and pedestrian count-down signals are aimed at those modes specifically however they are not included in this document's recommendations.

Similarly, strategies aimed specifically at Commercial Vehicle Operations are also not included in this document's recommendations.

Transit

The *Alameda Countywide Multimodal Arterial Plan – Final Needs Assessment* (Fehr & Peers, February 22, 2016) memorandum identified four performance objectives related to transit. One performance measure for each of the following areas were developed – Transit Travel Speed, Transit Reliability, Transit Infrastructure Index and Pedestrian Comfort Index. These performance objectives/needs are summarized as follows:

- **Transit Travel Speed**: Achieve a PM peak hour transit speed greater than 75 percent of the automobile congested speed.
- **Transit Reliability**: Achieve a PM peak hour to non-peak hour transit speed ratio greater than 0.7.
- **Transit Infrastructure Index**: Achieve a High rating for network segments along major transit corridors or a minimum of Medium rating for segments along crosstown routes.
- **Pedestrian Comfort Index**: Achieve a Medium, High or Excellent rating along network segments with high priority transit to ensure adequate pedestrian access to and from bus stops.

Of the four needs listed above, ITS strategies are capable of at least partially satisfying the Transit Travel Speed and Transit Reliability categories. According to the Needs Assessment memorandum, 92 percent of high priority transit study network segments do not meet the Transit Travel Speed objective today. That same number goes down to 86 percent under Year 2040 Standard Forecasting Scenario conditions. Other existing conditions findings related to Transit Travel Speed include:

- The North County Planning Area, which has the majority of high priority transit corridors in the county, was observed to have the lowest PM peak hour transit speeds within the county as 50 percent of segments operate in the range of five to 10 MPH.
- The East County Planning Area was observed to have the highest PM peak hour transit speeds as transit operates in the 20 – 30 MPH speed range along 40 percent of transit serving segments.
- Transit operates in the 10 – 20 MPH PM peak hour speed range along 79 percent of transit serving segments in the Central County Planning Area and along 100 percent of segments in the South County Planning Area.

In the area of Transit Reliability, 45 percent of high priority transit study network segments do not meet the Transit Reliability objective today. These numbers increase to 63 percent under Year 2040 Standard Forecasting Scenario conditions. Overall the North and Central County Planning Areas have the greatest need for transit improvements. In 2015 AC Transit identified, as part of their *Major Corridors Study*, major corridors that are slated to receive significant improvements by 2040, most of which are listed in **Attachment A**. Most of the major corridors are in the North and Central County Planning Areas.

Automobile

The *Alameda Countywide Multimodal Arterial Plan – Final Needs Assessment* (Fehr & Peers, February 22, 2016) memorandum identified two performance objectives/needs in which both can be at least partially addressed through ITS strategies. These are summarized below:

- **Automobile Congested Speed**: Achieve a speed greater than 40% of the posted speed limit.
- **Automobile Reliability**: Achieve a vehicle-to-capacity ratio less than 0.8.

According to the same Needs Assessment memorandum, only eight percent of the roadway network segments do not operate at greater than 40 percent of the posted speed limit. This number doubles to 16 percent under Year 2040 Standard Forecasting Scenario conditions in which 2040 traffic volume estimates were taken into consideration along with the implementation of planned and funded roadway improvement projects. Other existing conditions findings related to Automobile Congested Speed include:

- The North County Planning Area was observed to have the lowest PM peak period automobile speeds within the county as 29 percent of segments operate at less than 20 MPH, compared to 12 percent or less in other Planning Areas.
- The East County Planning Area was observed to have the highest PM peak period automobile speeds as 14 percent of segments operate at greater than 40 MPH, compared to less than one percent in other Planning Areas.
- About 70 percent of segments in the Central and South County Planning areas operate at speeds between 20 – 30 MPH during the PM peak period.

Concerning Automotive Reliability, currently, 44 percent of the roadway network segments with high automobile priority do not meet the Automotive Reliability performance objective. This number is about 45 percent under Year 2040 Standard Forecasting Scenario conditions. The Needs Assessment evaluation indicates the Central County Planning Area has the greatest need for automobile improvements compared to the other three planning areas.

The Needs Assessment memorandum highlights the high priority roadway segments in the County that are located on the Study Network that do not meet the automobile performance objectives according to Fehr & Peers Year 2040 Standard Forecasting Scenario analysis. As shown in Attachment B, this memo has identified the 55 roadway network segments that warrant ITS consideration were chosen as the segments that do not meet the performance objectives. Factors taken into account in narrowing the list of roadway segments include: PM Peak Hour Vehicle Volumes in excess of 1,500, proximity to transit (i.e. BART), use as a commuter route, and use as a freeway reliever route. Residential arterials were avoided for the most part due to their relatively low traffic volumes, and instead focused on commercial areas of the county. These criteria were chosen based on professional judgement in order to focus on improvements to segments that are used the most. In order to focus on heavily used arterials, a minimum level of 1,500 vehicles during the PM peak hour was established as representative of high traffic volumes. Proximity to transit routes, either BART or bus, was selected to ease the transit between modes and because measures benefitting transit benefits more people.

4 | Auto and Transit ITS Recommendations

Using the transit corridors and automobile roadway segments identified as not meeting the performance objectives in Section 3, an assessment was developed for each corridor/segment's ITS infrastructure for three time frames – existing, 2020 and 2040. Below is a summary of each time frame:

- **Existing**: Assessment of the segment's ITS level today.
- **2020**: Assessment of the segment's ITS level in the year 2020, assuming all projects in construction or in the planning stages are completed.

- **2040**: Assessment of the segment's ITS level in the year 2040, assuming all ITS recommendations in this document are implemented in addition to the improvements included in 2020.

Table 2 provides a brief definition of each ITS level. **Figure 1 through Figure 5** summarize proposed ITS improvements, in addition to displaying the baseline ITS infrastructure (e.g. ITS infrastructure that exists today or is planned and funded for implementation in the near future). Detailed recommendations for each corridor and roadway segment are provided in **Attachment A** and **B** of this technical memorandum.

Quantifying the percent increase in speed directly resulting from implementation of ITS strategies is not easily accomplished. It is not possible to assign or determine a percent increase in vehicle speed resulting from certain ITS infrastructure improvements for a transit corridor or roadway segment. Many ITS strategies are put in place to enable the implementation of other strategies that can actually improve overall vehicle speed. For example, constructing a communications network that allows for the control of traffic signals from a central location will enable the deployment of time-of-day traffic signal synchronization or adaptive traffic control along a corridor which will directly improve average vehicle speed; as such, the implementation of a communications network by itself does not result in any operational improvements Other ITS strategies are designed to provide increased monitoring capabilities so transportation operators can deploy measures aimed at eliminating or reducing traffic congestion resulting from accidents and incidents. An example of this is the deployment of CCTV cameras or additional vehicle detection sensors. While the deployment of a CCTV camera or vehicle sensor alone will have no direct impact on improving average vehicle speed, the information provided to transportation operators would result in improved incident response and clearance times which would then result in improved average vehicle speed.

ITS strategies that are well documented as directly improving average vehicle speed are Transit Signal Priority (TSP), traffic signal synchronization, and adaptive traffic signal control. The specific percent improvement for each of these ITS strategies varies considerably from corridor to corridor and largely depends on the existing conditions for that specific corridor. For example, roadway segments that either have no traffic signal synchronization or signal timing plans that have not been updated regularly (every 3 to 5 years) will experience a higher percentage increase in vehicle speed compared to those corridors where signal timing is revised regularly. It is estimated that the following range of vehicle speed increases are possible for the following ITS strategies and are based on the industry's long history of successfully planning, designing, deploying and evaluating these types of projects.

- Transit Signal Priority (TSP) – 10% to 15%
- Time-of-Day Traffic Signal Synchronization: 5% to 20%
- Adaptive Traffic Signal Control: 5% to 30%

Attachments A and **B** provide draft proposed ITS improvements along each transit corridor and roadway segment as well as assessed infrastructure levels for the years 2020 and 2040. The levels assigned to each segment for the existing, Year 2020, and Year 2040 are based on the information gathered throughout this project by the consulting team, ACTC and other stakeholders as well as professional judgement. Using the four levels described below, each segment listed in **Attachments A** and **B** was categorized according to what is in place in the field today, what is in the current project pipeline (Year 2020), and what is recommended to be deployed in addition to what is in the project pipeline (Year 2040).

Table 2 – ITS Level Summary

LEVEL	ITS STRATEGIES
0	No ITS infrastructure in place. There is no ability to remotely monitor or manage traffic signals.
1	Field-to-Center communications are in place. Ability to remotely monitor and manage traffic signals exists.
2	Level 1 plus CCTV cameras, Time-of-Day signal timing, adaptive signal control, Transit Signal Priority (TSP)
3	Level 2 plus Changeable Message Signs (CMS), Trailblazer Signs (TBS), Connected and Autonomous Vehicle (CAV) technologies.

5 | Institutional Coordination for Implementation

The intent of this section is to provide a framework that Alameda CTC and local agencies can use in developing a regional/multi-jurisdictional ITS operations program focused on local arterials. Generally, the goals of such a program are to:

- Improve multi-jurisdictional traffic signal coordination, including the use of signal timings that provide superior response to or adapt to traffic conditions;
- Improve ability to respond to traffic incidents;
- Improve ability to manage traffic flows associated with incidents and congestion on area roadways;
- Better integrated transportation system that considers multiple travel modes; and
- Provide improved and more reliable real-time traveler information.

Existing Multi-Jurisdictional ITS Project/Program Agreements

There are currently a number of existing and in-progress ITS projects and programs that involve multiple stakeholders that include MTC, Caltrans, AC Transit, Alameda CTC, and various local municipalities within Alameda County. For each project/program, an overview of the institutional arrangements are provided below with a focus on the issues of ownership of project improvements, on-going maintenance, and operational control. This presents an overall picture of how various Bay Area agencies within Alameda County are currently working together on large corridor ITS-related projects and programs that span multiple jurisdictions.

PROJECT/PROGRAM	I-80 INTEGRATED CORRIDOR MANAGEMENT (ICM)
Agreement	Memorandum of Understanding (MOU)
Parties to Agreement	Caltrans, Alameda CTC, AC Transit, Cities of Oakland, Emeryville, Albany, and Berkeley (*and other agencies outside Alameda County*)
General Framework	Defines overall project; project governance; operational principles; equipment ownership and maintenance; and roles and responsibilities of each party.
Ownership	All equipment within each agency's right-of-way are owned by that agency. For example, all equipment within the boundaries of Oakland are owned by Oakland.
Maintenance	All equipment within each agency's right-of-way are maintained by that agency. Exceptions include traffic signals along San Pablo Avenue (SR 123) in Oakland and Berkeley where Caltrans has delegated operations and maintenance responsibilities of those signal to each respective city. For cities within Alameda County, Alameda CTC provides funding for maintenance of ICM equipment.
Operations	Caltrans is primarily responsible for operation during an incident condition in accordance with an Incident Response Plan. During non-incident conditions, each agency is responsible for operations of equipment within their right-of-way.

PROJECT/PROGRAM	I-880 INTEGRATED CORRIDOR MANAGEMENT (ICM)
Agreement	Memorandum of Understanding (MOU)
Parties to Agreement	MTC, Caltrans, City of Oakland, and City of San Leandro
General Framework	Defines overall project; project governance; operational principles; equipment ownership and maintenance; and roles and responsibilities of each party.
Ownership	All equipment within each agency's right-of-way are owned by that agency. For example, all equipment within the boundaries of San Leandro are owned by San Leandro.
Maintenance	All equipment within each agency's right-of-way are maintained by that agency, with the exception of the trailblazer signs. The trailblazer signs will be maintained by MTC.
Operations	Caltrans is responsible for operation during an incident condition in accordance with an Incident Response Plan. During non-incident conditions, each agency is responsible for operations of equipment within their right-of-way with the exception of trailblazer signs.
PROJECT/PROGRAM	EAST BAY SMART CORRIDOR (SAN PABLO AVENUE)
Agreement	Memorandum of Understanding (MOU) Operations and Maintenance (O&M) Agreement
Parties to Agreement	Caltrans, Alameda CTC, Cities of Oakland, Emeryville, Albany, and Berkeley (*and other agencies outside Alameda County*)
General Framework	Defines project governance; operational principles; equipment ownership and maintenance; and roles and responsibilities of each party.
Ownership	All equipment within each agency's right-of-way are owned by that agency. For example, all equipment within the boundaries of Berkeley are owned by Berkeley.
Maintenance	All equipment within each agency's right-of-way are maintained by that agency. Exceptions include traffic signals along San Pablo Avenue (SR 123) in Oakland and Berkeley where Caltrans has delegated operations and maintenance responsibilities of those signal to each respective city. Alameda CTC provides funding for maintenance of ATMS field equipment.
Operations	Caltrans is responsible for operation during an incident condition.
PROJECT/PROGRAM	AC TRANSIT LINE 97 TRANSIT PERFORMANCE INITIATIVE (TPI)
Agreement	Memorandum of Understanding (MOU) Cooperative Agreement (*Currently Under Development*)
Parties to Agreement	MTC, Caltrans, AC Transit, Alameda County, Cities of Hayward, San Leandro, & Union City
General Framework	Defines overall project; project governance; equipment ownership and maintenance; and roles and responsibilities of each party.
Ownership	All equipment within each agency's right-of-way are owned by that agency. For example, all equipment within the boundaries of San Leandro are owned by San Leandro. Adaptive central system equipment will be jointly owned by Hayward, San Leandro, and Alameda County. (*Tentative*)
Maintenance	All equipment within each agency's right-of-way are maintained by that agency. The adaptive central system equipment will be maintained by Hayward and San Leandro. (*Tentative*)
Operations	Adaptive signal control operational parameters will be jointly determined by Hayward, San Leandro, and Alameda County. (*Tentative*)
PROJECT/PROGRAM	SILICON VALLEY INTELLIGENT TRANSPORTATION SYSTEM (SV-ITS)
Agreement	Memorandum of Understanding (MOU)
Parties to Agreement	MTC, Caltrans, City of Fremont (*and other agencies outside Alameda County*)
General Framework	Defines overall project; project governance; operational principles; and roles and responsibilities of each party.
Ownership	All equipment within each agency's right-of-way are owned by that agency. For example, all equipment within the boundaries of Fremont are owned by Fremont.
Maintenance	All equipment within each agency's right-of-way are maintained by that agency.
Operations	Each agency is responsible for operations of equipment within their right-of-way.

Based on these current ITS projects/programs in Alameda County, the current trend thus far points towards a more distributed form of coordination where overall decision making and authority rests with the individual agencies, with some minor exceptions. These trends for ownership, maintenance, and operations can generally be summarized as follows:

- **Ownership**: The trend for ownership generally follows that any equipment and/or improvements deployed by a particular project/program that are located within a particular agency's right-of-way are owned by that agency. There does not appear to be any situations to date, where any physical improvements deployed within one agency is owned by another.
- **Maintenance**: The trend for maintenance is similar to that for ownership. Generally, maintenance responsibilities for any equipment and/or improvements deployed within a particular agency are maintained by that agency. There are some exceptions where the maintenance is performed by another agency or the cost of maintenance is reimbursed by another agency. These exceptions are typically exhibited with local cities and usually only for some elements of the overall improvements such as message signs or CCTV cameras.
- **Operation**: The trend for operation appears to be the most fluid with a shift towards a more centralized format. With the more recent programs (I-80 and I-880 ICMs), there are provisions for one agency (Caltrans) to operate equipment, such as message signs and CCTV cameras, that are located in another agency (local cities). However, the inter-jurisdictional operations of traffic signals continues to be more restrictive. It is not typical for one agency to have day-to-day operational control of the traffic signals in another agency. But this is shifting as well with the two ICM programs where these will be the first instances where one agency (Caltrans) will be allowed to change the operation of traffic signals owned by local cities that are part of the ICM program. It should be noted that the changes are limited, well pre-defined, and pre-approved by the local cities and implemented only during an incident situation.

Interjurisdictional Coordination

The collaboration between Caltrans, MTC, Alameda CTC, local agency transportation departments, transit agencies, and other stakeholders is key to addressing regional mobility issues on arterials that span multiple jurisdictions. Based on our research, the MOU's described in the previous section are the only formal or informal coordination arrangements between agencies in the County in the areas of ITS and traffic signal operations. Iteris recommends the project stakeholders seek to partner with their neighbors on a formal or informal basis whenever possible. By working together, partner agencies can achieve significant benefits by addressing arterial operational issues from a system level perspective.

For any interjurisdictional effort to be successful, there needs to be a lead agency to serve as the project/program champion. There are a number of different organizational concepts that can be utilized ranging from where the lead agency is responsible for only providing the funding to partner entities to develop-operate-maintain the program (most distributed decision-making and authority) to where partner entities consolidate development-operation-maintenance of the program under the direction of the lead agency (most centralized decision-making and authority). The development of the organizational structure will need to address the needs listed below. These needs can and should be addressed in whatever order makes the most sense to each agency.

- Establishment of a formal reporting structure;
- Roles and responsibilities of participating agencies;
- Authority of any regional entity;
- Develop cost sharing arrangements;
- Develop structure for day to day operations; and

- Develop performance measures for continued assessment of the project/program.

The exact nature of the organizational structure will largely be dependent on the outcomes to the following questions:

- Who is responsible for purchasing and deploying any necessary communications and field equipment?
- Who has ownership of which pieces of equipment (and/or software licenses) deployed?
- Who is responsible for testing and inspecting any field equipment deployed?
- Who will develop the timing/operational plans?
- Who will implement the timing/operational plans?
- Who will perform project evaluation?
- Who is responsible for O&M of the field equipment and/or the timing plans?
- Who will be notified if timing plans need to be changed, are there restrictions on when timing plans can be changed, and what form of consensus is needed to implement the change?

The outcomes to these questions can typically be addressed through the development of a Concept of Operations report for the project/program. The Concept of Operations is a valuable tool that describes the operation of the system being developed from the various stakeholder viewpoints. It documents the user's requirements for ultimate system operations. It helps to identify what type of agreement will be more appropriate for implementation of and effective operation of a project or program considering the environment it will operate and the stakeholders involved.

- **Memorandum of Understanding (MOU)** – An MOU is generally established at the onset of the project/program to define the organizational structure and outline the basic principles and guidelines for how different partner agencies will work together. The MOU should describe the purpose and intent of the project/program and the relationships between partner agencies, as well as the administrative governance of the project/program. The MOU can be used to establish a Technical Advisory Committee (TAC) to address technical and day-to-day operational issues and a Policy Advisory Committee (PAC) to address program level issues and resolve issues that cannot be addressed at the TAC level. The MOU is generally a non-binding agreement.
- **Cooperative Agreement** – Cooperative agreements are similar in concept to the MOU but are typically legally binding contracts between partner agencies. The cooperative agreement can be used to further define each partner agency roles and responsibilities, obligate each partner agency to a financial commitment to the project/program, and define program/project product ownership.
- **Project Agreement** – A project agreement is typically used to initiate specific improvements within the framework of the larger overall program. Project agreements are typically needed in larger programs that may implement improvements over multiple phases and over various geographic areas. Typically, a project agreement is specific to particular project to be implemented with the larger program and may only be between a subset of all the partner agencies that are part of the program. Project agreements are typically legally binding.
- **Funding Agreement** – Funding agreements can be utilized to transfer funds between partner agencies and are typically a mechanism to facilitate cost sharing. This agreement may or may not be needed depending on the structure of any executed cooperative agreements or project agreements.
- **Operations and Maintenance (O&M) Agreement** – An O&M agreement is utilized to establish on-going operations and maintenance of the infrastructure and improvements

built and deployed by the project/program. An O&M agreement establishes the minimum level of maintenance, which agency(ies) will be responsible for on-going maintenance, cost-sharing of maintenance, the agency(ies) responsible for operating the improvements, and establish rules and protocol for operating the improvements and requesting changes in operation. This is typically a legally binding agreement.

- **Maintenance Agreement (Caltrans)** – This agreement is specific to address Caltrans facilities, such as a traffic signal along a state highway or at an interchange, that are located within a particular municipality. There may be situations where there is an identified need for a local municipality to take over operations and maintenance of a Caltrans signal. In this case, a Caltrans Maintenance Agreement would be needed for Caltrans to delegate authority of operations and maintenance to the local municipality. This is a legally binding agreement and typically also includes cost-sharing of the maintenance component.

Technical Integration Approach

With a strong foundation of cooperation between the project stakeholders in place, the high level technical approach to integrating the separate components and subsystems that comprise an ITS project is consists of the following:

- Following FHWA Systems Engineering guidelines in order to ensure what is deployed meets the original intent of the stakeholders. Additionally, ITS projects that include federal funding is required to follow FHWA's Systems Engineering guidelines. By doing so from the very beginning of a project or program (even if federal funds are not used initially) will increase the chances of receiving federal funds should the local agency and/or ACTC elect to apply at a later time.
- Selecting system components (hardware, software and firmware) that meets or exceeds the system requirements.
- Establishing robust and secure communications between the field devices and the owning agency's traffic management staff.
- Establishing robust and secure communications between all the stakeholder agencies that require access to the information and data provided to and/or from another agency's field devices.
- Properly configuring all network devices and field devices in accordance with the information sharing policies outlined in any applicable interjurisdictional agreements.
- Establishing acceptance testing plans and procedures at the unit, subsystem and system level, then meticulously executing those same plans and procedures.
- Properly documenting all system components in accordance with FHWA guidelines.
- Properly training all agency staff on the operation and maintenance of the system.

Maintenance Considerations

An Achilles heel of many ITS programs nationwide is maintaining the systems that are designed, constructed, and deployed using capital funds. There are two main factors behind this issue – staff training and funding. In the first few years after a project is deployed and accepted most system components are under an extended manufacturer's warranty that was included with the original purchase using capital funds. As a result, the maintenance needs are relatively small and the training received by agency staff is therefore not heavily utilized. In a lot of cases by the time system components begin to fail or require troubleshooting the staff's maintenance skills have either eroded through non-use or have disappeared through staff turnover. This situation results in the public realizing no benefit or less of a benefit from the capital investment made to deploy the system.

While there are a plethora of state and federal grant programs that provide capital funds to build a project, most local agencies are expected to pay for the ongoing maintenance themselves by using their own staff, who may or may not be adequately trained and frequently have many other responsibilities, or outsourcing the maintenance to a third party provider. Paying for the third party provider or in-house staff time is frequently done from the agency's general fund whose health is directly related to the amount of tax revenues collected in any given year.
The following general course of action is recommended regarding maintenance of ITS infrastructure:

- Include recurring Operations & Maintenance costs into the overall cost structure of any ITS project. There are industry standards for the useful life, replacement cost and annual maintenance cost for every ITS field device type. It is recommended that using those standards to calculate the annual maintenance and replacement cost for units that reach the end of their useful lives.
- Determine the maintenance responsibilities of each stakeholder agency so all parties have a clear understanding of their obligations in terms of labor and finances at the beginning of every project.
- Include Service Level Agreement provisions in all agency MOU's and cooperative agreements so all stakeholder agencies understand what is expected in terms of system uptime. These Service Level Agreements would be included in any contracts with third party maintenance providers.
- Determine the appropriate level of Operations & Maintenance funding to be provided by ACTC and the local agencies. It is envisioned that an arrangement where the local agencies monitor and maintain the material condition of the ITS infrastructure in their right-of-way and ACTC assists each agency to forecast annual operations and maintenance costs and determine the combination of local agency and ACTC funds that will finance it.

6 | Next Generation Transportation Technology

Transportation agencies, along with other public and private sector entities, must prepare for emerging technologies that will fundamentally change mobility. Looking ahead, cars, trucks, buses, the roadside, and personal mobile devices will all talk to each other. They will exchange information that will enable "connected vehicle" (CV) applications to be deployed to improve safety, mobility, the environment, and support agency efficiency. There are two main aspects of connected vehicle infrastructure, vehicle-to-vehicle (V2V) interactions and vehicle-to-infrastructure (V2I) interactions. V2V applications and advancement are being led by the automotive industry and moving ahead independent of public sector transportation agencies and will not be the focus of this memorandum. Instead, the focus will be on the V2I applications with particular emphasis on what the County needs to do to be prepared for the "I" in V2I.

V2I – Vehicle to Infrastructure

V2V – Vehicle to Vehicle

There are four main types of connected vehicle applications: Safety, Mobility, Environmental, and Support. Connected vehicle safety applications are designed to increase situational awareness and reduce or eliminate crashes. Connected vehicle mobility applications provide a connected, data-rich travel environment. These communications would support driver advisories, driver warnings, and vehicle and/or infrastructure controls, by capturing real-time data from equipment located on-board vehicles and within the transportation infrastructure. The data are transmitted wirelessly and used by transportation agencies in a wide range of dynamic, multi-modal applications to manage the transportation system for optimum performance. These applications would both generate and capture environmentally relevant real-time transportation data and use this data to support and facilitate green transportation choices, thus reducing the environmental impacts of each trip, and serving the final two types of CV applications.

There are close to 100 individual connected vehicle applications that are categorized into each of the four main types. For the Mobility and Environmental types, the applications are further organized into bundles. For example, the Mobility applications include six bundles: Enable Advanced Traveler Information Systems (Enable ATIS); Freight Advanced Traveler Information Systems (FRATIS); Integrated Dynamic Transit Operations (IDTO); Multimodal Intelligent Transportation System (MMITS); Response, Emergency Staging and Communications, Uniform Management, and Evacuation (RESCUME); and Intelligent Network Flow Optimization (INFLO). The Connected Vehicle Reference Implementation Architecture (CVRIA) sponsored and led by the United States Department of Transportation Intelligent Transportation Systems Joint Program Office (USDOT ITS JPO) provides a list and detailed description of each CV application. The CVRIA can be found at:
http://www.iteris.com/cvria/index.html

Transportation Agency CV Opportunities

As the steward of the nation's roadways, state and local DOT's as well as County MPO's such as Alameda CTC have a responsibility for ensuring the transportation infrastructure contributes to improving safety, mobility and air quality. Connected vehicle networks can positively impact all three areas.

According to the Insurance Institute for Highway Safety Highway Loss Data Institute (IIHS-HLDI), a total of 32,765 people died in motor vehicle crashes in 2014. The U.S. Department of

Transportation's most recent estimate of the annual economic cost of crashes was $242 billion dollars.[1] Vehicle-to-Vehicle and Vehicle-to-Infrastructure data transmissions supporting CV safety applications can provide drivers with information such as roadway hazards or inclement weather conditions. This additional information will improve driver situational awareness and eliminate some crashes. For the last 40 years the U.S. DOT has successfully focused on surviving crashes through requiring the use of seat belts and mandating air bags in all new vehicles. Soon government agencies can expand this into avoiding crashes altogether.

According to the Texas Transportation Institute's 2015 Urban Mobility Scorecard, travel delay due to traffic congestion caused drivers to waste more than three million gallons of fuel and kept travelers stuck in their cards for nearly seven billion extra hours – 42 hours per rush-hour commuter. This equates to a total cost of $160 billion, or $960 per commuter. V2I applications and anonymous information from passenger wireless devices have the potential to provide transportation agencies with significantly clearer picture of what is actually happening on the roadways. Obtaining actionable traffic, transit and parking data in real-time will allow public agencies to manage their infrastructure in the most efficient manner possible.

Automobiles, trucks and buses are major sources of greenhouse gas (GHG) emissions. Motor vehicles that idle or move in a stop-and-go manner as a result of traffic congestion are some of the worst mobile sources of GHG emissions. Connected Vehicle applications will generate and collect environmentally relevant real-time transportation data that can be used by transportation agency staff to manage the transportation network in a more environmentally sensitive manner.

Steps to V2I Deployment

The process by which CV infrastructure and applications will be planned and implemented by agencies is similar to that for any other transportation infrastructure and is generally an extension of existing ITS practices. The primary distinction is that the full effect of the CV infrastructure operation will grow and be realized over time as CV-equipped vehicles enter and multiply in the transportation environment. These vehicles will provide data to the system and, when equipped with CV applications, will be able to leverage information provided from the infrastructure. While the transportation agency has little control over the introduction of CV-equipped vehicles into the transportation environment (aside from supporting State-level regulations or legislation), the National Highway Traffic Safety Administration (NHTSA) is expected to issue regulations this year to require automobile manufacturers to equip new vehicles with basic CV equipment accommodating the Basic Safety Message (BSM) of speed and direction.

CV Needs Assessment

It is recommended that the first step in CV deployment is to identify the agency's needs and, where possible, match these needs to appropriate deployment opportunities. The CVRIA developed by US DOT ITS JPO identifies and provides descriptions of potential connected vehicle applications and NCHRP 03-101 Deployment Plan provides a tool for assessment of opportunities.

While many of the CV applications are intended to address very local operational problems, the benefits of the CV environment are much broader. It will be important to develop institutional awareness and support for local and regional deployments at an early stage as awareness and cooperation within and between agencies will be necessary to deploy infrastructure and applications

[1] IIHS-HLDI 2014 Yearly Snapshot, http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/overview-of-fatality-facts/2014.

that are useful to vehicles operating across jurisdictions. In this respect, local agencies consulting with both Alameda CTC and MTC is highly recommended as these organizations are either actively developing CV application deployment plans themselves or know of other local agencies who are doing the same.

Since the applications require connected vehicles to be present within the fleet, deployment assessment will need to address the prevalence of enabled vehicles within the population. While many vehicles are already capable of some level of connectivity, growth of DSRC and cellular connectivity within the target vehicle fleets will directly impact both the timing and effectiveness of infrastructure deployment.

Alameda CTC's CV Needs Assessment should rely upon the Multimodal Arterial Plan, the Goods Movement Plan and the Countywide Transit Plan as a basis for both identifying the transportation system needs and justifying the CV applications to satisfy those needs. The needs may be capital infrastructure, operations and maintenance, policy, or similar. Once the needs are identified, as assessment of the various CV application(s) can be performed that fulfill those needs. As an example, the CV application bundle that stands out to meet many of the needs, goals, and objectives of this multimodal arterial plan is the MMITS. MMITS is a next-generation traffic signal system that seeks to provide a comprehensive traffic information framework to service all modes of transportation that is focused at the arterial roadway level. The MMITS application bundle seeks to improve mobility along signalized corridors using advanced communications and data to facilitate the efficient travel of passenger vehicles, pedestrians, transit, and freight and include such applications as Intelligent Traffic Signal System (I-SIG), Freight Signal Priority (FSP), Mobile Accessible Pedestrian Signal System (PED-SIG), and Transit Signal Priority (TSP).

Application Evaluation

As part of pre-deployment planning, it will be appropriate to look at cost-benefit analyses of CV applications especially when comparing to traditional ITS solutions; however, many CV applications lack adequate cost-benefit information. To help with this, agencies should consider a local demonstration pilot CV project along one corridor. The pilot project would help identify the benefits and/or costs of future deployment projects as well as gaining insight into the technologies being implemented. The benefit estimates will be a large part of the overall acceptance of V2I into the City's current ITS system.

It should be noted that several state and local agencies are in the process of deploying connected vehicle technology pilot demonstrations in conjunction with the U.S. DOT, and the Research and Innovative Technology Administration's (RITA) Affiliated Test Bed initiative is coordinating information on these pilot demonstrations and testing opportunities. The cost-benefit analysis of these pilot deployments may be used by US DOT pilot participants to evaluate their own initial deployments.

Planning

This initial needs assessment and application evaluation should be followed by a planning stage which would culminate in the development of a Connected Vehicle Strategic Plan. This would provide the mechanism to understand the County's needs, goals and objectives; identify the specific CV applications to meet those needs, goals, and objectives; develop a deployment plan for each identified CV application; develop cost estimates for development, operations, and maintenance; identify needed stakeholders and partnerships; identify funding strategies; and identify performance based measurements so that benefit-costs can be determined to assess how each application meets the needs and achieves the goals and objectives. At this stage, a five to seven year plan is recommended.

Once an agency completes their CV Strategic Plan and begins to deploy we recommend following process outlined in FHWA's Systems Engineering Guidebook for ITS which can be found at https://www.fhwa.dot.gov/cadiv/segb/. Each project will have a Systems Engineering Management Plan (SEMP), Concept of Operations (CONOPS) and System Requirements documents developed to guide the detailed design and deployment. Unit, subsystem and system acceptance testing would also be conducted in accordance with FHWA's guidelines.

Included in the planning process is the development of a deployment plan. The deployment plan should integrate performance measurements to quantify the benefit-cost of each CV application deployment and establish prioritization of CV application roll out.

Deployment Considerations

Given that public agencies will almost exclusively concentrate on V2I deployments, there are key distinguishing characteristics to be considered in the project planning, design, and deployment phases:

- V2I equipment deployments may vary between project sites depending on the CV applications to be supported.
- Where DSRC radios are to be deployed, each DSRC radio will be licensed for the site and the frequency of the radio will vary depending on the conditions.
- Project deployments will depend on the availability of supporting systems such as security and credentials monitoring which may be provided by external service entities.
- CV projects will require sufficient (private) vehicle deployments to operate and measure the performance of the system. Equipped-vehicle penetration level requirements will depend on the CV applications needed and implemented.
- CV and V2I deployments will also depend on the eventual development of design and special provisions standards. These standards are currently being developed by FHWA and USDOT. They are still in the final approval process and expected to be released sometime in 2016.

Actions that local agencies can take to prepare for the widespread deployment of Connected Vehicles and eventually Autonomous Vehicles include providing digital infrastructure, considering systems for data capture and exploitation, preparing existing infrastructure, cyber security, operational leadership and partnerships.

Digital Infrastructure

Many of the benefits from Connected and Autonomous Vehicles (CAV's) rely, at least partially, on connectivity between the vehicle and the wider infrastructure. Wireless networks in urban areas will allow vehicles to communicate with traffic management systems in real-time, sharing information such as signal phasing, signal timing and live traffic conditions. This information will allow CAV's to optimize their speed and routing in order to reduce travel times and congestion.

Transportation agencies play an important role in delivering this connectivity by either putting in place the required telecommunications networks and/or making their traffic data and telecommunications networks available for integration with third parties in a secure manner.

Data Capture and Exploitation

CAV's are expected to generate an extremely large amount of detailed data on how, when and where people move about the County. The value of this data is quite high as many transportation agencies around the country are trying to tap data reserves from human driven vehicles. CAV's provide an additional opportunity to capture and exploit this data in order to improve transportation networks and better understand how people move about the County. Ensuring transportation agencies have access to the appropriate datasets and can make sense of it is key.

Infrastructure

Transportation agencies should consider how their infrastructure assets such as traffic signals, lamp posts, signs, roads and bridges are prepared to accommodate CAV's. Of primary concern is determining whether the current infrastructure can support the wireless connectivity required for CAV's. This is particularly important for traffic signals and related equipment (e.g., Emergency Vehicle Preemption systems, Transit Signal Priority systems). As infrastructure is replaced or renewed through maintenance and improvement, agencies should evaluate whether to deploy similar replacements or upgraded replacements that are capable of supporting CAV's. At a higher level, agencies should consider the impact of CAV's on new transportation schemes and modes. For example, increased use of CAV's may negate the need for building a new or expanding an existing road or parking facility.

Cyber Security

Acceptance and adoption of CAV's and related technologies is predicated on the safety and security of the vehicles. Data and information must be protected from external and internal attacks that will inevitably occur and the "Internet of Things" (IoT) is introduced to the County's transportation network. Simply put, transportation agencies must maintain a real-time understanding of the security of the network, and the threats, mitigations and weaknesses that exist 24/7. These costs should be factored into the overall operations and maintenance budgets as well. The days of closed traffic and ITS telecommunications networks are rapidly coming to an end. The same vigilance that is put towards an agencies Wide Area Network (WAN) is required for any ITS network.

Leadership

Transportation agencies should consider their role in leading CAV development from an operational perspective – challenging themselves to take the right technical and strategic view across their organization. New roles, such as chief digital officer or emerging technical divisions, which are becoming common in the private sector, must also be considered of relevance. Los Angeles has recognized this, appointing a transportation technology advisor position within the city's Department of Transportation, with a remit to consider the impact of new car and rideshare services, as well as planning for the arrival of CAV.

Partnerships

Transportation agencies should consider positioning themselves in order to maximize the potential for CAV technology at an early stage. One approach would be to partner with car manufacturers and other companies developing CAVs to provide opportunities for testing and development. Cities such as San Francisco and Las Vegas are becoming known for their relationship with CAV developers, giving them competitive advantages. Uber's decision to move 3,000 of their employees to downtown Oakland is one opportunity for Alameda County and the City of Oakland to establish a similar reputation.

Attachments

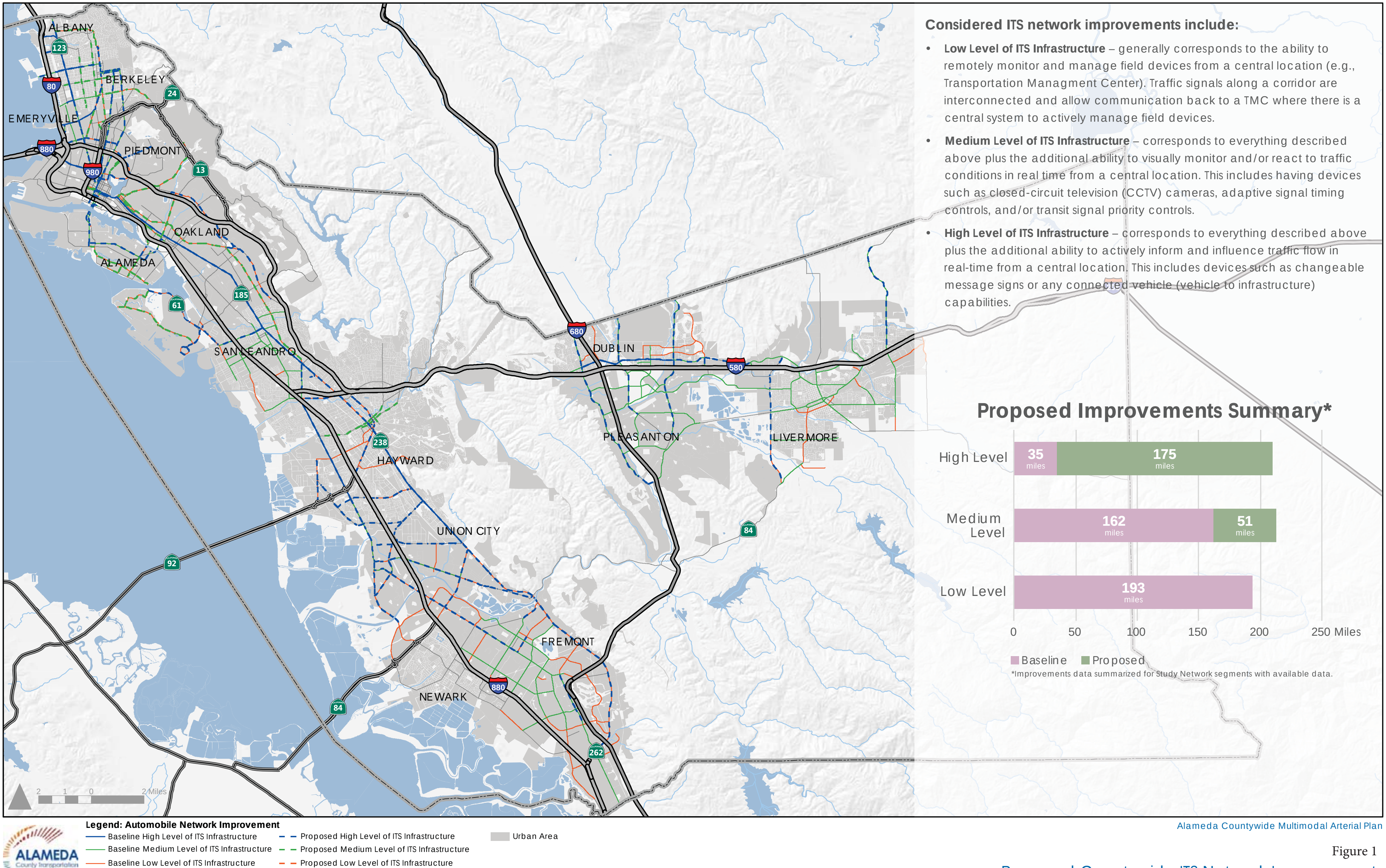
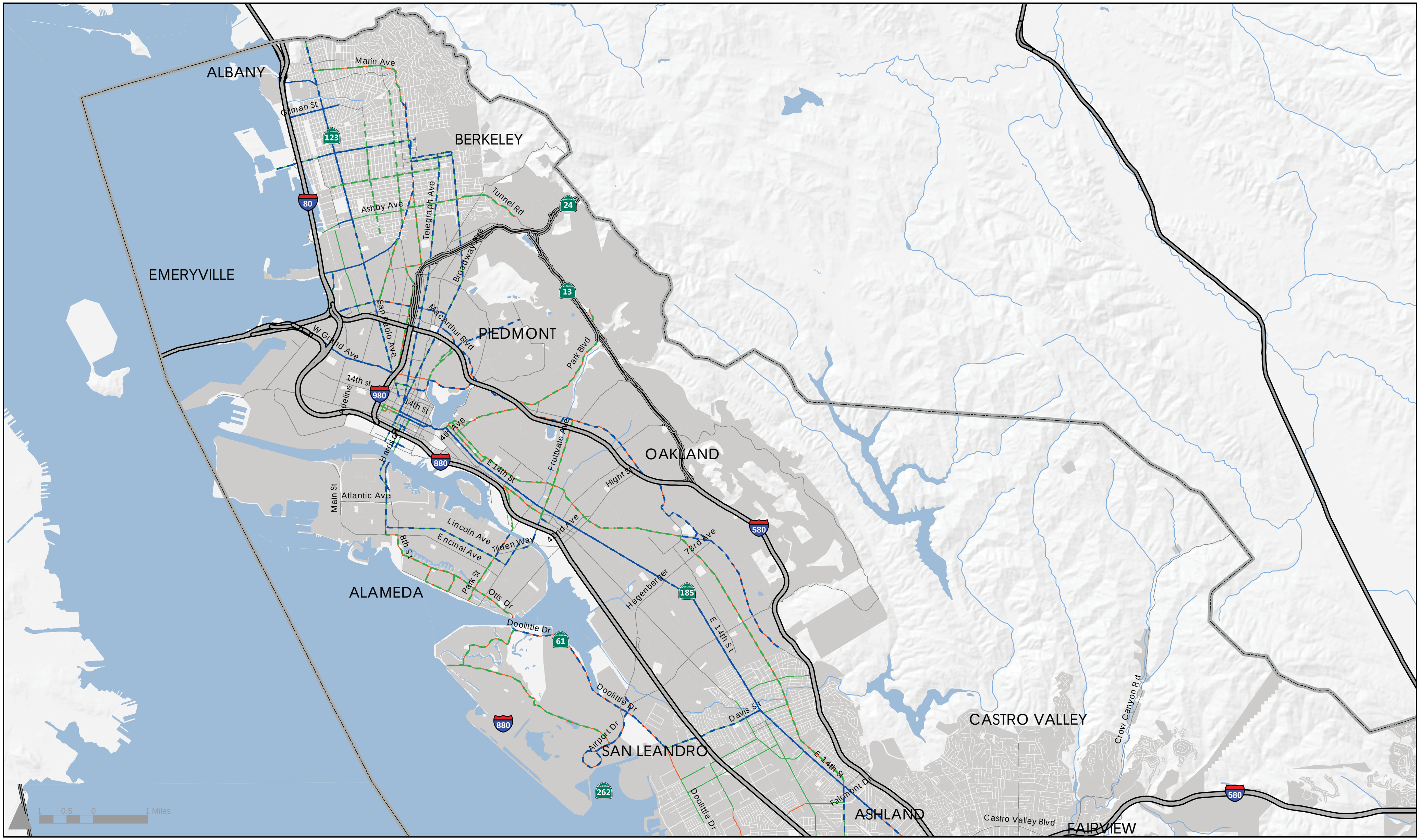


Figure 1
Proposed Countywide ITS Network Improvements



Legend

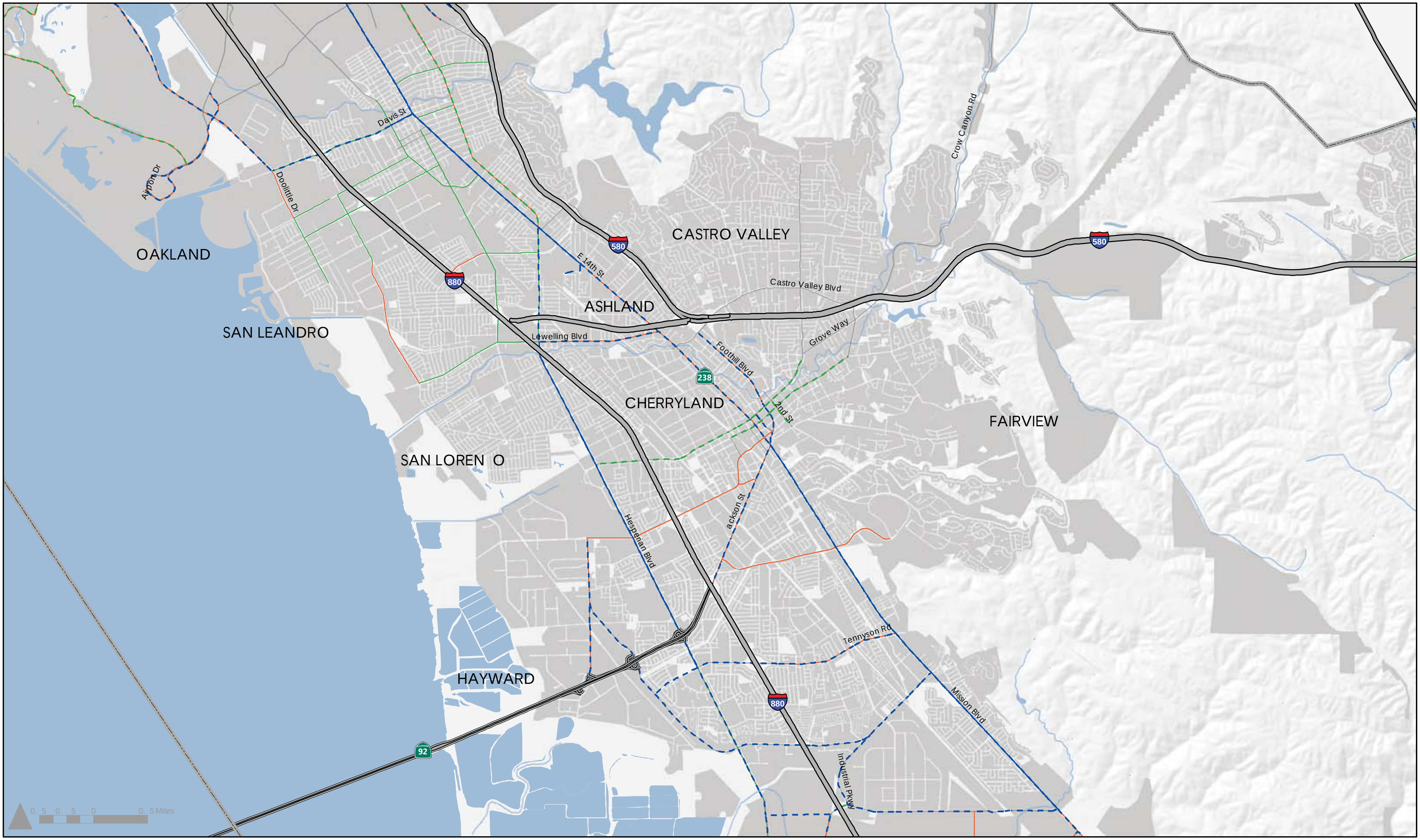
Baseline High Level of ITS Infrastructure	Proposed High Level of ITS Infrastructure
Baseline Medium Level of ITS Infrastructure	Proposed Medium Level of ITS Infrastructure
Baseline Low Level of ITS Infrastructure	Proposed Low Level of ITS Infrastructure
Urban Area	

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

North County
Figure 2

ITS Network Proposed Improvements



Legend

- Baseline High Level of ITS Infrastructure
- Baseline Medium Level of ITS Infrastructure
- Baseline Low Level of ITS Infrastructure
- Proposed High Level of ITS Infrastructure
- Proposed Medium Level of ITS Infrastructure
- Proposed Low Level of ITS Infrastructure
- Urban Area

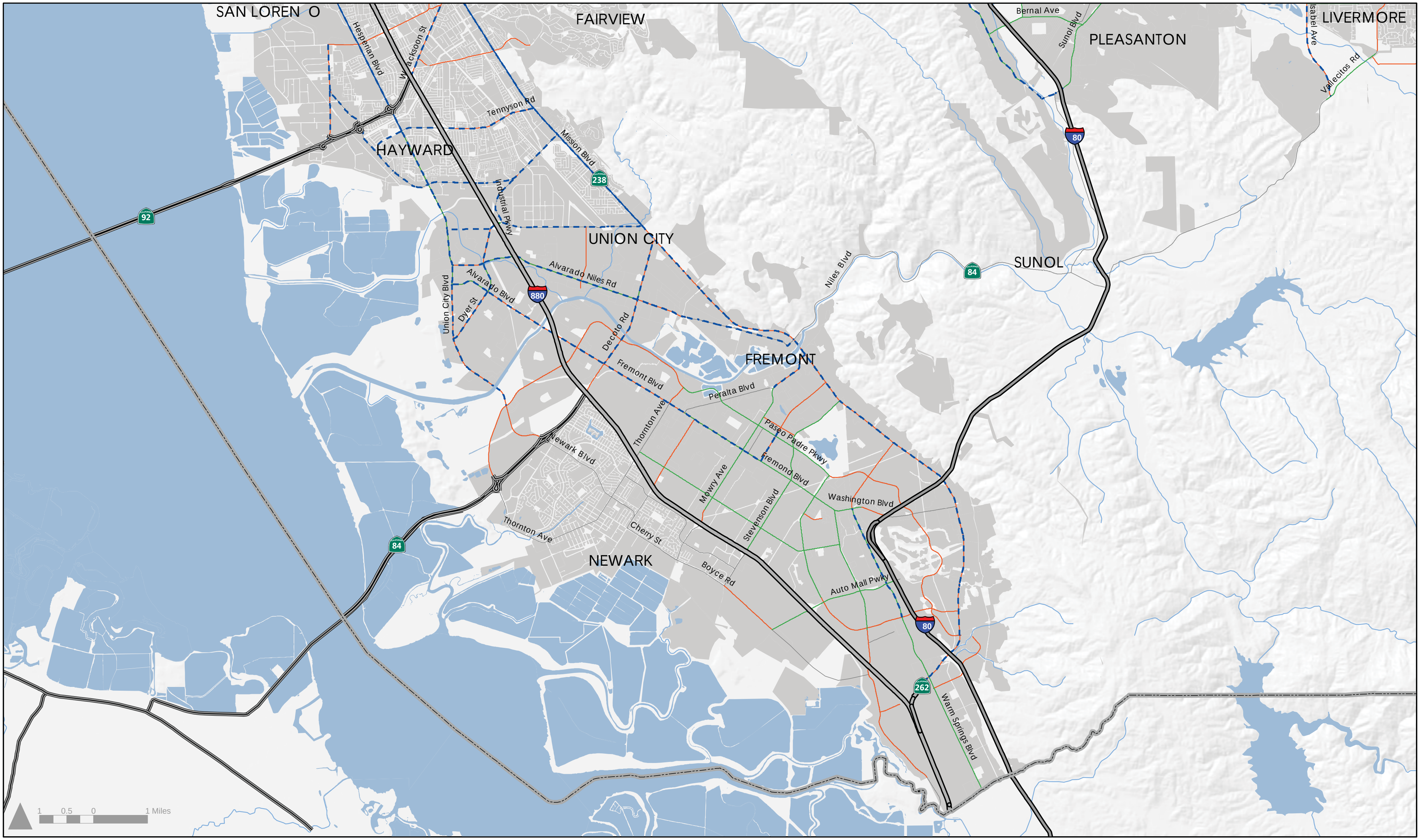
ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

Central County

Figure 3

ITS Network Proposed Improvements



Legend

- Baseline High Level of ITS Infrastructure
- Baseline Medium Level of ITS Infrastructure
- Baseline Low Level of ITS Infrastructure
- Proposed High Level of ITS Infrastructure
- Proposed Medium Level of ITS Infrastructure
- Proposed Low Level of ITS Infrastructure
- Urban Area

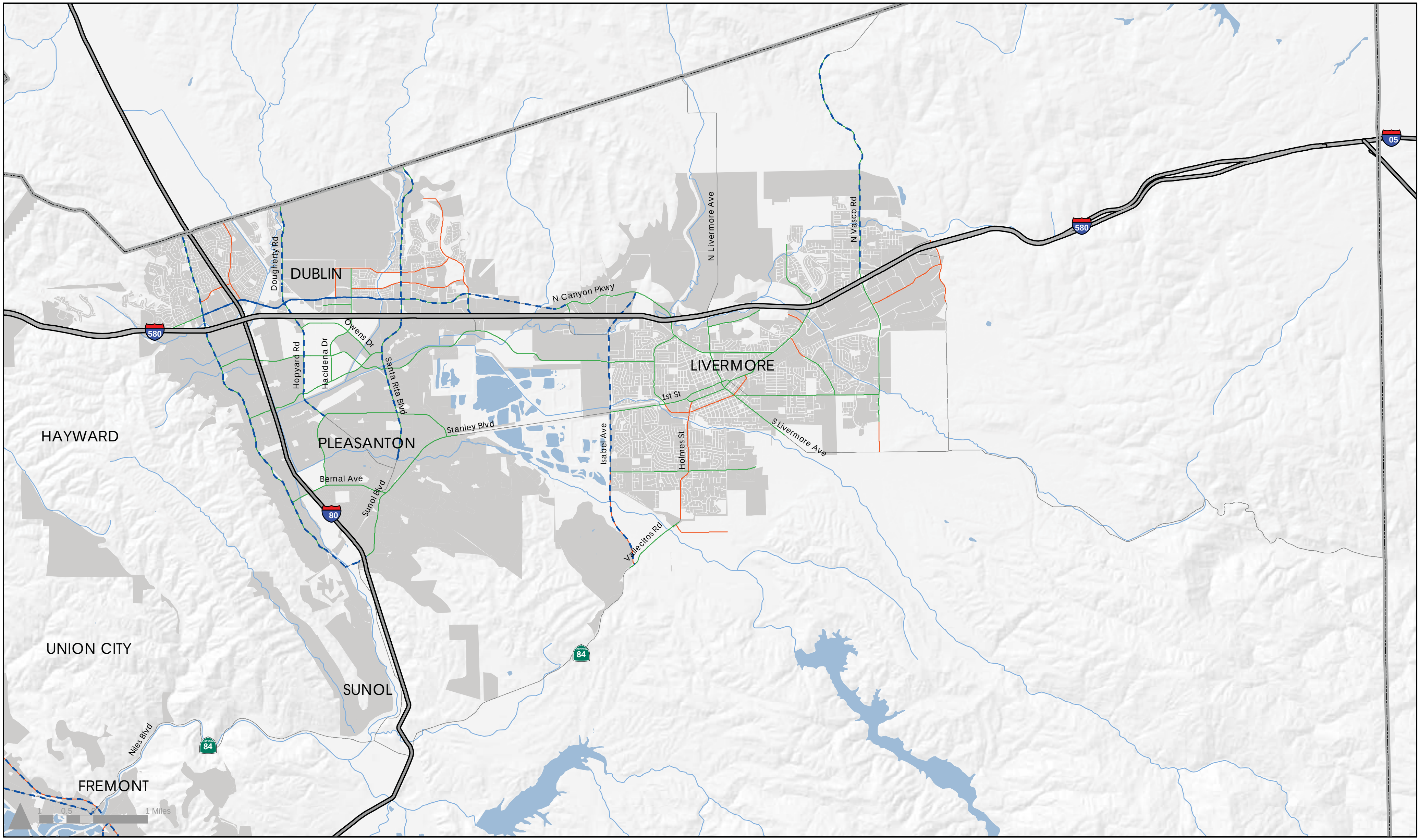
ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

South County

Figure 4

ITS Network Proposed Improvements



Legend

- Baseline High Level of ITS Infrastructure
- Baseline Medium Level of ITS Infrastructure
- Baseline Low Level of ITS Infrastructure
- Proposed High Level of ITS Infrastructure
- Proposed Medium Level of ITS Infrastructure
- Proposed Low Level of ITS Infrastructure
- Urban Area

ALAMEDA County Transportation Commission

Alameda Countywide Multimodal Arterial Plan

East County

Figure 5

ITS Network Proposed Improvements

ATTACHMENT A | Non-Performing Roadway Segments (Transit)

	Corridor	Routes Served	Existing	Planned/ Funded ITS Level (Year 2020)	Proposed ITS Improvements (Year 2040)	Notes
1	Adeline/40th St. (Emeryville, Oakland, Berkeley)	F	1	1	2	TSP, CCTV and upgraded Field-to-Center communications are needed. AC Transit has identified this corridor as a BRT candidate by 2040.
2	College Ave./University Ave. (Alameda, Oakland, Berkeley)	51A, 51B	1	2	3	TSP is planned for Route 51. Recommend real-time bus arrival information be provided at the stops and via the internet. AC Transit has identified this corridor as a BRT candidate by 2040.
3	East 14th St./Mission Blvd. (San Leandro, Hayward, Union City, Fremont)	99	1	1	3	Route 99 was considered to receive adaptive traffic control and TSP as part of the Transit Performance Initiative/NextGen AOP program. The project did not proceed due to funding constraints. Recommend going forward with adaptive and TSP on this corridor. AC Transit has identified this corridor as a BRT candidate by 2040. Segment includes a future east-west connector, and an additional segment located south of Fremont.
4	Foothill Blvd. (Oakland, San Leandro)	40	1	1	2	Existing ITS infrastructure on this corridor in the City of Oakland is minimal. There are no communications from the Oakland TMC to the intersection. Recommend establishing communications to the intersections and deploying TSP on this corridor.
5	Fruitvale Ave. (Oakland, Alameda)	20, 21	1	1	2	Existing ITS infrastructure on this corridor is minimal. There are no communications from the Oakland TMC to the intersection and limited communications in the City of Alameda. Recommend establishing or upgrading communications to the intersections and deploying TSP on this corridor.
6	Hesperian Blvd. (San Leandro, Union City, Hayward, Alameda County)	97	1	2	3	Will receive adaptive control and TSP as part of the Transit Performance Initiative/ NextGen AOP Program. Hesperian Blvd is also a corridor that is ideal for automobile ITS improvements such as CMS/Trailblazer Signs and CCTV cameras in addition to the TSP and adaptive control currently slated for deployment in 2017.
7	International/East 14th St. (Oakland, San Leandro)	1, 1R	1	3	3	TSP is currently installed on Route 1R. This corridor is part of AC Transit's East Bay BRT Project and will receive a wide array of ITS improvements. AC Transit is considering extending the BRT corridor from San Leandro BART to Bay Fair BART by 2040.
8	MacArthur Blvd. (Oakland)	57, 58L, NL	1	1	3	Existing ITS infrastructure on this corridor is minimal. Recommend deploying Center-to-Field communications and TSP. Additionally AC Transit has identified this corridor as a BRT candidate between now and 2040.

9	San Pablo/MacDonald (Oakland, Emeryville, Berkeley, El Cerrito, Richmond)	72, 72M, 72R	2	2	3	TSP has been installed on this corridor for over a decade as part of the 72 Rapid program. In the near term (i.e. 2020) recommend the existing TSP and communications capabilities be maintained as 72 Rapid system components reach the end of their useful life. This corridor has been identified by AC Transit as a BRT candidate between 2020 and 2040. Recommend consideration be given to deploying adaptive traffic control technology on the corridor as well.
10	Shattuck Ave. (Oakland, Berkeley, Albany)	18	1	1	2	Existing ITS infrastructure is lacking in major portions of the corridor. Recommend deploying/upgrading Center-to-Field communications along the length of the corridor and deploying TSP.
11	Telegraph Ave. (Alameda, Oakland, Berkeley)	1, 1R	2	2	3	TSP is deployed on this corridor as part of the 1 Rapid program. Between now and 2020, recommend consideration be given to deploying adaptive traffic controls on this corridor. This corridor has been identified as a BRT candidate by AC Transit.
12	Dublin Blvd./Stanley Blvd (Dublin, Livermore, Pleasanton)		2	3	3	LAVTA staff have identified this corridor as critical. It will be expanded as Dublin Blvd is extended to Livermore border.

ATTACHMENT B | Non-Performing Roadway Segments (Auto)

	Arterial	Segment Limits	Existing	Planned/ Funded ITS Level (Year 2020)	Proposed ITS Improvements (Year 2040)	Notes
1	Buchanon St.	I-580 to Pierce St. (Albany)	3	3	3	This segment is included in the I-80 ICM program and will be upgraded to Level 3.
2	Gillman St.	I-80 to Santa Fe Ave. (Berkeley)	3	3	3	The portion between I-80 and San Pablo are part of I-80 ICM and have communications to all signals as well as trailblazer signs between I-80 and San Pablo Avenue. This portion is considered Level 3 however the other half of the segment does not have any I-80 ICM upgrades. Recommend no ITS investment on the segment between San Pablo Ave and Santa Fe Ave since it is a residential street. As an aside, most of the local agencies on the I-80 ICM project are receiving upgraded central traffic control systems to support the signals in the I-80 ICM project area. This is replacing the existing McCain system that is rapidly becoming obsolete. Iteris recommends each city migrate all of their signals to the new system.
3	SR 13	Telegraph Ave. to SR24 (Berkeley)	1	1	2	Road changes name from Ashby to Tunnel Road at Claremont Ave. Recommend establishing filling any communication gaps, perform regular signal timing that is coordinated with the City of Berkeley as this is a state route that winds through the City. Also deploy CCTV cameras to monitor operations.
4	Constitution Way	Webster St. to Marina Village Parkway (Alameda)	Not Available	1	3	Recommend filling communications gaps, regular traffic signal timing, deployment of CCTV cameras, and deployment of CMS/Trailblazer signs to alert motorists of congestion in the tunnel prior to decision points.
5	Harrison St.	Grand Ave. to Fairmount Ave. (Oakland)	0	0	2	Recommend combining segments 6 through 9 into a single corridor. A lot of commuters travel from downtown Oakland to I-580 on Harrison Street. Recommend filling communications gaps, regular traffic signal timing and deployment of CCTV cameras.
6	Oakland Ave.	Perry Place to Santa Clara Ave. (Oakland)	0	0	2	I-580 Harrison Street on-ramp/off-ramp. Recommend filling communications gaps, regular traffic signal timing and deployment of CCTV cameras.
7	Harrison Street	Stanley Place to Santa Clara Ave. (Oakland)	0	0	2	I-580 Harrison Street on-ramp/off-ramp. Recommend filling communications gaps, regular traffic signal timing and deployment of CCTV cameras.
8	Oakland Ave.	Bayo Vista Ave. to Olive Ave. (Oakland/Piedmont)	0	0	3	Just east of 580/Harrison Street ramps. Recommend filling communications gaps, regular traffic signal timing and deployment of CCTV cameras.
9	Oakland Ave.	Sunnyside Ave. to Highland Ave. (Piedmont)	0	0	3	Just east of 580/Harrison Street ramps. Recommend filling communications gaps, regular traffic signal timing and deployment of CCTV cameras.

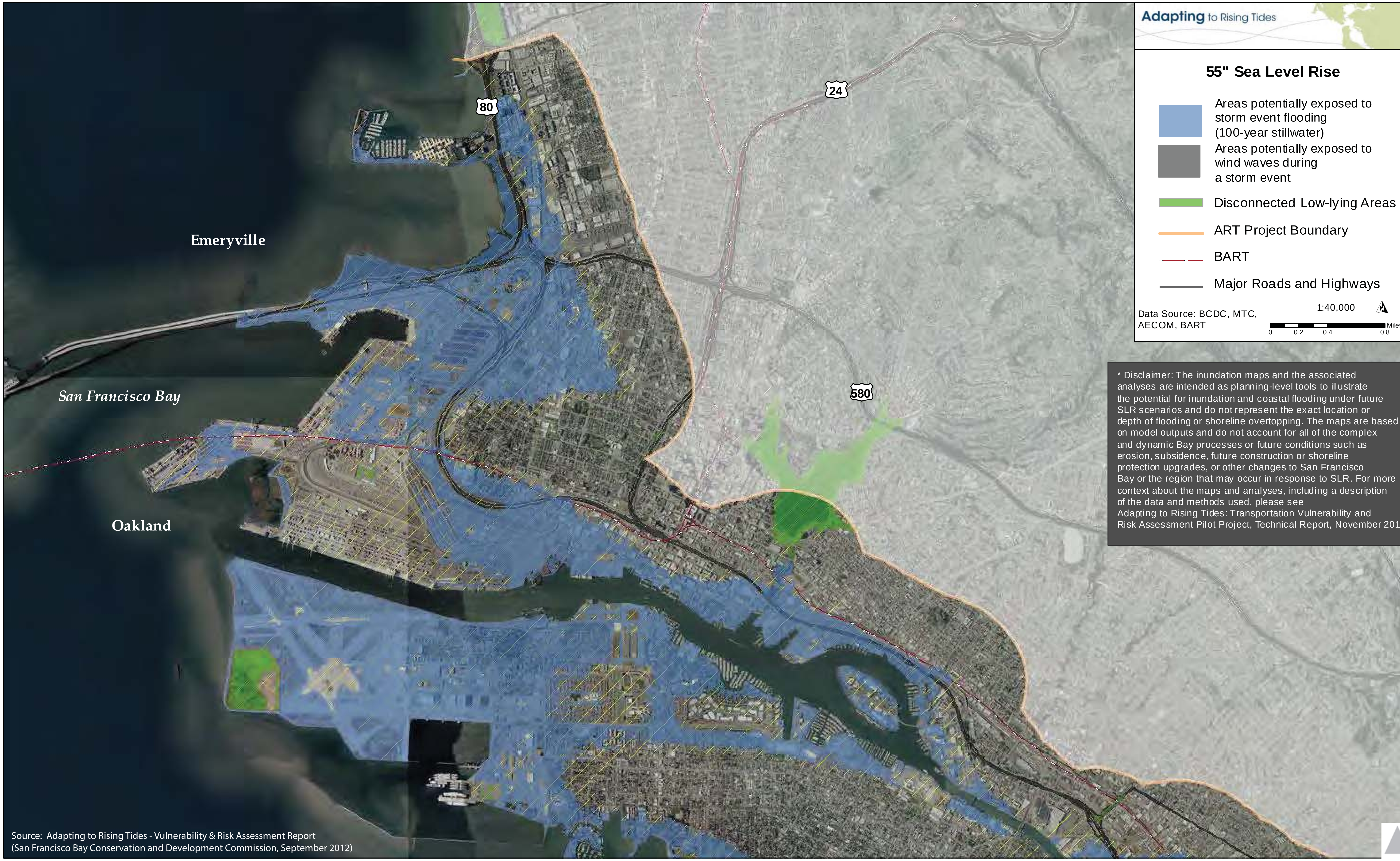
10	Doolittle Dr.	Fernside Ave. (Alameda) to Davis St. (Oakland)	Not Available	1	3	Recommend combining the next two segments with this into a single airport area project. Recommend establishing communications to all traffic signals, regular traffic signal timing to include special timing for holiday travel period, deployment CCTV cameras for monitoring and deployment of additional CMS units to display airport area travel information. The signs would present information that is similar to what is broadcast on the HAR. Recommend evaluating the future utility of HAR.
11	Airport Access Rd/Bessie Coleman Dr.	Hegenberger Rd. to OAK Arrival/Departure (Oakland)	1	1	3	See recommendations for Doolittle Drive.
12	Davis Street	Doolittle Dr. to East 14th St. (San Leandro)	2	2	3	See recommendations for Doolittle Drive. San Leandro staff recommended extending the segment over the freeway.
13	East 14th Ave.	Plaza Dr. to Elgin St. (San Leandro)	0	1	2	AC Transit has identified extending their BRT project from the San Leandro BART station to the Bay Fair BART station before 2040. This corridor would be adjacent to the extended BRT project. If this segment is extended another few blocks to Lewelling Blvd, then it would link to another underperforming corridor. Recommend filling any communications gaps, traffic signal timing at regular intervals
14	Lewelling Blvd.	Hesperian Blvd. to Mission Blvd. (San Lorenzo)	0	1	3	Reliever route for traffic on I-238 between I-580 and I-880. This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status. Recommend filling communications gaps, regular traffic signal timing, CCTV cameras, and consideration given to adaptive traffic control. Recommend deployment to CMS/Trailblazer signs to provide traveler information.
15	Hesperian Blvd.	Lewelling Blvd. to Tennyson Rd. (Hayward)	1	3	3	This segment is part of the MTC NextGen AOP and will receive adaptive traffic control by 2017. In addition, this segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status. Recommend combining with Lewelling Blvd. and applying the same strategies.
16	A St.	Foothill Blvd. to Grove Way (Hayward)	0	1	2	Segment is on the route from downtown Hayward to I-580. Recommend filling any communications gaps, traffic signal timing and CCTV cameras for monitoring.
17	Winton Ave.	D St. to Jackson St. (SR 92) (Hayward)	1	1	2	Jackson St is SR92 in the City of Hayward. Recommend filling any communications gaps, traffic signal timing and CCTV cameras for monitoring.
18	Jackson St.	Meek Ave. to Santa Clara St. (Hayward)	1	1	3	Combine with Winton Ave from D Street to Jackson St segment. Recommend traffic signal timing and CCTV cameras for monitoring.
19	Mission Blvd.	Jackson St. to Whipple (Hayward)	1	3	3	This portion of Mission Blvd was transferred from Caltrans to Hayward. Hayward has already upgraded the communications and deployed adaptive control (SCATS) on this segment. Recommend consideration be given to additional CCTV cameras and CMS/Trailblazer signs in the long term.
20	Mission Blvd.	Decoto Rd. to I-680 (Hayward to Fremont)	1	1	3	Recommend filling any communications gaps, traffic signal timing and CCTV cameras for monitoring. Recommend consideration of adaptive traffic control and additional CMS/Trailblazer signs.

21	Industrial Blvd./Industrial Pkwy.	Clawiter Rd. to I-880 (Hayward)	0	1	3	Cut-through for traffic going between I-880 and SR92 (San Mateo Bridge). This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status. Recommend filling any communications gaps, traffic signal timing and CCTV cameras for monitoring. Hayward staff recommend extending the segment beyond SR92 to Clawiter Road to close a gap in the ITS infrastrucuture.
22	Industrial Pkwy.	Russ Rd. to Huntwood Ave. (Hayward)	0	1	3	Could be combined with Industrial segment between Arden and I-880. This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status. Recommend filling any communications gaps, traffic signal timing and CCTV cameras for monitoring.
23	Whipple Rd.	Dyer St. to Industrial Pkwy SW (Hayward)	1	1	3	I-880/Whipple interchange. This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status.
24	Industrial Pkwy SW	Whipple Rd. to Industrial Pkwy W	0	1	3	This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status.
25	Alvarado Niles Rd./Smith St.	Union City Blvd to Osprey Drive (Union City)	1	1	3	This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status.
26	Mowry Ave.	Mission Blvd. to Peralta Blvd. (Fremont)	0	1	3	This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status.
27	Osgood Rd.	Washington Blvd. to Grimmer Blvd. (Fremont)	2	2	3	Parallels I-680 near Washington and Auto Mall on-ramps. A lot of retail is off of Auto Mall between I-880 and I-680. A new BART station is opening nearby. Recommend filling any communications gaps, traffic signal timing and CCTV cameras for monitoring. In addition, consider installation of CMS/Trailblazer units for incident management.
28	Mission Blvd.	I-680 to I-880 (Fremont)	1	1	3	Huge commuter route with lots of retail. This segment is part of the I-880 ICM program and will receive an upgrade to Level 3 status.
29	Isabel Road (SR84)	Vallecitos Road (SR84) to Concannon Blvd. (Livermore)	1	1	3	SR84 was rerouted to Isabel Road at Vallecitos Road with Isabel going to the State and the City taking over Vallecitos Road east of Isabel. This segment was not modernized when the road was turned over to Caltrans. Recommend filling communications gaps, traffic signal timing at regular intervals and CCTV cameras for monitoring. Consideration to be given to CMS/Trailblazer to alert motorists of incidents and alternate routes.
30	Vasco Road	I-580 to Los Vaqueros Road (Livermore/Unincorporated)	2	2	3	Vasco Road is known to have a high number of accidents. Many measures are already in place. Road is used as a commuter route for people living in the Brentwood area to Silicon Valley. Recommend additional CCTV cameras and CMS signs.
31	Foothill Rd./San Ramon Rd.	Golden Eagle Way to Contra Costa County Line (Pleasanton/Dublin)	2	2	3	Portion in Pleasanton from Stoneridge to 680 is meeting performance objectives. This is in front of Stoneridge Mall.
32	Fallon Rd./El Charro Rd.	580 to Dublin Blvd (Dublin)	2	2	3	Near Livermore Outlets and Fallon Shopping Center. Recommend extending the adaptive control system slated for installation on Dublin Blvd in 2017 through the MTC NextGen AOP to be extended along Dublin Blvd to this segment.

33	Santa Rita Rd./Tassajara Rd.	County Line (Dublin) to Del Valle Parkway (Pleasanton)	2	2	3	Recommend consideration be given to extending the adaptive control system slated for installation on Dublin Blvd in 2017 through the MTC NextGen AOP.
34	Hopyard Rd./Dougherty Rd.	Valley Ave. (Pleasanton) to Contra Costa County Line (Dublin)	2	2	3	Recommend extending the adaptive control system slated for installation on Dublin Blvd in 2017 through the MTC NextGen AOP to be extended along Dublin Blvd to this segment.
35	DeCoto Rd.	Mission Blvd to Paseo Padre Pkwy (Union City)	1	1	3	Union City staff have identified this corridor as critical.
36	Dyer St	Whipple Rd. to Union City Blvd. (Union City)	1	1	3	Union City staff have identified this corridor as critical.
37	Union City Blvd.	Whipple Rd. to Paseo Parkway (Union City)	1	1	3	Union City staff have identified this corridor as critical.
38	Alvarado Blvd.	Union City Blvd. to Galaxy Dr. (Union City)	1	1	3	Union City staff have identified this corridor as critical.
39	Dublin Blvd.	San Ramon Road to Tassajara Rd. (Dublin)	2	3	3	MTC's Next Generation Arterial Operations Program will install adaptive control in 2017 to go along with existing TSP. Adaptive will be deployed from San Ramon Road to Hacienda Drive. Recommend extending adaptive to the entire arterial. Currently that would be Tassajara Road. If Dublin Blvd. is ever extended to the Livermore City Limit, then recommend expanding the adaptive system as well. This corriedor serves as a freeway reliever route. In the long term deploying V2I infrastructure is recommended.
40	Tennyson Rd	East of I-880 to Industrial Blvd. (Hayward)	0	0	3	Hayward staff recommend deploying mid-level ITS measures. Currently there is nothing in place.
41	Foothill Blvd	Mission Blvd to I-580 (Hayward)	0/1	0	3	Hayward staff recommend deploying high-level ITS measures.
42	Second St.	A St. to E St. (Hayward)	1	1	1	Hayward staff recommend deploying low level ITS measures.
43	B St.	Foothill Blvd to 4th St (Hayward)	0	0	2	Hayward staff recommend deploying medium level ITS measures.
44	A St.	Meekland Ave and I-880 (Hayward)	0	1	2	Hayward staff recommend deploying medium level ITS measures.
45	Hesperian Blvd.	East 14th St and Thornally Drive (San Leandro)	2	2	3	San Leandro staff recommend deploying high level ITS.
46	Park Street	Santa Clara Avenue to Park Street Bridge (Alameda)	Not Available	0	3	Alameda staff recommend deploying high level ITS on this segment.
47	Shattuck Ave	Durant Ave. to Adeline St. (Berkeley)	0	0	3	Berkeley staff recommend deploying high level ITS including TSP and adaptive traffic control to support future dedicated bus ROW and transit queue jumps potentially.
48	Shattuck Ave.	Hearst St. to Rose St. (Berkeley)	0	0	3	Berkeley staff recommend deploying high level ITS including TSP and adaptive traffic control to support future dedicated bus ROW and transit queue jumps potentially.

49	Adeline St	Ward St to 62^{nd} St (Berkeley)	0	0	3	Berkeley staff recommend deploying high level ITS including TSP and adaptive traffic control to support future dedicated bus ROW and transit queue jumps potentially.
50	Sacramento St	Alcatraz Ave to Cedar St (Berkeley)	0	0	2	Berkeley staff recommend deploying medium level ITS on this segment.to include TSP and adaptive traffic control.
51	MLK Jr. Way	Hopkins St to Adeline St. (Berkeley)	0	0	2	Berkeley staff recommend deploying medium level ITS on this segment.to include TSP and adaptive traffic control.
52	Shattuck Ave.	Woolsey St to Adeline St. (Berkeley)	0	0	2	Berkeley staff recommend deploying medium level ITS on this segment.to include TSP and adaptive traffic control.
53	College Ave.	Broadway to Bancroft Ave. (Berkeley)	0	0	2	Berkeley staff recommend deploying medium level ITS on this segment.to include TSP and adaptive traffic control.
54	Dwight Way	7th St and Warring St. (Berkeley)	0	0	2	Berkeley staff recommend deploying medium level ITS on this segment.to include TSP and adaptive traffic control.
55	Ashby Ave.	Adeline St and Telegraph Ave. (Berkeley)	0	0	2	Berkeley staff recommend deploying medium level ITS on this segment.to include TSP and adaptive traffic control.

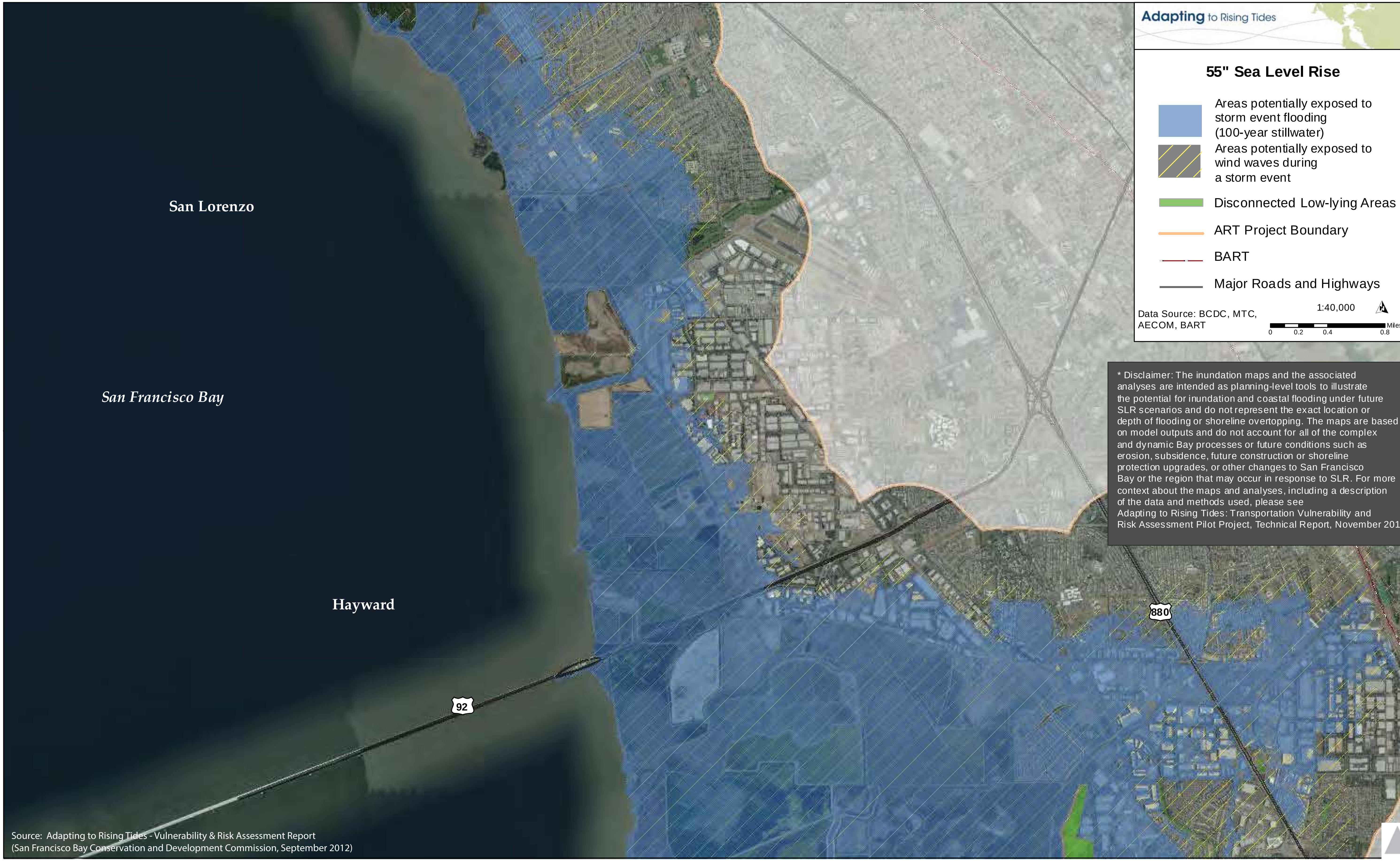
Appendix 4.6.1
Sea Level Rise Inundation Maps



ALAMEDA County Transportation Commission

Sea Level Rise Inundation Maps


Adapting to Rising Tides
55" Sea Level Rise
Areas potentially exposed to storm event flooding (100-year stillwater)
Areas potentially exposed to wind waves during a storm event
Disconnected Low-lying Areas
ART Project Boundary
BART
Major Roads and Highways
Data Source: BCDC, MTC, AECOM, BART
1:40,000
0 0.2 0.4 0.8 Miles
* Disclaimer: The inundation maps and the associated analyses are intended as planning-level tools to illustrate the potential for inundation and coastal flooding under future SLR scenarios and do not represent the exact location or depth of flooding or shoreline overtopping. The maps are based on model outputs and do not account for all of the complex and dynamic Bay processes or future conditions such as erosion, subsidence, future construction or shoreline protection upgrades, or other changes to San Francisco Bay or the region that may occur in response to SLR. For more context about the maps and analyses, including a description of the data and methods used, please see Adapting to Rising Tides: Transportation Vulnerability and Risk Assessment Pilot Project, Technical Report, November 2011.
Alameda
San Francisco Bay
San Leandro
880
Source: Adapting to Rising Tides - Vulnerability & Risk Assessment Report
(San Francisco Bay Conservation and Development Commission, September 2012)


Adapting to Rising Tides
55" Sea Level Rise
Areas potentially exposed to storm event flooding (100-year stillwater)
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Disconnected Low-lying Areas
ART Project Boundary
BART
Major Roads and Highways
Data Source: BCDC, MTC, AECOM, BART
1:40,000
0 0.2 0.4 0.8 Miles
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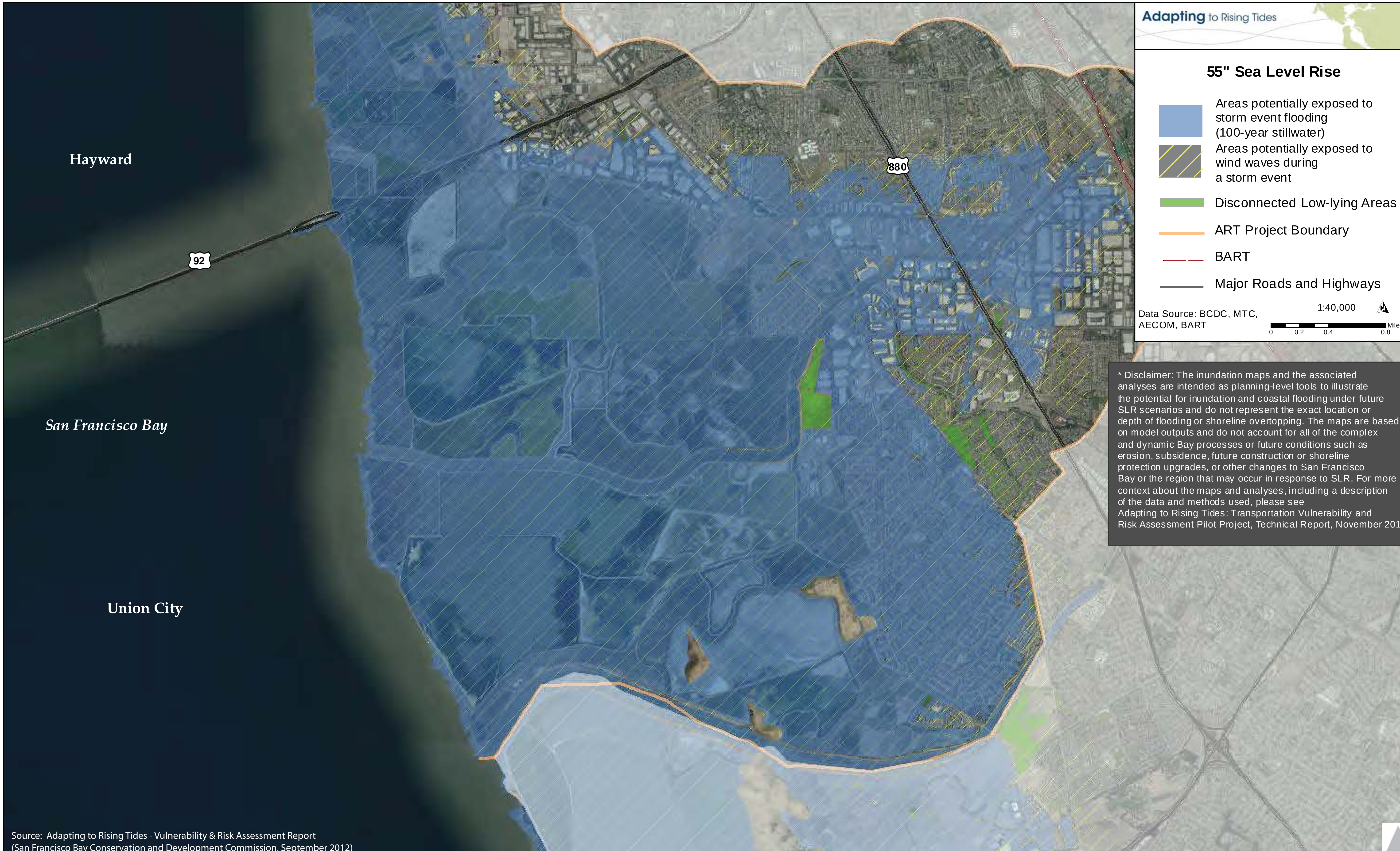
San Lorenzo
San Francisco Bay
Hayward
92
880
Source: Adapting to Rising Tides - Vulnerability & Risk Assessment Report
(San Francisco Bay Conservation and Development Commission, September 2012)


Adapting to Rising Tides
55" Sea Level Rise
Areas potentially exposed to storm event flooding (100-year stillwater)
Areas potentially exposed to wind waves during a storm event
Disconnected Low-lying Areas
ART Project Boundary
BART
Major Roads and Highways
Data Source: BCDC, MTC, AECOM, BART
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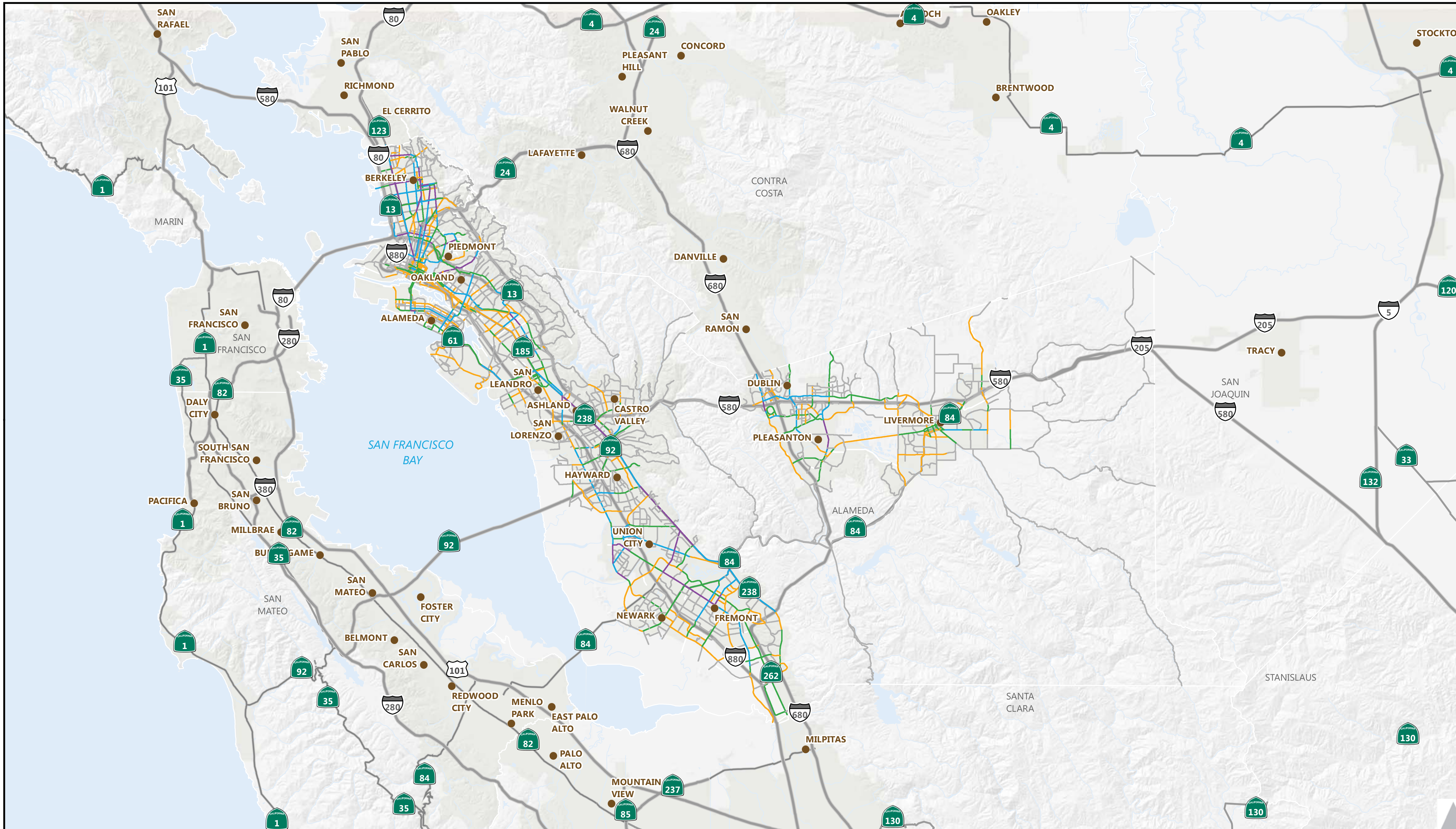
Hayward
92
880
San Francisco Bay
Union City
Source: Adapting to Rising Tides - Vulnerability & Risk Assessment Report
(San Francisco Bay Conservation and Development Commission, September 2012)

Appendix 5.2.1
Total Mode Improvements by Segment

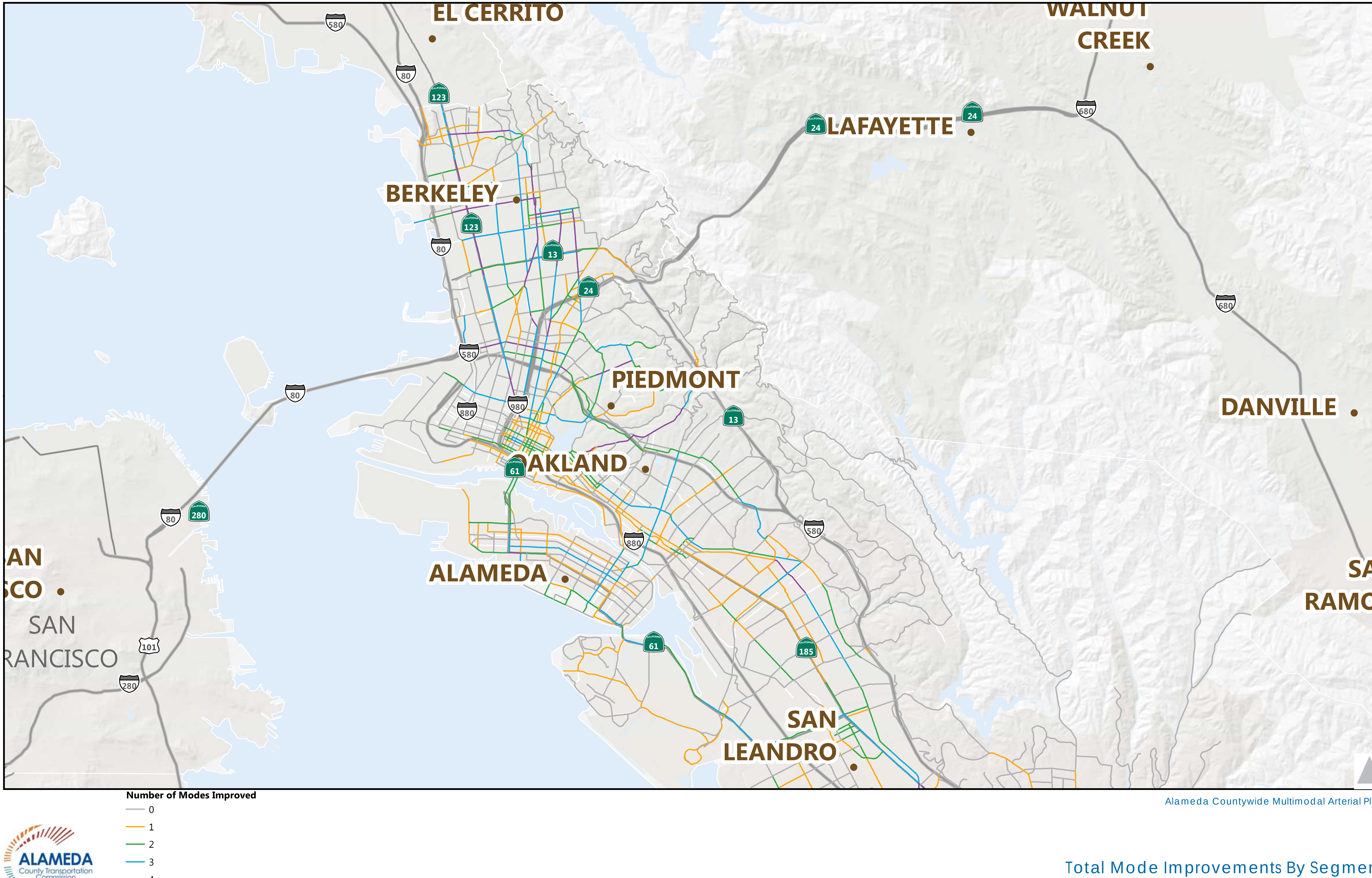


Number of Modes Improved

- 0
- 1
- 2
- 3
- 4

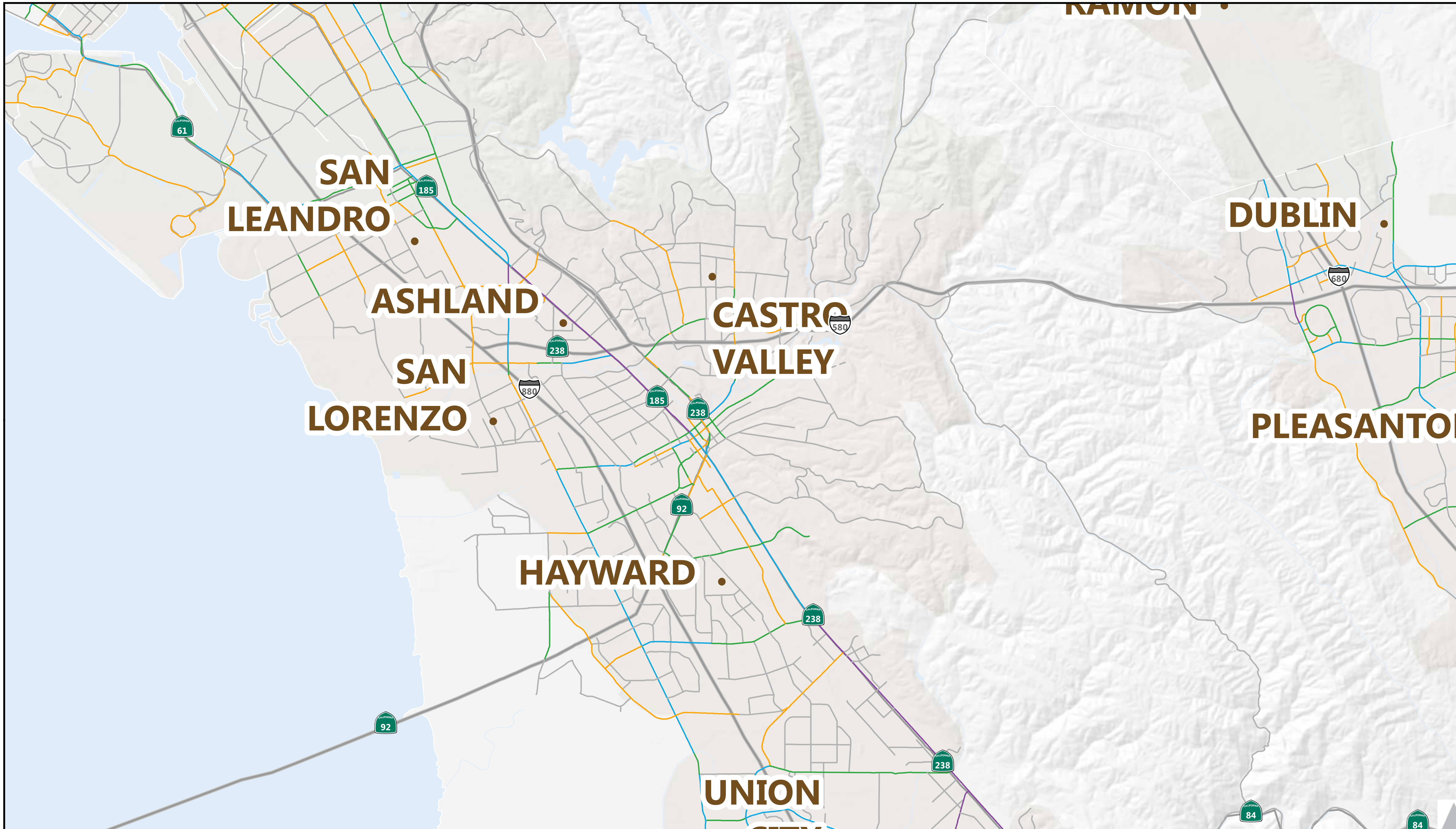
Alameda Countywide Multimodal Arterial Plan

Total Mode Improvements By Segment



Alameda Countywide Multimodal Arterial Plan

Total Mode Improvements By Segment



Number of Modes Improved

- 0
- 1
- 2
- 3
- 4

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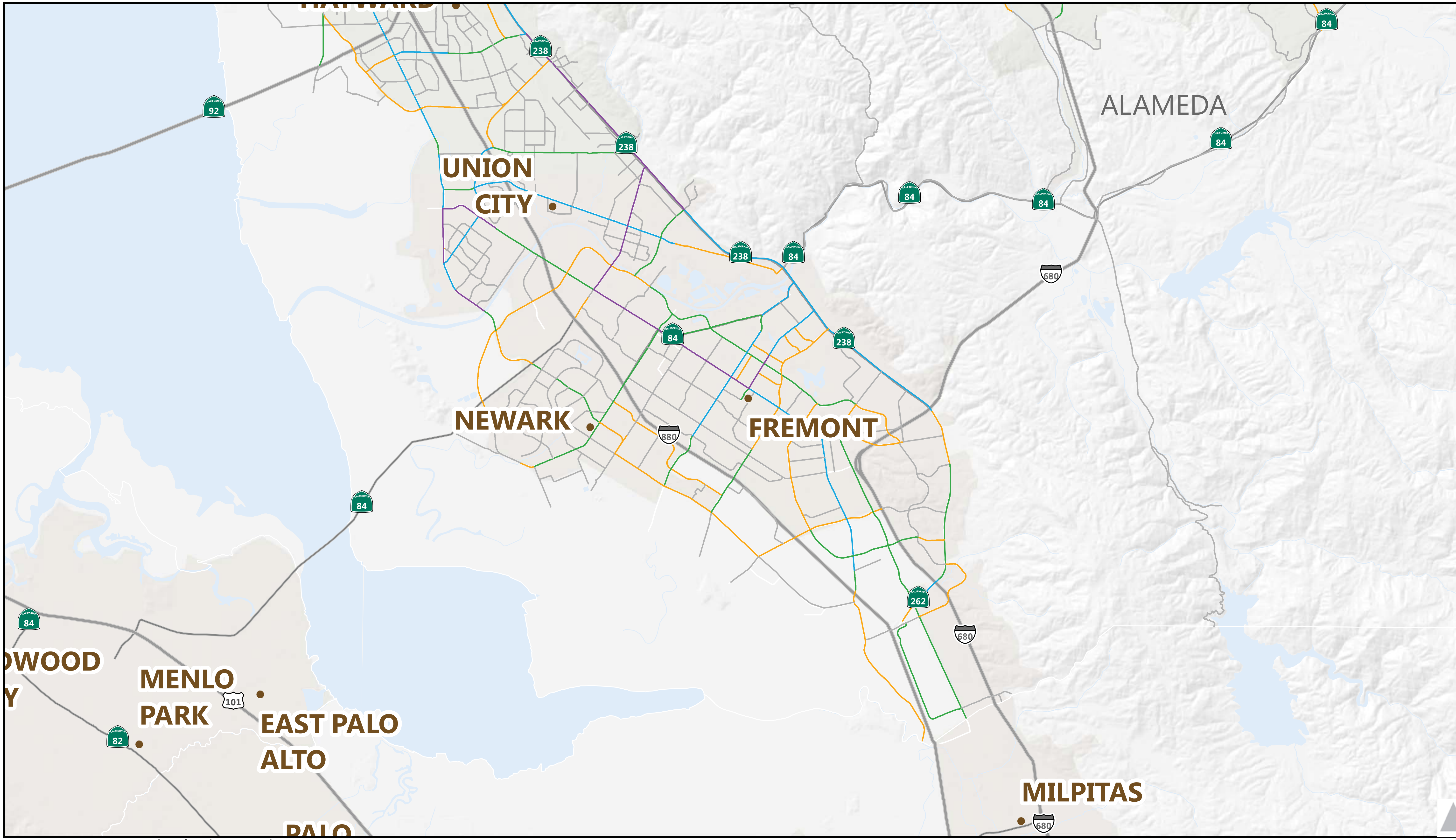
Total Mode Improvements By Segment



Number of Modes Improved
- 0
- 1
- 2
- 3
- 4

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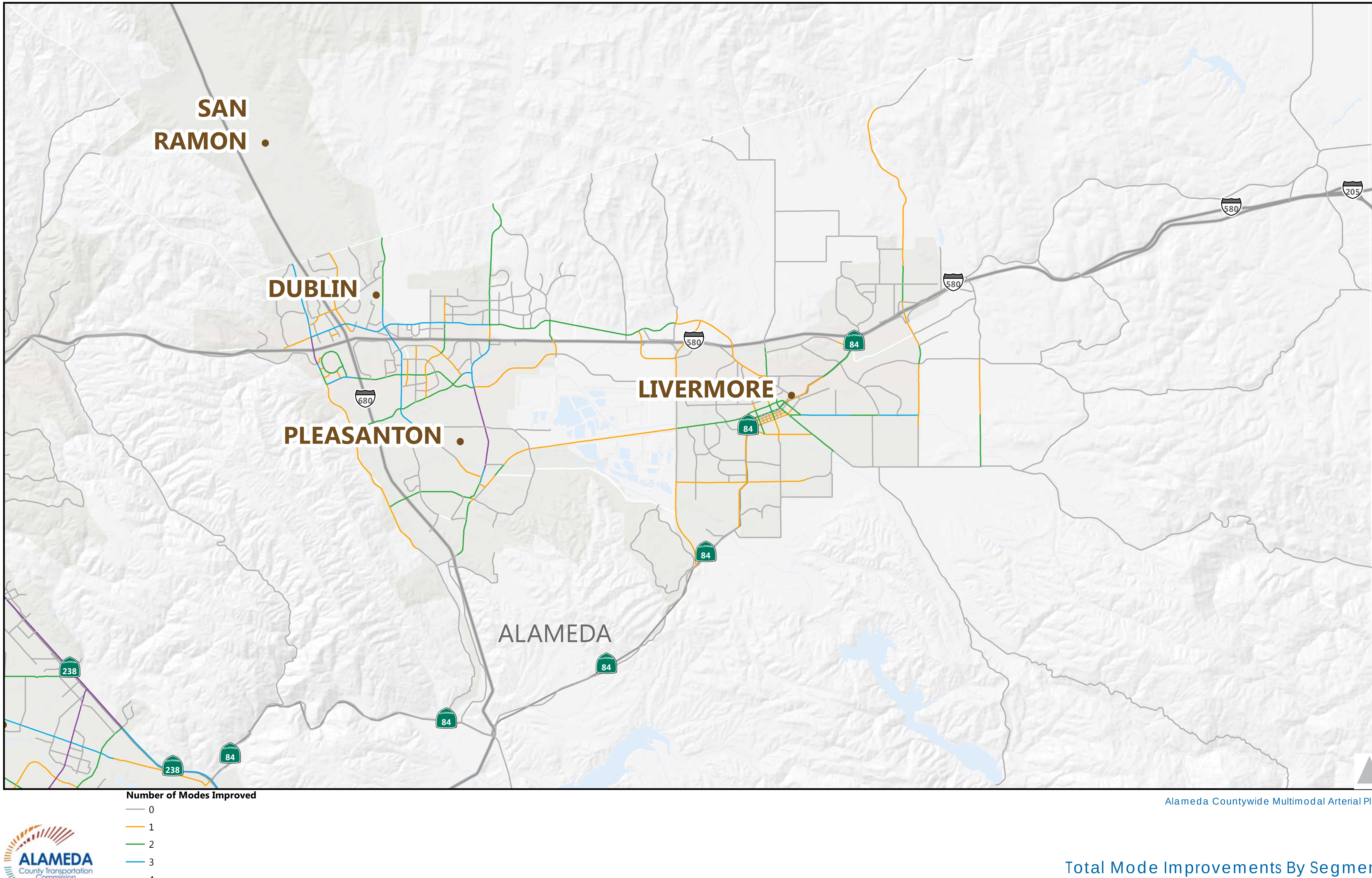
Total Mode Improvements By Segment



Alameda Countywide Multimodal Arterial Plan

Total Mode Improvements By Segment

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