Countywide Transit Plan Development Technical Advisory Committee Meeting Agenda
Wednesday, October 7, 2015, 1:00 p.m.

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Staff Liaisons: Tess Lengyel and Kara Vuicich
Technical Team Members: Alameda County Technical Advisory Committee
Consultant: Parsons Brinckerhoff
Public Meeting Coordinator: Angie Ayers

	Page	A/I
1. Welcome and Introductions		
2. Public Comment		
3. Work Update (Verbal) Staff will present a project update and discuss complete and in-progress deliverables.		I
4. Approval of Draft Transit Network Recommendations, Evaluation Methodology and Performance Measures Staff will present the draft network recommendations proposed for further evaluation as well as the evaluation methodology and performacne measures that will be used to analyze the draft transit recommendations.		A
5. Adjournment		
6. Next Steps/Next Meeting		

(A = Action Item; I = Information Item)

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DATE:	October 2, 2015
SUBJECT:	Alameda Countywide Transit Plan Draft Network Recommendations, Evaluation Methodology and Performance Measures
RECOMMENDATION:	Approve the Countywide Transit Plan Draft Network Recommendations, Evaluation Methodology and Performance Measures.

Summary

The first ever Alameda Countywide Transit Plan will identify a 2040 vision of a comprehensive countywide transit network designed to support Alameda County's future needs and enable Alameda County's jurisdictions and transit providers to better align transit planning with local development and improved transit services. Combined, these efforts provide opportunities for greater ridership and accessibility throughout the county.

The Transit Plan will include a set of *Network Recommendations* that will provide the basis for a 2040 vision of a comprehensive transit network. The Network Recommendations will address how existing transit services can be improved to grow ridership, achieve fiscal sustainability, and improve access across Alameda County.

Significant work has been done for the development of the Countywide Transit Plan, including:

- *Baseline Assessment*: included identifying the existing conditions of the transit network and creating the Vision and Goals of the Transit Plan which were adopted in March 2015.
- *Network Development:* performed an analysis of travel patterns and transit travel markets in 2040 and developed a set of *Draft Network Recommendations* designed to meet these future needs (See Attachment A, Technical Memorandum #5).
- *Evaluation Methodology:* included developing a set of *Performance Measures* which will be used to evaluate the Draft Network Recommendations (see Attachment B) and the comprehensive Vision Network against 2040 and 2010 baseline conditions.

The proposed *Draft Network Recommendations* includes outcomes from close coordination with transit stakeholders. An initial meeting was held with transit operator staff in March 2015 to review and comment on the Network Development methodology and approach.

The consultant team then held a series of meetings in June 2015 with transit operator and local jurisdiction staff where feedback was solicited on the methodology and proposed network recommendations.

The evaluation methodology and performance measures presented in Attachment B were developed in consultation with transit operators and closely coordinated with the AC Transit Major Corridors Study. Attachment C provides additional detail on the proposed modeling approaches that will be used to evaluate individual network recommendations and the comprehensive transit network vision using the performance measures detailed in Attachment B.

Staff is recommending that the Commission approve the *Draft Network Recommendations,* the *Evaluation Methodology*, and the *Performance Measures* at this time. Based on this approval, the consultant team will use the adopted evaluation methodology and performance measures to evaluate the draft transit network recommendations and the overall vision network and recommend refinements as well as priorities for implementation and phasing.

Future tasks, not included as part of this recommendation, but which will come to the Commission in early 2016, include the development of final near- and long-term network recommendations, a complementary paratransit strategy, strategies for better agency coordination, technology and customer service considerations, design guidelines and transit-oriented development infrastructure improvements, and a financial plan.

Background

The Countywide Transit Plan builds on recent transit planning efforts led by the Metropolitan Transportation Commission as part of the Transit Sustainability Project, and is being closely coordinated with planning efforts currently underway by individual transit operators, including AC Transit's Major Corridors Study which will develop, analyze and rank capital improvements for AC Transit's major corridors, and a Comprehensive Operations Analysis currently in progress for LAVTA/Wheels in the Tri-Valley. In addition, the Transit Plan recognizes that there are many other transit studies underway, including some in environmental phases of development, such as ACE Forward and the BART to Livermore/ACE project. In addition, Capital Corridor released its long-term vision in late 2014, and MTC is leading the Transbay Core Capacity Study with BART, AC Transit and Muni. The transit plan will acknowledge these additional planning efforts; however, it will not make recommendations on these specific studies since they are doing more detailed analyses of specific corridors than what this plan was scoped to perform.

Draft Transit Network Recommendations

Technical Memorandum #5 (Attachment A) describes the Draft Transit Network Recommendations developed to help Alameda County realize its vision to "Create an efficient and effective transit network that enhances the economy and the environment and improves quality of life." This technical memorandum focuses on the identification of draft recommendations for changes to the existing transit network for incorporation into the

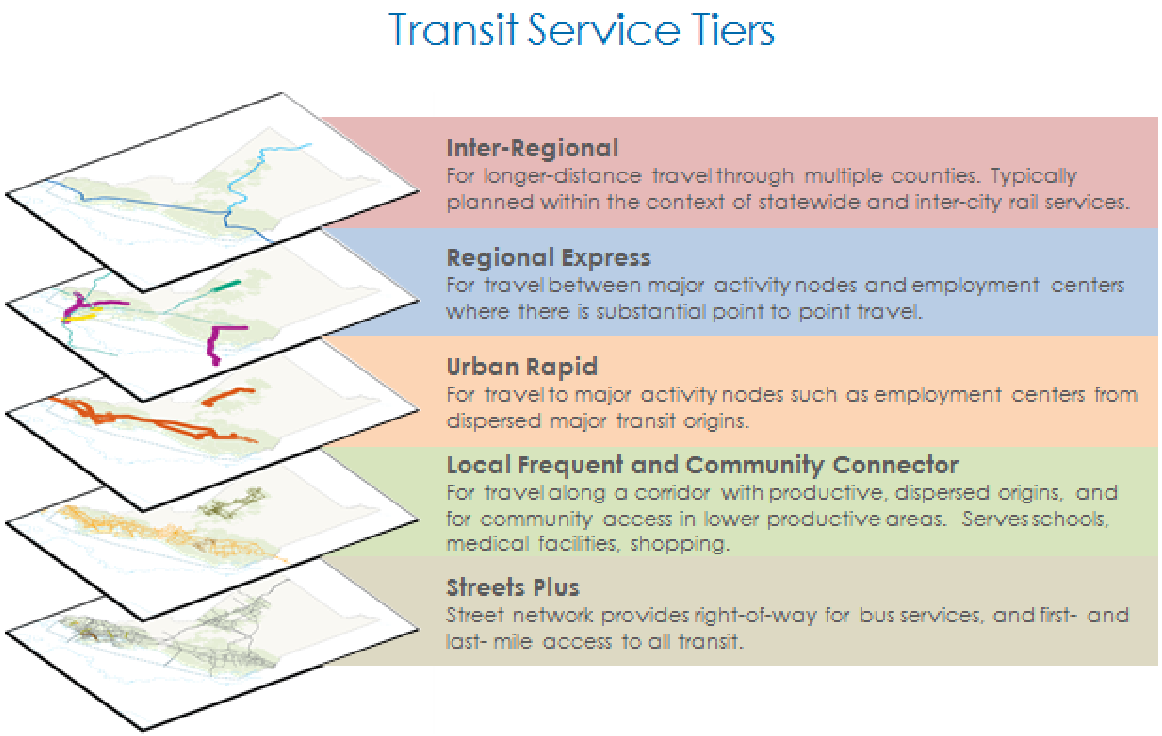
Countywide Transit Plan. It also presents a conceptual framework in the form of transit service tiers to clarify the differing elements of the demand for and provision of transit service in the county.

The Draft Transit Network Recommendations resulted from an in-depth analysis of future (year 2040) travel and land use forecasts and were refined in consultation with staff from the transit operators serving Alameda County and local jurisdictions. This analysis enabled the consultant team to identify areas where travel and land use patterns as well as employment and population densities indicated that there would be a strong market demand for fast, frequent transit service. In other words, there would likely be high enough transit ridership to support the more significant capital and operating investments typically required to provide transit service that is fast and frequent. Conversely, providing fast, frequent transit service in these areas would be most likely to result in the greatest number of people using transit.

While the focus of the Draft Transit Network Recommendations is on identifying areas where implementing fast, frequent transit service could not only significantly increase transit ridership but also substantially enhance the functionality and efficiency of our transit network, the final Countywide Transit Plan will provide a comprehensive set of recommendations for better integrating all tiers of transit service into a fully functional, effective and efficient transit network. To facilitate that effort, Technical Memorandum #5 also discusses the existing studies and plans currently being undertaken by AC Transit, Capitol Corridor, the Altamont Corridor Express (ACE), the Water Emergency Transportation Authority (WETA), and BART and how they relate to the specific recommendations made as part of the Countywide Transit Plan.

A transit tier structure is used as an organizational tool to help frame the discussion of the existing array of transit services and the potential for additional services that will foster a more efficient and seamless transit system. It is important to note that the tier structure does not imply a hierarchy of importance among the transit services or tiers. The purpose of the transit tier structure is to facilitate the understanding of different transit markets, service operations and operational characteristics, how they relate to the proposed network improvements, and how they combine together to create a comprehensive transit network. Each geographic transit tier is fundamentally connected to the rest, and the strength (or weakness) of each tier strengthens (or weakens) the entire transit network. Figure 1 provides an overview of the transit tier structure developed for the Countywide Transit Plan, which is described in more detail in Attachment A.

Figure 1



The Countywide Transit Plan will ultimately address all of the tiers of the transit network outlined in Figure 1. However, the focus of the Draft Network Recommendations is on the Regional Express and Urban Rapid tiers for the following reasons:

- Transit services within the Regional Express and Urban Rapid tiers carry the great majority of transit trips within, to and from Alameda County.
- Capital and operating investments that improve the capacity and operating effectiveness (in terms of travel time, frequency and reliability) of transit services within the Regional Express and Urban Rapid tiers are likely to have the greatest effect on increasing transit ridership, improving transit efficiency and sustainability, and achieving the Transit Plan's adopted vision and goals.
- To date, transit service in the Urban Rapid tier is significantly under developed. As a result, the level of transit mode share is significantly lower than would be expected given the very strong transit travel markets within Alameda County.
- While transit service in the Regional Express tier already meets the service objectives of being fast, frequent and reliable, it is at or over capacity, and additional service is needed to meet the demand both now and especially in the future.
- Alameda CTC, in partnership with local jurisdictions, transit operators, and regional agencies, can play an active role in facilitating significant improvements in transit services in the Regional Express and Urban Rapid tiers through capital and operating investments.

The Draft Transit Network Recommendations are detailed in Attachment A. It is important to note that all of the Draft Transit Network Recommendations are conceptual. In other words, specific routing and alignments have not been determined, and subsequent studies and environmental analyses will be required to determine specific alignments, routing, and capital and operating costs.

Evaluation Methodology and Performance Measures

Performance measures will be used for two types of evaluations, which will be performed based on Commission approval of performance measures:

- **Network:** This evaluation will quantify the anticipated benefits cumulatively resulting from the draft recommendations with respect to each identified goal. Performance measures will be applied to the existing (2010) and future (2040) baseline alternatives as well as the "Vision" network in order to gauge the relative effect of each network alternative.
- **Project:** The assessment will consider the costs and benefits of both capital and operating activities associated with each draft recommendation or proposed project. General assumptions will be made regarding capital and operating costs for each proposed network recommendation. (Those projects that are already in the project development or environmental phase will not be evaluated.) These cost assumptions will be used only for comparative purposes and are intended to provide information that can be used in prioritizing and/or phasing of project implementation.
    - **Capital:** This evaluation will allow Alameda CTC to do a comparative assessment of capital projects with respect to each identified goal.
    - **Operations:** A significant portion of the county's funds will continue to support operations and maintenance of transit services. The operating performance varies significantly across transit operators. This evaluation will allow Alameda CTC to evaluate operations practices of transit operators.

Both quantitative and qualitative performance measures have been identified for network and project evaluation. These are described below. Results from the evaluation of the draft recommendations using quantitative and qualitative performance measures will be presented in a matrix format. The transit vision network will also be evaluated against existing conditions and baseline conditions networks. For each performance measure, results will be presented on a three-point scale (low, medium, high). Each performance measure will be assigned weights determined through discussions with Alameda CTC. The performance evaluation outcomes will be presented to the Commission in early 2016.

Quantitative Performance Measures

Quantitative performance measures for each goal are summarized in Table 2 and are described in the following section.

Table 2: Quantitative Performance Measures

#	Goals	Performance Measures		
		Network-Level	Project-Level Capital	Project-Level Operating
1	Increase transit mode share	Per capita daily transit ridership	Net new riders	
		Percentage of intra-county trips on transit		
2	Increase effectiveness (including inter-regional travel)	Passenger trips per revenue vehicle mile		Passenger trips per revenue vehicle mile
		Miles of dedicated right-of-way (proxy for travel time reliability)	Miles of dedicated right-of-way (proxy for travel time reliability)	
		Daily transit trips (unlinked)	Daily transit trips (unlinked)	
			Reduction in transit travel time (peak/off-peak)	
		Number of transit hubs served, including inter-regional hubs		
3	Increase cost efficiency		Capital cost per net new rider	
		Operating cost per boarding		Operating cost per boarding
4	Improve access	Number of HH/jobs within half-mile of transit stops within each service tier	Number of HH/jobs within half-mile of transit stops	
		Number of Communities of Concern affected		
5	Reduce emissions	GHG emissions	Zero emission vehicles	
6	State of good repair		Cost of mid-life overhaul and/or replacements before 2045 to be included in cost estimates	

The definitions for the quantitative performance measures are as follows:

- **Per capita daily transit ridership**: This measure will be used to compare transit usage normalized with population over time (2010 vs. 2040). For evaluation of networks, ridership and population data will be taken from the travel demand estimation process (using both the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix of Attachment B). For evaluation of operations, ridership data reported by transit agencies and population estimates/projections prepared by state or regional agencies will be used.
- **Percentage of intra-county trips on transit**: This measure will be used to track progress towards increasing transit mode share for intra-county trips. For evaluation of networks, intra-county ridership data will be taken from the travel demand estimation process (using both the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix of Attachment B).

- **Net new riders**: This measure will be used to compare the ability of a project to attract new riders to transit. This measure will be used for evaluation of projects only and will use estimates of net new riders from the travel demand estimate process.
- **Passenger trips per revenue vehicle mile**: This measure will be used to assess the utilization of service for both networks and projects. For network and project evaluations, the passenger trips will come from the travel demand estimation process, while the revenue vehicle mile data will be derived from proposed service levels.
- **Miles of dedicated right-of-way**: This measure is a proxy for the reliability of transit service under the assumption that exclusivity reduces schedule variability associated with intermittent general purpose traffic congestion. The measure will be used for both network and project evaluations. The data will come from each project definition.
- **Daily transit trips**: This measure will show the transit trips associated with the project and will be aggregated at the network level. This measure is being used in addition to net new riders to allow for comparison to other transit agencies and provide input to efficiency metrics such as passenger trips per revenue vehicle miles. This data will come from the travel demand estimation process.
- **Reduction in transit travel time**: Transit travel time improvements will be estimated based on the type of physical changes proposed for the corridor. This measure will be applied at the project level. This data will come from a combination of using the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix of Attachment B.
- **Number of transit hubs served, including inter-regional hubs:** This measure will show the "interconnectivity" of a particular transit line. This data will come from project definition evaluated against the existing and planned transit hubs.
- **Capital cost per net new rider**: This measure will be applied at the network and project level. Capital costs will be estimated from data bases that have compiled costs for comparable types of improvements in Alameda County and in other regions.
- **Operating cost per boarding**: This measure will be applied at the network and project level. Operating costs will be estimated from current operating costs for comparable types of service in Alameda County and other regions.
- **Number of households (by income level) and jobs within half-mile of transit stop within each service tier**: This measure provides useful information related to the potential overall market and equity issues associated with proposed service changes. It will be applied at the network and project levels. It also, provides a measure that helps provide context for the comparison of proposed projects in Alameda County to similar transit projects implemented elsewhere in the US.
- **Number of Communities of Concern affected:** This measure will help to establish whether the proposed modification will have a positive impact on Communities of Concern, i.e. those communities that face particular transportation challenges, either because of affordability, disability, or because of age-related mobility limitations. These may also be defined as those areas covered by Community Based Transportation Plans. A qualitative assessment of the extent to which proposed transit improvements benefit these communities will also be performed.

- **GHG emissions:** This measure will be applied on the network-level only and is generated based on output from the travel forecasting process (using both the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix of Attachment B).
- **Zero emission vehicles**: This measure will be applied at the project level as an indicator of relative fleet emission impacts associated with the proposed improvement. Information on the use of zero-emission vehicles will be obtained from individual transit operators.
- **Cost of mid-life overhaul and/or replacements before 2045:** In order to reflect the goal of state of good repair, project cost estimates will take into account the cost of a mid-life overhaul and capital replacement required before 2045 as appropriate depending on asset type. This information will be obtained from individual transit operators as well as from the consultant team's database of relevant transit capital projects.

Qualitative Performance Measures

In addition to the quantitative measures listed above, the projects will also be evaluated using a set of qualitative performance measures to capture those benefits that cannot be readily modeled or forecasted so as to provide a quantitative metric. Qualitative measures include:

- **Support TOD strategy:** Linking transit investment with supportive land use patterns is critical to the success of transit. This performance measure will assess the characteristics of land uses adjacent to the proposed transit project to assess the potential for transit success by addressing the following questions:
  - *Density* – Are high density development and housing affordability requirements in place for development near transit stations/stops?
  - *Mix of Uses* – Does the local jurisdiction have policies that encourage mixed-use development, such as zoning codes that allow a mix of uses, form-based development codes (which generally facilitate mixed use development or co-location of different uses better than conventional zoning approaches), innovative jobs/housing balance policies and programs, shared parking allowances or requirements?
  - *Parking Management Policies* – Does the local jurisdiction have progressive parking policies, such as value or demand priced parking, reduced parking requirements in areas served by transit, parking maximums, shared parking policy, reduced parking for affordable housing units, provision of free or reduced-cost transit passes, and a tracking system to monitor these programs?
- **Number of existing or planned major activity nodes served:** Major activity nodes with high levels of transit demand serve as anchors for transit routes. Generally, major activity nodes are locations where there are a concentrated number of trip destinations and/or origins, such as colleges or universities, downtown central business districts, shopping centers, and large medical centers. The routes that are most productive not only have major anchors at each end of the route, but also have the potential to generate robust transit demand along the route.

Proposed projects will be evaluated in terms of how well they serve multiple existing or planned major activity nodes (including active PDA's).

- **Intermodal connectivity**: Projects will be evaluated in terms of how effectively they connect different types of transit services within the transit network. This will be evaluated by assessing the number of transit service tiers served and the ease of access between different transit modes.
- **Customer experience:** Customers' expectations evolve as amenities and services become available to them. Most transit agencies in Alameda County have carried out customer satisfaction surveys to identify factors that affect customer decision-making related to using transit. Most agencies have also adopted performance measures to track customer satisfaction over time. A qualitative assessment will be made of each project's impact to the rider's experience based on factors such as: service reliability, ease of transfers, ease of access to transit information and whether or not the proposed project has the potential to improve customer satisfaction.
- **Compatibility with Arterials Plan recommendations**: Coordination with the Arterials Plan typologies will ensure consistency between both plans.

Fiscal Impact: There is no fiscal impact.

Attachments

A. Countywide Transit Plan Technical Memo #5 Draft Network Recommendations
B. Countywide Transit Plan Technical Memo #6 Evaluation Methodology and Performance Measures

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Draft Transit Network Recommendations

Countywide Transit Plan

DRAFT Technical Memo #5

ALAMEDA
County Transportation Commission

Prepared for:
Alameda County Transportation Commission

Prepared by:
Parsons Brinckerhoff

With

Cambridge Systematics
Community Design & Architecture
Strategic Economics

October 2015

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Introduction

This technical memorandum describes the Draft Transit Network Recommendations developed to help Alameda County realize its vision to "Create an efficient and effective transit network that enhances the economy and the environment and improves quality of life."[1] As an early step in the development of a transit network vision for Alameda County, this technical memorandum focuses on the identification of draft recommendations for changes to the existing transit network for incorporation into the Countywide Transit Plan. It also presents a conceptual framework in the form of service tiers to clarify the differing elements of the demand for and provision of transit service. In future stages of plan development, the proposed recommendations identified in this memorandum will be evaluated, revised, and combined with existing service and other planned improvements to form an integrated vision for future transit service in Alameda County.

The Draft Transit Network Recommendations resulted from an in-depth analysis of future (year 2040) travel and land use forecasts and were refined in consultation with staff from the transit operators serving Alameda County and local jurisdictions. This analysis enabled the consultant team to identify areas where travel and land use patterns as well as employment and population densities indicated that there would be a strong market demand for fast, frequent transit service. In other words, there would likely be high enough transit ridership to support the more significant capital and operating investments typically required to provide transit service that is fast and frequent. Conversely, providing fast, frequent transit service in these areas would be most likely to result in the greatest number of people using transit instead of private automobiles, since fast, frequent transit service could provide a more effective means of transportation in terms of travel time and cost.

While the focus of the Draft Transit Network Recommendations is on identifying areas where implementing fast, frequent transit service could not only significantly increase transit ridership but also substantially enhance the functionality of our transit network, the final Countywide Transit Plan will provide a comprehensive set of recommendations for better integrating all tiers of transit service into a fully functional, effective and efficient transit network. To facilitate that effort, this memorandum also discusses the existing studies and plans currently being undertaken by AC Transit, Capitol Corridor, the Altamont Corridor Express (ACE), the Water Emergency Transportation Authority

1 Alameda CTC Countywide Transit Plan Vision and Goals adopted March 26, 2015.

(WETA), and BART and how they relate to the specific recommendations made as part of the Countywide Transit Plan.

Overview of Opportunities and Challenges

Alameda County has both conditions supportive of higher transit ridership and at the same time many obstacles to overcome. The key opportunities and challenges that were discussed in detail in Technical Memorandum #2 are summarized below.

Opportunities – Alameda County has a Strong Overall Transit Market

Overall, Alameda County has strong markets for transit, both now and in the future as demonstrated by current and future technical analyses which focused on transit market opportunities. This means that the majority of communties in Alameda County have favorable land use characteristics and population and employment growth projections that point toward an increasing demand for transit use. This market strength was identified in the transit market assessment conducted and documented in Technical Memorandum #2 using a Transit Competitiveness Index (TCI) tool to evaluate competitive transit markets in the county, and is briefly summarized here.[2]

The TCI is a tool to identify which transit markets are most competitive for transit. An individual transit market is an origin and destination pair with a unique set of travel characteristics. Consider the following two trips: A downtown Oakland origin to a San Francisco Embarcadero destination compared to a Fremont residential origin to a Livermore office park destination. These two transit markets have different characteristics which describe the origins and destination, including streescape quality, parking availability, roadway congestion, and population and employment density.

Some individual transit markets have characteristics that make a particular origin-destination pair more competitive for transit, making it more likely that transit is the travel mode chosen for this trip. Common attributes of the most competitive transit markets include medium to high density land uses often with a mix of uses (where there is a more concentrated are for people to collect to use transit services); limits on free parking; and congested roadways that slow auto travel. Conversely, some *travel markets* have disadvantages, making the use of transit as a mode of travel less competitive. These include low density land uses (which make it more challenging to

[2] TCI analysis conducted by Cambridge Systematics, 2015.

concentrate people in a single area to use transit), plentiful free parking, and an unpleasant pedestrian environment.[3]

An overall transit market aggregates individual transit markets within a geographic area.The TCI assessment of all of Alameda County's *travel markets* shows a overall transit-competitive market for travel within, into and out of Alameda County.[4] In the 2010 baseline, almost 54% of all Alameda County trips and 43% of the work trips were in transit competitive markets.

By 2040, the overall transit market is forecasted to show 58% of all trips and 48% of work trips being made in transit competitive markets. The analysis further showed that a significant number of the existing transit routes in Alameda County operate in strong transit markets, but that the ridership on these routes does not always reflect the high potential for transit use.

Capturing the trips in these underperforming transit markets is critical to increasing transit ridership in the county.

Challenges – Strong Transit Markets Don't Necessarily Result in High Tranist Ridership

While Alameda County has conditions supportive of increasing transit ridership, there are significant obstacles to overcome. The following facts provide evidence that improvements systemwide are necessary:

- **Low transit mode share**: Despite the high overall transit competitive markets shown by the TCI scores,[5] transit currently only captures approximately 14% of the commute trips in the county.
- **Transit ridership growth for intra-county buses is flat:** Despite the presence of good market conditions for transit in Alameda County,[6] bus ridership declined between 2006 and 2012 and then remained relatively flat until 2014, the most recent year for which data was collected. This may be linked to service cuts and poor on-time performance of bus operators throughout the countywide network. [7] Where transit markets are strong **and** transit service is frequent, reliable, and highly competitive with vehicle travel times, such as the East Bay-San Francisco transbay corridor, transit ridership has grown significantly.

[3] Metropolitan Transportation Commission, Transit Sustainability Project. *TCI Draft Primer*. n.d. http://www.mtc.ca.gov/planning/tsp/TCI-DRAFT-PRIMER.pdf.
[4] The analysis was based on the 2014 update of the Alameda Countywide Travel Demand Model, which uses 2010 as a base year.
[5] TCI analysis conducted by Cambridge Systematics, 2015.
[6] TCI analysis conducted by Cambridge Systematics, 2015.
[7] Alameda CTC 2014 Performance Report.

- **Systemwide operating costs are increasing faster than ridership:** This points towards a lack of sustainability for operators. Improving transit's share in the overal transportation market is a key element in the county's ability to accommodate new residents, supportenvironmental goals and meet Alameda County's vision of increasing transit mode share.
- **Poor on-time performance and declining bus operating speeds:** This affects both ridership as well as the financial sustainability of our bus transit systems. Slow operating speeds require additional vehicles and drivers just to maintain current frequencies. This reduces the resources available to expand service frequencies and realize potential ridership gains that are likely to result from more frequent, reliable service. Close coordination between local jurisdiction and transit operators is critical to address this challenge.

In addition to the existing transit challenges, population and employment are forecasted to continue their growth by more than 30% by 2040.[8] Improving transit's share in the overal transportation market is a fundamental component that will be needed to accommodate increases in population and mobility needs.

The Countywide Transit Plan focuses on how Alameda CTC can help to improve the transit system and service for the future by focusing investments in those areas that have the greatest potential to increase transit ridership. Although specific proposed changes will be discussed in detail later in this technical memorandum, the main areas that provide opportunities to improve transit performance and increase transit ridership include:

- **Speed, Frequency and Reliability**—Poor on-time performance and variable transit travel times currently experienced on many bus routes can be addressed through transit-related improvements to roadway elements (e.g. queue jumps, bus bulbs, transit priority lanes, transit signal priority, etc.) which will need to be coordinated closely with local jurisdictions and Caltrans, as applicable.
- **Transit integration—**For a transit system to be successful, it needs to have both physical and institutional integration that allows the customer to experience a seamless trip by transit. In Alameda County and throughout the Bay Area, the lack of full integration between transit providers is reflected in poor connectivity, multiple fare structures and ticketing, and poorly integrated transit information. Though the Clipper Card has resulted in improvements for transit riders, it has yet to be fully integrated and accessible (it is not yet availabile on all transit operators), and transfers between operators still require additional fares. This

[8] Plan Bay Area, Metropolitan Transportation Commission, 2013. Alameda County population is expected to increase by 32 % and employment by 36% between 2010 and 2040.

lack of seamless transition between operators discourages transit use for those that have alternative choices and makes transit travel less convenient and more costly for those who are transit dependent.[9]

- **Gaps in service coverage**—While transit service coverage is generally high in Alameda County, gaps in hours of operation, frequency of service, and in route capacity can deter transit riders. Capacity constraints are a particularly acute problem in the Transbay corridor to San Francisco.

Organization of this Technical Memorandum

This technical memorandum is organized to lead the reader through the process used in developing the recommended transit improvements. A brief summary of each of the following sections is provided below.

The **Transit Tier Structur**e describes the five tiers that form the transit network and how these tiers are integrated to form a complete transit system for Alameda County. It also describes the agency roles for each transit tier and what the focus of investment is for Alameda County to achieve the best transit future. Tiers are not intended to denote priorities, rather they are used to describe distinct characteristics of types of transit service.

The **Network Development Methodology** section describes the market analysis that was conducted to identify the most highly competitive transit markets in Alameda County. It describes the approach that was used to identify the major centers of concentrated activity in Alameda County, determine the strongest transit markets linking the activity centers, and develop the draft recommendations for transit infrastructure and service improvements based on the greatest potential for capturing new transit riders.

The **Draft Network Recommendations** section lays out the proposed transit improvements by tier and includes a brief description of each draft recommendation.

[9] Seamless Transit, How to make Bay Area public transit function like one rational, easy-to-use system, April 2015, SPUR.

Transit Tier Structure

This section of the memorandum describes the transit tier structure that forms the framework for the Draft Transit Network Recommendations that follow. A transit tier structure was selected as an organizational tool to help frame the discussion of the existing array of transit services, the methodology used to identify future needs, and the draft recommendations.

It is important to note that the tier structure does **not** imply a hierarchy of importance among the transit services or tiers. The purpose of the transit tier structure is to facilitate the understanding of different transit markets, service operations and operational characteristics, how they relate to the proposed network improvements, and how they combine together to create a comprehensive transit network. Each geographic transit tier is fundamentally connected to the rest, and the strength (or weakness) of each tier strengthens (or weakens) the entire transit network.

Why Create Transit Tiers?

To be effective, an urban transit system must function at several different levels, serving different markets and modes and weaving together the services that are provided by multiple operators. This is a particular challenge in the Bay Area, which has so many different transit service providers. A well-functioning transit system will have a means of not only delivering different types of service, but also of connecting the different service levels so that a trip on transit, particularly one requiring transfers, is as seamless as possible for the transit rider.

This technical memorandum uses a transit service tier structure as an organizing principle to explain how the Alameda County transit system functions today and to present the potential improvements to the transit network. Separation of transit services into tiers allows for a more nuanced discussion of the differing aspects of transit service including:

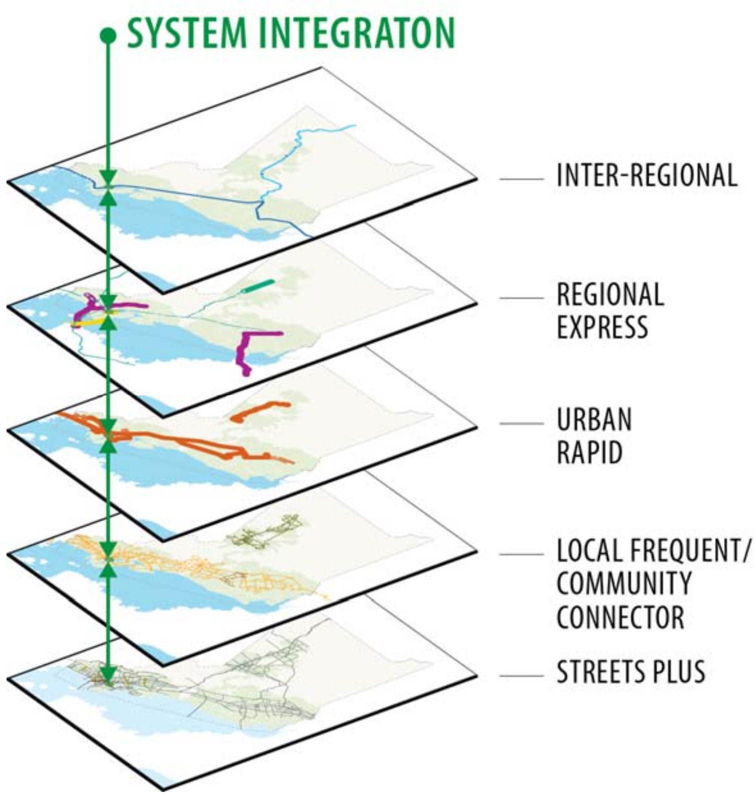
- Transit markets and operating environments
- Distribution of trip purposes and traveler profiles
- Service operating characteristics
- Volume of passengers and levels of investments required

Categorizing transit into separate tiers also facilitates the discussion of the inter-relationships between service providers and how connectivity between the transit tiers can be accomplished. Connectivity is provided in two ways: 1) physically, by bringing the various tiers of transit together at major transit hubs or activity centers where quick and easy transfers between modes or operators can be made and 2) institutionally by integrating transit information, transit fares, and fare collection systems.

The following section describes the attributes and existing conditions for each tier in the Alameda County transit network. The tiers were developed by surveying transit operators. A more detailed description of the approach to development of the tiers is provided in Appendix A.

Figure 1 provides an overview of the Transit Tier Structure. Each of the five transit tiers and the underlying street network all serve important functions in the delivery of transit services. However, Alameda CTC has the greatest potential to affect transformative changes to transit at the Regional Express and Urban Rapid tiers. By investing in fast, reliable, and high capacity transit services throughout the county, transit becomes a more attractive and convenient choice for a broader spectrum of travel.

Figure 1. Transit Tier Structure



System Integration

Critical elements of a successful transit system include physical integration (i.e. how the street network functions) in conjunction with the transit network and institutional integration (i.e. how services and information are coordinated) both affect the transit customer experience. The physical integration includes how different transit services provide connectivity and the role of activity nodes and transit hubs in facilitating those connections. Institutional integration includes coordination on those elements that support transit services such as fare payments, transfer policies, and transit information.

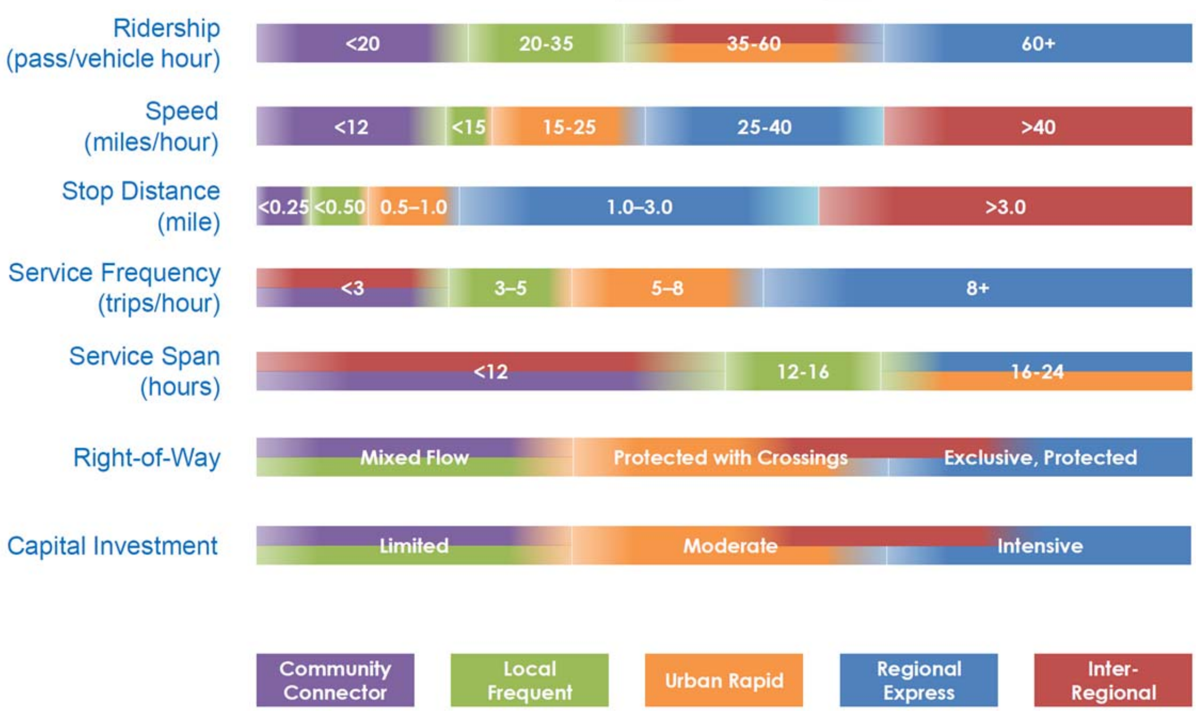
Providing an integrated transit system depends on the cooperation and willingness of all levels of government and the private sector to play a role in improving transit services.

Source: Parsons Brinckerhoff, 2015

Service Characteristics of Transit Tiers

Each of the tiers serves a different travel market and has different service characteristics. Figure 2 presents the general spectrum of characteristics for each type of service with the exception of Inter-regional service and the Streets Plus tier. As shown in Figure 2, there is some overlap of service characteristics at the boundaries of each service tier.

Figure 2. Transit Tier Characteristics



Source: Arup and Parsons Brinckerhoff, 2015

Because the trips served are generally longer distance trips that connect to major employment and other activity centers, the Regional Express tier provides the highest level of service in terms of capacity, speed, frequency and span of service. Regional Express services are often operating in exclusive or protected rights-of-way with limited stops and require extensive capital investments, such as BART.

Urban Rapid services, which provide fast, frequent, reliable transit service for intra-county trips, may have dedicated lanes on surface streets with transit signal priority at intersections and provide more frequent stops than Regional Express services, but limit stops to provide faster service to final destinations. Depending on the type of service provided, captial investments can be significant (as in the case of bus rapid transit with dedicated transit lanes, level boarding, proof of payment systems, and stations) or more moderate (for example, rapid services may include some but not all of the elements of a full bus rapid transit line).

Local Frequent services provide frequent service along productive (in terms of ridership) corridors, but with more dispersed origins and destinations and therefore don't warrant the same level of intense investment service as Urban Rapid corridors. Services in the Local Frequent tier also provide important cross-town connectivity between Urban Rapid services. The Community Connector services provide a basic level of community coverage for access to critical community facilities and shopping and to connect to other transit service tiers. Both of these services have less freqent (as compared to Urban Rapid services) and lower overall passenger capacity, but are critical in providing mobility within a community and connectivity to more rapid higher tier services.

The characteristics of Inter-regional rail service (Capitol Corridor and ACE) fall on a somewhat different scale than those that are presented for the four tiers summarized in Figure 2. On one end of the specturm, inter-regional travel generally serves trips that are longer-distance (greater than 40 miles), at higher speeds (greater than 40 miles per hour), and with limited stops (greater than 3.0 miles apart). Inter-regional services usually operate on exclusive rail rights-of-way (ROW), but often share the ROW with freight operations, which can impact their services. Capital investments tend to be significant, but may be lower than investments in a system such as BART depending on the type of service provided. On the opposite end of the spectrum, the service frequency and span of service tends to be more limited, generally falling into peak periods or running at frequencies of one hour or greater.

The five transit tiers and the Streets Plus tier are described in more detail below.

Inter-Regional Tier

Altamont Corridor Express

Capitol Corridor

Distinguishing features of the Inter-regional tier

- Typically longer-distance lines than other tiers, usually greater than 40 miles.
- Service and passenger trips pass through multiple counties.
- Passenger rail service shares right-of-way with freight rail service.
- Typically framed and planned within the context of statewide and inter-city rail services.
- Trips tend to have dispersed origins arriving at the station via a variety of modes.
- Stations act as hubs for longer-distance travel and provide an opportunity for intermodal connections.
- Much of the service area is outside of Alameda County's sphere of influence.
- Combined ridership for all existing services in the inter-regional tier represents less than 1% of the total transit ridership in Alameda County.[10]

Service included in the Inter-regional tier

- Altamont Corridor Express (ACE)
- Capitol Corridor
- Amtrak San Joaquin

Service characteristics of the Inter-regional tier

- Higher speed (above 40 mph)
- Very limited stops (3 to 15 miles apart)
- Peak or hourly service frequency
- Exclusive, protected right-of-way (ROW)
- Capital intensive investment

Importance to overall network

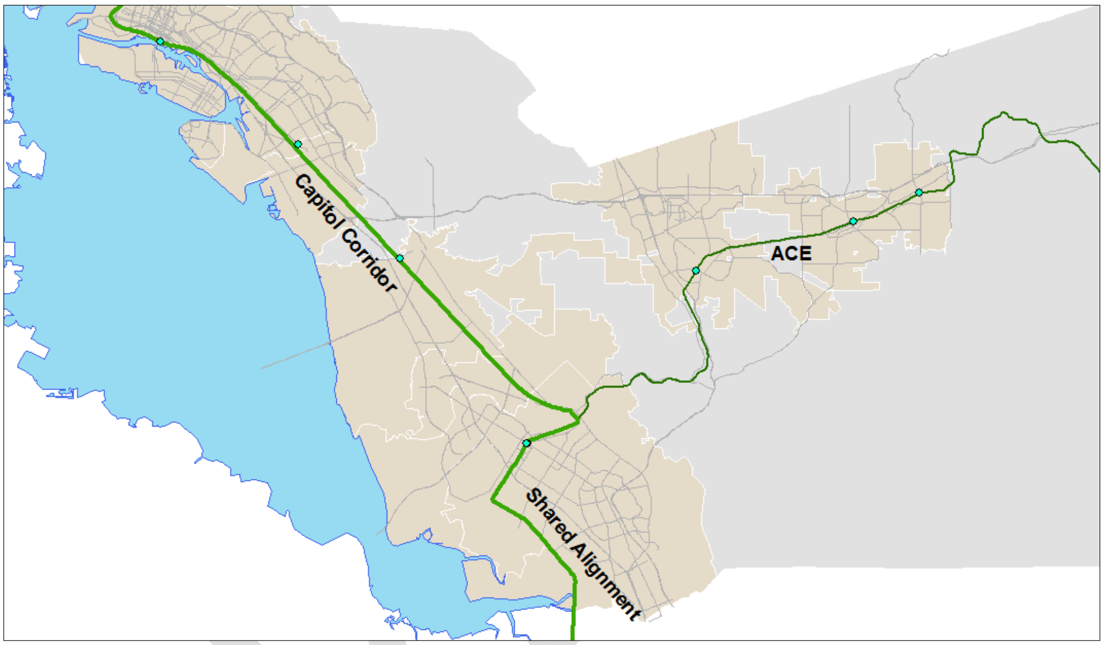
- Links Alameda County (and other Bay Area) origins and destinations with the regional and statewide passenger rail network.
- Relieves pressure on congested highways.
- Provides access to affordable housing outside of the urban core.
- Provides transportation network resiliency (provides redundancy to absorb disruptions to the other elements of the overall transportation system).

[10] Alameda Countywide Transit Plan, Technical Memorandum #2, Alameda CTC, June 2015.

Primary Responsibility for Service

- Statewide Focus - California Transportation Agency, California Transportation Commission (CTC), Regional Joint Powers Authorities
- The existing Inter-regional transit tier is shown in Figure 3.

Figure 3. Existing Inter-regional Tier



Source: Parsons Brinckerhoff, 2015

Regional Express Tier

AC Transit Transbay

BART

Dumbarton Express

WETA

Distinguishing features of the Regional Express tier

- Serves multiple counties and longer distance trips (e.g. Alameda to downtown San Francisco).
- Travel occurs between major nodes where there is substantial point to point travel. Provides access to major employment centers (e.g. downtown Oakland, Berkeley, and San Francisco).
- Transit stations act as hubs for intermodal connections and can serve as a catalyst for Transit Oriented Development (TOD).
- Carries a large portion of county's transit trips.[11]

Service included in the Regional Express tier

- Bay Area Rapid Transit (BART)
- Water Emergency Transportation Authority (WETA)
- Dumbarton Express
- Alameda-Contra Costa (AC) Transit Transbay Service
- LAVTA Express Lines
- County Connection Express Lines

Service characteristics of the Regional Express tier

- High speed (above 25 mph)
- Very limited stops (1 to 3 miles apart)
- High service frequency (greater than 8 trips/hour or headways of 8 minutes or less)
- Service span of 16 to 24 hours
- High ridership (more than 60 passengers/vehicle hour)

[11] Alameda Countywide Transit Plan, Technical Memorandum #2, Alameda CTC, June 2015.

- Exclusive, protected right-of-way (ROW) with the exception of express bus service
- Capital Intensive investment with the exception of express bus service

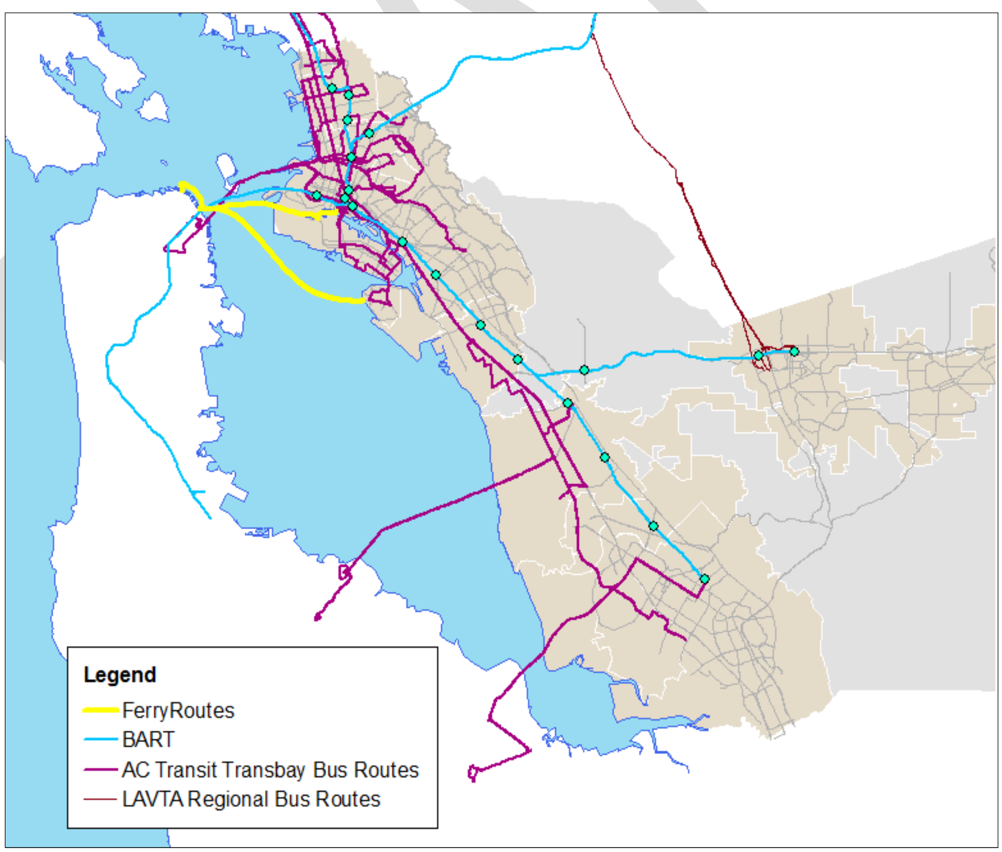
Importance to overall network

- Critical alternative to congested bridges and major highways.
- Links major employment and activity centers with housing.
- Transit stations serve as primary connection points between transit modes and operators.
- Provides transportation network resiliency.

Primary Responsibility for Service

- Regional Focus – Metropolitan Transportation Commission, BART, WETA, AC Transit
- The existing regional express transit tier is shown in Figure 4.

Figure 4. Existing Regional Express Tier



Source: Parsons Brinckerhoff, 2015

Urban Rapid Tier


East Bay BRT


AC Transit Route 1R


LAVTA Rapid Bus

Distinguishing features of the Urban Rapid tier

- Provides travel options between major nodes from productive major transit origins to concentrated destinations. Provides access to major employment centers, universities, and other high trip generators.
- Considered within the spectrum of BRT, but may or may not include complete exclusive ROW operations for the full length of the route.
- Rapid Bus services have been implemented in Alameda County, and the East Bay BRT service on International Boulevard will be the first Bus Rapid Transit (BRT) service in the East Bay.
- Serves trips primarily within Alameda County, but potential to combine or overlap with Transbay service.

Service included in the Urban Rapid tier

- AC Transit (Route 1R, 72R, and East Bay BRT - under construction)
- Livermore Amador Valley Transit Authority (Tri-Valley Rapid)

Service characteristics of the Urban Rapid tier

- Mid- speed (15 to 25 mph)
- Limited stops (0.3 to 1.0 miles depending on presence of underlying local service)
- High service frequency (5 to 8 trips/hour or headways of 12 minutes or less)
- Service span of 16 to 24 hours
- High ridership (35 to 60 passengers/vehicle hour)
- Exclusive, primarily surface operation, protected ROW with crossings
- Moderate capital investment

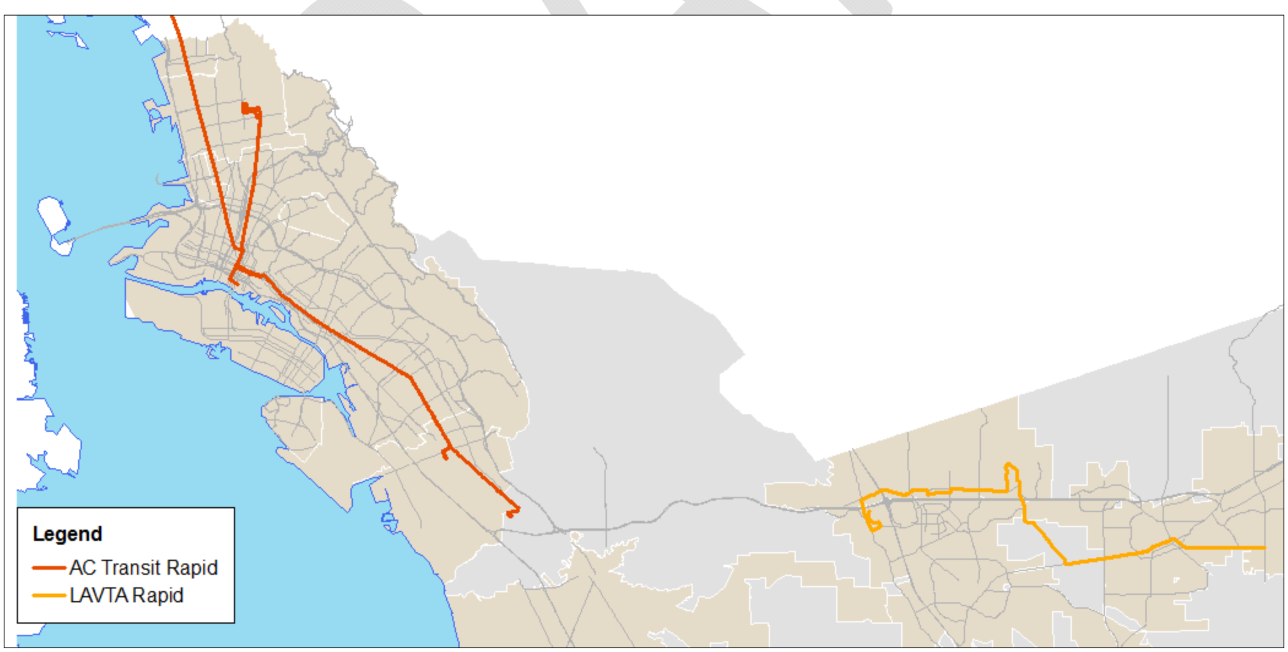
Importance to overall network

- Provides faster and more reliable bus service to complement rail service and primarily serves intra-county travel markets.
- Potential to improve ridership from existing transit service through:
    - Higher quality
    - Increased frequency and reliability
    - Decreased travel time
    - Ease of use
- Proven ability to increase transit ridership when properly implemented.
- Provides services to intermodal stations.

Primary Responsibility for Service

- Countywide Focus – Alameda CTC, Alameda County, Cities, AC Transit, LAVTA
- The Existing Urban Rapid transit tier is shown in Figure 5.

Figure 5. Existing Urban Rapid Tier



Source: Parsons Brinckerhoff, 2015

Local Frequent Tier

Distinguishing features of the Local Frequent tier

- Travels along a corridor with productive, dispersed origins and destinations.
- Serves local trips within Alameda County communities and cities.
- About 32% of the county's transit trips are carried by this tier of service.[12]

Service included in the Local Frequent tier

- AC Transit
- Oakland's Broadway Shuttle
- Emery-Go-Round
- LAVTA
- Union City Transit

Service characteristics of the Local Frequent tier

- Low-speed (below 15 mph)
- Frequent stops (less than 0.3 miles apart)
- Mid-service frequency (3 to 5 trips/hour or 15 to 20 minute headways)
- Service span of12 to 16 hours
- Moderate ridership (20 to 45 passengers/vehicle hour)[13]

Importance to overall network

- Provides service coverage for the county and interconnectivity between Regional and Urban Rapid tiers.
- Provides services to intermodal stations.
- Local community focus rather than longer distance trips.

Primary Responsibility for Service

- County and City Focus – Alameda County, Cities, AC Transit, LAVTA, Union City Transit

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[12] Alameda Countywide Transit Plan, Technical Memorandum #2, Alameda CTC, June, 2015.
[13] Ibid. For AC Transit, a few lines exceed these ridership guidelines.

Community Connector Tier

Distinguishing features of the Community Connector tier

- Provides community access in less productive areas.
- Serves schools, medical facilities, shopping centers.
- Serves trips within Alameda County communities and cities.

Service included in the Community Connector tier

- AC Transit
- LAVTA
- Union City Transit
- First- and last-mile shuttle services, e.g. Kaiser Shuttle, Emery-Go-Round

Importance to overall network

- Critically important to those who are transit dependent
- Provides connections to other modes
- Local community focus rather than longer distance trips

Service characteristics of the Local Frequent tier

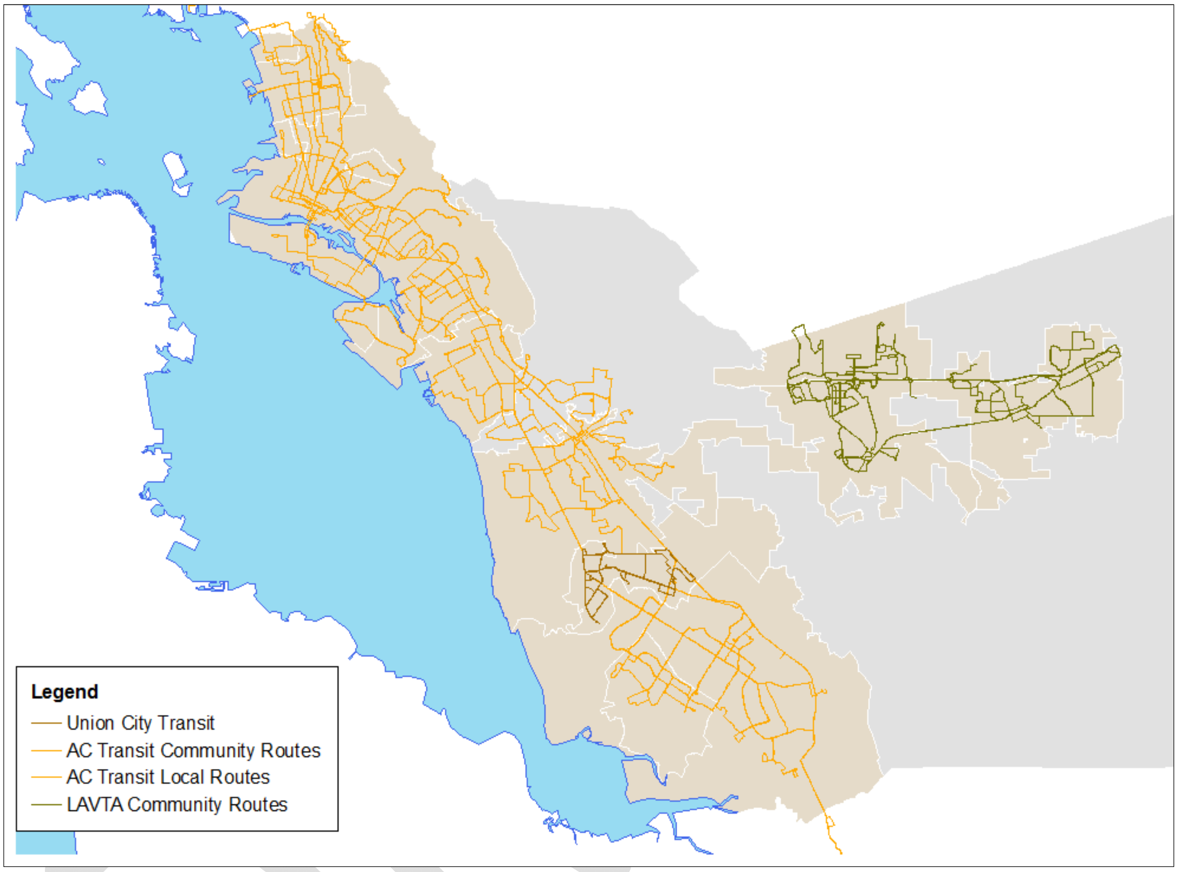
- Low-speed (less than 12 mph)
- Frequent stops (less than 0.25 miles apart)
- Mid-service frequency (less than 3 trips/hour or headways that are 20 minutes or greater)
- Service span of less than 16 hours
- Lower ridership (less than 35 passengers/vehicle hour)
- Surface operation in mixed-flow
- Limited opportunities for capital investment

Primary Responsibility for Service

- Community and City Focus – Alameda County, Cities, AC Transit, LAVTA, Private operators
- The existing combined Local Frequent and Community Connector transit tiers are shown in Figure 6 (with the exception of shuttle services). Because the focus of the Countywide Transit Plan is on those service tiers that require more intensive capital investment and serve multiple jurisdictions, subsequent

discussion of these two service tiers is combined. It is assumed that local jurisdictions and transit agencies will have primary responsibility for planning and implementing these services.

Figure 6. Existing Local/Community Tier



Source: Parsons Brinckerhoff, 2015

Streets Plus Tier

Distinguishing features of the Streets Plus tier

- The street network provides the right of way within which bus service operates and is therefore a critical component of creating an efficient and effective transit network.
- All transit trips in Alameda County start as walk, bicycle, or auto trips and use the street network for access to the transit system.
- Certain streets are particularly critical to maintaining and enhancing the functionality of the bus transit network either because of the number of bus

routes that converge or run on them or because they provide critical links in the surface transit network.

Service included in the Streets Plus tier

- Pedestrians
- Bicyclists
- Buses
- Automobiles and trucks

Importance to overall network

- Provides first and last-mile access to transit, whether by bus, shuttle bus, bicycle, or walking.
- For transit patrons, having a safe, clean, and pleasant experience on the street is critical to customer satisfaction.
- Provides vehicular access to park-and-ride and kiss-and-ride transit stations.

Primary Responsibility for Service

- Local – Alameda County and Cities

All of the tiers of the transit network need to function as a well-integrated system for transit to be successful. To realize the transit vision for Alameda County, investments in the transit network, transit service levels, and the supporting infrastructure and institutional framework are needed. Cooperation from all of the responsible parties identified above will be required to achieve that success.

The following sections describe how the recommendations for network and service improvements were developed and what improvements are recommended for further evaluation.

Network Development Methodology

This section describes the overall approach and methodology that was used to develop the Draft Transit Network Recommendations. Given the challenges identified earlier in this document and the expected growth in population and employment, the focus of the network development task was to identify strong transit travel markets and match them with appropriate transit facilities and services that will ultimately result in increased ridership and higher transit mode share within Alameda County.

Five transit service tiers were identified in the previous section of this technical memorandum. In developing draft recommendations for network improvements, the focus was on the core Regional Express and Urban Rapid markets. These are the markets that are served by BART, the ferries, AC Transit, and LAVTA. These markets are the ones that have the greatest potential to capture more transit riders by expanding capacity and service levels and by improving service frequency and reliability.

The Inter-regional service tier and its travel markets extend beyond the scope of Alameda County, and improvements to those services are planned within the context of the statewide rail system and greater Northern California region. Both Capitol Corridor and ACE are currently in the process of developing a future vision for their services in coordination with the communities that they serve. Consequently, this memorandum does not include specific recommendations for Inter-regional service. Instead, the Countywide Transit Plan will ultimately incorporate the outcomes of those ongoing planning efforts.

The Local Frequent and Community Connector services are focused on services that link to the Regional Express and Urban Rapid tiers and do not require the same level of capital investment to improve transit service. Rather than make specific recommendations for the numerous Local Frequent and Community Connector routes, the Countywide Transit Plan will highlight the role these service tiers play in creating a cohesive transit network.

Furthermore, it is important to note that the draft recommended network changes identified in this technical memorandum do not represent the final plan. Individual projects presented later in this document represent ideas worthy of further investigation based on a combination of factors including market demand, regional connections, ability to improve existing transit system constraints. Each potential change to the transit network will be evaluated against the adopted goals and performance measures in a future phase of this project.

Focus on Competitive Markets

Why Focus on Markets?

While most of Alameda County has competitive transit markets (as documented in Technical Memorandum #2), the methodology intentionally focuses the identification of potential new corridors for transit investment on areas showing the most highly competitive markets that would benefit from infrastructure improvements to facilitate the flow of transit on the busy street network. These are generally bus transit lines in the Urban Rapid tier – those that have potential for high ridership, but are experiencing poor on-time performance and reliability due to congestion and could be providing higher frequency service. The focus on these transit markets is critical to addressing one of the key challenges facing transit in Alameda County – the lack of growth in bus ridership, particularly on AC Transit routes.

Typical Factors that Contribute to Increased Transit Ridership:

- *Higher housing and employment density*
- *Increased employment*
- *Limited access to a car*
- *Higher gasoline prices*
- *Lower costs for transit*
- *Limited and costly parking*

Alameda County has a mature transit system with a robust local bus network in addition to inter-regional rail, BART and transbay buses and ferries. The key to increasing transit ridership and transit mode share in the county is to link the promising yet underperforming transit markets with an enhanced infrastructure and level of service that can capture more choice riders and better serve existing riders. When high levels of service are provided in robust transit markets, ridership increases, as evidenced by the surge in ridership on BART's and AC Transit's transbay services.

To identify the competitive markets for further evaluation, a tool called the Transit Competitive Index (TCI) was used. The TCI evaluates travel market conditions to determine the potential for transit success in a given area. The travel markets consist of all motorized modes of travel between identified nodes of activity – either where trips start (origins) or end (destinations). The TCI measures the conditions that have the greatest effect on the competitiveness of transit relative to auto travel and aggregates them into a single number.

For Alameda County, the conditions are taken from the mode choice module of the Alameda CTC travel demand model. The conditions evaluated include: land use density and diversity, roadway congestion, parking cost and search time, household characteristics, trip purpose, central business district characteristics, and tolls.

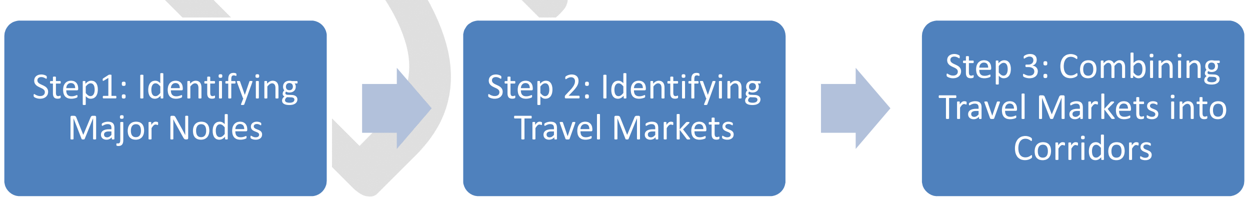
This section describes the methodological approach to identifying the most competitive transit markets and the process by which draft recommendations for infrastructure and service improvements were developed.

Analyzing the Transit Market

The analysis of transit markets relies on the 2040 projected travel patterns generated from the Alameda CTC travel demand model updated in 2014. The county travel demand model uses population and employment projections for 2040 based on anticipated population and employment growth from the most recently adopted *Plan Bay Area*. The Association of Bay Area Governments (ABAG) and MTC provide a common growth projection for the region, which is allocated to the counties and cities within the nine-county Bay Area region. The plan projected an increase of 1.1 million jobs, 2.1 million people, and 66,000 homes in the Bay Area between 2010 and 2040. Growth was distributed to communities with access to existing or planned transportation investments in line with the requirements from SB 375 to help achieve the regional greenhouse gas reduction targets and to house all of the region's projected population growth across income levels.[14,15]

The trip volumes generated from the travel demand model and used for the transit market analysis were based on the growth projections from *Plan Bay Area* that were allocated to Travel Analysis Zones (TAZs). Using the model data and the Transit Competitiveness Index (TCI) tool, an analysis was conducted to determine the potential viability of transit markets in Alameda County. Transit viability was based on the density of trips, housing, and jobs within each TAZ and confirmed against the TCI score for the TAZ. Once transit viability was confirmed, corridors were identified for transit investments (see Figure 7) based on trip density.[16]

Figure 7. Corridor Development Process



Source: Arup and Parsons Brinckerhoff

[14] Plan Bay Area, Strategy for a Sustainable Region, Metropolitan Transportation Commission, July 2013.
[15] Senate Bill 375 mandates a Sustainable Community Strategy (SCS) to be incorporated into the regional transportation plan.
[16] The Transit Competitiveness Index was developed by Cambridge Systematics (CS) and the market assessment was also conducted by CS.

The methodology had three main objectives:

- Identifying major activity nodes (locations with a large conecntration of trip origins or destinations) from the 2040 projections for trip origins and destinations by travel analysis zones (TAZs).
- Defining travel markets between the major origin and destination activity nodes according to their projected travel volumes in 2040.
- Analyzing the travel markets and identifying corridors for potential transit improvements.

Identifying Alameda County Activity Nodes

Seven separate analytical steps (described below in more detail) were used to identify major activity nodes. A more detailed discussion of the process is documented in Appendix B.

1. **Identifying trip origins and destinations for each of the 1,580 traffic analysis zones (TAZs) in Alameda County through the use of the regional travel forecasting model.** The TAZs were ranked in descending order based on the number of trip origins and destinations.

2. **Determining TAZ thresholds to identify competitive transit markets.** The ranked lists developed in Step 1 were classified in ArcGIS using the "natural breaks" method. The natural breaks method is a statistical method that uses data clustering to create distinct classifications of data and to maximize the variance between the classifications. It is a method for creating naturally occurring categories. For the transit plan, the approach was to create a break point that distinguished the most *highly* competitive transit markets in the county from the broader number of competitive markets that exist throughout Alameda County. The trip density break points that were developed using this methodology were:

    - Origin Nodes: 70,000 trips per square mile, and
    - Destination Nodes: 100,000 trips per square mile

3. **Validating TAZ population and employment densities through land use and market analysis.** To confirm that the TAZs selected as activity nodes were accurately capturing the most transit competitive areas of the county and where growth was most likely to occur, a check was made against independently produced population, housing, and job density maps that overlaid the county's Priority Development Areas (PDAs). The activity nodes were also compared to the most active residential and commercial areas using a market index tool as an

indicator of where growth was most likely to occur.[17,18] Minor inconsistencies between land use and trip densities were corrected.

4. **Refining the transit market by consolidating TAZs to create major activity nodes**. Activity nodes were consolidated to form major activity nodes. A 1/3 mile radius circle was drawn from the centroid of each activity node. If the 1/3 mile radius circle overlapped other activity nodes, the nodes were combined to form a major activity node and a new centroid was defined.[19] If the 1/3 mile radius circle did not overlap other activity nodes, then the activity node alone was identified as a major activity node.

5. **Final delineation of the major activity nodes.** For the next step in the creation of major activity nodes, a 1/2 mile radius buffer was created around each of the major node centroids described above. A 1/2 mile radius circle was drawn from the centroid of the newly defined major activity nodes. TAZs were once again combined if at least half of the TAZ fell within the 1/2 mile radius circle, the distance that is considered to be a reasonable walking distance to access transit. Applying the "natural breaks" methodology to these newly defined major activity nodes, a second tier of thresholds was established for these more broadly defined major activity nodes:

    - Origin Nodes: 50,000 trips per square mile, and
    - Destination Nodes: 80,000 trips per square mile.

    The final delineation of the major activity nodes included the most competitive activity nodes aggregated with those that that had a slightly lower trip density and a slightly higher potential walk distance. Nodes that qualified as both origin and destination major activity zones were identified as such.

6. **Validating the designation of major activity nodes through the application of the TCI score (a separate indicator of transit competitiveness).** As a final check on the methodology, the aggregate TCI scores were measured for each of the major activity zones. All of the major activity zones that were created had a TCI above 500, indicating that they were all strongly competitive transit markets.[20]

    The desired outcome of the systematic application of this methodology was to create a manageable number of major activity nodes that would not generate a

[17] April 10, 2015 Memorandum from CD&A: Identifying TAZ clusters as Activity Nodes for TCI Modeling.
[18] April 10, 2015 Memorandum from Strategic Economics, Market Index Technical Memorandum.
[19] The activity nodes were aggregated if the 1/3 mile radius circle encompassed at least ½ of an adjacent node.
[20] On the TCI scale, a score above 125 is strongly competitive for transit. To distinguish the best markets in Alameda County, it was necessary to set the bar at a higher level.

network too large for a feasible transit network, or too small that it excluded a major activity node. The application of the methodology for the existing and future timeframe yielded the following results:

- For 2010, 54 nodes were identified in Alameda County, where 26 nodes were designated major origins (O), 16 nodes as major destinations (D), and 12 as both a major origin and a major destination.
- For 2040, 71 nodes were identified in Alameda County, where 26 nodes were designated major origins, 16 nodes as major destinations, and 29 were designated both a major origin and a major destination.

The 71 nodes identified as a result of this analysis for the 2040 land use forecast is a reasonable number of nodes to use as the basis for identifying potential new corridors in the Regional Express and Urban Rapid transit network. Figure 8 shows the major origins and destinations identified in Alameda County.

Identifying Alameda County Travel Markets

Once major origin and destination nodes were identified, travel markets (including all modes and trip types) were identified based on an analysis of the major activity node O-D pairs. The following steps were completed:

1. Examined travel volumes for travel between all of the major O-D nodes throughout Alameda County.

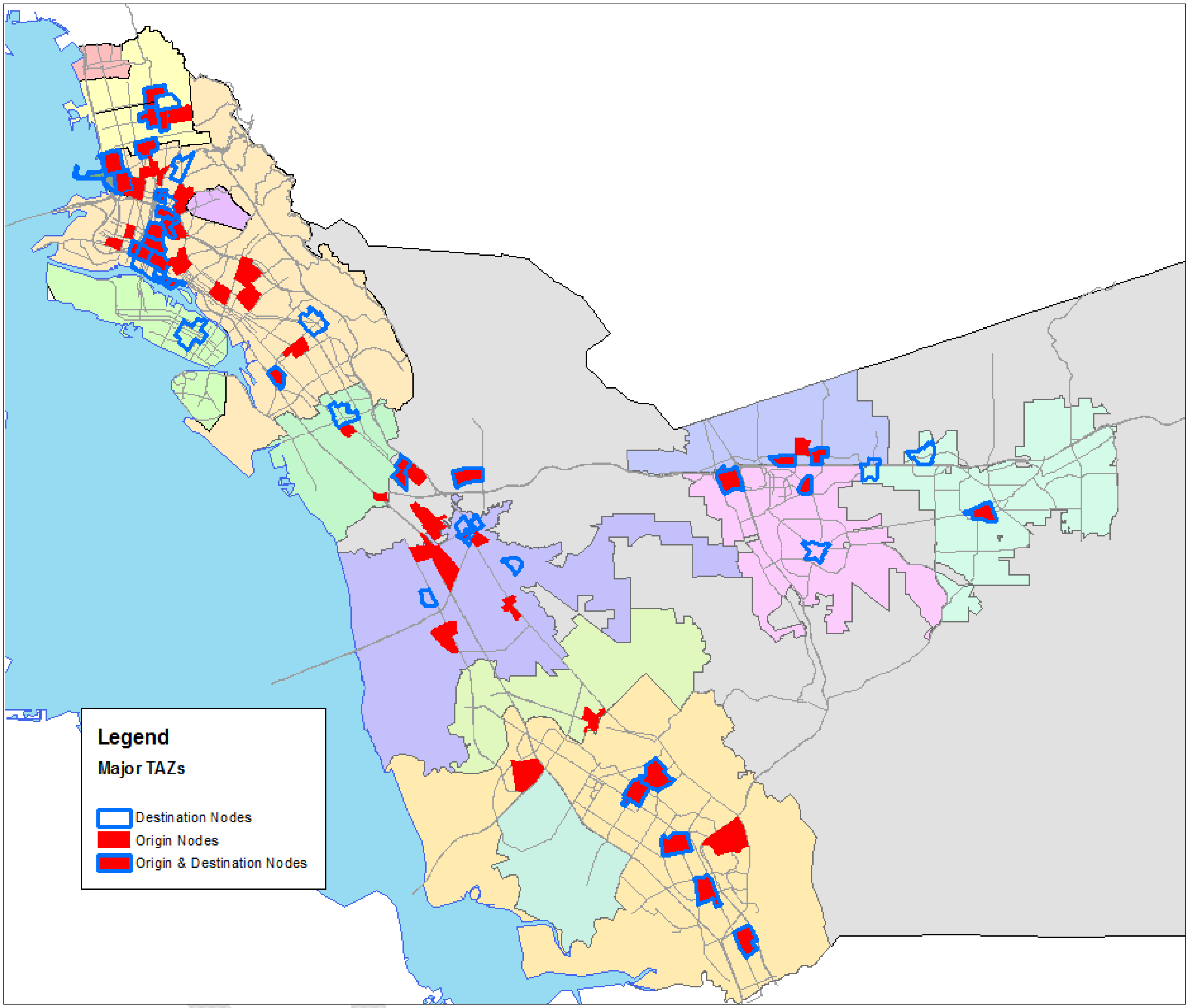
2. Produced a matrix with the origin and destination nodes that shows the total number of daily trips between each major activity node pair.

3. Created a "desire line" map using the results of this matrix showing the total number of daily trips occurring between a given major activity node O-D pair, or "travel market". The minimum threshold for desire lines was set at 200 trips so only the more robust travel markets were identified. Figure 9 shows the desire lines between major O-D pairs within Alameda County.

4. Classified desire lines by trip volume. To facilitate the development of draft recommendations for the most viable transit corridors, the trip volumes were classified in three categories, as follows (refer to Figure 9):

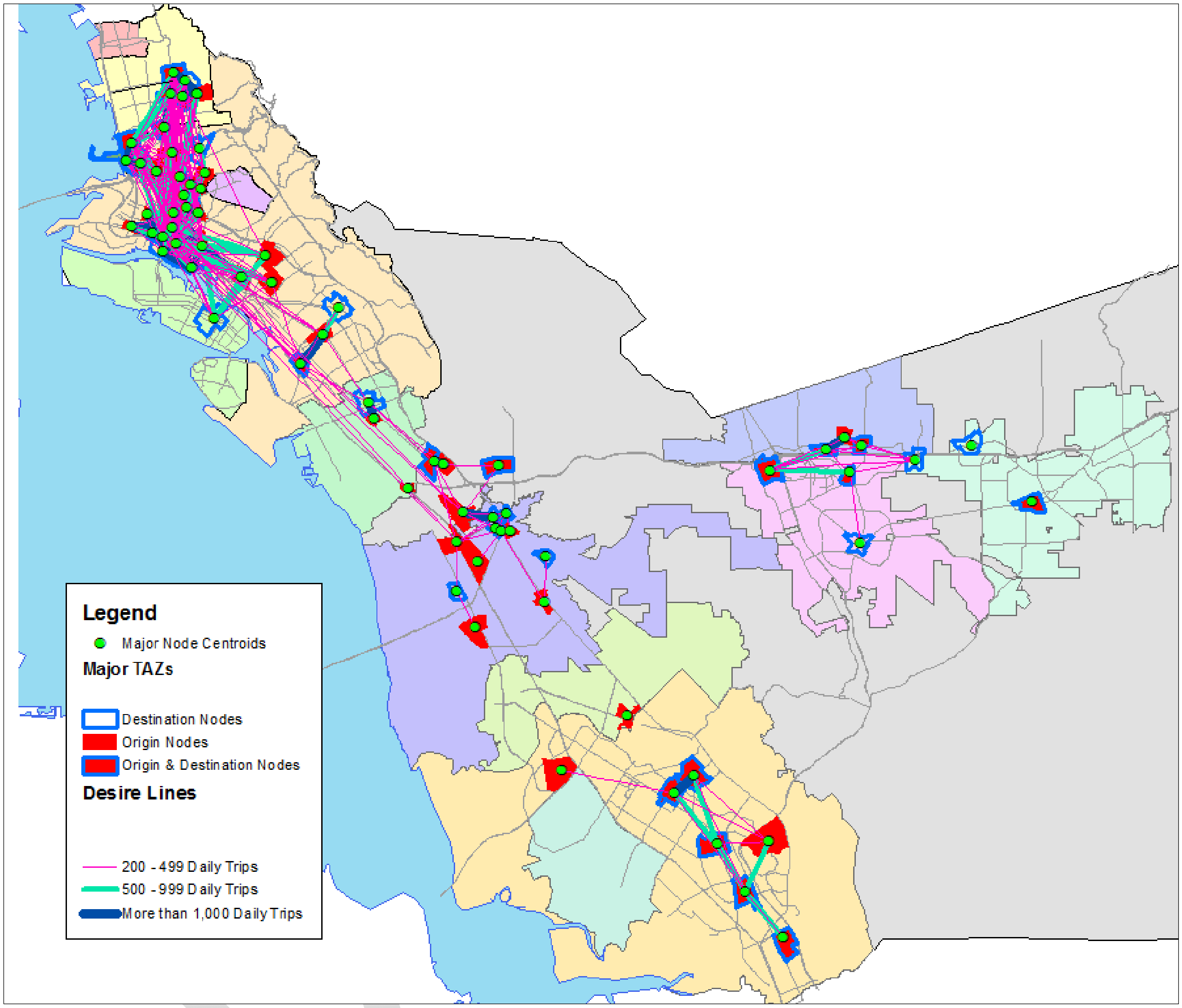
   - Minor travel market: 200 to 499 trips;
   - Moderate travel market: 500 to 999 trips; and
   - Major travel market: 1,000 or greater trips.

Figure 8. 2040 Major Origin-Destination Nodes within Alameda County



Source: Cambridge Systematics: TCI tool, density maps, market indices, and Alameda County Travel Demand Model, 2015

Figure 9. 2040 Daily Trips between Major Origin and Destination Nodes within Alameda County



Source: Cambridge Systematics: TCI tool, density maps, market indices, and Alameda County Travel Demand Model, 2015

As was done with the creation of major activity nodes, the methodology to identify travel markets was structured to result in a manageable number of major travel markets for transit corridor improvements, but not so few that significant travel markets were excluded.

Even with this methodological approach, a few of the identified major activity nodes were "stranded," that is they did not have enough travel to and from other major nodes to result in a desire line with more than 200 trips. This suggests that though these major activity nodes might be transit competitive based on density, overall trip volumes, and TCI scores, the trips are likely going to or from dispersed origins and destinations. These activity nodes then might be better served by services that include park-and-ride facilities or feeder bus services to provide a concentrated point of access for transit.

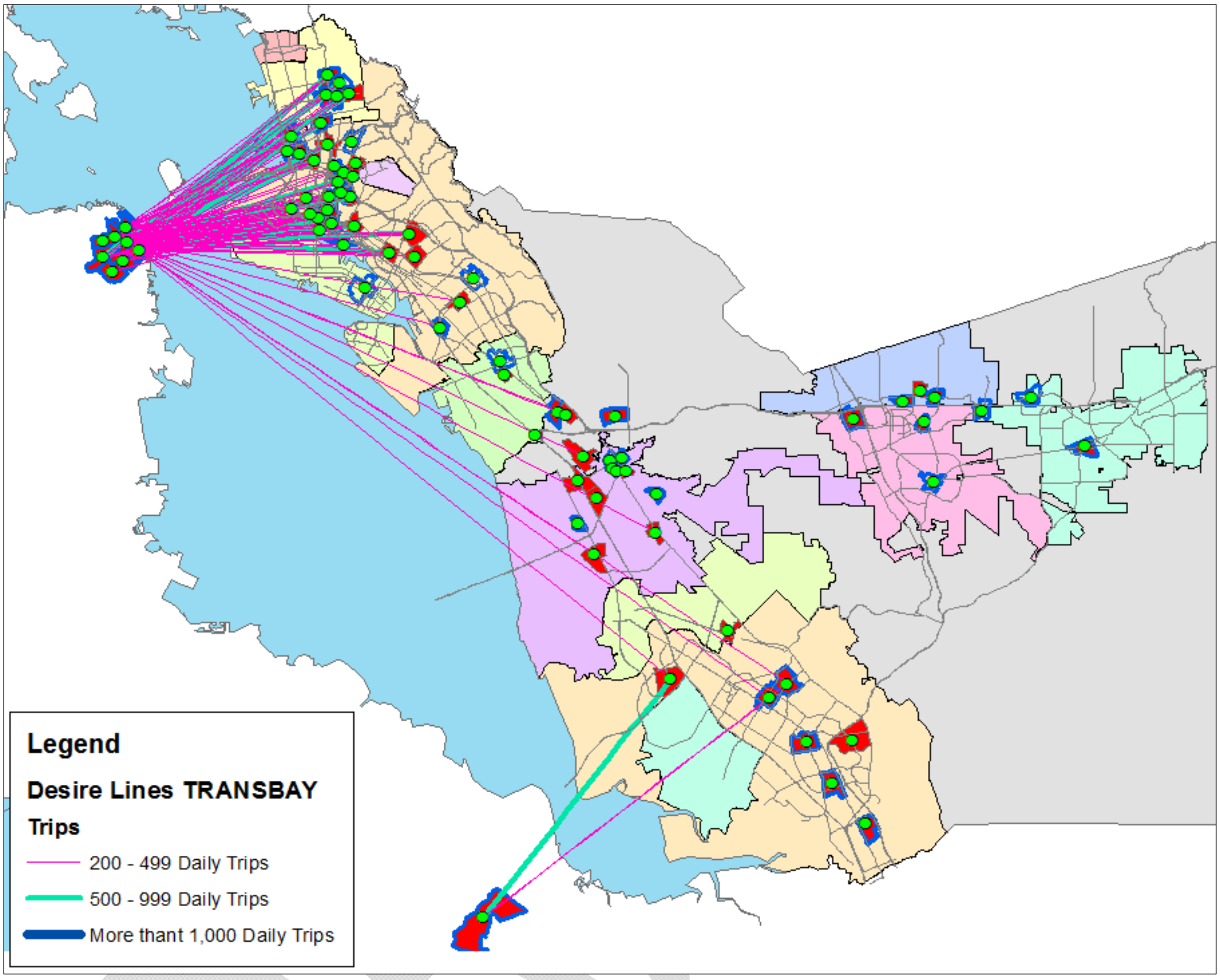
Identifying Regional Activity Nodes and Travel Markets

The identification of regional activity nodes and travel markets required a slightly modified approach to the one used within Alameda County. After assessing the results of the Alameda County analysis, an additional analysis was undertaken to identify the potential travel markets between Alameda County and other counties in the Bay Area.

Because the demand for regional types of services comes from a broader market, the trip origins and destinations tend to be more dispersed than those related to the demand for Urban Rapid core services. The regional services are accessed not only by walking, but also by feeder bus, park-and-ride, and kiss-and-ride so the service areas are significantly larger than those defined by a half-mile walking distance. As a result, different thresholds were used to identify major markets for inter-county trips (as noted in Appendix B).

For this regional analysis, the TCI threshold was lowered to 250. By lowering the TCI threshold to 250, major activity nodes in San Francisco as well as outside were highlighted. This analysis showed eight major activity nodes in San Francisco along Market Street, from The Embarcadero to Van Ness Avenue; one major activity node in downtown Palo Alto, and one major activity node in downtown San Jose. Figure 10 shows the inter-county desire lines between major O-D pairs in Alameda, San Francisco and San Mateo counties. A discussion of regional trips between San Joaquin and Alameda Counties is provided on page 32 of this memorandum in the section titled "Travel Demand Originating Outside the Bay Area".

Figure 10. Trips between Major Origin and Destination Nodes Transbay



Source: Cambridge Systematics: TCI tool, density maps, market indices, and Alameda County Travel Demand Model, 2015

Even with lowering the TCI threshold to 250, there were still a few existing markets that did not show a large demand for regional travel. For example, the City of Alameda contributes substantially to both ferry ridership and BART ridership, but does not appear as a major market between the island and San Francisco. This is also true of the major activity nodes in East County, where there is an established BART market that is not reflected in the identification of major transit markets. This likely represents a condition where the major activity nodes are not generating large volumes of travel to single points of activity. In other words, the origins and the destinations may be more dispersed or spread out than in other locations in the county. The transit solutions for these types of conditions need to be more focused on concentrating the access to transit by providing park-and-ride or transit feeder services.

Combining Travel Markets into Transit Corridors

The final step in developing the draft recommendations for transit corridor improvements is the combining of travel markets into transit corridors. This step requires not only a systematic approach, but an understanding of transit service planning and close coordination with the transit agencies.

The process that is outlined below focused on developing draft recommendations for enhancing transit service in the Regional Express and the Urban Rapid tiers. These tiers are emphasized because they provide the greatest opportunity for impacting transit ridership in Alameda County. Ridership on Regional Express services has been growing in recent years and additional capacity is needed to serve the county. The Urban Rapid service is intended to provide the infrastructure and service enhancements that will better serve bus transit patrons and reverse the decline in ridership that the bus operators have experienced over the past decade.

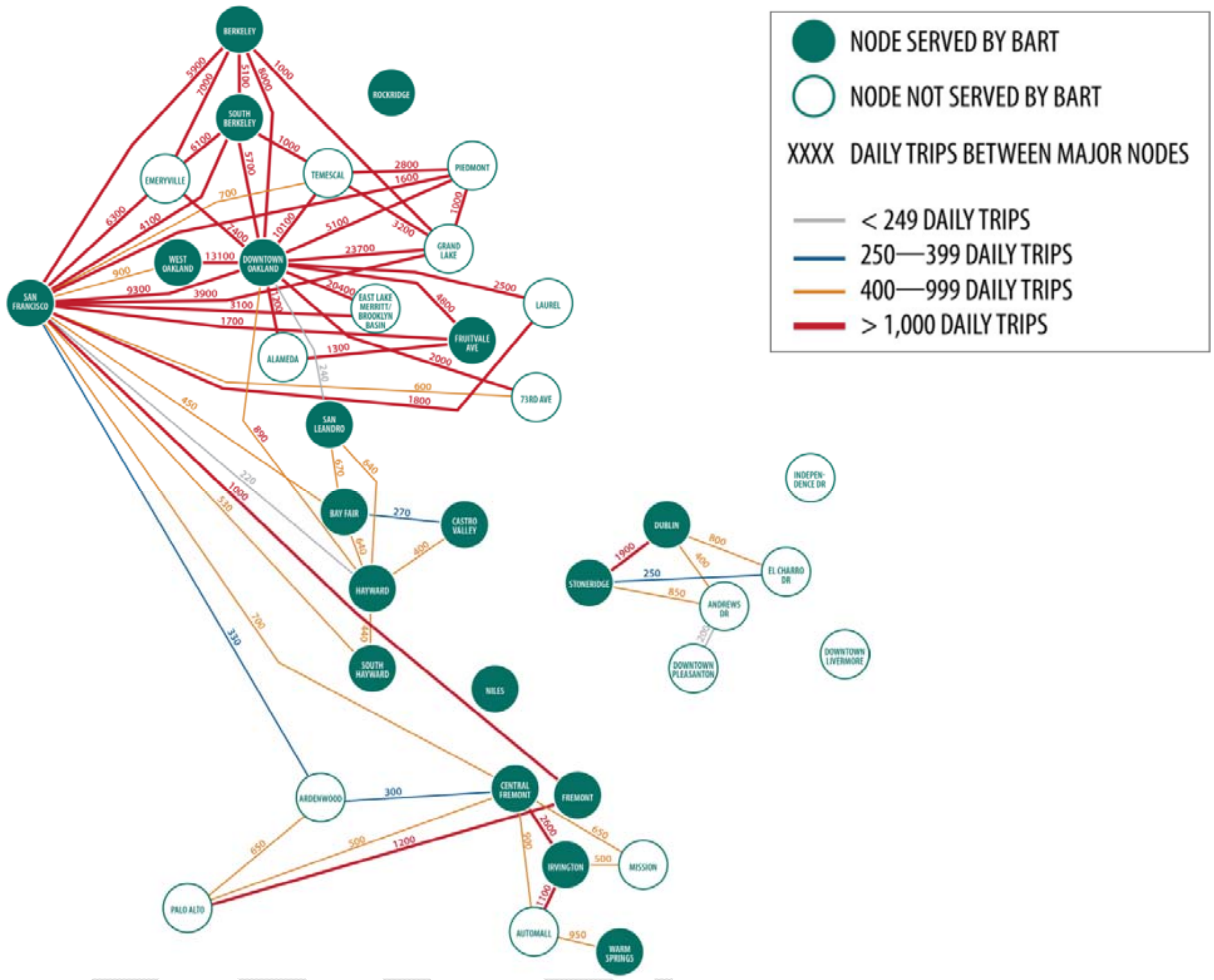
The transit corridors that are recommended for improvements were identified by applying the following criteria to the travel markets identified in the previous steps:

- Acknowledging the current structure of transit services;
- Acknowledging current and proposed plans and programs; and
- Identifying potential corridors that offer opportunities for transit priority treatments.

Figure 11 shows an abstract presentation of the O-D pairs and the 2040 forecasted daily trips between the identified major activity nodes that were identified in Figure 7 and Figure 8.

The travel links shown in Figure 11 were combined to create potential service corridors where service could be upgraded to a Regional or Urban Rapid tier in order to capture more transit riders out of the total travel market. Corridors were designed where possible to match existing service routes to reduce unnecessary change or to serve underserved markets where development is expected to occur or intensify between now and 2040, e.g. between Berkeley, Emeryville, and San Francisco. This effort was also coordinated with AC Transit to ensure consistency between the Major Corridors Study currently underway and the draft recommendations for the Countywide Transit Plan. Any findings or recommendations from LAVTA's Comprehensive Operations Analysis (COA), which was initiated in Fall 2015, will also be incorporated into the Countywide Transit Plan.

Figure 11. 2040 Trip Densities Between Major Origin-Destination Nodes



Source: Arup, 2015
Note: Diagram only includes trip levels greater than 250. Diagram is not to scale.

Travel Demand Originating Outside the Bay Area

Outside of the nine-county Bay Area region, San Joaquin is of particular interest to the development of a Countywide Plan as trips coming over the Altamont Pass have a significant impact on travel in the I-580 corridor. Transit solutions for this corridor are the subject of two separate studies. The ACE*forward* planning efforts, at the inter-regional level, are looking at increasing the number of daily trains coming over the Altamont Pass and increasing service to Alameda and Santa Clara counties. The proposed BART to ACE (originally BART to Livermore) project is evaluating the potential extension of BART service to Isabel Avenue and beyond, including a direct connection to ACE, to better serve the inter-regional trips and the Tri-Valley. The service improvements for the ACE train and the proposed BART extension provide an opportunity to ultimately provide a link between the inter-regional service and the regional service in the vicinity of Livermore and improve transit options for those commuting in the I-580 corridor.

Environmental review is underway on both of these projects. This plan acknowledges both of these studies (see the following section on draft recommendations), but does not presuppose the outcomes of the recommendations. Detailed ridership projections will be included as part of the published environmental documents for each project.

Draft Network Recommendations

The Countywide Transit Plan will ultimately address all of the tiers of the transit network described in this memorandum. However, the focus of the Draft Network Recommendations is on the Regional Express and Urban Rapid tiers for the following reasons:

- Transit services within the Regional Express and Urban Rapid tiers carry (and have the potential to carry) the majority of transit trips within, to and from Alameda County.
- Capital and operating investments that improve the capacity and operating effectiveness (in terms of travel time, frequency and reliability) of transit services within the Regional Express and Urban Rapid tiers are likely to have the greatest effect on increasing transit ridership, improving transit efficiency and sustainability, and achieving the Transit Plan's adopted vision and goals.
- To date, transit service in the Urban Rapid tier is significantly under developed. As a result, the level of transit mode share is significantly lower than would be expected given the very strong transit travel markets for trips made within Alameda County.
- While transit service in the Regional Express tier already meets the service objectives of being fast, frequent and reliable, it is at or over capacity, and additional service is needed to meet the demand both now and especially in the future.
- Alameda CTC, in partnership with local jurisdictions, transit operators, and regional agencies, can play an active role in facilitating significant improvements in transit services in the Regional Express and Urban Rapid tiers through capital and operating investments.

The travel market analysis described in the previous section of this memorandum yielded recommendations for the Regional Express and Urban Rapid tiers, primarily focusing on potential improvements to both transbay bus service and major trunk route bus services that would form the basis of a fast, frequent surface transit network within Alameda County. In addition to the recommendations for enhanced regional bus service, improvements included in the current Regional Transportation Plan (RTP) and proposed improvements that are under consideration as part of ongoing regional studies or are proposed as part of future developments are also included in this section, e.g. the introduction of new ferry service from Alameda Point or the potential for a second BART tube under the Bay connecting San Francisco with the East Bay. The

Countywide Transit Plan does not presuppose an outcome for these studies, but includes them as part of the context for the future transit network in Alameda County.

In addition to enhancing connectivity between major activity nodes, the Draft Transit Network Recommendations were developed based on a detailed understanding of transit operations and transit priority treatments that can lead to reduced travel times, improved on-time performance, better inter-modal integration, and ultimately higher ridership and customer satisfaction.

Recommendations for Inter-Regional, Frequent Local/Community and Streets Plus Tiers

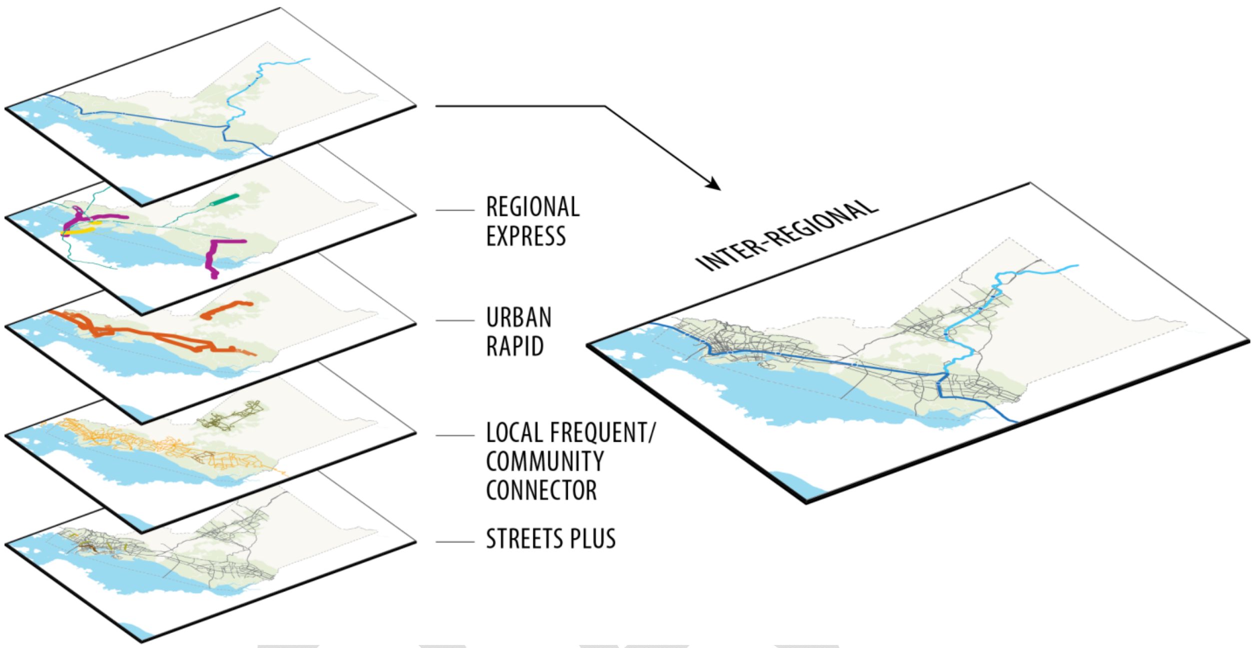
Inter-regional transit service is a key component of our transit network because it connects Alameda County to the greater Northern California mega-region and the state and provides a much needed transit alternative to congested roadways. Higher speed (125 miles per hour or faster) inter-city rail services could provide a new inter-city transportation option that currently does not exist in California. The two primary providers of inter-regional rail service, Capitol Corridor and ACE, are currently developing vision plans for future service improvements. Rather that presuppose the outcomes of these efforts, the Countywide Transit Plan will incorporate the recommendations that are ultimately adopted. Consequently, this memorandum describes the planning efforts currently underway and their relationship to other transit services in Alameda County.

The Local Frequent and Community Connector tiers generally do not require major infrastructure investments at stops or in the street right-of-way to deliver service. For this reason, this memorandum does not make specific recommendations for improvements to transit services within these tiers. Instead, the Countywide Transit Plan will describe the importance of these services in terms of the critical first- and last-mile connectivity they provide to Regional Express, Urban Rapid and Inter-Regional transit services and will incorporate these tiers into system and network integration recommendations made as part of the final plan.

The Streets Plus tier is the layer upon which all bus service operates – our roadways. Independent from the corridor transit improvements that are described in the Regional Express and Urban Rapid tiers, there are physical roadway improvements that would improve operations overall for transit which are described for the Streets Plus layer. The Draft Network Recommendations focus on key roadway segments that are of critical importance for Alameda County's surface transit network. In addition, the Countywide Transit Plan will also address best practices in street and urban design that facilitate transit operations and access.

Following is a discussion of potential improvements for each transit tier, with the focus of the Draft Network Recommendations being on the Regional and Urban Rapid tiers.

Inter-Regional Tier



As stated previously, the two primary providers of inter-regional rail service, Capitol Corridor and ACE, are currently developing vision plans for future service improvements. Rather that presuppose the outcomes of these efforts, the Countywide Transit Plan will incorporate the recommendations that are ultimately adopted. Consequently, this memorandum describes the planning efforts currently underway and their relationship to other transit services in Alameda County.

For both Capitol Corridor and ACE, one of the primary objectives for future planning efforts is to increase the frequency of service and reduce travel times. Another key consideration for both planning efforts is creating a direct connection to BART in Alameda County and thus connecting the Inter-Regional and Regional Express transit service tiers within the county. Currently, the Capitol Corridor station and BART station are co-located at the Coliseum stop in Oakland; however, passengers must walk several hundred feet and traverse several stairways to move between the two services. Currently, the only connection between ACE service and BART is via connecting bus or shuttle transit in the Tri-Valley or Fremont.

In addition to the lack of direct connections between Inter-Regional transit services and Regional Express services, the fact that both Capitol Corridor and ACE share rail right-of-way with Union Pacific freight operations is a significant limitation in the ability to expand service frequency. Union Pacific (UP) owns the right-of-way on which both Capitol Corridor and ACE operate, and the passenger rail operators purchase “slots” from UP during which they can operate passenger service. This shared operating environment also limits the amount of freight rail traffic that can traverse the right-of-way.

Capitol Corridor Vision Plan

In their 2014 update to the [Capitol Corridor Vision Plan](), the Capitol Corridor Joint Powers Authority identified short-term, mid-term, and long- term improvements for their service. Capitol Corridor is expected to complete its Vision Planning effort in 2016. Figure 12 shows the current Capitol Corridor route map.

Figure 12. Capitol Corridor Current Route Map

Source: Capitol Corridor

Short-term improvements are focused on increasing the number of daily round trips from 7 to 11 between Oakland and San Jose. This would require rail infrastructure improvements to allow the growth in passenger and freight rail service. A realignment of service south of the Oakland Coliseum is also under consideration to facilitate travel time savings and better operating patterns. This would affect service to the Hayward and Fremont stations.

Mid-term improvements would allow the expansion from 11 to 15 daily round-trip trains between Oakland and San Jose. The exact mix of infrastructure improvements have not been identified, but they would likely include double or triple-tracking the segment over the Alviso wetlands (Don Edwards San Francisco Bay National Wildlife Refuge).

For long-term improvements, multiple options for different alignments throughout Alameda County have been identified to address constraints on the system that result from the joint operation of freight and passenger service in the Union Pacific Railroad right of way (ROW). These long-term improvements, which would potentially include creating a dedicated ROW for passenger rail service, electrification, and operating speeds of 125 miles per hour or greater, would enable Capitol Corridor to achieve a travel time between Sacramento and Oakland of one hour and between Oakland to San Jose of 30 minutes and improve frequencies to every 15 minutes during peak periods.

The following potential improvements have been identified for the three segments of the Capitol Corridor rail in Alameda County.

Central Oakland to Richmond

Improvements in this section are focused on the creation of dedicated passenger tracks expanding the existing 100-foot ROW an additional 20 to 30 feet between Grand Avenue and 65th Street to separate passenger and freight operations. A grade-separated option was identified only for the southern sections with an underground alignment beneath Mandela Parkway in Oakland, with the potential to connect to a new BART transbay tube.

Central Oakland

The current surface rail operations in downtown Oakland are neither safe nor efficient and they impede access to Jack London Square. Options for improvements are limited by the Webster and Posey tubes that provide access to Alameda. Three potential grade-separated options have been identified for further exploration:

- Grade-separated passenger/freight tracks on the existing alignment would require closure of streets to facilitate the grade-separation of track and provide a new parking facility with a pedestrian overpass connecting to Jack London Square.

- Fifth Street subway would realign rail service to Fifth Street just north of I-880 traveling in either a subway or elevated guideway and connecting to a new right-of-way along the BART alignment; connecting Capitol Corridor to the West Oakland BART station.
- Tunnel under downtown Oakland would construct a deep-bore tunnel 3 to 5 miles in length under downtown Oakland between the Lake Merritt Channel and I-580 in Emeryville. This would facilitate a connection with the 19th Street BART station.

Oakland Coliseum to San Jose

Speed and capacity are the key issues in this segment, as large sections of the alignment have only a single track, limiting maximum speeds, operational flexibility, and service frequencies. The service currently runs on the Coast Subdivision from San Jose to the Niles Cutoff in Fremont where it transitions to the Niles Subdivision to continue to Oakland. Long-term options for improving service include realignment to generate additional freight and passenger capacity. Three options have been identified thus far.

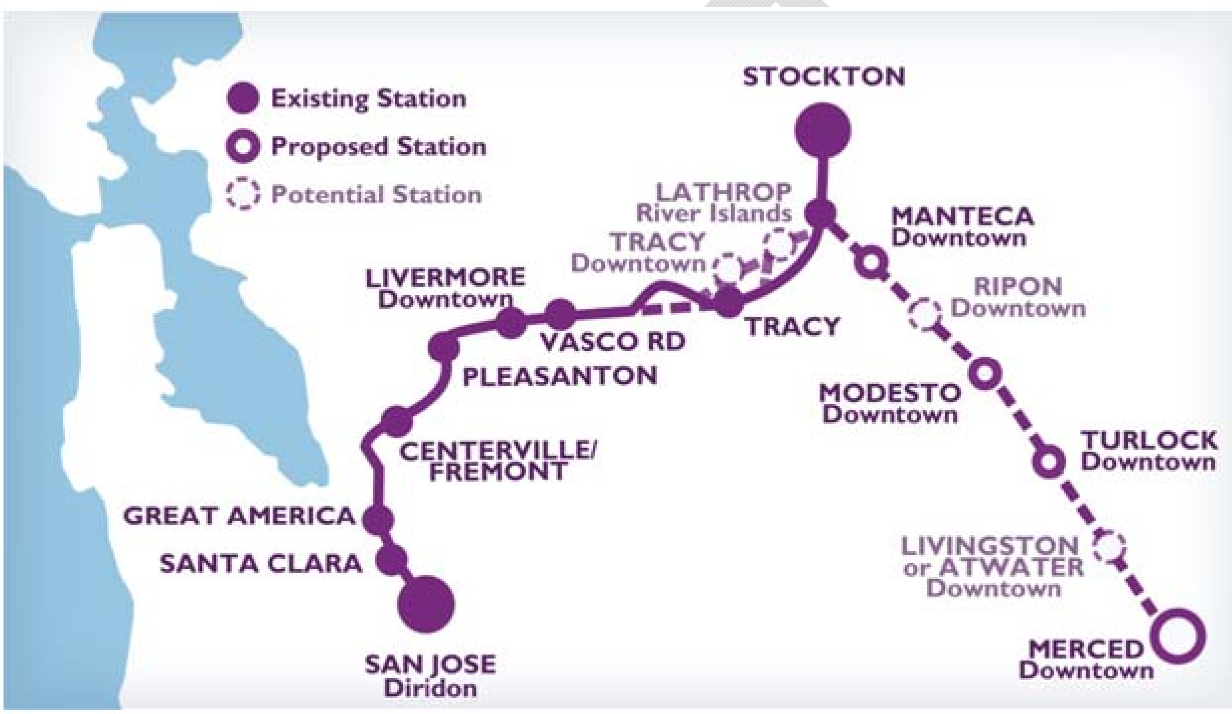
- Coast Alignment – This option would realign Capitol Corridor service to the Coast Subdivision along the bay shoreline from San Jose, rejoining the Niles Subdivision just south of the Oakland Coliseum. Portions of the Coast Subdivision would have to be reconstructed to account for sea level rise.
- Inland Alignment – This option would use the Warm Springs Subdivision transitioning to the Niles Subdivision in Newark between I-880 and I-680. It would stay on the Niles Subdivision to Jack London Square.
- Hybrid Alignment – This option would stay on the Coast Subdivision transitioning at the Niles Subdivision to the Oakland Subdivision where it would continue through to just north of the Oakland Coliseum. This option would facilitate the development of the Union City Intermodal Rail Station that is identified as a project in the RTP and the Measure BB Transportation Expenditure Plan (TEP).

Altamont Corridor Express

The San Joaquin Regional Rail Commission (SJRRC) has initiated the ACE*forward* Program (ACE*forward*) in an effort to modernize the existing rail service. The focus of ACE*forward* is on near-term improvements and the extension of the existing ACE service to increase the frequency of service, reduce travel times, and expand ACE to additional markets in the Central Valley. ACE*forward* is actively planning to increase service between Stockton and San Jose from the current 4 daily round trips to 6 daily round-trips by 2018 and 10 daily round-trips by 2022. This will require siding improvements at multiple locations, grade separations, new track connections, and a maintenance facility expansion as well as new rolling stock.

ACE also has plans to extend ACE service to the downtowns of Manteca, Modesto, Turlock, and Merced. Stations in downtown Tracy, Ripon, Livingston, Atwater, and a new Lathrop station at River Islands are also under consideration. The extension of ACE to Merced will provide a direct connection to the Initial Operating Segment of the California High-Speed Rail service. Figure 13 maps the potential improvements being considered as part of ACE*forward*.

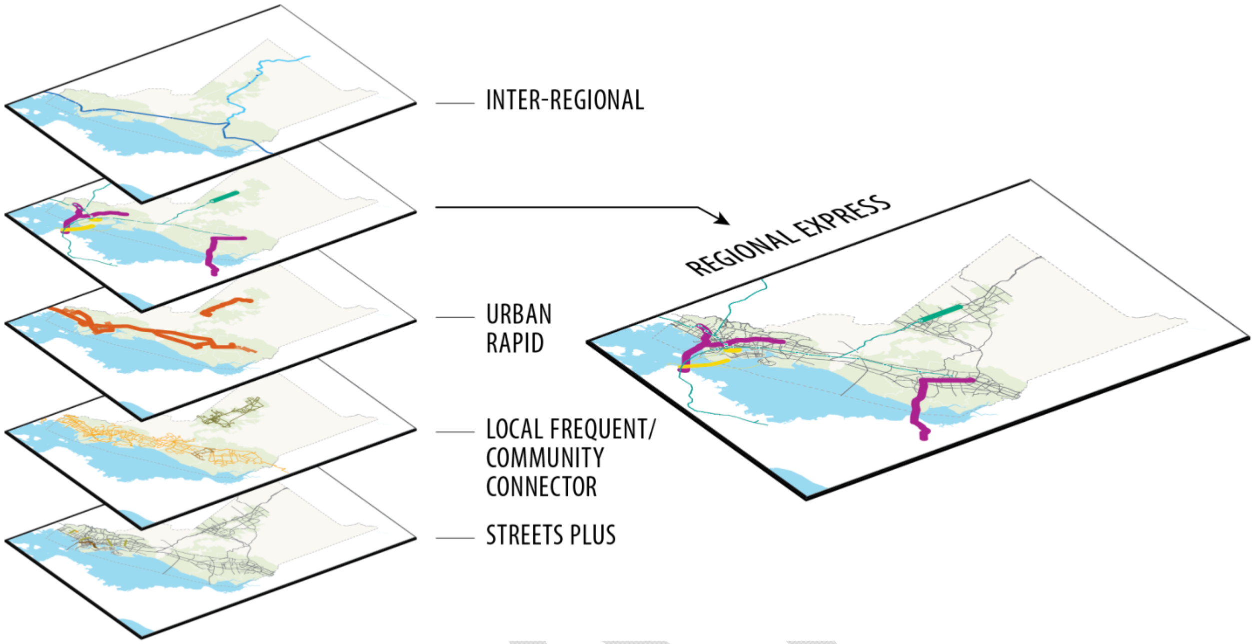
Figure 13. 2040 ACE*forward* Map



Source: Altamont Corridor Express (ACE)

A separate white paper is being prepared in conjunction with the Goods Movement Plan to lay out an integrated strategy for Alameda CTC on the integration of goods movement and passenger rail service. The recommendations will be incorporated into the final Countywide Transit Plan.

Regional Express Tier



Although the services within the Regional Express tier extend beyond Alameda County, these services form the backbone of the transit system serving the county and carry a significant portion of the county's transit riders. The capacity of the existing BART system is severely stressed at the same time that major system expansion is underway. Investment in the core BART system has been identified as a critical need to serve the growing demand on the system and to support the planned expansions. These core capacity improvements, which include fleet replacement and expansion, upgrades to the Hayward Maintenance Facility, and train control modernization, are also the key to facilitating planned expansion of the BART system.

The market analysis that was conducted shows the strongest market for regional travel is from the Berkeley and Oakland areas to San Francisco, with additional strong markets in San Leandro, Hayward, and Fremont. A strong regional market was also identified between Fremont and Palo Alto. There is also an established market for BART services in East Alameda County; and it is assumed that this market will continue to be served by BART and improvements that are already planned.

The Draft Transit Network Recommendations include additional transbay BART capacity for the future. This additional capacity is contingent upon the ability to implement the core capacity improvements to BART outlined above. In the near-term, the ferry system and regional express buses can provide additional capacity in Alameda County to meet this regional transit demand.

As in the Inter-regional service tier, there are multiple studies that have been completed or are underway that would impact Regional Express service in the future. The potential improvements that have been identified in Alameda County are briefly summarized below. As detailed studies for these projects have not yet been completed at the regional level, specific improvements are not recommended at this point. They are described here as context for the recommended Draft Transit Network Recommendations to the Regional Express service tier.

BART Sustainable Communities Operations Analysis Study

Similar to the approach for delivering transit in the Alameda Countywide Transit Plan, the BART Metro Core and Metro Commute Strategy outlined the strategies for BART service in the future in the BART Metro Core area, defined as the area between Daly City and Richmond, MacArthur, and Bay Fair stations. These are the segments of the BART system where transit can be competitive with driving for all types of trips throughout the day. The Metro Commute area was defined by BART as the area where transit would be competitive primarily for peak period trips into congested job centers.[21]

The Sustainable Communities Operations Analysis Study developed service strategies outlined in the BART Metro Core and Metro Commute Strategy and identified the capital improvements that were prerequisite to meet its objectives for quality of service and to meet the projected ridership increases in the Bay Area. As ridership grows, BART has identified the following investments that are prerequisite to their service plans for the Metro Core and Metro Commute system and service expansions to the Oakland Airport, Warm Springs and Berryessa, and eBART to Antioch:[22]

- Increase the BART fleet size;
- Improvements to the Hayward maintenance facility;
- Station improvements at Embarcadero, Montgomery, and possibly in downtown Oakland; and
- Modernized train control system.

Enhancement projects were identified to deliver more cost-effective and reliable service:

- New or upgraded crossovers at Daly City/Colma, 24th/Mission, Richmond, South Hayward, Lafayette, and Pleasant Hill;
- Tail track extensions at Millbrae and Dublin;

[21] BART Metro, www.bart.gov/about/projects/future/faq, September 6, 2015.
[22] BART Sustainable Communities Operations Analysis, June 2013, Nelson\Nygaard and Arup for BART.

- Highway Barrier Improvements on the Dublin line;
- Turnback facilities at Glen Park and Bayfair; and
- Maintenance facilities at Millbrae and Colma.

These improvements would result in the ability to provide peak period base headways initially at 15 minutes and ultimately to 10 minutes as transbay capacity improvements are made.

BART Vision Plan

The BART Vision Plan identified multiple potential improvements for the BART system in the future. Those that are proposed for Alameda County are summarized below.

Station Capacity Improvements

Potential station capacity improvements have been identified for the 12th and 19th Street stations in downtown Oakland. Union City Intermodal, Jack London Square, and Lakeshore Avenue are all identified as potential station expansion locations. The latter two would be considered in association with a potential new transbay tube.

Potential Infill Stations

Multiple locations have been identified for potential BART infill stations in Alameda County. A total of nine potential infill stations have been identified: Solano Avenue in Albany; West Oakland Intermodal, 51st/Children's Hospital, San Antonio District, 55th Avenue, and 98th Avenue in Oakland; Whipple Road in Union City; and Irvington and Shinn in Fremont. Most of these stations are located in areas that were identified as highly competitive transit markets.

Track Improvements

Two phases of track improvements are proposed:

- Dublin-I-580 high speed intrusion barrier (Phase 1)
- Dublin/Pleasanton tail track storage extension (Phase 1)
- Bayfair Connector (provides a southbound connection for trains between the Tri-Valley to Hayward and points south (Phase 2)

Capacity Expansion

In addition to a study of expanded transbay service discussed below, two additional potential capacity expansions have been identified for Alameda County:

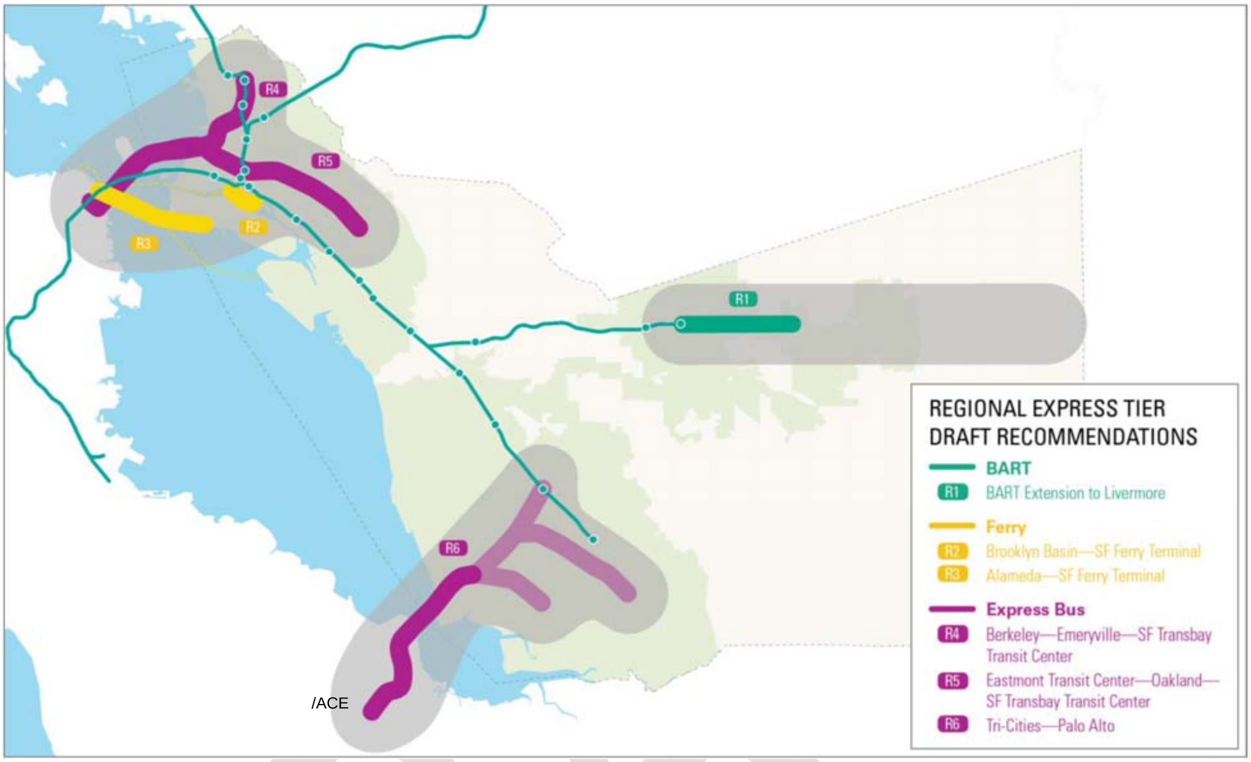
- BART to Livermore/ACE – The planned extension of BART to Livermore/ACE is currently in environmental review and is discussed in greater detail in the following pages.
- Eastshore Corridor – A potential new Eastshore Corridor would extend from West Contra Costa County (including an extension north of Richmond BART station) south to the Coliseum BART station. Though the specific alignment and technology have not been specified, it could potentially run along the East Bay shoreline, to the west of the current BART alignment.

MTC Core Capacity Study

This study, which was initiated by MTC in conjunction with BART, AC Transit, San Francisco Municipal Transportation Agency (SFMTA), and the San Francisco County Transportation Authority (SFCTA), is exploring the potential for a second tube under the Bay connecting Alameda County and downtown San Francisco. This study will also evaluate nearer term solutions such as additional transbay bus service, bus only lanes on the Bay Bridge, and improvements at the downtown San Francisco BART/Muni stations. The purpose of this study is to focus on solutions to alleviate the transit capacity constraints in the system.

As recommendations come forward from these studies, the proposals will be incorporated into the Countywide Transit Plan future updates. Given the timing and the regional nature of the studies, it is premature to recommend specific improvements for Alameda County at this time.

Regional Express Tier Draft Recommendations



It is important to note that all of the Draft Transit Network Recommendations presented here are conceptual. In other words, specific routing alignments and termini have not been determined, and subsequent studies and environmental analyses will be required to determine potential alignments, specific routing, and specific capital and operating improvements.

In addition to the potential regional transit improvements discussed above, regional transit investments for Alameda County were identified in the 2040 Regional Transportation Plan (RTP) *Plan Bay Area*. These improvements, summarized below, are assumed to be in place as part of the baseline Regional Express network in 2040:

- BART Extension to San Jose/Santa Clara (includes the extension to Warm Springs in Alameda County)
- New Transbay Transit Center
- Irvington BART Station
- Dumbarton Express Bus Frequency Improvements

- Ferry service between Berkeley and San Francisco[23]

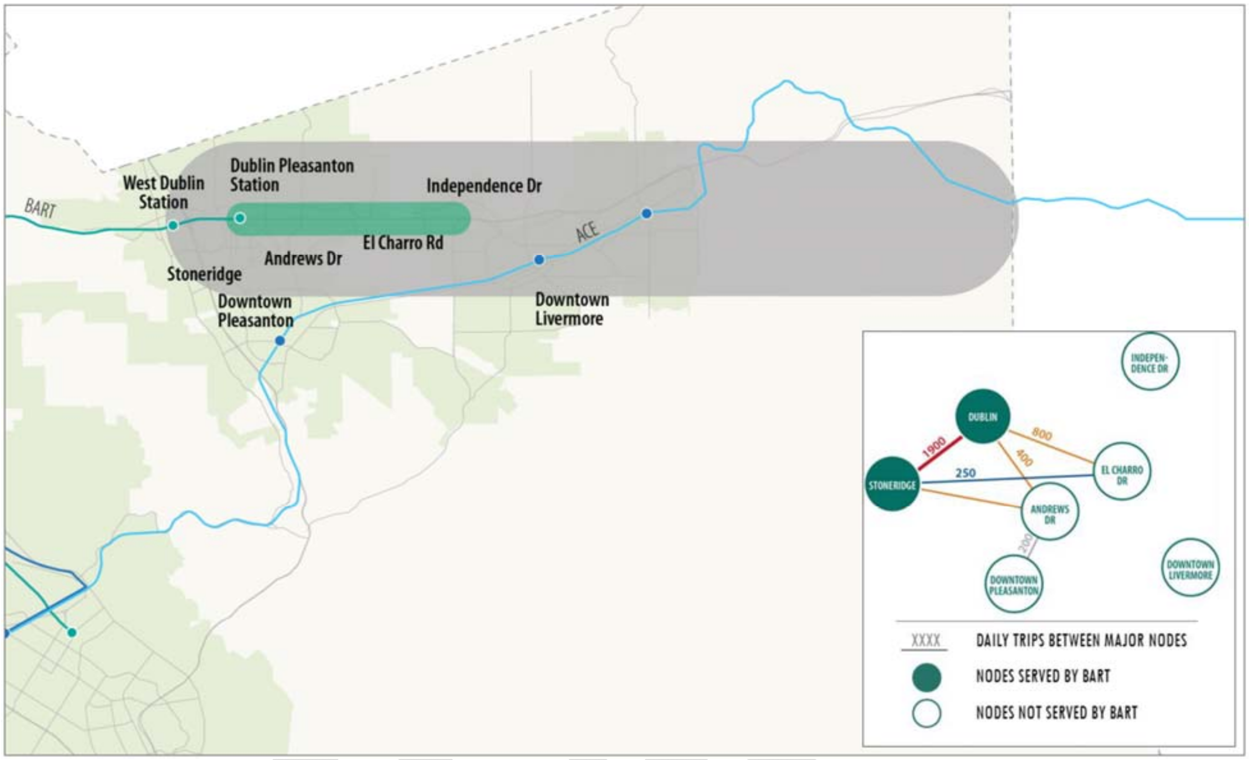
Measure BB identified two of the regional projects from the RTP to be funded through the Alameda County sales tax measure and identified funding for four additional BART projects that are focused on the core capacity improvements discussed above, as well as the BART to Livermore/ACE extension.

- Dumbarton Corridor Area Transportation Improvements
- Irvington BART Station
- BART to Livermore/ACE
- BART station upgrades and system improvements
- BART Metro Bayfair Connector Project
- BART station modernization

Five draft recommendations to the Regional Express tier were identified after review of travel demand markets and on-going regional planning efforts. These are described below.

[23] Operating and capital funds for implementing Berkeley Ferry service have not yet been fully secured.

R1 BART Extension to Livermore/ACE

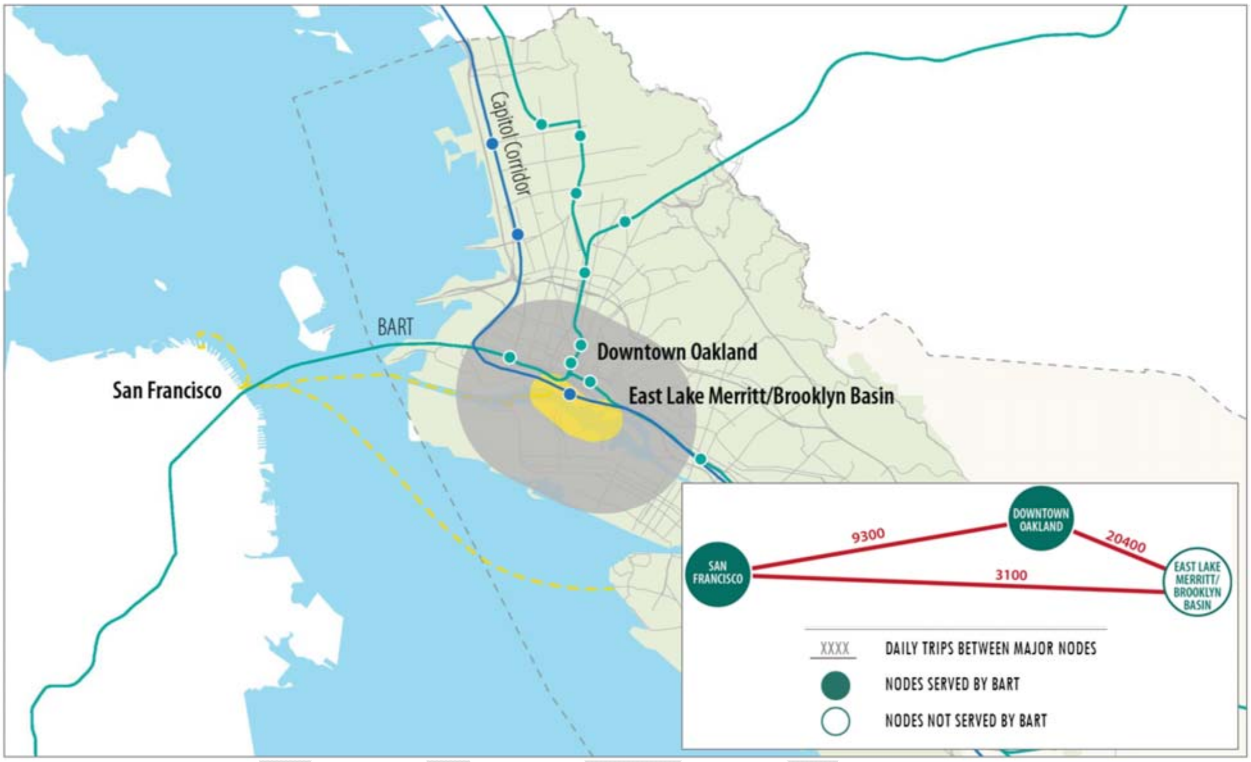


R1. BART Extension to Livermore/ ACE

This connection was identified as an inter-regional link in the San Francisco Bay Area Regional Rail Plan (2007). A draft Environmental Impact Report is currently being prepared for the extension to Livermore/ACE; therefore it is included as a potential network modification in this countywide transit plan. A potential intermodal connection with ACE is also under consideration. This project has the potential to improve mobility between the Tri-Valley and other parts of the region and the potential to provide an alternative to the severe congestion on I-580.

More precise definitions of alternatives, or additional alternatives, as well as more detailed analysis of the demand will be completed during preparation of the Draft EIR. Project alternatives currently under consideration include a No Build alternative, a Diesel Multiple Unit or Electric Multiple Unit (DMU/EMU) alternative, an Express Bus/Bus Rapid Transit (BRT) alternative, and an Enhanced Bus alternative. For the purposes of this network development task, the first phase of the BART rail extension to Isabel has been identified.

R2 Brooklyn Basin - SF Ferry Terminal



R2. Brooklyn Basin - SF Ferry Terminal

This regional project would provide ferry service between Brooklyn Basin and San Francisco Ferry terminals via Jack London Square. This project would build upon existing successful service currently operated by WETA from Jack London Square and Main Street Alameda to San Francisco and provide an alternative to the increasingly congested Bay Bridge and transbay BART tunnel for the travel demand anticipated between Brooklyn Basin and San Francisco. Intermodal connections are available near both terminals.

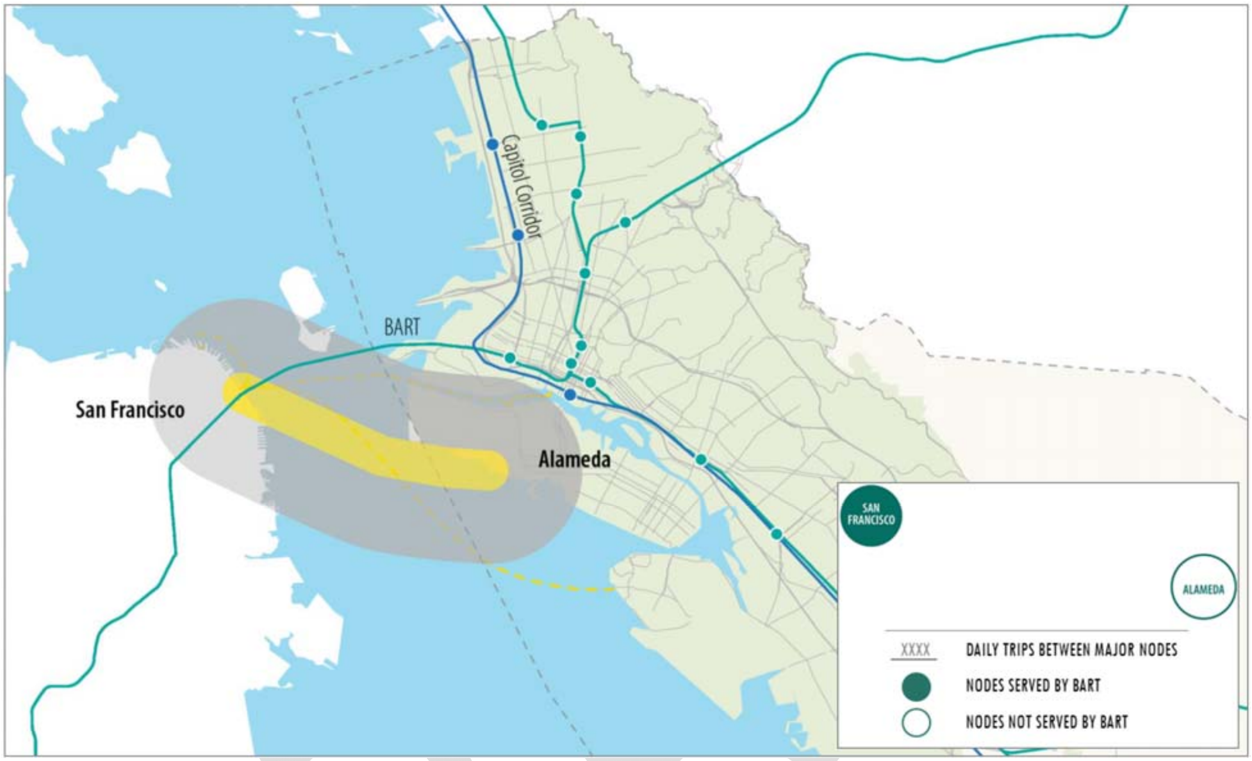
Draft recommended capital improvements include:

- New vessels
- New terminal facilities at Brooklyn Basin

Draft recommended service levels include:

- 15 hours of service
- 30 to 60 minute headways
- 40 to 45 minute trip time from Brooklyn Basin to San Francisco

R3 Alameda - SF Ferry Terminal



R3. Alameda - SF Ferry Terminal

This regional project would provide ferry service between a new ferry terminal at the Alameda Point development, and the San Francisco Ferry terminal, consistent with the adopted plans for Alameda Point. This project would provide an alternative to the increasingly congested Bay Bridge, Alameda Posey and Webster Street tubes, and Transbay BART tunnel. Service would need to be considered in light of other ferry services that are provided throughout the region, particularly the existing Harbor Bay ferry service.

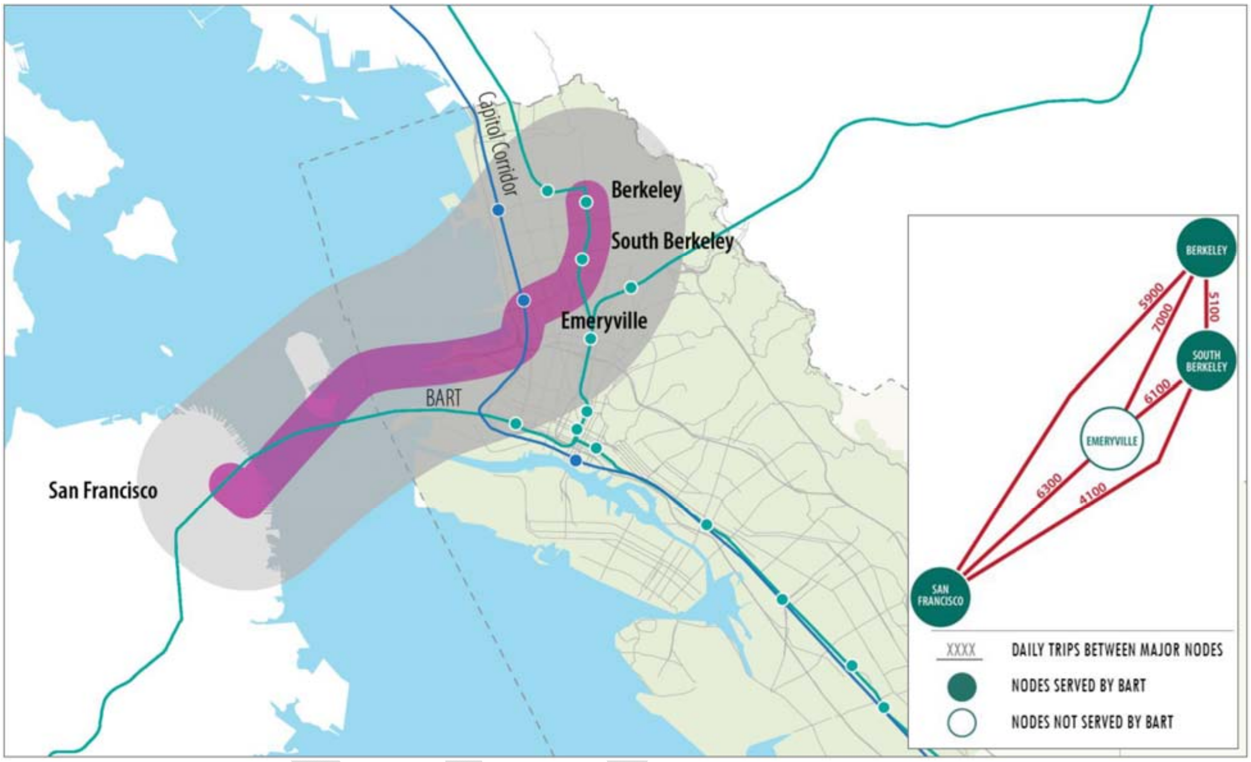
Draft recommended capital improvements include:

- New vessels
- New terminal facilities at Alameda Point

Draft recommended service levels include:

- 15 hours of service
- 30 to 60 minute headways
- 15 to 20 minutes trip time between Alameda Point and San Francisco

R4 Berkeley - Emeryville - SF Transbay Transit Center



R4. Berkeley - Emeryville - SF Transbay Transit Center

This project is an upgrade to the existing F-Line operated by AC Transit and would serve the northern transbay transit market between Berkeley, Emeryville and downtown San Francisco. It would also support local service between Berkeley and Emeryville.

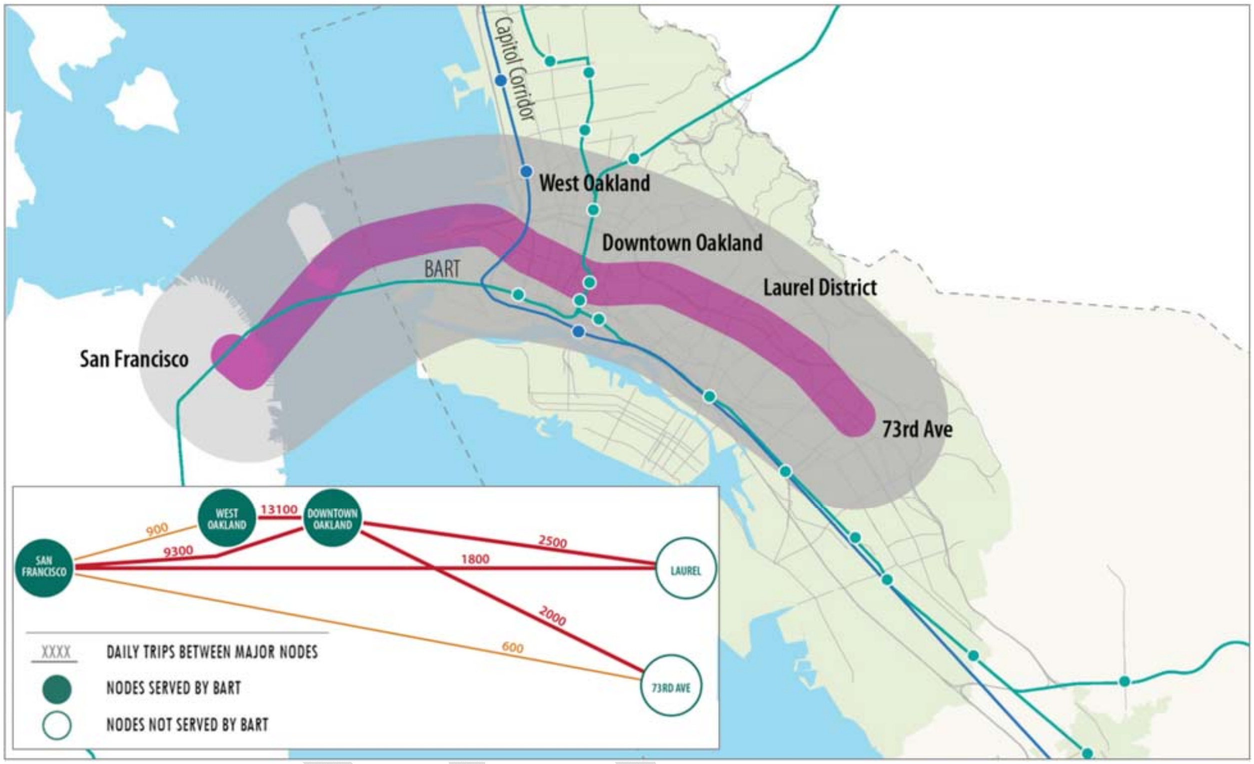
Draft recommended capital improvements include:

- Bus bulbs
- New buses
- Primarily dedicated transit lanes with some semi-exclusive, and mixed-flow lanes
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control
- Queue jumps

Draft recommended service levels include:

- 20 hours of service
- Transbay and local 10 minute headways
- 40 minutes trip time transbay

R5 Eastmont Transit Center - Oakland – SF Transbay Transit Center



R5. Eastmont Transit Center - Oakland - SF Transbay Transit Center

This project is an upgrade to the existing AC Transit route NL that operates along MacArthur Boulevard and serves Mills College and the Eastmont Transit Center. It also serves multiple local routes, including Line 57. The routes currently experiences relatively high ridership and relatively poor on-time performance - 64% for Line NL and 54% for Line 57. This project is consistent with recommendations in the AC Transit Major Corridors Study.

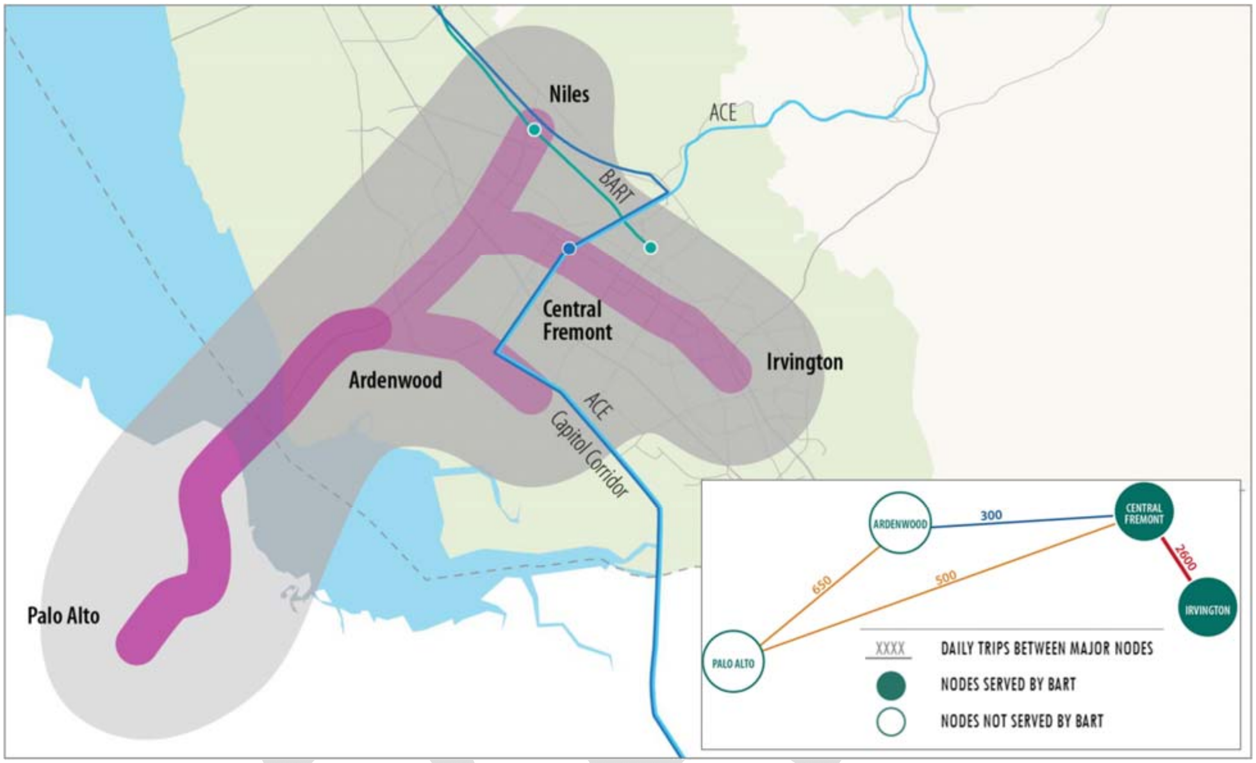
Draft recommended capital improvements include:

- New buses
- Portions of the route operating on dedicated or semi-exclusive lanes
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control

Draft recommended service levels include:

- 20 hours of service
- 10 minute headways
- 16 miles
- 45 minute trip time transbay

R6 Tri-Cities - Palo Alto



R6. Tri-Cities - Palo Alto

This project is an upgrade to the existing bus lines operating on the Dumbarton Bridge including the U, DB, and DB1 lines operated by AC Transit that serve the transbay market between the Tri-Cities area (Union City, Newark, and Fremont), Ardenwood, and Palo Alto. A study is planned to evaluate these services and determine the appropriate terminus points and types of improvements, which might include expanded park-and-ride facilities to capture more transit riders in Southern Alameda County. Recommendations for this corridor will be further and development and refined through future studies to define the Dumbarton Corridor Area Transportation Improvements.

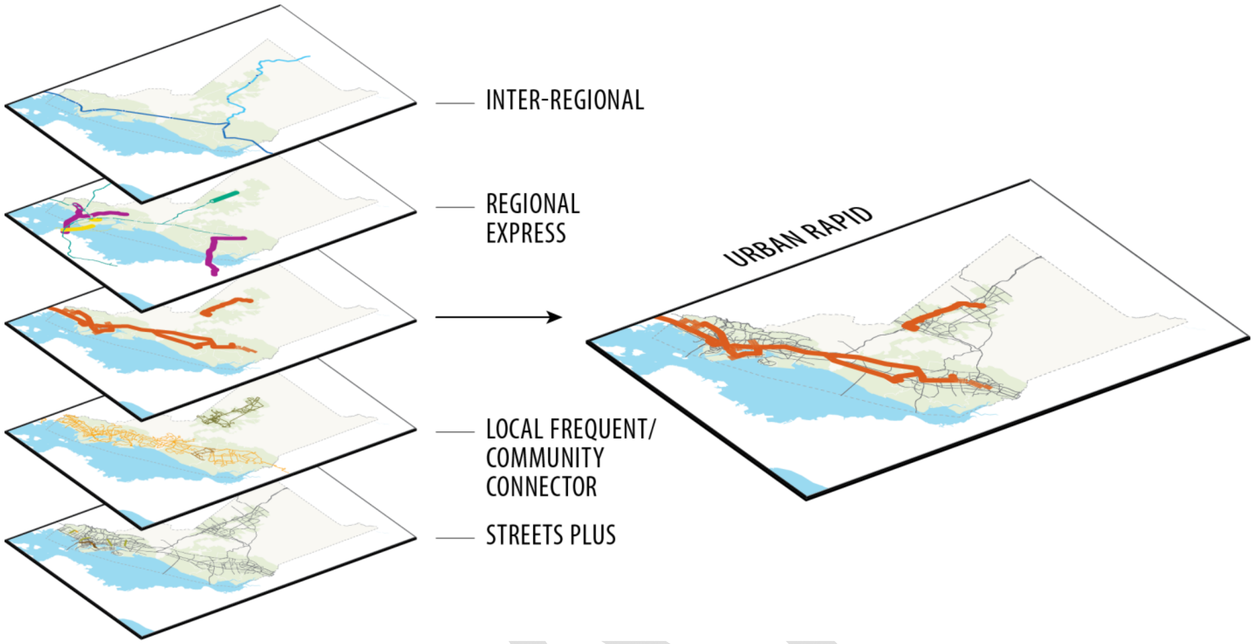
Draft recommended capital improvements include:

- New buses
- Portions of the route operating on dedicated bus lanes
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control
- Expanded park-and-ride facilities

Draft recommended minimum service levels include:

- 16 hours of service
- 15 minute headways
- 1 hour trip time

Urban Rapid Tier



Most of the proposed network modifications included in this technical memorandum fall into the Urban Rapid tier. Key characteristics of the urban rapid tier include frequent all-day service, transit signal priority (TSP), and roadside preferential treatments such as bus bulbs, queue jumps or transit priority lanes. Light Rail, Bus Rapid Transit (BRT), Rapid Bus, and Enhanced Bus services fall into this category. Often the routes are separately branded and have additional amenities at stops including high quality shelters, lighting, and next bus arrival displays.

Seven potential corridors have been identified for Urban Rapid improvements in Alameda County. The type of transit service envisioned has the potential to:

- Effectively improve the frequency and reliability of bus service when properly implemented (See Table 1 and Table 2 for a description of the type of priority treatment and expected levels of operational improvement.)

Table 1. Reported Benefits Associated with Transit Signal Priority

Location	Type of Priority	Reported Benefits
Los Angeles	Extension, Truncation	7% bus travel time reduction
Chicago	Priority, Pre-emption	12 to 23% bus travel time reduction
Bremerton, WA	Pre-emption	Average 10% bus travel time reduction
Portland, OR	Extension, Truncation	5 to 12% bus travel time reduction
Anne Arundel County, MD	Pre-emption	13 to 18% bus travel time reduction, 4 to 9% impact on other traffic

Source: Transit Capacity and Quality of Service Manual 2nd Edition

Table 2. Roadway and Stop Treatments Associated with Urban Rapid Tier

Treatment	Bus Travel Time Improvements	Vehicle Delay Impacts	Additional Considerations
Bus-activated signal phases	up to 10%	Minimal	Applications may include special bus detection technologies that distinguish buses from general traffic.
Bus signal priority	3-15% of overall travel time, up to 75% of signal delay	Minimal to significant, highly dependent on the strategy and location	Travel time improvements are a function of the existing signal delay.
Bus signal preemption	Up to 20%, up to 90% of signal delay	Potentially significant	Potential disruptions to signal coordination and transportation capacity
Dedicated Bus Lanes (Business Access and Transit Lanes)	5-25% reduction in travel time through the segment	Depends on level demand on roadway and implementation	Can be implemented during peak periods or all-day. Can be combined with peak period parking restrictions to avoid taking a lane of travel.
Special bus turn provisions	Depends on route	Minimal	Safety concerns may require changes to signalization for bus-only movement.
Queue Jump 5	5-25%	None, if using existing turn lane	Advance green at the intersection may facilitate exit from queue jump lane.
Curb Extensions	Not enough data	Potentially significant	Potential impacts to general traffic.
Boarding Islands	Not enough data	Potentially significant	Potential impacts to general traffic.
Stop Consolidation	3-20% of overall run time, up to 75% of dwell time	None	Accessibility to transit service is reduced.

Source: Transit Capacity and Quality of Service Manual 2nd Edition

- Address gaps identified in Technical Memorandum # 2 and the need to better serve strong transit markets.
- Increase ridership with an appropriate level of service
- Be flexible allowing customization for each unique market
- Be adaptable to unique characteristics of each corridor – key destinations, intermodal hubs, roadway network, etc.
- Be cost effective when compared to other modes (e.g. light rail)

What Changes can be Expected from Creating a Robust Urban Rapid Service Tier?

In recent years, other transit operators have faced similar speed and reliability challenges to those experienced by the bus operators in Alameda County. The idea of making bus travel more attractive and making physical infrastructure improvements to give priority to buses is not only becoming more common, but it is yielding positive results by increasing transit ridership.

Case Study – King County Metro Rapid-Ride

In the late 1990s Metro Transit was faced with degrading transit speed and reliability on routes that served several main corridors in their service area. In response, the agency decided to modify some of the high ridership routes on the most congested corridors to Urban Rapid characteristics.

Identification and Selection of Corridors

Sixteen initial corridors were identified for potential implementation. The list was screened down to three promising corridors based on addressing the following questions:

- *Would the service compete with regional rail projects?*
- *What is the ridership potential along the corridor?*
- *Would the BRT service provide significant connections for the riders?*
- *What is the potential for improvement in speed and reliability?*

After identifying the candidate corridors, Metro developed a Request for Proposals (RFP) for the jurisdictions along each of the identified routes and created a competition where jurisdiction had to respond to specific questions and commit to contributions such as implementing traffic operations changes, implement transit signal priority (TSP), expedite technical review and permitting, etc.

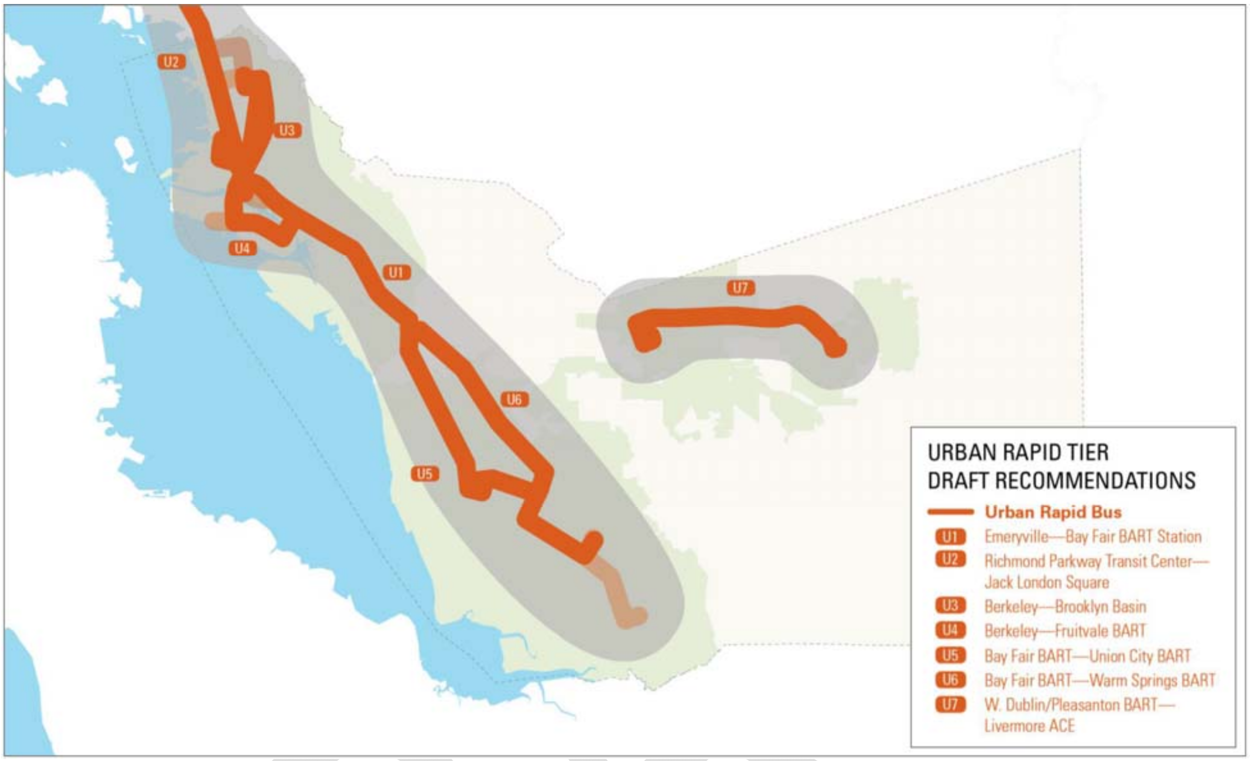
Results

The six King County Metro RapidRide corridors that went into operation between 2010 and 2014 (3 original corridors and 3 additional corridors) were successful in both improving operating performance and attracting new riders. Highlights of the program include:

- *Reliability – headway adherence ranges from 78% to 87%*
- *Ridership – ridership increases ranged from 20% to 81% from the start of service (2010 through 2014 depending on the route) to December 2014.*
- *Travel Time Reduction – Depending on the route the travel time decreased from 3% to 19% compared to previous operations.*

Additional information is available in Appendix C

Urban Rapid Tier Draft Recommendations



It is important to note that all of the Draft Transit Network Recommendations presented here are conceptual. In other words, specific routing alignments and termini have not been determined, and subsequent studies and environmental analyses will be required to determine potential alignments, specific routing, and specific capital and operating improvements.

In addition to the Urban Rapid transit improvements discussed above, major transit investments for Alameda County were identified in the 2040 Regional Transportation Plan (RTP) *Plan Bay Area*. These improvements, identified below, were assumed to be part of the baseline Urban Rapid network in 2040:

- East Bay BRT
- Grand-MacArthur BRT
- Alameda-Oakland BRT
- Dumbarton Express Bus Frequency Improvements

Measure BB identified similar projects for transit investment:

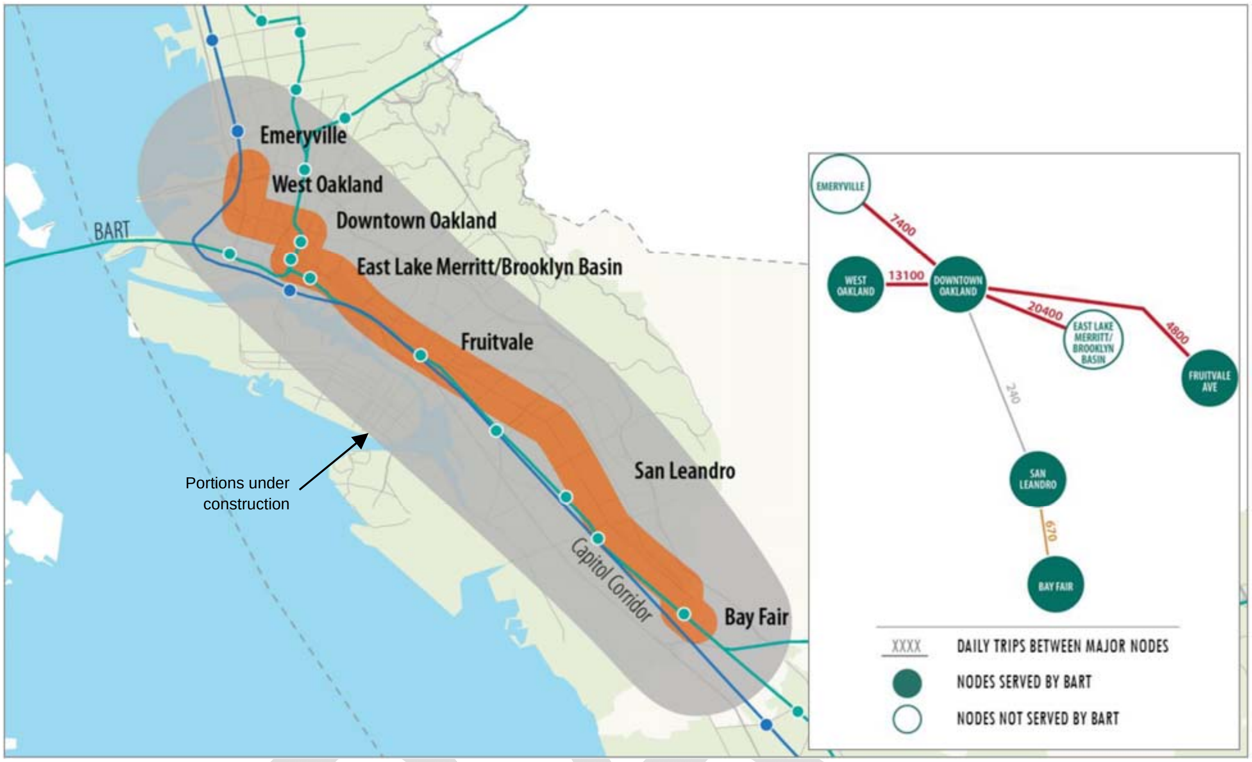
- Telegraph Avenue/East 14th/International Boulevard BRT (the segment from downtown Oakland to San Leandro is currently in construction)
- College/Broadway Corridor Transit Priority (currently in construction)
- Grand/MacArthur BRT
- Alameda to Fruitvale BRT

These recommendations are consistent with those included in this memorandum.

AC Transit is currently developing recommendations for transit investments as part of the Major Corridors Study. This study is looking at investments in multiple corridors in the East Bay, and the recommendations for the Countywide Transit Plan have been refined to be consistent with the recommendations that are being developed in the Major Corridor Study. Service levels are currently being assessed by both AC Transit and LAVTA as part of operational studies. The recommendations for these studies will be integrated with these studies to the extent possible.

The following recommendations for the Urban Rapid tier were identified through the market analysis and working in cooperation with the transit operators and local jurisdictions. These recommendations also include high ridership routes and routes that have already been included in the RTP, but have not yet been clearly defined, such as the Grand-MacArthur and the Alameda-Oakland BRT lines.

U1 Emeryville – Bayfair BART Station



U1. Emeryville - Bay Fair BART Station

This project links the East Bay BRT improvements on International Boulevard with a potential extension to Emeryville to serve emerging markets. AC Transit routes 1 and 1R are two of the most highly used routes in the system. They are also two of the worst performing routes in terms of on-time performance meeting their goal only 55% of the time. The route serves the north-south intra-county market in Oakland and Emeryville. This proposed modification overlaps with the East Bay BRT, which will extend from downtown Oakland to Downtown San Leandro.

Draft recommended capital improvements include:

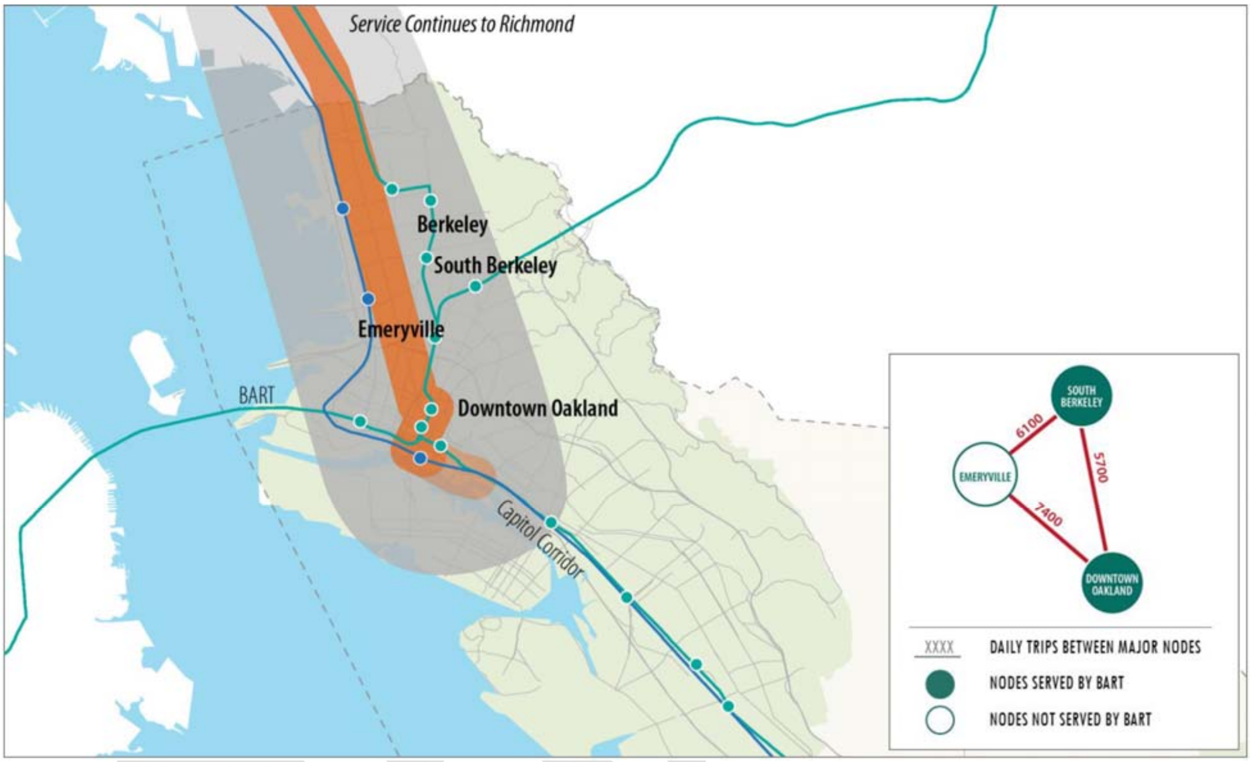
- New buses
- Large portions of the route operating on dedicated bus lanes
- Bus Bulbs
- Queue Jumps
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control

Draft recommended service levels include:

- 24 hours of service

- 5 minute headways
- 14 miles
- 36 minute trip time

U2 Richmond Parkway Transit Center – Jack London Square



U2. Richmond Parkway Transit Center - Jack London Square

This project is an upgrade to the existing AC Transit routes 72, 72M, and 72R, three of the more highly used routes in the system. They are also some of the worst performing routes in terms of on-time performance varying between 55% and 63% depending on the route. Service on this route extends into Contra Costa County to the Richmond Parkway Transit center. The line could terminate in Downtown Oakland or could be extended to serve Brooklyn Basin.

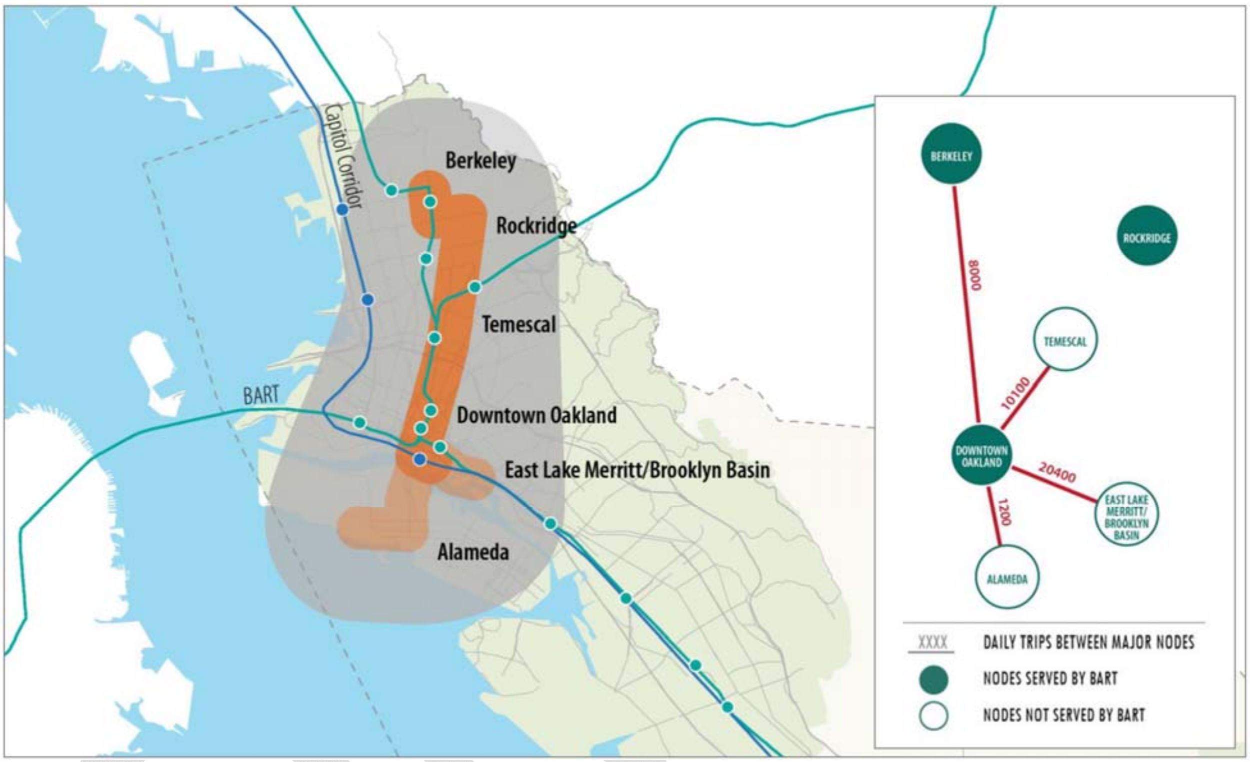
Draft recommended capital improvements include:

- New buses
- Bus Bulbs
- Portions of the route operating on dedicated or semi-exclusive lanes
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control

Draft recommended service levels include:

- 24 hours of service
- 5 minute headways
- 14 miles
- 38 minute trip time

U3 Berkeley – Brooklyn Basin



U3. Berkeley – Brooklyn Basin

This project is an upgrade to the existing AC Transit routes 1 and 1R that run on Telegraph Avenue and are two of the most highly utilized routes in the system. They are also two of the worst performing routes in terms of on-time performance meeting their goal only 55% of the time. The proposed project includes portions of the existing East Bay BRT and could potentially include an extension to Brooklyn Basin to accommodate the anticipated growth in this area, or an extension and incorporation of the proposed Alameda BRT.

Draft recommended capital improvements include:

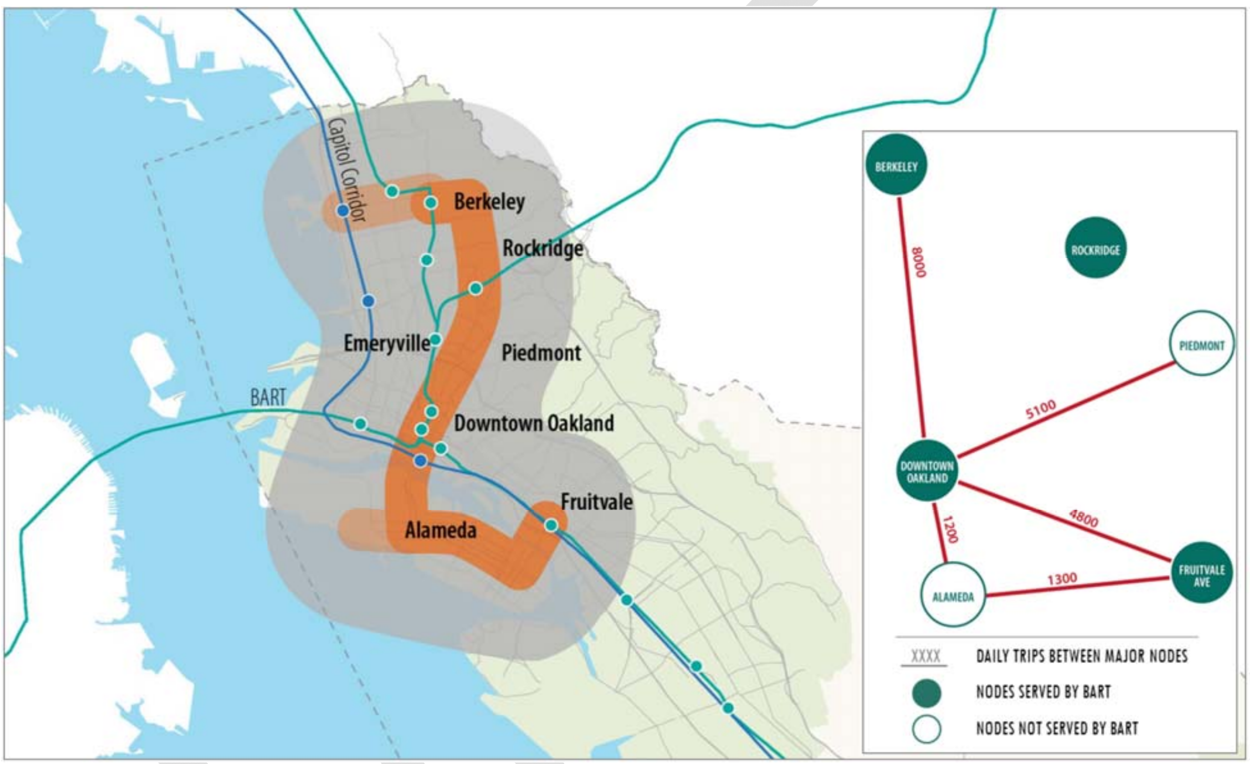
- New vehicles
- Bus bulbs
- Queue jumps
- Portions of the route operating on dedicated or semi-exclusive lanes

- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control

Draft recommended service levels include:

- 24 hours of service
- 5 minute headways
- 8 miles
- 40 minute trip time

U4 Berkeley – Fruitvale BART



U4. Berkeley – Fruitvale BART

This project is an upgrade to the existing AC Transit routes 51A and 51B; two of the top five highest ridership routes in the system. On-time performance is better than other routes in the system, but still low compared to national standards at 66 to 69%. The project includes potential extensions along University Avenue and to Alameda Point.

Draft recommended capital improvements include:

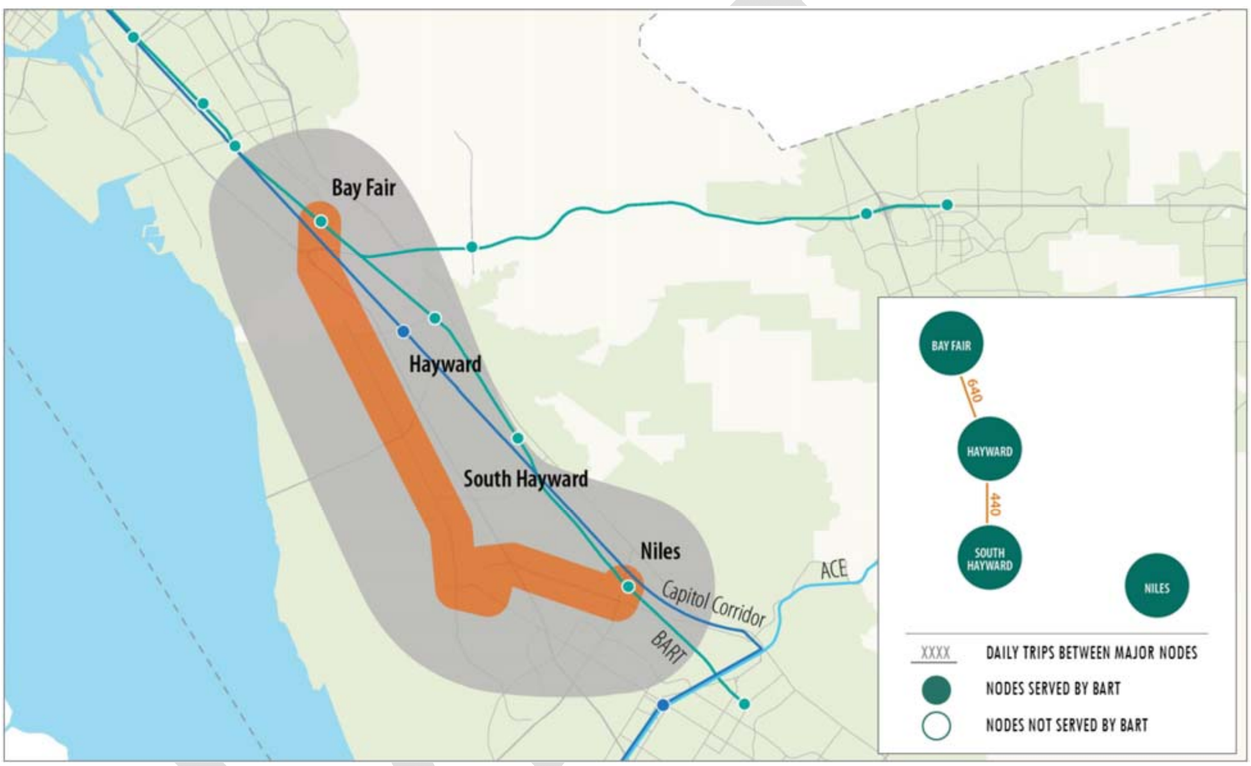
- New buses
- Bus Bulbs
- Queue Jumps
- Portions of corridor with semi-exclusive lanes
- Other selected transit priority treatments including transit

signal priority (TSP) and adaptive signal control

Draft recommended service levels include:

- 20 hours of service
- 12 minute headways for Rapid Bus and 20 minute headways for local service
- 11 miles
- 50 minute trip time

U5 Bay Fair BART – Union City BART



U5. Bay Fair BART – Union City BART

The proposed route would provide connections via Hesperian Boulevard to two BART stations in central Alameda County. Though this corridor did not show a high trip density in the market analysis, it was identified as one of AC Transit's Major Corridors. The Line 97 has strong ridership of more than 1.3 million annual riders, but an intensification of lands uses along this corridor would likely improve the transit compatibility and improve the relatively poor on-time performance of 65%.

Draft recommended capital improvements include:

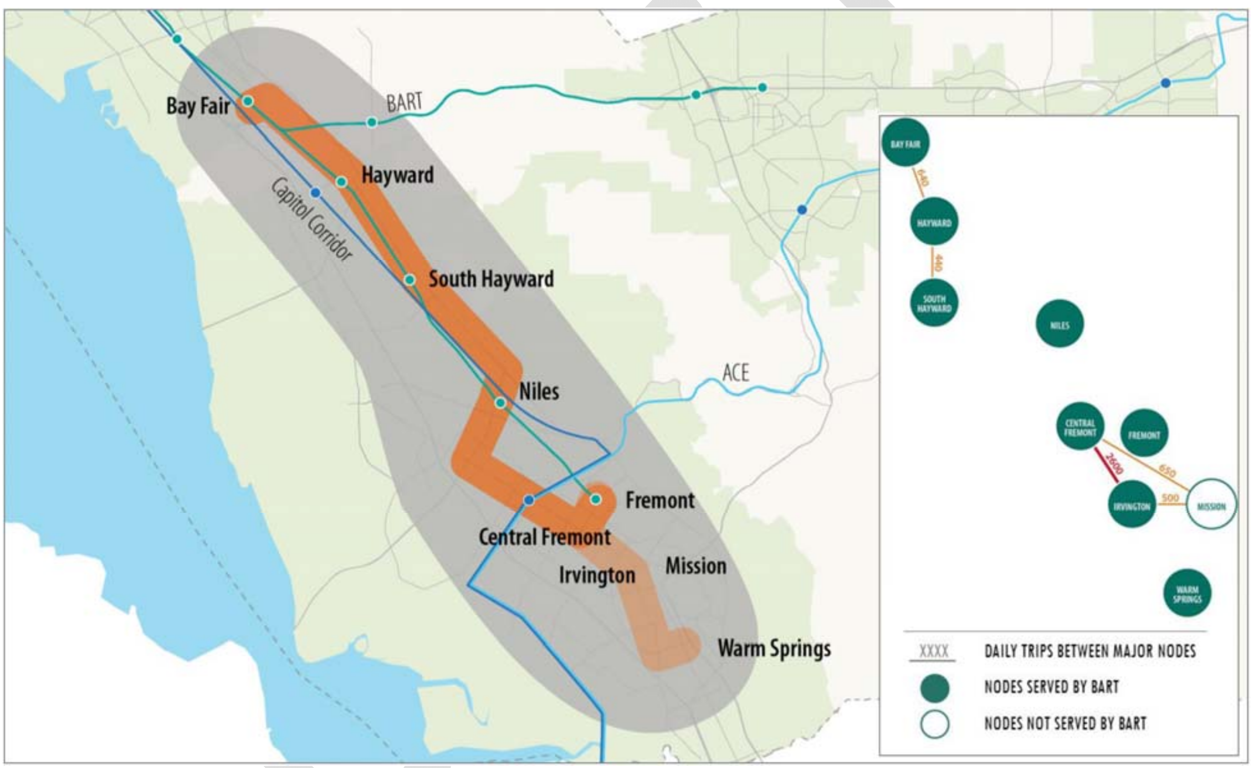
- New buses
- Bus bulbs
- Queue jumps
- Semi-exclusive lanes on portions of the corridor, otherwise

mixed flow
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control (currently being designed)

Draft recommended service levels include:

- 20 hours of service
- 12 minute headways for Rapid Bus and 20 minute for local service
- 12 miles
- 35 minute trip time

U6 Bayfair BART – Warm Springs BART



U6. Bay Fair BART – Warm Springs BART

The proposed route would provide connections to two BART stations in central Alameda County along Mission Boulevard. Though this corridor did not show a high trip density in the market analysis, it was identified as one of AC Transit's Major Corridors. While the Line 99 has strong ridership of more than 900,000 annual riders, an intensification of lands uses along this corridor would likely improve the transit compatibility. Transit preferential treatments would also improve the relatively poor on-time performance of 59% for this route. The line could potentially be extended to serve the new Warm Springs BART station.

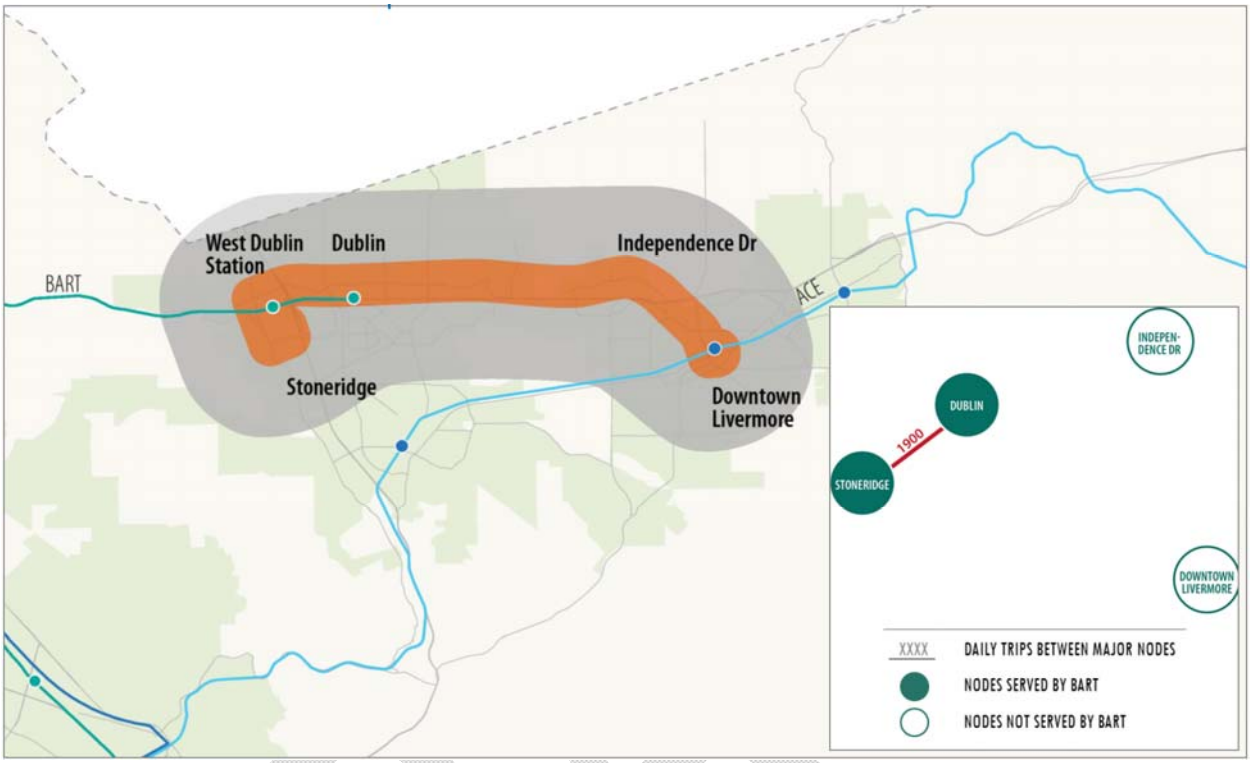
Draft recommended capital improvements include:

- New buses
- Portions of the route would have dedicated lanes
- Other selected transit priority treatments including transit signal priority (TSP) and adaptive signal control

Draft recommended service levels include:

- 24 hours of service
- 5 minute headways
- 20 miles
- 50 minute trip time

U7 W. Dublin/Pleasanton BART – Livermore ACE



U7. W. Dublin/ Pleasanton BART– Livermore ACE

The current LAVTA Rapid bus has had lower than anticipated ridership and is not meeting farebox recovery standards set by MTC for receipt of Regional Measure 2 operating funds. The realignment of the existing Rapid line to capture more of potential ridership to the north of the I-580 is contingent upon the proposed future extension of Dublin Boulevard to North Canyons Parkway. LAVTA's Comprehensive Operations Analysis (which is currently underway) may recommend modifications to this proposed recommendation; these will be incorporated to the extent possible based on the timing of the two planning efforts.

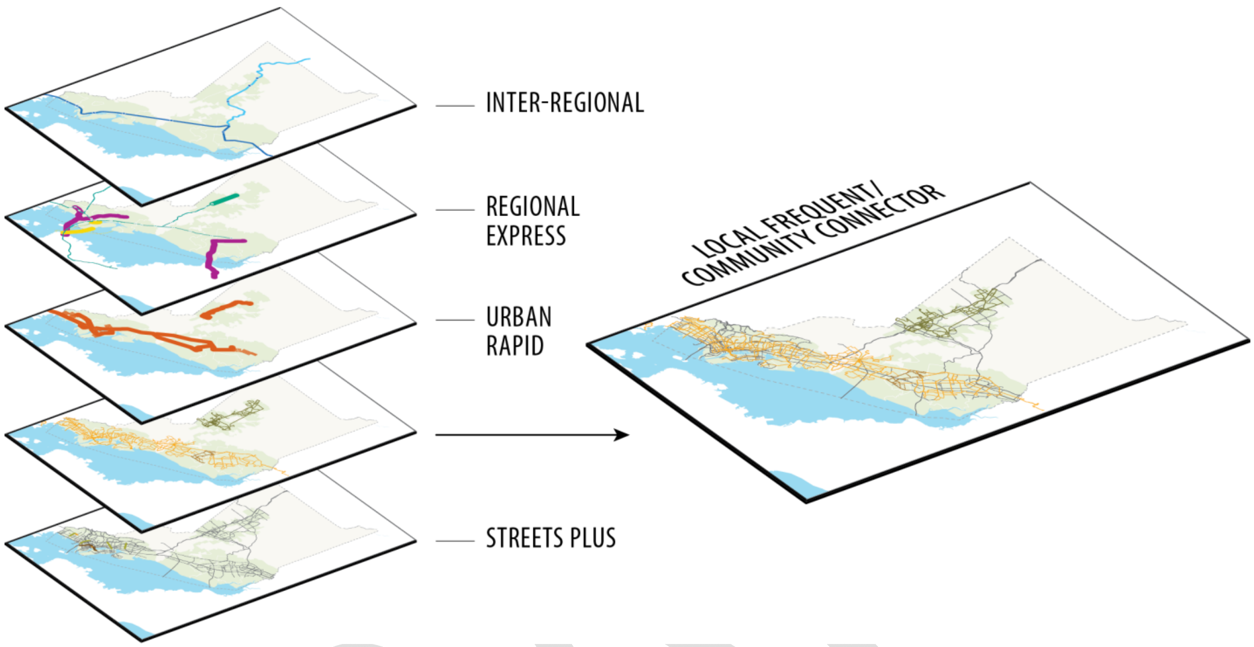
Draft recommended capital improvements include:

- Primarily dedicated transit lanes with some mixed flow
- Selected transit priority treatments including TSP

Draft recommended service levels include:

- 20 hours of service
- 12 minute headways
- 20 miles
- 50 minute trip time

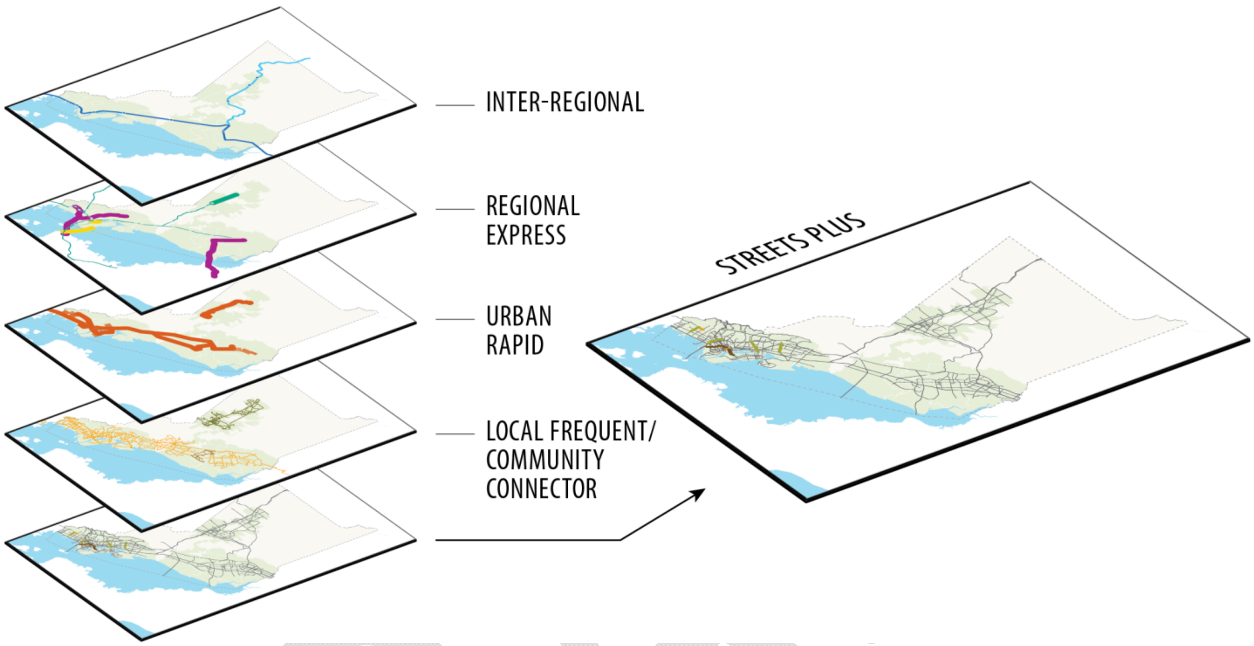
Local Frequent/Community Connector Tier



The Local Frequent and Community Connector tiers are critical to the provision of transit service. These two tiers combined provide basic transit service coverage in communities and also serve first and last-mile connecting functions to the Regional Express and Urban Rapid and services. These services also connect more dispersed trip origins and destinations.

There are no proposed capital or route modifications to the local/community tier of service within Alameda County. This level of service does not require intensive capital investments. Transit service for these routes would be based on the service standards laid out in the previous sections of this technical memorandum and are expected to be determined by the transit providers in consultation with local jurisdictions. Improvements to these services in the future would be undertaken as part of service improvement efforts such as regularly updated Short Range Transit Plans and AC Transit's current Service Expansion Plan, and transit plans and studies undertaken by local jurisdictions.

Streets Plus Tier



The street network provides the public right-of-way within which all bus services operate. It also provides access to and from transit stops and stations. Specific transit corridor improvements have been described in previous sections, but additional infrastructure improvements have been identified that are necessary to facilitate our transit system functioning at the optimal level and to support the goal of increasing transit ridership.

Such improvements include transit preferential treatments on streets that would serve multiple transit routes, e.g. Broadway in Downtown Oakland, and where improvements would greatly facilitate more efficient transit operations. Other improvements are recommended for streets that provide critical east/west connections to the Urban Rapid services that are aligned primarily along north/south corridors and which, due to their length, might not rise to the level of a major investment for transit, but nonetheless provide critical connectivity between routes.

A few street segments warrant special transit consideration due to the concentration of transit services that operate on these streets and their location within major activity centers. They are designated as Transit Priority Zones, consistent with the recommendations included in the Major Corridors Study for AC Transit. In these Transit Priority Zones, pedestrian facilities and amenities are important features as are design elements intended to minimize delays for bus transit. Design features may include single or double transit lanes, off-board payment areas, boarding islands, parking and turn restrictions, and pedestrian improvements, stop optimization, bus bulbs, and transit signal priority.[24]

Transit Priorities in the AC Transit Service Area

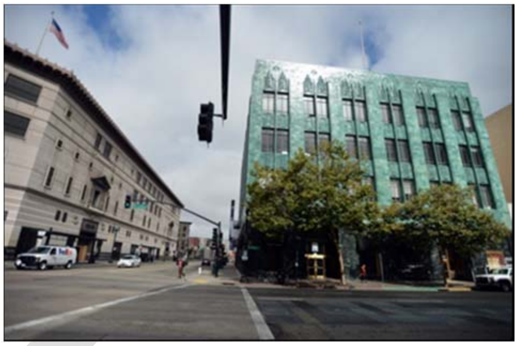
Transit Priority Zones in Downtown Oakland and Downtown Berkeley

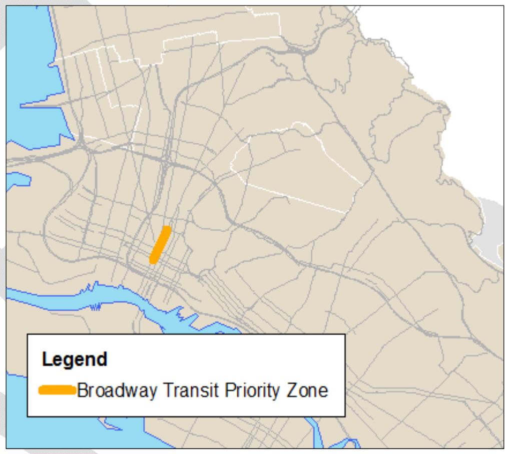
Two locations in the study area stand out for special consideration, given their locations in the major corridors' service areas: Broadway in downtown Oakland and Shattuck Avenue in downtown Berkeley. In both places, there is a high concentration of transit activities, including the convergence of several bus lines, intermodal transfers, and on-street passenger activity. Because of this high concentration of transit services, any reduction in delays in these areas could be a keystone to improvements along the remainder of the corridors. Transit Priority Zones are being proposed for both locations.

In addition to the more specific improvements below that have been outlined in AC Transit's Major Corridor Study, transit flows in these two downtown areas would benefit from modern, integrated traffic signal control systems that facilitate traffic progression.

[24] Major Corridors Study, Task 3 Development of Alternatives, July 20, 2015, Final Draft.

Downtown Oakland





Downtown Oakland

In downtown Oakland, there is an opportunity to create a Transit Priority Zone on Broadway between 11th Street and 20th Street, where many of the major corridors' bus lines and many other lines converge. In fact, 11 bus lines currently travel on this street during the weekdays, with 40 buses traveling along Broadway every hour during peak periods to provide a combined headway of 1.5 minutes.[25] The International Boulevard BRT line will also operate along Broadway when it begins service in 2016. AC Transit's intermodal Uptown Transit Center, another major transit facility, is located on Broadway and 20th Street, and its bus operations would improve with Transit Priority Zone treatments.

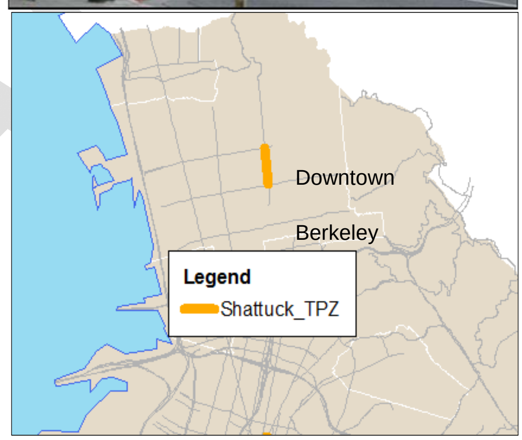
Potential Transit Priority Zone improvements on Broadway include TSP and adaptive signal control; station enhancements, including improved bus stop signage, that would complement the planned BRT stations currently being designed for the International Boulevard BRT line; parking and turn restrictions for cars; and creating signage to direct autos to the parallel streets of Franklin and Webster, which have wide rights-of-way and (currently) a good amount of capacity.

[25] Communication with Steven Newhouse, AC Transit, June 16, 2015

The vision of downtown Oakland and the transit priority treatments on Broadway will be shaped by the Downtown Oakland Comprehensive Circulation Study, led by Alameda CTC, and the Downtown Specific Area Plan, led by the City of Oakland, which are currently underway.

Downtown Berkeley

There is also an opportunity to create a Transit Priority Zone along Shattuck Avenue in downtown Berkeley, namely around University Avenue and Allston Way near the BART station.



Currently, to improve pedestrian access and safety, the City of Berkeley is looking at reconfiguring the west (southbound) leg of Shattuck Avenue into a two-way street, while the east (northbound) leg would remain a one-way street. Accompanying this new circulation pattern would be new bus stops, concrete bus pads, traffic signals, curb modifications, and other changes. The City of Berkeley will also reconstruct the public plaza above the downtown Berkeley BART station. (Design plans are not available at this time.)[26] These proposed changes do not conflict with the principles of creating a Transit Priority Zone and could be augmented to include more intensive transit-priority treatments in this area, including a semi-exclusive bus lane; transit signal priority (TSP) and adaptive signal controls; and sidewalk extensions and sufficiently long bus loading zones at the new public plaza.

[26] City of Berkeley, Shattuck Reconfiguration and Pedestrian Safety Project, Information Sheet, April 2015, Available: http://www.ci.berkeley.ca.us/uploadedFiles/Public_Works/Level_3_-_Transportation/Info%20Flyer Shattuck%20Reconfig_Apr%202015.pdf

Transit Network Priority Opportunities

Two major opportunities have been identified for further evaluation as part of this network definition task: Webster/Posey tubes and the San Pablo/Grand Avenues corridor from Telegraph Ave to the I-80 ramps to the Bay Bridge. Both of these transit priority opportunities are locations that currently have multiple bus lines or the potential for serving multiple bus lines and experience significant recurring congestion that regularly impairs the speed and reliability of routes operating in the corridor. These locations overlap with proposed urban rapid routes, but at this stage of the network development process they are still under consideration.

Webster/Posey Tubes

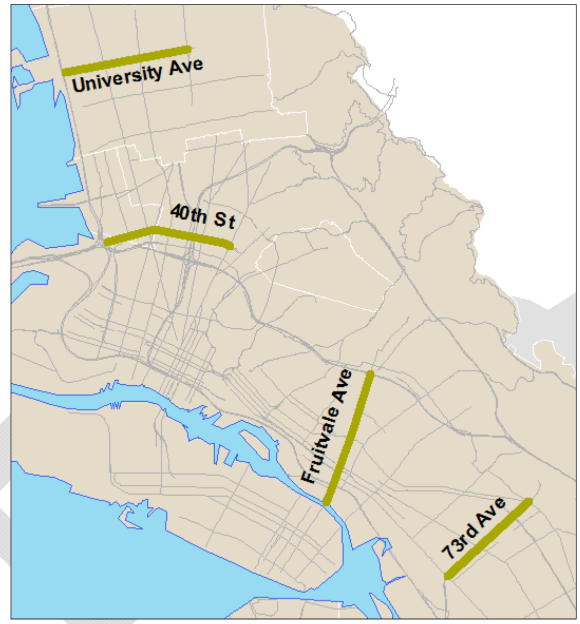
The Webster and Posey tubes provide access between the island of Alameda and downtown Oakland. The tubes provide the primary means of getting to and from the island for the west end of Alameda. Nearly 6,000 total trips (all modes) pass through the tubes in the PM peak hour and the tubes experience back-up in the morning peak hour getting off the island and in the afternoon in Oakland returning to the island.[27] The AC Transit buses become stuck in these queues with the rest of traffic. By providing transit preferential treatments, such as queue jumps and transit signal priority, delays for the transit patrons would be reduced.

Grand Avenue

Grand Avenue is a main access route to the Bay Bridge from downtown and West Oakland. It is a four-lane roadway that feeds directly onto the Bay Bridge and is presently used by the Line NL bus to access the bridge. As queues form on the Bay Bridge approaches during congested commuter hours, this route may also become congested. While traffic is not currently severe on Grand Avenue, the opportunity to provide dedicated or semi-exclusive bus lanes on this corridor to accommodate future transit accessing the Bay Bridge is recommended for further consideration if additional transbay transit lines are considered for routing via Grand Avenue from Oakland.

[27] PM peak hour two-way volumes estimated from the Alameda County Travel Demand model for the Alameda County Multi-Modal Arterials Plan, Fehr & Peers, 2015.

Improvements in these locations could help improve transit operations and reliability for all bus routes traveling on these streets. Improvements will be defined as a combination of transit speed and reliability treatments such as queue jumps, transit signal priority, etc. These improvements could be implemented with the institution of new urban rapid service or on their own.



Improvements to East/West Corridors

The geography of the east bay area results in a very north-south focused roadway network and set of transit services. A robust transit network would include strong east-west connections on key arterials.

The following east/west street segments are critical in providing connections between the north/south Urban Rapid services.

- University Avenue in Berkeley
- 40th Street in Emeryville/Oakland
- Fruitvale Avenue in Oakland
- 73rd Avenue in Oakland

These east/west connectors could benefit from transit priority treatments, such as transit signal priority or bus bulbs.

Transit Priority Areas in East and South County

In addition to the Transit Priority Zones identified for AC Transit, key roadways in East and South Alameda County are critical to the efficient operation of LAVTA and Union City Transit bus routes. These roadways generally provide access to rail stations which are key intermodal transit hubs served by a number of bus and shuttle routes in both East and South County. These rail stations also have large park-and-ride facilities, and the roadways used by buses and shuttles to access rail stations are often the same as those used by automobiles to access the rail station park-and-ride facilities. Consequently, it may be necessary to invest in infrastructure improvements on these roadways to ensure that buses and shuttles have quick, reliable and safe access to rail stations.

In East County, portions of Santa Rita Road and Owens Drive in Pleasanton and Dublin as well as portions of Stanley Boulevard and Railroad Avenue in Livermore provide key connections to BART and ACE rail stations. Additionally, ensuring efficient transit operations on roadways that connect the Tri-Valley cities of Livermore and Pleasanton (e.g. I-580, Jack London Boulevard and Stanley Boulevard) are critical for efficient and reliable operation of LAVTA's routes that serve multiple communities in the Tri-Valley.

In South County, the Union City BART Station is a key intermodal transit hub for Union City Transit, AC Transit and BART. Portions of Decoto Road and Alvarado Niles Road provide primary access to the station not only for transit vehicles, but for private automobiles as well. Additionally, Alvarado Niles Road is the spine of most Union City Transit bus routes and connects its key hubs at the Union City BART Station and Union Landing.

In addition, current and future BART stations in Fremont (Fremont, Warm Springs, and potentially Irvington) also serve as intermodal hubs as well as major park-and-ride facilities, and the roadways leading to and from these stations provide important access for local bus connections. In Newark, a new transit center and park-and-ride is being considered in coordination with Dumbarton Corridor Area Improvements; facilitating inter-county and local bus travel to and from this new transit center will be important to ensuring frequent, reliable bus service.

System Integration

Previous sections of this technical memorandum have focused on how to make transit infrastructure and service improvements on all tiers of the system to facilitate faster, more reliable transit service. The last factor that is critical to achieving success in improving transit ridership is the delivery of an integrated transit system. Physical integration (i.e. how the transit services connect and how the street network functions) in conjunction with the transit network and institutional integration (i.e. how services and information are coordinated) both affect the transit customer experience. Providing an integrated transit system depends on the cooperation and willingness of all levels of government and the private sector to play a role in improving transit services.

The building blocks for system integration are laid out below. A more detailed discussion of how to implement these elements will be the subject of future technical memoranda addressing interagency coordination, transit oriented development, and implementation strategies. The following section introduces key concepts necessary for system integration.

Physical Integration

The tier structure that is proposed as an organizing element for the transit network in Alameda County relies on making connections between the transit tiers at major activity nodes and transit hubs. These nodes or hubs provide the points where these connections occur, facilitating the integration of transit services. This integration requires cooperation between the transit operators and the local jurisdictions to ensure that transit hubs and their function are understandable and easy to use by transit customers.

In addition to the physical integration of the transit tiers, the street network serves as the access system to all transit services, whether the transit customer is driving, walking, or bicycling to their transit stop. The transit patron wants to feel safe and secure and have a pleasant experience getting to their destination. This means a positive experience getting to and from the transit stop a well as on the bus or train.

The achieve this, the street network and its interface with the surrounding land use should be designed with attributes, as noted below, that promote a transit oriented community, rather than focusing on density alone as a means to realizing increased transit ridership.

- Signal systems on street networks that facilitate the flow of transit.
- Street networks that minimize out of direction travel for pedestrians walking to bus stops
- Minimizing barriers to pedestrian flows (e.g. walled developments that limit the number of access points to major bus routes)
- Sidewalks of adequate width to accommodate pedestrians on all streets
- A network of safe bicycle routes that connect to major transit hubs and bus stops
- Clean, well-lighted bus stops with access to transit information
- Land use guidelines that orient buildings and front doors of residential and commercial buildings to the sidewalk, rather than abutting large expanses of parking

Because the authority for the street network and land use regulations lies with cities and the county, they play a large role in helping to improve the potential for transit success.

Institutional Integration

Making physical improvements alone will not achieve the desired results for transit, if institutional barriers to transit use remain. The experience for the transit customer also needs to be as seamless as possible, as transit riders move from one mode to another. Better integration of transit information, fares, and fare payment systems are critical to attracting “choice” riders to transit and providing improved services (and potentially lower fare costs) for those dependent on transit.

This institutional integration is difficult to achieve solely at a countywide level given the multitude of transit service providers within the Bay Area and in Alameda County. This integration requires advocacy on the part of Alameda CTC to achieve results at a regional level. The elements of a better institutionally integrated transit system include:

Provide clear and consistent transit information

Ease of access to transit information is a challenge to the transit user with so many different operators. MTC can take a role at the regional level to create a regional transit map, but Alameda CTC could initiate this at a county level as a pilot for a regional program.

Provide easy access to transit information

In the past, the regional 511 Transit Trip Planner served as a one-stop shopping center for obtaining transit information. Today applications such as Google’s transit trip planner are becoming increasingly popular. New informational kiosks, such as those provided by New York Metropolitan Transportation Authority provide interactive touch-screen access to a multitude of transit options. Transit operators are encouraged to continue to share information and incorporate these new opportunities into their transit information toolkit.

Implement real-time transit and first and last-mile connecting information and options at transit stations

Applications with interactive digital maps, routes/locations, and real-time information on the location of transit vehicles and shuttles can facilitate connectivity between transit modes and ease of trip planning. At transit stations where parking is the key to providing access to the transit system, integrate real-time parking information for transit patrons. Universities have been some of the early adopters of real-time parking information. This avoids the need for potential transit patrons to circle the garages or lots in search of parking.

While the sharing of information is critical, so is the availability of options for connecting to and from transit services. Providing bicycle-sharing, shuttle service, and ride-sharing options at transit stations can encourage more transit ridership.

Provide universal fare collection with integrated fare structures

The introduction of the Clipper Card has had a positive impact on the ease of transfers among different operators, but it is not fully integrated with all operators at this time nor is it easy to secure and add value to the cards.

Cash value and transit passes can be loaded to the Clipper Card at BART and Muni stations, at service centers (e.g. Walgreens and the Transbay Transit Center), online, through Autoload, and through employee benefit programs. Monthly passes and cash value can be purchased, but each transit operator still maintains their own accounts, which means it is not only more costly for transit services, but it is also more time consuming when adding value to the Clipper Card. Unlike other programs such as the Los Angeles Tap or the Atlanta Breeze cards, Clipper Cards need to be purchased at designated outlets and must be registered on-line. Though Clipper Cards can be used for parking payments at BART stations and a limited number of public garages, this requires a separate account to be maintained.

As MTC undertakes the update to the Clipper Card services, consolidation of fare structures and providing a universal transit pass would be desirable. According to the recent SPUR Seamless Transit Report, the New York City Transit system reported a

20% increase in ridership in the 1990's when they launched the Metro card, which integrated fare policies and the payment system.[28]

Institute convenient on-line ticketing

While on-line access to add fares is currently available with the Clipper Card, there can be delays in the registering of purchases made on-line. This can make on-line purchases less convenient that purchasing from a ticket machine. Innovations in ticketing, such as Clipper card values that cover all types of service without regard to operator, mobile ticketing, and digital wallets, and proof-of-payment should be explored to eliminate the delays in registering fare payments.

[28] *Seamless Transit, How to make Bay Area public transit function like one rational, easy system*, SPUR Report, April 2014, citing *Increasing Transit Ridership: Lessons from the Most Successful Transit Systems in the 1990's*, Brian Taylor and Peter Hass, Mineta Transportation Institute, June 2002.

Next Steps

Many of the improvements included in this technical memorandum can result in significant improvements to transit operations and increased ridership and productivity. To assess the potential for transit benefits, it is necessary to provide enough detail for proposed changes to existing operations and the roadway network to estimate cost and travel time benefits during the evaluation process. However, at the county-wide planning level it is neither feasible nor prudent to perform all the transit planning, traffic and civil engineering required to create detailed street-by-street, intersection-by-intersection designs for each of the proposed routes.

The approach taken in this network development phase was to identify concept-level candidate corridors (which could include variations on alignments) and develop a prototypical alignment with a spectrum of preferential transit treatments such as those described in Table 2 based on the market analysis, knowledge of the corridor, and an understanding of the relevant transit agencies operations. These prototypical services will then be used as input into the estimation of benefits (e.g. travel time reductions) and cost that will inform the evaluation process to be performed in a future task.

Appendix A

Purpose

Appendix A documents the approach used to identify and define the organizational structure of transit service tiers that is recommended for the Alameda County Countywide Transit Plan. Examples of how transit operators in the Bay Area and a few other select examples apply service tiers are included for reference.

Background and Constraints

Alameda County voters approved Measure BB in November, 2014. With the passage of Measure BB. significant increases in funding for public transit have become avaialable. As part of the Countywide Transportation Planning process, the Alameda County Transportation Commission is developing a Countywide Transit Plan to provide a framework for future reliable, convenient, and highly utilized transit services.

The Countywide Transit Plan is intended to provide a vision for transit services in the county. Though Measure BB provides an infusion of new funding, transit resources are still limited. As a result, the transit vision is intended to not only provide a framework for the future, but also to help decision-makers prioritize both operating and infrastructure funding to ensure that the public receives the best value for its investment.

The objective of the Countywide Transit Plan is to:

- Identify important transit service markets
- Match those markets with realistic infrastructure improvements
- Create comprehensive transit products (service and infrastructure) that make good use of available funds

Transit service markets can be characterized using different descriptors. These include the general categories of:

- Inter-regional – long distance trips connecting communities across regions and the state
- Regional – across county lines or long distances within a county
- Local – on arterials or other main streets, but generally serving trips of one to five miles, and

- Community – serving shorter connecting trips, also shuttle services serving social needs

Measure BB is able to fund any of these services at transformative levels, but it cannot fund all the service types at a scope that makes impactful changes. A necessary first step in developing a transit network is organizing service markets into service types or tiers to establish a common language for understanding the characteristics of each service tier, the types of trips served, and the necessary infrastructure for successful operation of each tier.

The first step in recommending service tiers for use by Alameda CTC in the Countywide Transit Plan involved understanding how transit providers approach the establishment of service tiers. This understanding was achieved through a survey of transit providers.

Current Practice in Defining Transit Service Tiers

In March 2009, the Center for Urban Transportation Research (CUTR) at the University of South Florida issued Best Practices in Transit Service Planning. This report reviewed transit practices at 60 transit operators (including Orange County Transportation Authority and Santa Barbara Metro Transit in California) across the country. The study outlined four different categories that transit agencies ordinarily use to define their fixed-route service structure:

- Number of stops or service frequency,
- Population or target market type served,
- Route design, and
- Time of day.

Examples of service types are shown in Table 1, and were considered, as a structure for the Countywide Transit Plan was developed.

Table 1. Examples of Service Types

Classification System	Examples of Service/Route Categories
Number of stops or service frequency	• Local service – comprises the majority of the system and represents the "average route." Also known as regular, base, or core service • Limited-stop service – has fewer stops, operates at higher speeds than local service, and tends to run on a freeway or arterial to increase speeds • Rapid service or bus rapid transit – a form of limited-stop service that combines a much higher operating speed with transit priority and possibly segregated infrastructure • Express service – serves two distinct points with no or few intermediate stops, typically from the suburbs to downtown or employment centers
Population served	• Commuter/work-based service – peak period service for commuters • Community-based service – service geared toward a specific community or area, typically for transit-dependent populations • Student-based service – service geared toward schools and university students • Regional service – service that is focused on the regional population, connecting one major urban area with another
Route design	• Radial/trunk routes – act as the backbone of the system, operating on arterials • Cross-town routes – non-radial routes that do not directly serve the central business district • Circulator routes – provide service within a confined area • Feeder / shuttle routes – provide service in higher density areas to feed to other routes in the system or regional transit stations • Regional routes – service that is regional in nature, connecting one major urban area with another
Time of day	• Peak-period service (AM and PM peak periods) • Non-peak service • Night service

Source: Best Practices in Transit Service Planning, March 2009, Center for Urban Transportation Research (CUTR) at the University of South Florida.

Peer Transit Agencies

While the general guidance provided by best practices research is useful, each transit operator chooses to define service slightly differently, using different groupings of service characteristics. Bay Area transit agencies were surveyed to understand their service tier definitions, as defined by policy. Most agencies nationwide do not explicitly document their service tiers, although a few agencies, including King County Transit and Denver RTD, do and are included here for reference. Service design guidelines for peer transit agencies are described below:

AC Transit

AC Transit has a variety of service types defined primarily by residential density and route design. These include the following:

- Trunk Routes and Major Corridors – Operates on corridors where residential densities are at least 20,000 residents per square mile (or equivalent commercial density). These routes are the backbone of the system.
- Rapid – Provides limited-stop service along a Trunk Route and Major Corridor.
- Urban Secondary, Crosstown, and Feeder Routes – Services operating in medium density corridors (10,000–20,000 residents per square mile or equivalent commercial density). These routes complement the Trunk Routes.
- Suburban Crosstown and Feeder Routes – Operates in low-density corridors (5,000–10,000 residents per square mile). These routes feed BART and other AC Transit routes, and provide circulator services.
- Low-Density Routes – Operates in areas of very low density (fewer than 5,000 residents per square mile).
- All-Nighter (Owl) Routes – Provides service between midnight and 6:00am.
- Transbay Routes – Provides service to downtown San Francisco via the Bay Bridge Corridor and to Peninsula destinations via the San Mateo and Dumbarton bridges.

Golden Gate Transit

Golden Gate Transit defines three categories of service — GGT Bus, Golden Gate Ferry, and GGT Partnership — according to the level of service provided. These categories are described below:

- GGT Bus
  - Regional Commute – Operates only during peak weekday commute periods between residential neighborhoods and collection points within Marin and Sonoma counties with express service to San Francisco

Financial District and Civic Center. Level of service is set to match demand.

- Regional Basic – Operates all day, seven days a week with limited stops between San Francisco (Transbay Terminal and Civic Center) and various suburban centers in Marin and Sonoma counties. Level of service is set by policy (30- to 60-minute frequency).
- Regional Commute Shuttle – Provides commute period shuttle services to and from the direct Transbay bus routes.

- Golden Gate Ferry
  - Operates two ferry routes between Marin County and San Francisco all day, seven days a week.
- GGT Partnership
  - Partnership Basic Service – Operates between service areas of AC Transit and other East Bay agencies in Contra Costa County and GGT service areas in Marin County.
  - Partnership Commute Service – Provides commute express service between Santa Rosa and San Francisco.
  - Partnership Marin Local – Operates local Marin County routes, and one seasonal route
  - Marin recreational route (service level set by and funded by Marin Transit).

SamTrans

SamTrans operates five types of fixed route service, and Caltrain and BART shuttles, according to the following design standards:

- Fixed-route Community – Consists of the majority of SamTrans' routes and serves local youth, shopping centers, residential areas, and government centers (average 60 minute headways).
- Fixed-route Express – Operates during weekday peak hours only and connects to at least one of four BART stations (10- to 30-minute headways).
- Fixed-route BART Connections – Connects to BART stations within San Mateo County seven days a week, on weekdays from 6am until 11pm, and on weekends from roughly 8am to 8pm.

- Fixed-route Caltrain Connections – Connects to Caltrain stations. Generally operate between 6am and 8pm weekdaysy, with several routes also providing night and weekend service.
- Fixed-route BART and Caltrain Connections – Connects BART and Caltrain stops, in addition to other destinations. Operates seven days a week, from 6am to 1:30am.
- Employer Shuttles – Operates shuttles linking BART and Caltrain stations to employment centers in San Mateo County. In general, shuttles operate during morning and evening commute hours.

SF Muni

The Muni Forward program categorizes service based on service characteristics as follows:

- Rapid Network – Consists of the heaviest demand routes operating with the most frequent service (5- to 10-minute service frequency)
- Local Network – Combines with Rapid Network to create core network (10- to 15-minute service frequency)
- Community Connector – Fills gaps in coverage and connects to core network (15- to 30- minute service frequency)
- Specialized Services – Augments all day service and addresses focused needs (includes express routes)

VTA

The VTA Service Design Guidelines, adopted in February 2007, define service categories in the Santa Clara Valley area. Land use and density targets are defined for categories such as light-rail transit (LRT) and bus rapid transit (BRT). Five general types of transit service are defined based on the service level provided:

- Community Bus – Provides circulator service in lower-density communities.
- Local Bus – Provides service to major activity centers. Three types of local routes are defined: feeder, secondary grid, and primary grid (with shorter routes being considered local feeder routes and longer routes as local primary grid routes).
- Express Bus – Provides fast service traversing long distances and connecting suburban areas with employment centers. Limited Stop, Express, and Regional Express routes are defined within this category based on the type of trip served.
- BRT – Operates frequent and fast bus service on major corridors with higher densities, similar to rail transit, with service frequency between 5 and 15 minutes. BRT-1 and BRT-2 are defined in this category based on the level of segregation from mixed-flow traffic.

- LRT – Provides high-speed and environmentally friendly rail service linking major corridors, trip generators, and county cores.

WestCAT

The 2008 WestCAT Short Range Transit Plan defines five types of service:

- Dial-A-Ride – Provides accessibility through curb-to-curb service to comply with the service standards of the Americans with Disabilities Act.
- Local Fixed Route – Provides a high degree of accessibility to residents operating on a fixed route with 30-minute peak service frequencies and hourly base/midday service.
- Express Bus – Express service offers much lower accessibility but provides a high degree of mobility with frequent, direct service. Express routes have high speeds and carry large numbers of passengers and connect with BART stations. Service frequencies are 15 minutes peak and 30 minutes base/midday.
- Transbay Express Bus – Fast express service to downtown San Francisco, operating throughout the day. Service frequencies are 15 minutes in the peak and 75 to 90 minutes midday.
- Regional Service – Service linking the service area to the county seat and the local community college. Service frequencies are 30- to 60-minutes peak and 60 minutes base/midday.

King County Metro

King County Transit Golden Gate Transit defines six “Service Families” based on the level of service frequency:

- Very Frequent – 15 minutes or more throughout the day/7 days week
- Frequent – 15 minutes peak/30 minutes midday/7 days a week
- Local – 30 minutes peak/60 minutes midday/5 to 7 days a week
- Hourly – 60 minutes or less often/weekdays only
- Peak – Limited peak only service/8 trips a day, directional/weekdays
- Alternative Servicer – No Standards

Denver RTD

Denver Regional Transportation District operates a variety of service types, organized by land use type and route design:

- Local – Central Business District. These are local services operating into the Denver CBD.

- Local – Urban. These routes are local or limited routes that serve urban areas, having residential population densities of about 9 people per acre and employment densities of 4 to 20 people per acre.
- Light Rail Transit – Rail transit service operating on fixed track at high speeds (50+ miles per hour) on exclusive right of way, with the ability to operate in mixed-flow traffic on city streets.
- Limited – Bus services on high-density corridors with stops at 0.5 to 1.5 mile intervals, providing faster service than local routes, but not operating on freeways.
- Local – Suburban. These routes have population densities of 5 people per acre and employment densities of 2 people per acre.
- Express – High-speed service on limited access freeways from suburban sections to downtown and other employment centers. Express service is provided up to a maximum distance of 16-18 miles.
- Regional – Long-haul routes provide service between outlying communities and employment centers in Denver and Boulder, with distances of about 18 miles.
-

Transit Service Categories for the Alameda County

Based on a review of the service typologies summarized above, the following criteria were outlined to assist in classifying transit services into categories consistent with their functional design for the Countywide Transit Plan:

- Principally define service tiers by the design of the route (trunk, local, last-mile, etc.), but include temporal elements (peak versus all-day service).
- Use a geographic-based system, which is convenient and easy to remember for the County (regional express versus urban rapid).
- Make service tiers descriptive enough to clearly distinguish between different categories and service levels.
- Pair service tiers with characteristics that influence transit use, such as density, parking policy, mix of uses, and urban design so that the most intensive transit services serve the areas most likely to use transit services. The Transit Competitiveness Index (TCI) identifies transit competitive areas in the County and packages these characteristics into a common metric.

As the transit service market is identified through a review of transit competitiveness and overall market size (the “demand” approach), the “supply” response to the layering of service tiers – that match the size and requirements of the market. AC Transit – the dominate surface transit operator in Alameda County – already organizes its services using these characteristics, as described in the previous section.

Based on the basic guidelines outlined above, a review of other best practices, and the existing organization of AC Transit service types, the service tiers recommended for the Alameda Countywide Transit Plan are summarized in Table 2.

Table 2. Recommended Countywide Transit Plan Service Tiers

Type	Where Used
Inter-Regional	For travel that extends beyond and through the nine-county Bay Area.
Regional Express	For travel between major travel nodes where there is substantial point to point traffic. Major employment access.
Urban Rapid	For travel to major travel nodes from productive (transit competitive) origins to concentrated destinations. Major employment access/often university access.
Local Frequent	For travel along a Corridor with productive, dispersed origins
Community Connector	For community access in lower productive areas. Serves schools, medical facilities, shopping.

Table 3 describes in more detail the service charactieristics for each of the five service categories. There may be some overlap in service definitions among these categories.,

Table 3. Transit Service Tier Descriptions

Type	Description	Example
Inter-Regional	High-speed (above 40 mph) Very limited stops (3 to 15 miles) Peak or hourly service frequency ROW, exclusive, protected Capital intensive	Capitol Corridor Altamont Commuter Express
Regional Express	High-speed (above 25 mph) Limited stops (1 to 3 miles) High service frequency (> 8 trips/hr) Service span (16-24 hours) High ridership (> 60 passengers/veh hr) ROW: exclusive, protected Capital intensive	BART LA Silver Line (Bus) Seattle Sound Transit Bus
Urban Rapid	Mid-speed (15-25 mph) Limited stops (0.5 to 1 mile) High service frequency (5- 8 trips/hr) Service span (16-24 hours) High ridership (35 to 60 passengers/veh hr) Primarily surface operation ROW: protected, but with crossings Moderate capital investment	Bus Rapid Transit – East Bay BRT LAVTA Rapid Bus Rapid Transit – Lane County (Eugene) LRT (SF Muni T-Third, San Diego, Portland, Salt Lake)

Type	Description	Example
Local Frequent	Low-speed (12-15 mph) Frequent stops (0.25 - 0.50 mile) Mid-frequency service (3-5 trips/hr) Service span (12-16 hours) Moderate ridership (20-35 passengers/veh hr) All surface operation ROW: in mixed flow Limited capital investment	AC Transit Lines 57, 12, 88
Community Connector	Low-speed (8-12 mph) Frequent stops (0.20 - 0.25 mile) Low-frequency service (<3 trips/hr) Service span (<12 hours) Low ridership (<20 passengers/ veh hr) All surface operation ROW: in mixed flow Limited capital investment	AC Transit Line 65, 67 Kaiser Shuttle Emery-Go-Round

Appendix B

Purpose

Appendix B documents the methodology used to determine where transit investments should be made in Alameda County. It outlines the process of identifying activity nodes, defining travel markets, and aggregating the markets into corridors recommended for transit investments.[1]

Approach

Five tiers of transit service have been identified for the Alameda County transit network:

- Inter-regional
- Regional Express
- Urban Rapid
- Local Frequent
- Community Connector

The core transit network described in this memo is focused on identifying the markets to be served by the regional express and the urban rapid networks in Alameda County. These are the markets that have countywide significance in terms of transit services and are the markets that have the greatest potential for increasing transit ridership if the appropriate level of investments is made. The inter-regional market is one that is framed and planned within the context of statewide rail services. The Local Frequent and the Community Connector tiers are focused on providing local transit services that link from the Regional Express and Urban Rapid services to the local communities within the county and ensure adequate transit coverage throughout the county.

The core network is meant to provide a framework for Alameda CTC, the transit agencies operating in Alameda County, and the local jurisdictions to focus transit service investments and to improve market conditions in the county. The focus is on transit priority treatments that will provide effective, cost efficient Regional Express and Urban Rapid transit service. Most of Alameda County has competitive transit markets. The methodology developed for specifying the core network, limits the number of designated travel markets to those most highly competitive so the quality of the urban

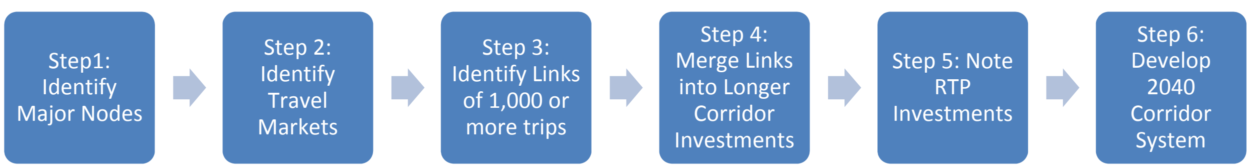
[1] Cambridge Systematics and Arup were the primary authors of this technical memorandum based on memorandum submitted to Parsons Brinckerhoff.

rapid service can be ensured and sustained. To identify these most competitive markets, the methodology limits the number of major nodes to those with the highest trip densities. It selects only travel markets between these major nodes that have the highest trip volumes.

The approach to market definition relies on the 2040 projected travel patterns generated from the Alameda CTC Travel Demand Model updated in 2014.[2] The trip volumes generated from the travel demand model and used for the transit market analysis were based on the growth projections from *Plan Bay Area* that were allocated to Travel Analysis Zones (TAZs). Using the model data and the Transit Competitiveness Index (TCI) tool an analysis was conducted to determine the potential viability of transit markets in Alameda County. Transit viability was based on the density of trips, housing, and jobs within each TAZ and confirmed against the TCI score for the TAZ. Once transit viability was confirmed, corridors were identified for transit investments based on trip density (see Figure 1). The methodology has three main objectives:

- Identify major activity nodes from the 2040 projections for trip origins and destinations, by travel analysis zones (TAZs).
- Define travel markets between these major origin and activity nodes according to the projected travel volumes of travel in 2040.
- Select the corridors for transit investments by combining travel markets into rational service corridors.

Figure 1. Corridor Development Process



Source: Arup and Parsons Brinckerhoff, 2015

Major Activity Node Identification

The approach to major node and primary transit market identification began with an examination of the trip densities, by TAZ, generated within the Alameda County Travel Demand Model and culled from the Transit Competitive Index (TCI) tool, described in Technical Memorandum #2.[3] TAZs with the highest trip densities were considered to be the most promising for transit service.

[2] The Alameda CTC Travel demand model was updated in 2014 to include the Play Bay Area growth projections from Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) regional travel demand model.
[3] Alameda Countywide Transit Plan, Technical Memorandum #2, Alameda CTC, June 2015.

The TCI methodology is relatively new; however, it has been used in the Bay Area for MTC's Transit Sustainability Project and also applied by Cambridge Systematics (CS) in a similar approach for a Small Starts feasibility study in Las Vegas for the Regional Transportation Commission (RTC) of Southern Nevada, the Maryland Parkway Alternative Analysis.[4]

The Maryland Parkway Alternative Analysis was completed in March of 2014.[1] CS developed a methodology for identifying "anchor stations" along the five mile corridor which runs through downtown Las Vegas. This methodology included a screening process that identified the major nodes of activity as potential anchor stations and the volume of travel between these nodes as the potential preferred alignment. The methodology produced station locations and a preferred alignment that was so appealing to the stakeholder groups, RTC, and the FTA; it was selected without the usual lengthy process of screening multiple alternatives. FTA praised the approach and has recommended it be adopted for future Small Starts alternative

Six separate analytical steps were undertaken to create the activity nodes. The process was scaled from its application in a single corridor (Maryland Parkway) to its application for the development of a core transit network across Alameda County.

1. **Identifying trip origins and destinations for each of the 1,580 TAZs in Alameda County in 2040.** From the initial trip table matrix, two lists were created. The first ranked all TAZs in descending order based on their destination trip densities. The second ranked them according to trip origin densities.

2. **Determining TAZ thresholds to identify competitive transit markets.** The ranked lists created in Step 1 were classified in ArcGIS using the Natural Breaks method. The natural breaks method is an accepted statistical technique that employs data clustering classification to reduce the variance within classes and maximize the variance between classes.[5] It is designed to place data values into naturally occurring categories. For this study, the intent was to identify a reasonable break point that would begin to segregate the most highly competitive transit markets from the broad number of competitive transit markets in Alameda County. This will allow the limited transportation funding dollars available to be spent in the markets that are

[4] Developed by Cambridge Systematics for the Regional Transportation Commission (RTC) of Southern Nevada commissioned the Maryland Parkway Corridor Alternatives Analysis (AA) to study potential transit improvements between downtown Las Vegas and the McCarran International Airport. http://www.rtcsnv.com/wp-content/uploads/2014/04/Maryland-Pkwy-AA-Final-Report-DRAFT-v1.0.pdf

[5] A method of statistical data classification that partitions data into classes using an algorithm that calculates groupings of data values based on the data distribution. Jenks' optimization seeks to reduce variance within groups and maximize variance between groups.

most likely to produce the highest return in ridership due to their potential transit productivity.

The TAZs in this top tier became the initial seed (or nucleus) TAZs. The trip density thresholds established using this method are:

- o Origin Nodes: 70,000 trips per square mile; and
- o Destination Nodes: 100,000 trips per square mile.

The TAZs with trip densities above the thresholds identified above were designated as seed TAZs. This methodology produce 54 seed TAZs in 2010 and 71 in 2040. As an initial outcome, this seemed within an appropriate range of nodes for a core network. The consultant team had expected to identify a network that would function effectively with somewhere between 50 and 100 nodes countywide. Thus, adhering to the Natural Break method resulted in a reasonable outcome for establishing initial trip density thresholds. In the next step, this outcome was compared to a separate methodology based on employment and residential densities to confirm the results.

3. **Validating TAZ population and employment densities through land use and market analysis.** To confirm that the TAZs selected as activity nodes were accurately capturing the most transit competitive areas of the county and where growth was most likely to occur, a check was made against independently produced population, housing, and job density maps that overlaid the county's Priority Development Areas (PDAs). The activity nodes were also compared to the most active residential and commercial areas using a market index tool as an indicator of where growth was most likely to occur.[6,7] Some minor inconsistencies between the land use and trip densities were resolved using Google map inspections to assess whether the TAZ boundaries resulted in a reasonable mix of land uses combined into a single TAZ.

4. **Refining the transit market by consolidating TAZs to create major activity nodes.** Activity nodes were consolidated to form major activity nodes. A 1/3 mile radius circle was drawn from the centroid of each activity node. If the 1/3 mile radius circle overlapped other activity nodes, the nodes were combined to form a major activity node and a new centroid was defined.[8] If the 1/3 mile radius circle did not overlap other activity nodes, then the activity node alone was identified as a major activity node.

[6] April 10, 2015 Memorandum from CD&A, Identifying TAZ clusters as Activity Nodes for TCI Modeling.
[7] April 10, 2015 Memorandum from Strategic Economics, Market Index Technical Memorandum.
[8] The activity nodes were aggregated if the 1/3 mile radius circle encompassed at least ½ of an adjacent node.

5. **Final delineation of major activity nodes: For the next step in the creation of major activity nodes, a 1/2 mile radius buffer was created around each of the major node centroids described above.** A 1/2 mile radius circle was drawn from the centroid of the newly defined major activity nodes. TAZs were once again combined if at least half of the TAZ fell within the 1/2 mile radius circle, the distance that is considered to be a reasonable walking distance to access transit. Applying the "natural breaks" methodology to these newly defined major activity nodes, a second tier of thresholds was established for these more broadly defined major activity nodes:

   - 50,000 trips/sq. mile or greater for origin trip density, and
   - 80,000/trips/sq. mile or greater for destination trip density

   The final delineation of the major activity nodes included the most competitive activity nodes aggregated with those that that had a slightly lower trip density and a slightly higher potential walk distance. Nodes that qualified as both origin and destination (O-D) major activity zones were identified as such.

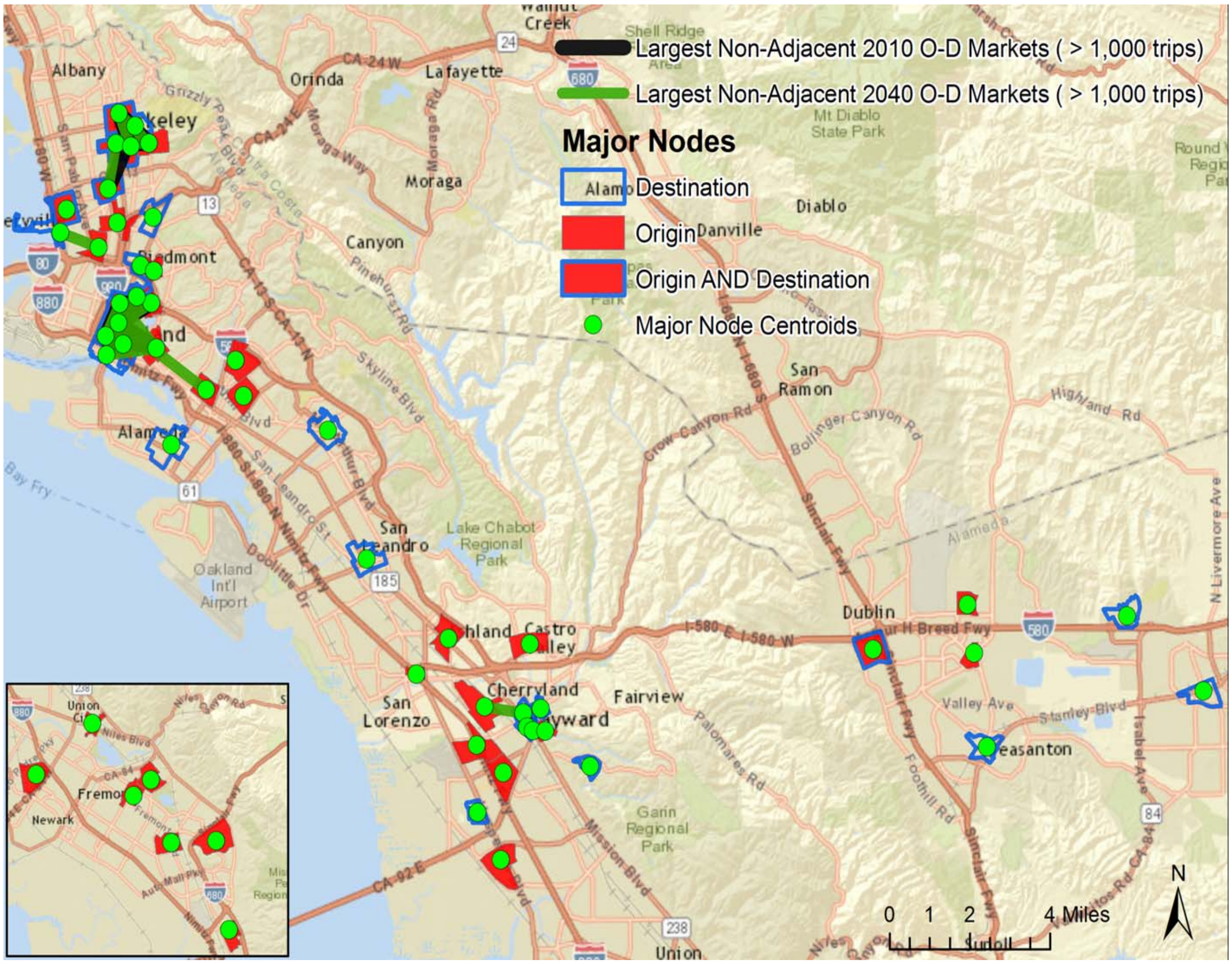
   These thresholds represent the next (second) tier of trip densities using the Natural Breaks method described in Step 2. This method created major nodes consisting of a seed TAZ that had trip densities in the first tier (above the thresholds in Step 2) plus adjacent TAZs that fell within the second tier.

6. **Validating the designation of major activity nodes through the application of the TCI score (a separate indicator of transit competitiveness).** As a check on the methodology, the aggregate TCI scores for each of the major destination and origin nodes were measured. The results showed that each node had a TCI of greater than 500. The TCI score for a destination node is based on all travel from any TAZ in the Bay Area to that node and the score for an origin node is based on all travel from that node to destination TAZs anywhere in the Bay Area.

The study team made the three following adaptations/ refinements to the methodology. First, some major O-D nodes —for example, downtown Oakland—abut one another forming continuous larger areas. The study team subdivided these larger areas into several smaller nodes based on the 1/2 mile radius criteria. Second, the size and shape of TAZs in Alameda County varies greatly. The study team minimized the number of TAZs in a major activity node as much as possible to maintain the 1/3 to 1/2 mile radius, but inevitably, some major nodes ended up larger in area than others. Third, some major nodes satisfied both the origin and destination criteria, so these nodes were designated as both a major origin and major destination node.

The major nodes were identified for two analysis years - 2010 and 2040. Figure 2 shows the major origin, destination, and dual origin/destination nodes in 2010 and 2040.

Figure 2. Major Origin and Destinations Nodes for Alameda County in 2010 and 2040



Source: Cambridge Systematics, 2015

The application of the methodology yielded the following results:

- For 2010: a total of 54 nodes in Alameda County, where 26 nodes were designated major origins, 16 nodes as major destinations, and 12 as both a major origin and major destination.
- For 2040: a total of 71 nodes in Alameda County, where 26 nodes were designated major origins, 16 nodes as major destinations, and 29 were designated both a major origin and major destination.

The desired outcome of a systematic application of this methodology was to create a manageable number of major activity nodes that would not generate a core network too large for a feasible Urban Rapid tier, or too small that it excluded a major activity node.

The 71 nodes appear to be a manageable number and in reasonable locations given the projected development patterns. As the methodology is reviewed with the transit agencies and local jurisdictions, however, unique situations that do not fit within the framework of the described thresholds may be identified. This may warrant inclusion or removal of some nodes that were identified through this systematic methodological approach based on unique or compelling circumstances.

Core Network Identification

Once major origin (O) and destination (D) nodes were identified, the major node O-D pairs were connected using desire line maps created in ArcGIS. The methodology involves the following steps:

1. Examine travel volumes for travel between all of the major origin and destination nodes throughout Alameda County.

2. Produce a matrix with the origin nodes along one axis (column) and the destination nodes along the other (rows) that shows the total number of trips between each major node.

3. Create a "desire line" map in ArcGIS using the results of this matrix. The desire line map showed the total number of trips occurring between a given major node O-D pair, or "travel market". Maps were created for both 2010 and 2040 analysis years. Using sensitivity analysis and in consultation with other members of the consultant team, the minimum threshold for the desire lines was set at 200 trips; no desire lines were shown for O-D pairs for which there were fewer than 200 trips.

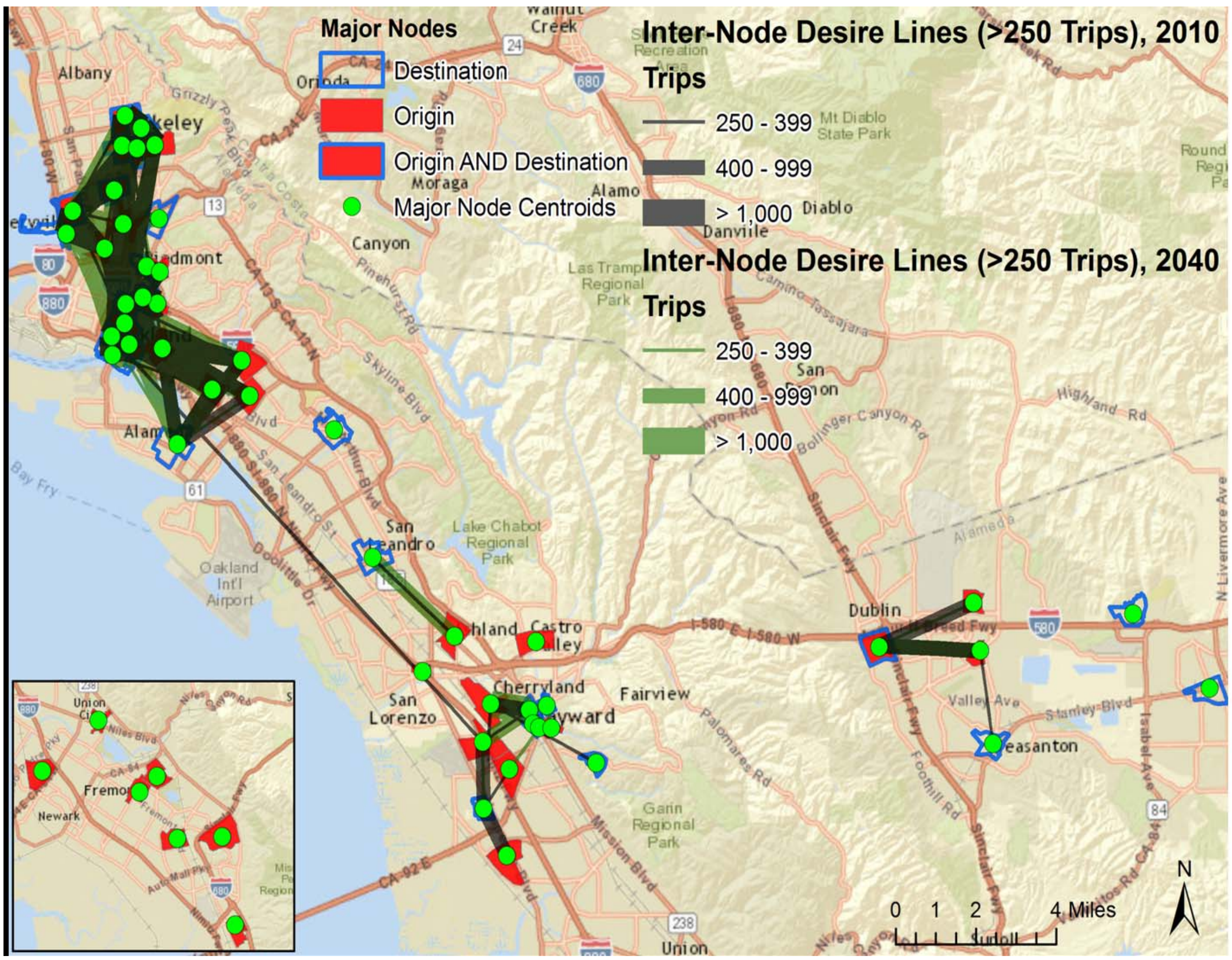
4. Classify trips based on the following break points, and draw desire lines with corresponding thicknesses:

    - Minor travel market: 200 – 499 trips;
    - Moderate travel market: 500-999 trips; and
    - Major travel market: 1,000 or greater trips.

Figure 3 shows the results of this process for all of Alameda County for 2010 and 2040. Because travel markets in the Berkeley-Emeryville- Oakland area are very dense, a separate analysis of travel volumes of 1,000 daily trips or greater between major nodes was completed for this area. The results are shown in Figure 4.

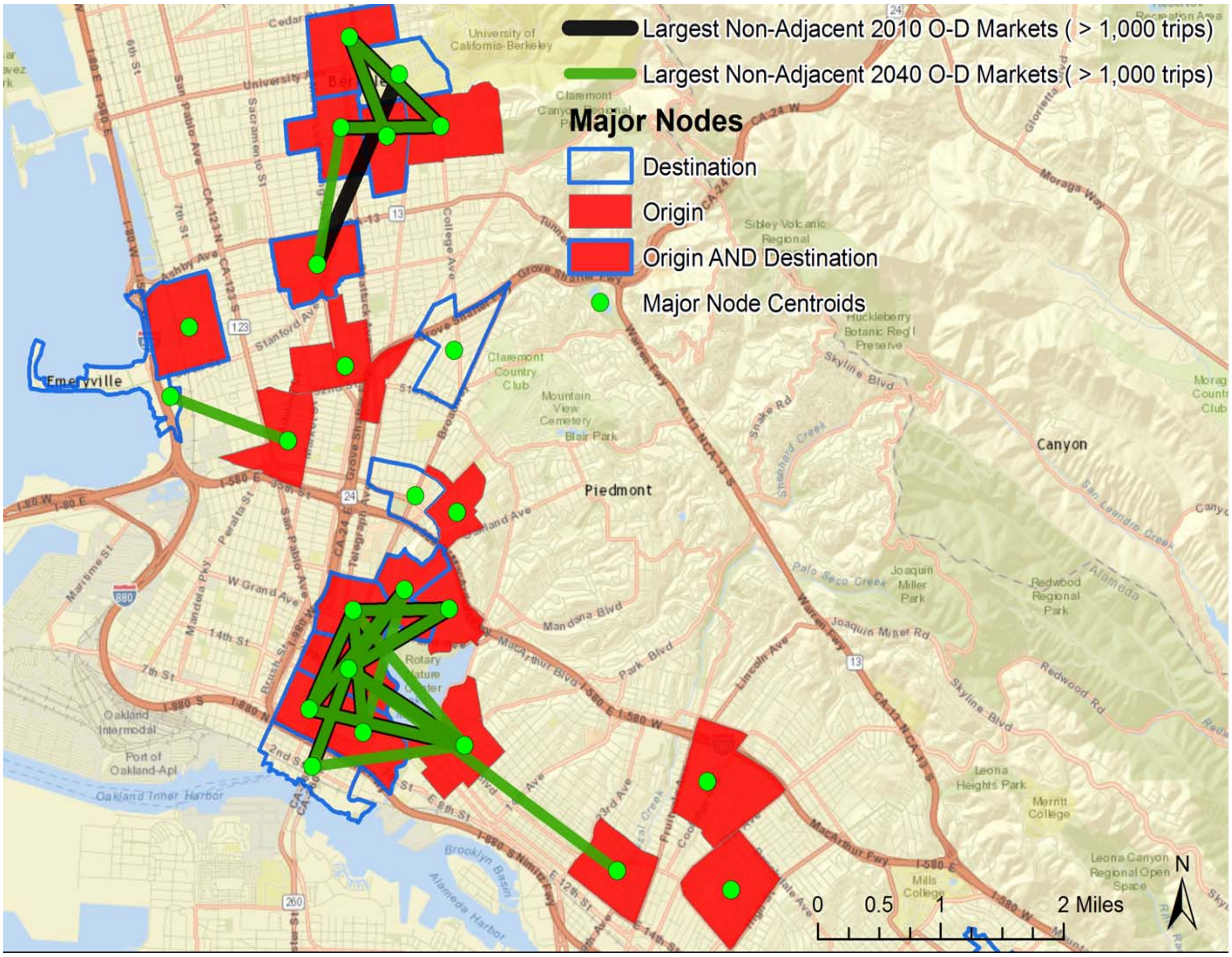
As with the methodology used to create major activity nodes, the methodology and the thresholds used to identify travel markets was structured to generate a manageable number of major travel markets for transit corridor improvements, but not so few that significant travel markets were excluded. Even with this approach, a few of the major nodes were “stranded,” because they did not have enough travel to and from other major activity nodes to result in a desire line of more than 200 trips. This suggests that while these major activity nodes might be transit competitive based on density, overall trip volumes, and TCI scores, the trips are likely going to and from dispersed origins and destinations. These activity nodes might be better served by services that include park-and-ride facilities or feeder bus services to provide a concentrated point of access for transit.

Figure 3. Major Travel Markets between Major Nodes throughout Alameda County in 2010 and 2040



Source: Cambridge Systematics, 2015

Figure 4. Major Travel Markets Greater than 1,000 Daily Trips within the Northern Inner East Bay in 2010 and 2040



Source: Cambridge Systematics, 2015

As noted above, unique situations that do not fit within the framework of the described thresholds may be identified. This may warrant inclusion or removal of some travel markets identified through this systematic methodological approach based on unique or compelling circumstances.

Bay Area Core Network Analysis

The identification of regional activity nodes and travel markets required a slightly modified approach to the one used within Alameda County. After assessing the results of the Alameda County market analysis and receiving feedback from Alameda CTC, transit operators, and other stakeholders, a subsequent analysis was undertaken to identify the potential travel markets between Alameda County and other counties in the Bay Area.

Because the demand for regional types of services comes from a broader market, the trip origins and destinations tend to be more dispersed than those related to the demand for Urban Rapid core services. The regional services are accessed not only by walking, but also by feeder bus, park-and-ride, and kiss-and-ride so the service area is larger than those defined by a 1/2 mile walking distance. As a result, different thresholds were used to identify major markets for inter-county or regional trips.

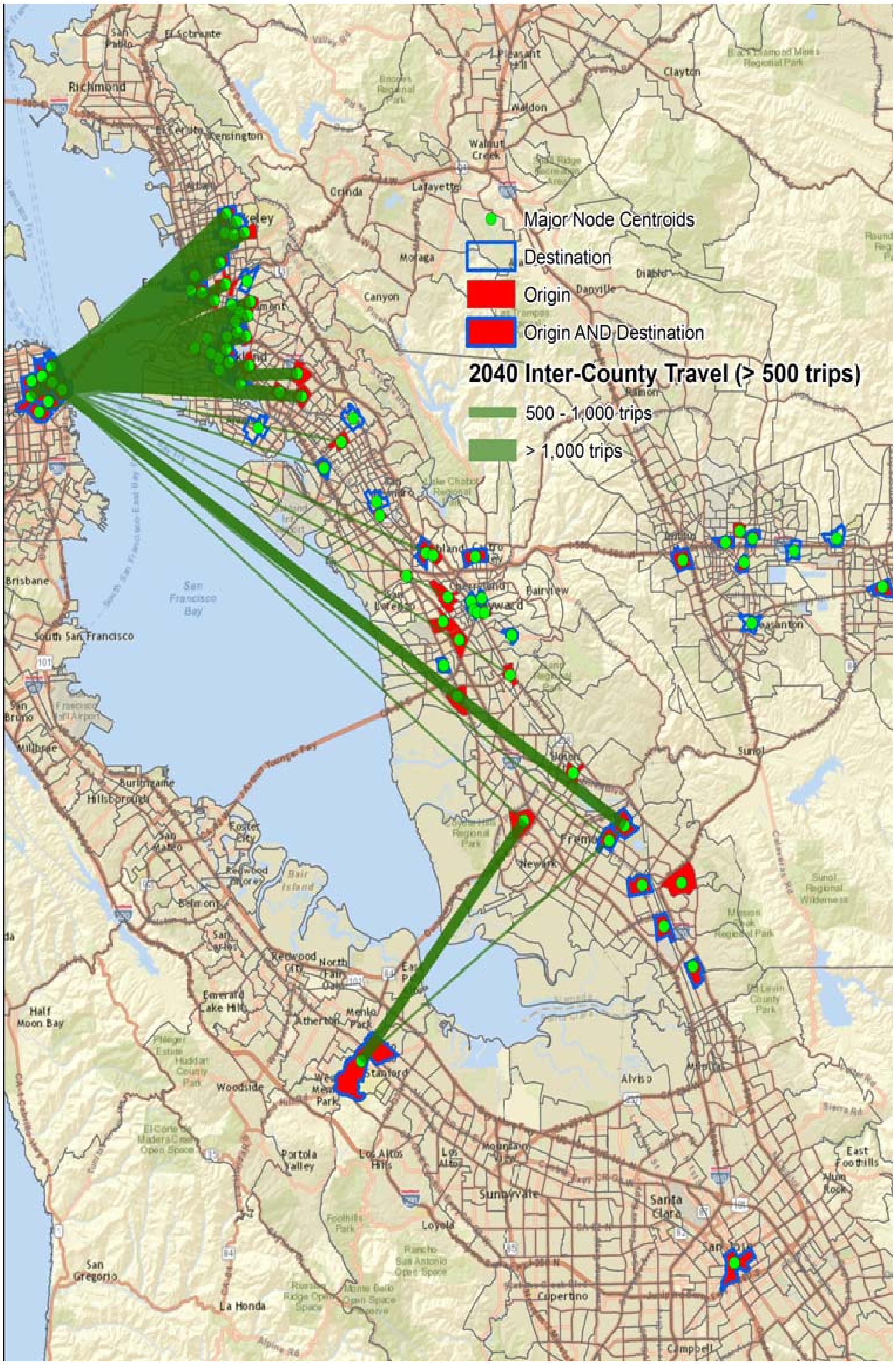
In order to identify major nodes in other parts of the Bay Area, the TCI heat maps (maps showing density by intensity of color) were examined for each major origin and major destination node in Alameda County. TAZs that showed up in the composite of all heat maps with a TCI of greater than 250 were selected for analysis. The threshold of 500 was lowered because using this threshold throughout Alameda County would have excluded all nodes except those along Market Street in San Francisco. This refined analysis yielded eight major nodes in San Francisco centered along Market Street which formed a continuous agglomeration along Market Street from The Embarcadero to Van Ness Avenue. To more effectively assess travel markets, the elongated node was broken into eight smaller nodes, sized in a similar manner to the Alameda County analysis. All eight were designated as major origin and destination nodes.

In addition to the eight major nodes in San Francisco, the study team identified one major node in downtown Palo Alto (which included a portion of Stanford University), and one in downtown San Jose. These regional major nodes had aggregate TCI scores of greater than 250 for both origin and destination trips, which are half the level of 500, achieved for the Alameda County major nodes. Both of these nodes are designated as major origin and destination nodes. The study team added these major nodes to the Alameda County Core Network, and mapped desire lines for intra- and inter-county trips using trip volumes, shown as Figure 5. The markets which showed as having competitive activity node, but did not have high trip densities, represent those areas where trips origins and destinations are dispersed and therefore do not achieve high trip densities in any one market. For example, San Jose has major activity nodes, but not concentrated trips densities from any one activity node in Alameda County. These are the type of transit trips that are best served by providing concentrated access points such as park-and-ride facilities.

Travel Demand Originating Outside the Bay Area

Outside of the nine-county Bay Area region, San Joaquin is of particular interest to the development of a Countywide Plan as trips coming over the Altamont Pass have a significant impact on travel in the I-580 corridor. Transit solutions for this corridor are the subject of two separate studies. The ACE*forward* planning efforts, at the inter-regional level, are looking at increasing the number of daily trains coming over the Altamont Pass and increasing service to Alameda and Santa Clara counties. The proposed BART

Figure 5. Major Bay Area Nodes and Travel Markets Outside of Alameda County



Source: Cambridge Systematics, 2015

to Livermore project is evaluating the potential extension of BART service to Isabel Avenue and beyond to better serve the City of Livermore. The service improvements for the ACE train and the proposed BART extension provide an opportunity to ultimately provide a link between the inter-regional service and the regional service in the vicinity of Livermore and providing more transit options for those commuting in the I-580 corridor.

Environmental review is underway on both of these projects. This plan acknowledges both of these studies (see following section on draft recommendations), but does not presuppose the outcomes of the recommendations. Detailed ridership projections will be included as part of the published environmental documents for each project.

Combining Travel Markets into Transit Corridors

The final step in developing the draft recommendations for transit corridor improvements is the combining of travel markets into rational transit corridors. This step requires not only a systematic approach, but an understanding of transit service planning and close coordination with the transit agencies.

The process that is outlined below focused on developing draft recommendations for enhancing transit service in the Regional Express and the Urban Rapid tiers. These tiers are emphasized because they provide the greatest opportunity for impacting transit ridership in Alameda County. Ridership on Regional Express services has been growing in recent years and additional capacity is needed to serve the county. The Urban Rapid service is intended to provide the infrastructure and service enhancements that will better serve bus transit patrons and reverse the decline in ridership that the bus operators have experienced over the past decade.

The consultant team respected the current practices of the transit operators. AC Transit, LAVTA, Union City and BART operate their systems and their routings for operational, market, social and historic reasons. Unless there was an overriding rationale to change a route, the consultant team respected the current practices. In some cases, Corridors were combined to mirror the current routes, while in other cases routes were altered to realize opportunities for infrastructure improvements on an adjacent street or to respond to an identified market and demographic demand.

These market opportunities are identified though the Transit Competitiveness Index tool to identify nodes and corridors where transit can compete for trips well. The TCI assumes that transit is providing an attractive service. This is defined as:

- Safe
- Reliable
- Accessible

- o Frequent service
- o Robust spans-of-service, and
- o Functional and attractive stops and terminals

- Fast

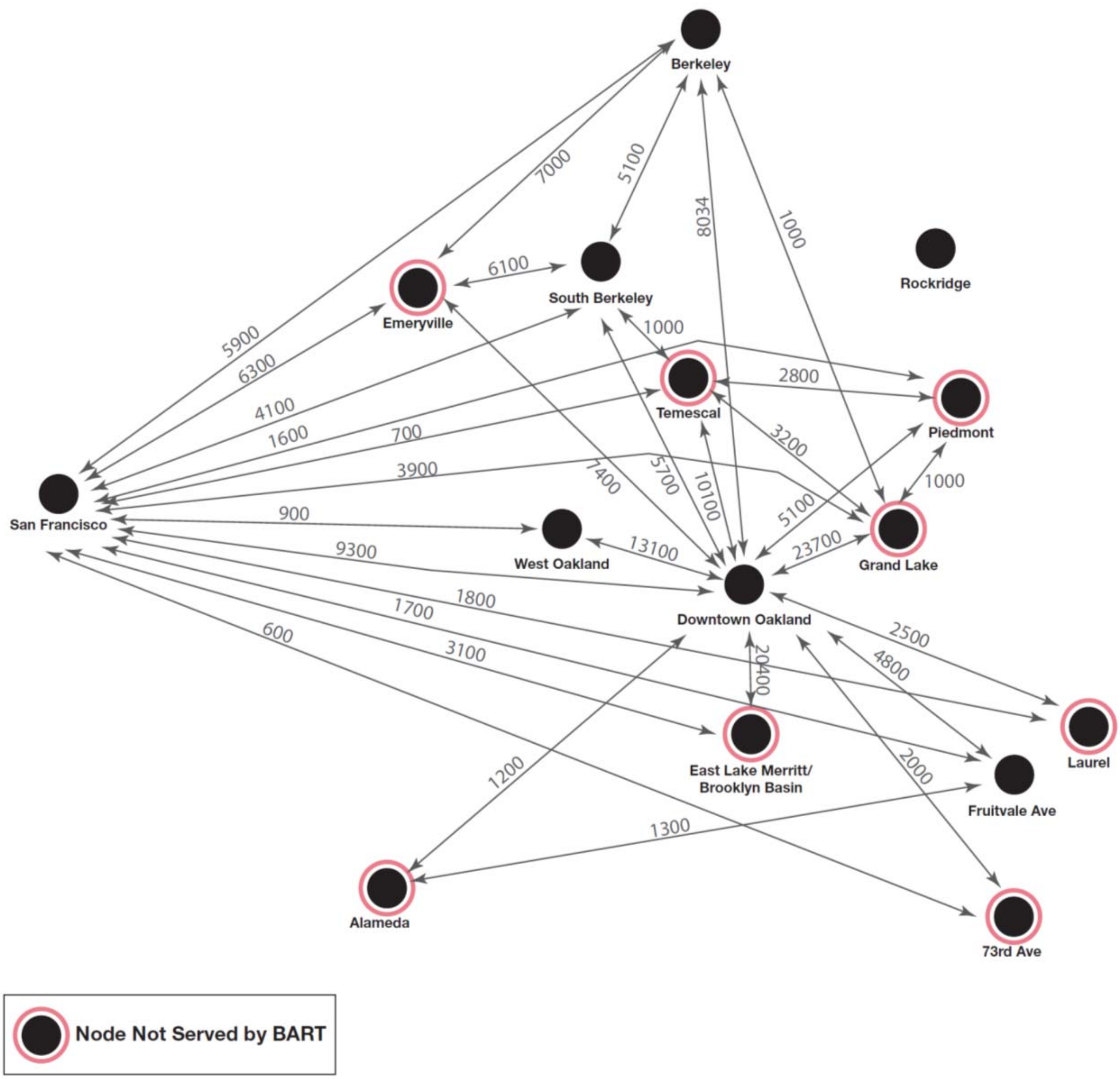
The actual provision of service and improvements focuses on these four core qualities. The intent of this process is to focus resources in the most transit competitive markets to enhance countywide transit services and attract new transit riders. Corridors are the vehicle to focus Alameda CTC resources.

The transit corridors that are recommended for improvements were identified applying the following criteria to the travel markets identified in the previous steps:

- Acknowledging the current structure of transit services;
- Acknowledging current and proposed plans and programs; and
- Identifying potential corridors that offer opportunities for transit priority treatments.

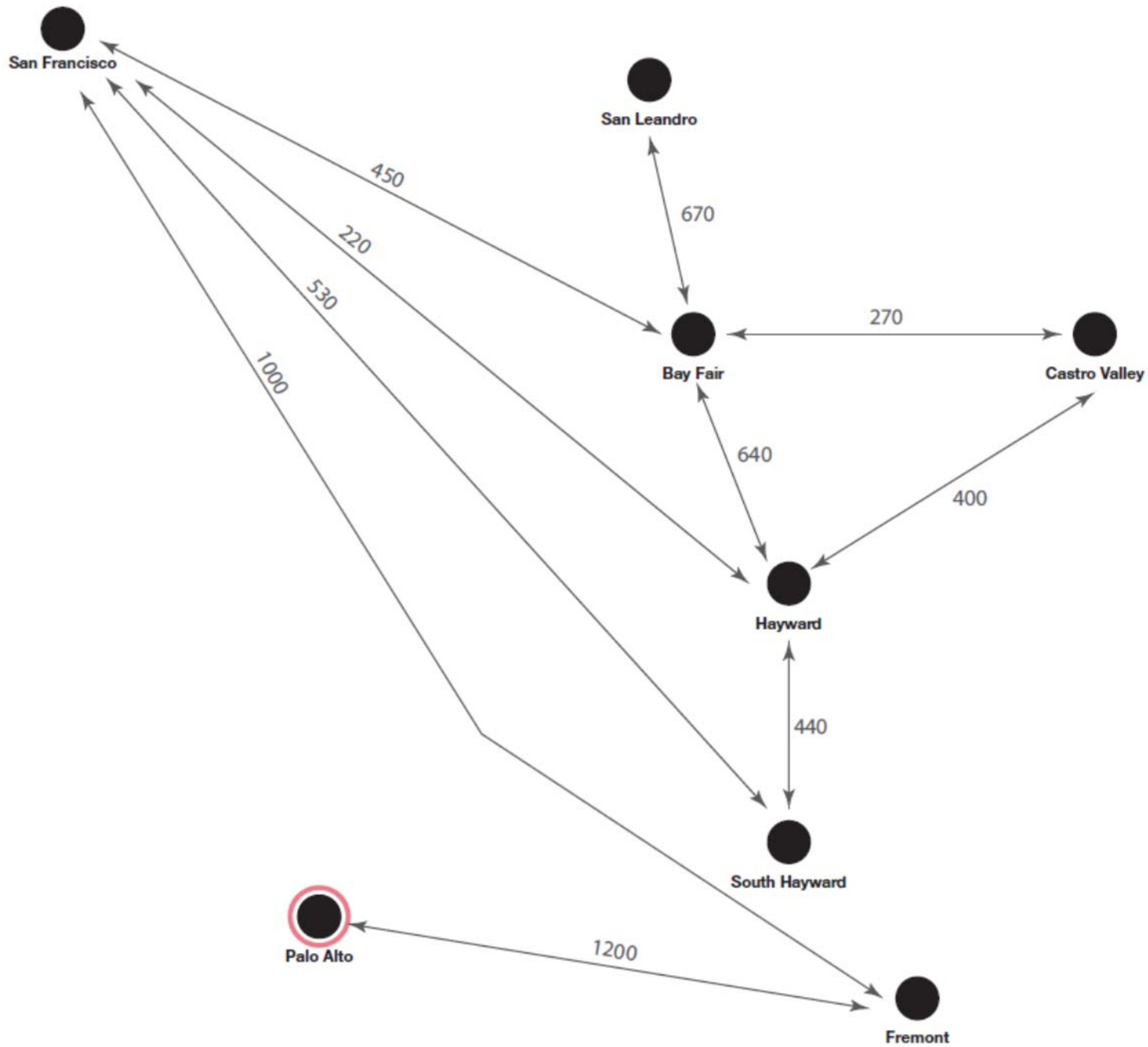
Figure 6 through Figure 10 show an abstract presentation of the O-D pairs and the forecasted daily trips between the identified major activity nodes that were identified in Figure 3 and Figure 5.

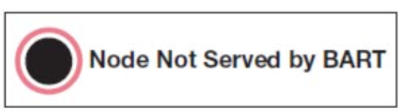
Figure 6. 2040 Trips between Nodes - North Alameda County



Source: Arup, 2015

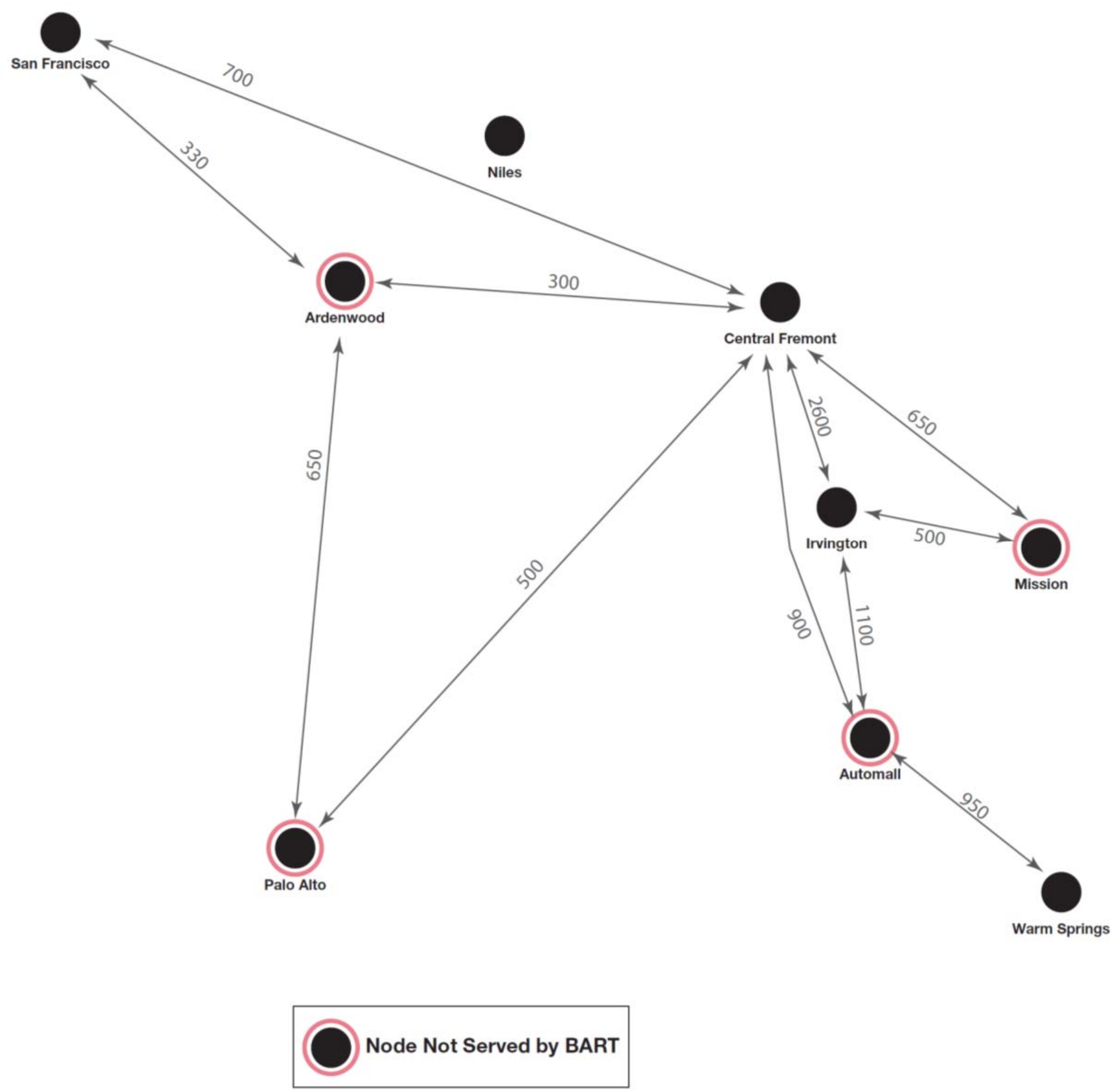
Figure 7. 2040 Trips between Nodes - Central Alameda County





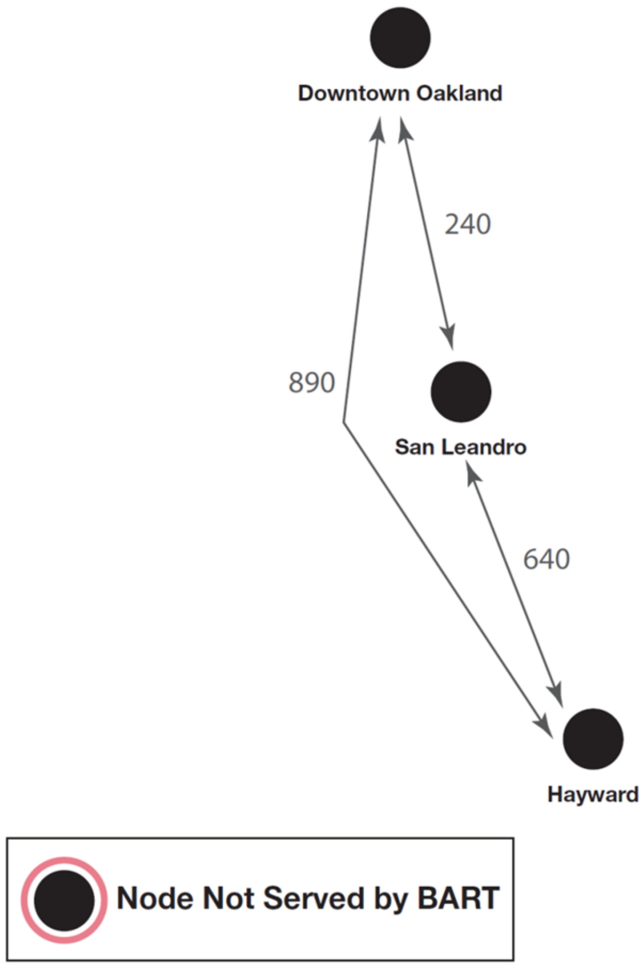
Source: Arup, 2015

Figure 8. 2040 Trips between Nodes - South Alameda County



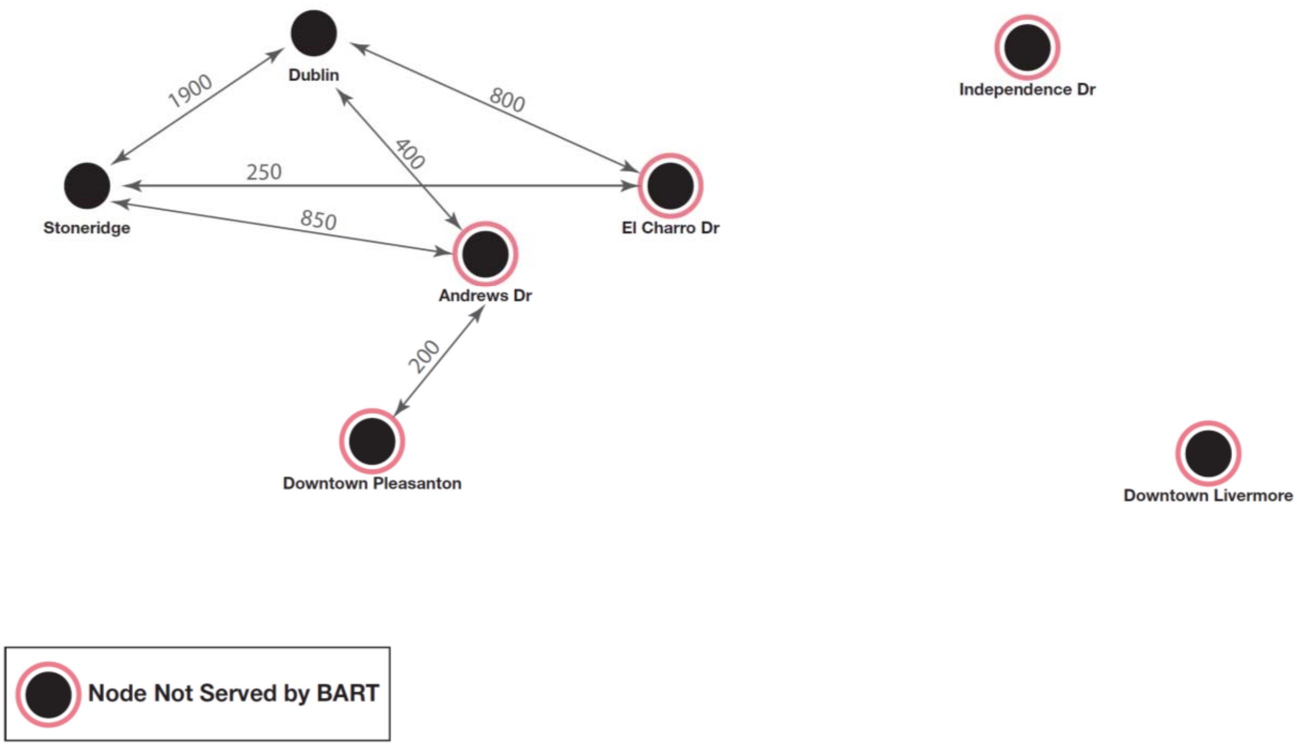
Source: Arup, 2015

Figure 9. 2040 Trips between Nodes – North to South Alameda County



Source: Arup, 2015

Figure 10. 2040 Trips between Nodes - Tri Valley



Source: Arup, 2015

The team used a high trip threshold – 1,000 in most cases – to focus on the highest activity corridors. While the major activity nodes serve as the anchors at each end of the identified travel demand corridors generating a high level of potential transit ridership, the more trip generators along the corridor, the higher the potential for, significantly increasing the overall transit market.

The travel links with the highest potential ridership were identified and were combined to create potential service corridors where service could be upgraded to capture more transit riders. The individual links were combined into corridors by combining travel from one node to others – for example, from downtown Oakland to Temescal and to south Berkeley and then to downtown Berkeley. In other cases, for example, Berkeley to Emeryville to San Francisco, the corridors were designed to match existing service routes to reduce unnecessary change or to serve underserved markets where development is expected to occur or intensify between now and 2040.

Existing and proposed transit services, including projects in the 2040 Regional Transportation Plan (RTP), were assumed as follows:

- All future regional planned or programmed transit high-category projects are included as part of the 2040 base network. This also includes projects that are currently under construction, such as the East Bay Bus Rapid Transit route along International Boulevard and the BART to Warm Springs project.
- Future planned or programmed projects were identified through a combination of regional and county plan documents. These include Plan Bay Area, Measure BB Expenditure Plan, and AC Transit planning documents.
- The enhanced network assumes the Phase I Service Plan from the BART Sustainable Communities Operations Analysis – Peak Commute Period. This Analysis includes minor reroutings, some additional turnbacks (for example, at BayFair station), as well as additional service frequencies.
- Service or operational changes from the ACE*forward* or Capital Corridor Vision Plan will be incorporated into the Countywide Transit Plan as specific recommendations from these independent planning efforts are developed.

Using the steps outlined above, a 2040 Corridor system that focuses on the Inter-Regional Services, Regional Express routes and Urban Rapid services was developed. This creates a limited number of highly capitalized corridors. The remaining parts of the network – including the Local Frequent and the Community Connector services are the lower tier elements of the system, continue to operate, and receive some operating and capital funding to ensure the entire system functions well. Parts of the corridor system are familiar – the fixed rail services – while the development of the surface corridors was informed by infrastructure quality, right-of-way and existing travel patterns.

Proposed Alameda County Transit Corridors

These 2040 major transit corridors were identified as follows:

Inter-Regional

Capitol Corridor: Via UPRR from Richmond (CC County) to Emeryville, Oakland, Coliseum, and then to Fremont and San Jose (three route options south of Coliseum).

ACE: Via UPRR from Tracy (San Joaquin County) to Livermore, Pleasanton, Fremont, and San Jose.

Regional Express

BART Corridors:

- Santa Clara County/Warm Springs to San Francisco/Daly City
- Santa Clara Co/Warm Springs to Richmond
- Livermore-Dublin/Pleasanton to San Francisco/Daly City
- Richmond to San Francisco/Peninsula
- Pittsburg to San Francisco/Peninsula.

Ferry Transit:

- Brooklyn Basin – SF Ferry Terminal: Oakland to Alameda to San Francisco with an extension to Brooklyn Basin (includes Estuary)
- Alameda to SF Ferry Terminal: Alameda to San Francisco with a new terminal at Alameda Point in addition to the Harbor Bay terminal

Transbay Surface Corridors:

- Berkeley - Emeryville - San Francisco Transbay Transit Center: This route provides transbay service from Berkeley and Emeryville (generally conforms with AC Route F)
- Eastmont Transit Center – Oakland - San Francisco Transbay Transit Center: This routes services the Maxwell Park and Laurel Districts via MacArthur/Grand to downtown Oakland and San Francisco (generally conforms with AC Route NL)
- Tri-Cities - Palo Alto: Enhanced investments in the Tri-Cities area of southern Alameda County to serve the transbay market to Palo Alto (generally confirms with AC Routes U, DB, and DB1).

Urban Rapid

Intra-East Bay Services

- Emeryville – Bay Fair BART Station: Downtown Oakland-International Blvd District to San Leandro (generally conforms with AC Route 1R), but potentially extends service to Emeryville
- Richmond Parkway Transit Center – Jack London Square Amtrak: From Richmond to downtown Oakland via San Pablo Avenue (generally conforms with AC Route 72R)
- Berkeley – Brooklyn Basin: Downtown Berkeley to downtown Oakland and with a potential extension to Brooklyn Basin (generally conforms to AC Route 1R)

- Berkeley – Fruitvale BART: Downtown Berkeley via College/Broadway to downtown Oakland and Alameda connecting to Fruitvale BART with an extension to serve Alameda Point (generally conforms to AC Route 51A/51B)
- Bay Fair BART – Union City BART: Connecting San Leandro, Hayward and Union City via Hesperian Boulevard (generally conforms to AC Route 97).
- Bay Fair BART - Warm Springs BART: Connecting San Leandro, Hayward, and Fremont via Mission Boulevard (generally conforms to AC Route 99).
- West Dublin BART – Livermore ACE: To Los Positas College and downtown Livermore via Stoneridge Mall Rd, Dublin Blvd, North Canyons Parkway and Portola/Livermore Avenue (realignment of existing Rapid service contingent upon proposed extension of Dublin Boulevard).

The Corridor system identifies those corridors capable of supporting high frequency transit service, but acknowledges that these corridors operate within a universe of diverse transit products. Below the higher-level transit corridor tier, additional Local Frequent arterial and Community Connector services will operate, and, if socio-economic and land use characteristics change, these services may be re-evaluated for consideration as competitive corridors and become part of the Urban Rapid tier. Local and community transit service is critical to providing a full range of services for the county. This service is assumed to be made available based on local needs and priorities.

APPENDIX C

Urban Rapid Bus
Case Study – King County Metro Transit RapidRide

Background

In the late 1990s Metro Transit encountered severe challenges maintaining transit speed and reliability on several main corridors in their service area. In order to maintain existing schedules at that time they were forced to increase service hours. The agency added over 100,000 annual service hours between 1995 and 2001 just to maintain existing service levels and quality. To combat the speed and reliability issues the agency decided to modify these routes with the following improvements aimed not only at speed and reliability improvements but also providing a better customer experience overall. The physical and operational changes included the following:

- Off-board fare payment
- Branded Stations with distinctive shelters, seating, lighting, real-time customer information “next bus” signage, etc.
- Transit Signal Priority, Continuous vehicle-to-roadside communication
- Bus Pullouts
- Transit Queue Jumps
- Transit Priority or Business Access Transit Lanes (BAT)
- Frequent Service (minimum 10-minute frequency weekdays from beginning of morning rush to end of evening rush)
- Longer Stop Distance

Identification and Selection of Corridors

Sixteen initial corridors were identified for potential implementation. The list was screened down to three promising corridors based on the following criteria:

Would the service compete with current or planned regional rail projects?

What is the ridership potential along the corridor? Current weekday ridership and surrounding population and employment densities were used as indicators. Specific ridership forecasts were not prepared.

Would the BRT service provide significant connections for the riders? The number of designated urban centers that would be served, and the number of transit hubs and transfer points that would be served to provide connections to other transit services were considered in the evaluation.

What is the potential for improvement in speed and reliability in the corridor?

After identifying the candidate corridors Metro developed a Request for Proposals (RFP) for the jurisdictions along each of the identified routes and created a competition where jurisdiction had to respond to specific questions and commit to contributions such as implementing traffic operations changes, implement TSP, expedite technical review and permitting, etc. The order of implementation was based on the responses from the jurisdictions. Eventually three additional corridors were added to the program for a total of six RapidRide Corridors that are now in operation.

Relevance to Proposed Urban Rapid Corridors for Alameda Countywide Transit Plan

The six King County Metro RapidRide corridors that went into operation between 2010 and 2014 provide a wealth of information regarding the potential results for urban rapid routes in Alameda County. Some of the key similarities between the existing RapidRide system and the proposed urban rapid routes include:

Similar Environments

- Similar urbanized area population—3M Seattle vs. 3.2M SF/Oakland (NTD/2010 census)
- Similar levels of traffic congestion affecting transit operation—INRIX and Tom-
- Tom both put Seattle and SF/Oakland in the top 8 in the US
- Similar types of service areas—Mix of urban, suburban and exurban, with geographic constraints including highly congested bridges
- Similar transit interfaces—inter-city rail, commuter rail, light rail, ferries, street cars
- King County Metro and AC Transit are peer agencies in terms of unlinked passenger trips carrying 117M and 97M annual trips respectively.

Similar Proposed Roadway Treatments and Operations

- Neither are full BRT with exclusive lanes
- Both include moderate capital improvements such as: Queue Jumps, Bus Bulbs, Transit Priority Lanes, Longer Stop Spacing, higher station amenities.
- With the exception of the shorter (6-7 mile) routes near Fremont, the proposed route lengths are similar to KCM RapidRide routes.
- Both transit agencies are mature systems looking for ways to enhance existing ridership
- Both include the application of modern technologies (TSP and real-time bus arrival information)

Results of King County Metro Rapid Ride Implementation

In December of 2014, Metro Transit published the King County Metro RapidRide Performance Evaluation Report. The agency currently has six RapidRide lines (A through F) throughout King County. The agency document significant increases in surveys customer satisfaction and metrics of operational performance. Highlights in several main categories include:

- **Reliability**—headway adherence ranges from 78% to 87%
- **Ridership**—ridership increases ranged from 20% to 81% from the start of service (2010 through 2014 depending on the route) to December 2014.
- **Travel Time Reduction**—Depending on the route the travel time decreased from 3% to 19% compared to previous operations.

4.0B

Evaluation Methodology and Performance Measures

Countywide Transit Plan

DRAFT Technical Memo #6

ALAMEDA
County Transportation Commission

Prepared for:
Alameda County Transportation Commission

Prepared by:
Parsons Brinckerhoff

With

Cambridge Systematics
Community Design & Architecture
Strategic Economics

October 2015

PARSONS BRINCKERHOFF

Table of Contents

Acronyms

Acronym/Abbreviation	Definition
ACE	Altamont Commuter Express
Alameda CTC	Alameda County Transportation Commission
BART	Bay Area Rapid Transit
FTA	Federal Transit Administration
GHG	Greenhouse Gas
HH	Households
MMAP	Multi-Modal Arterials Plan
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
PDA	Priority Development Area
SANDAG	San Diego Association of Governments
TOD	Transit Oriented Development

1.0. Introduction

1.1. Study Process

This Technical Memorandum documents the performance measures and methods that will be used to evaluate the Draft Transit Network Recommendations described in Technical Memorandum #5. The purpose of the memo is to:

- Provide structure and consistency to the evaluation process, and
- Provide decision makers with a procedure for identifying key differences among proposed recommendations.

The evaluation methodology builds on the transit vision and goals adopted by Alameda CTC in March 2015[1], and will be applied to the draft recommendations and proposed network modifications.[2]

Transit Vision and Goals

The performance measures for the Alameda Countywide Transit Plan are derived from the transit vision and goals documented in Technical Memorandum #3. That document provides a description of the linkage between the vision and goals for the Transit Plan and Alameda CTC's vision and goals from the 2012 Countywide Transportation Plan.

Transit Vision

The adopted vision focuses on the challenge to improve transit network efficiency and effectiveness, while providing environmental and economic benefits and is as follows:

"Create an efficient and effective transit network that enhances the economy and the environment and improves the quality of life."

A simple, focused vision sets the stage for an effective performance framework. The strategic goals define what the vision needs to accomplish through a set of separate, yet integrated elements that support the vision.

Transit Goals

Based on the vision, and an understanding of the current conditions in the county, a set of seven transit goals were identified:

[1] See Technical Memorandum #3: Vision and Goals, Alameda Countywide Transit Plan, March 2015
[2] See Revised Draft Technical Memorandum #5: Transit Network Methodology, Alameda Countywide Transit Plan, August 2015

1. **Increase transit mode share**. The number of people living in Alameda County and their auto trips are growing significantly faster than the number of people that are riding transit. If this trend continues, congestion will continue to increase over time and air quality will continue to degrade. To realize a more environmentally sustainable future, transit ridership will need to increase at a rate faster than auto trips. The goal is to not only increase transit ridership, but to increase the per capita use of transit for all types of trips.

2. **Increase effectiveness**. The transit effectiveness goal seeks to increase the number of transit users for the available transit capacity. To achieve a more financially sustainable transit system, it is important to ensure that major transit investments benefit and are used by the greatest number of people, and that supply matches demand.

   Because transit serves multiple purposes in a community, transit effectiveness must also take into account the need to provide a basic level of transit service. During peak hours, transit provides a critical alternative to private auto trips and to travel on highly congested roadways. Transit also serves as the lifeline for transit-dependent populations that may have no other transportation option. Effectiveness (developing transit facilities and services that match demand and generate the highest ridership) must always be balanced with the need to maintain a basic level of service coverage.

3. **Increase effectiveness of inter-regional transit.** One of the roles of transit service in Alameda County is to provide connections to adjacent regions and to the statewide rail network. These services provide alternatives to auto travel on some of the most heavily congested corridors in Alameda County. The Capitol Corridor provides an alternative to travel on I-80 and I-880 from Contra Costa, Solano, Yolo, and Sacramento counties, and ACE provides an alternative to travel on the I-580 corridor from San Joaquin County.

   By maximizing the effectiveness of these transit services that link the state rail network to regional and local transit services, the demand for inter-regional travel on the county's freeway system, as well as vehicle miles traveled and greenhouse gas emissions, is reduced.

4. **Increase cost efficiency**. The cost of providing transit service is increasing in the county without a commensurate increase in service levels or passengers. To maintain and expand transit services, and to increase frequency and service hours, resources must be used as efficiently as possible.

5. **Improve access to work, education, services and recreation**. The transit system should make it easier for people to travel without having

to rely on a car. Integration with appropriate land use and enhanced first- and last-mile connectivity will increase transit viability and overall accessibility.

6. **Reduce emissions**. Alameda County has adopted a goal to reduce greenhouse gas emissions to 1990 levels. With transportation being the single largest contributor to greenhouse gas emissions, shifting travel away from cars and onto transit can help reduce emissions and enhance the quality of life and the environment in Alameda County.
7. **Achieve a state of good repair**. To provide a safe and reliable transit experience for the user, the transit system needs to be in good working condition. Maintenance of the existing transit facilities and fleet need to be balanced against system expansion.

   This is a particularly acute issue for BART, which is the backbone of the county's transit system, but it is also important for the delivery of reliable bus and ferry service. Maintenance of the core network is critical to being able to accommodate future growth of the system.

1.2. Development of Projects Included in Transit Network

In many transit studies, projects included in the evaluation process are proposed by communities, elected officials, or transit advocates as part of a community visioning process and represent a wide range of improvement ideas. Typically, a high-level screening is applied to the initial set of projects to eliminate those that are infeasible or do not meet the goals and objectives as well. This is not the case for the Alameda Countywide Transit Plan. For this planning effort, the Draft Transit Network Recommendations defined during the creation of the network vision were developed through a strategic technical analysis based on a thorough review of existing conditions, existing plans and studies, a market and transit operational analysis, and an understanding of the Alameda CTC's transit vision and goals. As a result, the evaluation of the transit vision network begins with a relatively limited set of Draft Transit Network Recommendations described in Technical Memorandum #5. [3]

The qualitative and quantitative performance measures, described in the rest of this memorandum, represent a refined set of measures that will be used to provide a more robust picture of the performance of the transit vision network as a whole and for individual draft recommendations. The focus of the evaluation will be to provide information regarding the characteristics of each draft recommendation rather than the development of a rank-ordered

[3] See Revised Draft Technical Memorandum #5: Transit Network Methodology, Alameda Countywide Transit Plan, August 2015

list of recommendations. In that context, relationships or inter-dependencies between recommendations will be discussed in detail.

1.3. Network Alternatives

Task 5 generated a set of draft recommendations to help the county make progress towards achieving the transit vision and goals. These draft recommendations are collectively referred to as the transit "vision" network. The vision network will be compared against existing conditions and a future baseline network that is consistent with the projects contained in MTC's Regional Transportation Plan (see Table 1 below).

Table 1: Network Alternatives

#	Network Alternatives	Year	Description
1	Existing Conditions	2010	Land use and transportation conditions as they were in 2010 per the updated Countywide Travel Demand Model.
2	Baseline Conditions	2040	Consistent with MTC's regional transportation plan.
3	Vision	2040	Set of all improvements identified in the Countywide Transit Plan

SOURCE: Parsons Brinckerhoff, 2015

2.0. Evaluating Performance

2.1. Performance Measures

The performance measures were developed to assess how the transit vision network and draft recommendations support implementation of the adopted transit vision and goals. These measures were compared with selected recent transit studies to validate the scope and completeness of the measures used. In particular, the following studies were reviewed when developing the performance measures presented below:

- Sound Transit Long-Range Plan/ST2 Planning: System and Project Evaluation Methodology Report 02/2006
- Sound Transit: North Corridor Transit Project Alternatives Analysis Report 09/20/2011
- City of Seattle and Sound Transit: Ballard to Downtown Seattle Transit Expansion Study 05/30/2014

- SANDAG 2050 Regional Transportation Plan: Technical Appendix 4 – Transportation Project Evaluation Criteria and Rankings
- City of Seattle Transit Masterplan Final Summary Report April 2012
- Community Transit Long Range Plan, 2011
- Federal Transit Administration National Transit Database, updated annually

Performance measures will be used for two types of evaluations, which will be documented in a future technical memorandum:

- **Network:** This evaluation will quantify the anticipated benefits cumulatively resulting from the draft recommendations with respect to each identified goal. Performance measures will be applied to the existing and future baseline alternatives as well as the "Vision" network in order to gauge the relative effect of each network alternative.
- **Project:** The assessment will consider the costs and benefits of both capital and operating activities associated with each draft recommendation or proposed project. General assumptions will be made regarding capital and operating costs for each proposed network recommendation. (Those projects that are already in the project development or environmental phase will not be evaluated.) These cost assumptions will be used only for comparative purposes and are intended to provide information that can be used in prioritizing and/or phasing of project implementation.
    - **Capital:** This evaluation will allow Alameda CTC to do a comparative assessment of capital projects with respect to each identified goal.
    - **Operations**: A significant portion of the county's funds will continue to support operations and maintenance of transit services. The operating performance varies significantly across transit operators. This evaluation will allow Alameda CTC to evaluate operations practices of transit operators.

Both quantitative and qualitative performance measures have been identified for network and project evaluation. These are described below.

Quantitative Performance Measures

Quantitative performance measures for each goal are summarized in Table 2 and are described in the following section.

Table 2: Quantitative Performance Measures

<table>
<tr><th rowspan="2">#</th><th rowspan="2">Goals</th><th colspan="3">Performance Measures</th></tr>
<tr><th>Network-Level</th><th>Project-Level Capital</th><th>Project-Level Operating</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Increase transit mode share</td><td>Per capita daily transit ridership</td><td colspan="2">Net new riders</td></tr>
<tr><td>Percentage of intra-county trips on transit</td><td></td><td></td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">Increase effectiveness (including inter-regional travel)</td><td>Passenger trips per revenue vehicle mile</td><td></td><td>Passenger trips per revenue vehicle mile</td></tr>
<tr><td>Miles of dedicated right-of-way (proxy for travel time reliability)</td><td>Miles of dedicated right-of-way (proxy for travel time reliability)</td><td></td></tr>
<tr><td>Daily transit trips (unlinked)</td><td colspan="2">Daily transit trips (unlinked)</td></tr>
<tr><td></td><td>Reduction in transit travel time (peak/off-peak)</td><td></td></tr>
<tr><td colspan="2">Number of transit hubs served, including inter-regional hubs</td><td></td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Increase cost efficiency</td><td></td><td>Capital cost per net new rider</td><td></td></tr>
<tr><td>Operating cost per boarding</td><td></td><td>Operating cost per boarding</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Improve access</td><td>Number of HH/jobs within half-mile of transit stops within each service tier</td><td>Number of HH/jobs within half-mile of transit stops</td><td></td></tr>
<tr><td colspan="3">Number of Communities of Concern affected</td></tr>
<tr><td>5</td><td>Reduce emissions</td><td>GHG emissions</td><td>Zero emission vehicles</td><td></td></tr>
<tr><td>6</td><td>State of good repair</td><td></td><td>Cost of mid-life overhaul and/or replacements before 2045 to be included in cost estimates</td><td></td></tr>
</table>

SOURCE: Parsons Brinckerhoff, 2015

The definitions for the quantitative performance measures are as follows:

- **Per capita daily transit ridership**: This measure will be used to compare transit usage normalized with population over time (2010 vs. 2040). For evaluation of networks, ridership and population data will be taken from the travel demand estimation process (using both the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix). For evaluation of operations, ridership data reported by transit agencies and population estimates/projections prepared by state or regional agencies will be used.
- **Percentage of intra-county trips on transit**: This measure will be used to track progress towards increasing transit mode share for intra-county trips. For evaluation of networks, intra-county ridership data will be taken from

the travel demand estimation process (using both the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix).

- **Net new riders**: This measure will be used to compare the ability of a project to attract new riders to transit. This measure will be used for evaluation of projects only and will use estimates of net new riders from the travel demand estimate process.
- **Passenger trips per revenue vehicle mile**: This measure will be used to assess the utilization of service for both networks and projects. For network and project evaluations, the passenger trips will come from the travel demand estimation process, while the revenue vehicle mile data will be derived from proposed service levels.
- **Miles of dedicated right-of-way**: This measure is a proxy for the reliability of transit service under the assumption that exclusivity reduces schedule variability associated with intermittent general purpose traffic congestion. The measure will be used for both network and project evaluations. The data will come from each project definition.
- **Daily transit trips**: This measure will show the transit trips associated with the project and will be aggregated at the network level. This measure is being used in addition to net new riders to allow for comparison to other transit agencies and provide input to efficiency metrics such as passenger trips per revenue vehicle miles. This data will come from the travel demand estimation process.
- **Reduction in transit travel time**: Transit travel time improvements will be estimated based on the type of physical changes proposed for the corridor. This measure will be applied at the project level. This data will come from a combination of synthetic and incremental modeling exercises (as detailed in Section 2.2 and the Appendix).
- **Number of transit hubs served, including inter-regional hubs:** This measure will show the "interconnectivity" of a particular transit line. This data will come from project definition evaluated against the existing and planned transit hubs.
- **Capital cost per net new rider**: This measure will be applied at the network and project level. Capital costs will be estimated from data bases that have compiled costs for comparable types of improvements in Alameda County and in other regions.
- **Operating cost per boarding**: This measure will be applied at the network and project level. Operating costs will be estimated from current operating costs for comparable types of service in Alameda County and other regions.

- **Number of households (by income level) and jobs within half-mile of transit stop within each service tier**: This measure provides useful information related to the potential overall market and equity issues associated with proposed service changes. It will be applied at the network and project levels. It also, provides a measure that helps provide context for the comparison of proposed projects in Alameda County to similar transit projects implemented elsewhere in the US.
- **Number of Communities of Concern affected:** This measure will help to establish whether the proposed modification will have a positive impact on Communities of Concern, i.e. those communities that face particular transportation challenges, either because of affordability, disability, or because of age-related mobility limitations. These may also be defined as those areas covered by Community Based Transportation Plans. A qualitative assessment of the extent to which proposed transit improvements benefit these communities will also be performed.
- **GHG emissions:** This measure will be applied on the network-level only and is generated based on output from the travel forecasting process (using both the Alameda County Travel Demand Model as well incremental approaches to ridership forecasting as detailed in the Appendix).
- **Zero emission vehicles**: This measure will be applied at the project level as an indicator of relative fleet emission impacts associated with the proposed improvement. Information on the use of zero-emission vehicles will be obtained from individual transit operators.
- **Cost of mid-life overhaul and/or replacements before 2045:** In order to reflect the goal of state of good repair, project cost estimates will take into account the cost of a mid-life overhaul and capital replacement required before 2045 as appropriate depending on asset type. This information will be obtained from individual transit operators as well as form the consultant team's database of relevant transit capital projects.

Qualitative Performance Measures

In addition to the quantitative measures listed above, the projects will also be evaluated using a set of qualitative performance measures to capture those benefits that cannot be readily modeled or forecasted so as to provide a quantitative metric. Qualitative measures include:

- **Support TOD strategy:** Linking transit investment with supportive land use patterns is critical to the success of transit. This performance measure will assess the characteristics of land uses adjacent to the proposed transit project to assess the potential for transit success.

- *Density* – Are high density development and housing affordability requirements in place for development near transit stations/stops?
- *Mix of Uses* – Does the local jurisdiction have policies that encourage mixed-use development, such as, zoning codes that allow a mix of uses, form-based development codes (which generally facilitate mixed use development or co-locations of different uses better than conventional zoning approaches), innovative jobs/housing balance policies and programs, shared parking allowances or requirements?
- *Parking Management Policies* – Does the local jurisdiction have progressive parking policies, such as, value or demand priced parking, reduced parking requirements in areas served by transit, parking maximums, shared parking policy, reduced parking for affordable housing units, provision of free or reduced-cost transit passes, and a tracking system to monitor these programs?

- **Number of existing or planned major activity nodes served:** Major activity nodes with high levels of transit demand serve as anchors for transit routes. Generally, major activity nodes are locations where there are a concentrate number of trip destinations and/or origins, such as colleges or universities, downtown central business districts, shopping centers, and large medical centers. The routes that are most productive, not only have major anchors at each end of the route, but also have the potential to generate robust transit demand along the route.

  Proposed projects will be evaluated in terms of how well they serve multiple existing or planned major activity nodes (including active PDA's).
- **Intermodal connectivity**: Projects will be evaluated in terms how effectively they connect different types of transit services within the transit network. This will be evaluated by assessing the number of transit service tiers served and the ease of access between different transit modes.
- **Customer experience:** Customers' expectations evolve as amenities and services become available to them. Most transit agencies in Alameda County have carried out customer satisfaction surveys to identify factors that affect their decisions to use transit. Most agencies have also adopted performance measures to track customer satisfaction over time. A qualitative assessment will be made of each project's impact to the rider's experience based on factors such as: service reliability, ease of transfers, ease of access to transit information and whether or not the proposed project has the potential to improve customer satisfaction.
- **Compatibility with Arterials Plan recommendations**: Coordination with the Arterials Plan typologies will ensure consistency between both plans.

2.2. Modeling Considerations

Because forecasts of transit demand associated with individual or groups of draft recommendations are a critical input to several of the most important evaluation criteria, it is important to understand the advantages and disadvantages of different modeling procedures and how the results should be interpreted. Therefore, a brief discussion of travel demand modeling and the proposed combined approach is provided below.

This evaluation employs a combination of **synthetic** and **incremental** approaches to forecasting transit ridership.

The **synthetic** evaluation method uses a travel demand model (in this case, the 4-step Alameda County Travel Demand Model), which forecasts both travel mode choice and route choice based on statistical estimates of origins and destinations given future land use and transportation system changes.

Incremental approaches to transit ridership forecasting are based on observed transit usage. They forecast transit ridership changes by applying demand elasticities to whatever type of change is being made (fares, frequency, etc.).

An FTA-sponsored survey of MPOs found that 63 percent of the respondents used service elasticities to forecast ridership and 51 percent used 4-step travel models, with many using both in combination. The primary reason for using both is that each method has important limitations that can be overcome through the use of the other method. This can be seen in the comparison table below (see Table 3).

Table 3: Network Alternatives

Synthetic Methods (4-step models)	Incremental Methods (elasticities)
Advantages • Sensitive to changes in land uses and to transportation projects, including improvements in other modes • Can forecast ridership for new modes or extension of an existing mode to areas not previously served	Advantages • Use of route-level survey data eliminates the upstream error (land use data, income data, etc.) found in travel models. The base ridership will be accurate • Can be used to forecast changes for small-scale projects
Weaknesses • Intended to function at a large scale; incapable of forecasting effects of micro-scale projects such as queue jumps • Provides reasonable forecasts for transit as a whole but not for individual bus routes	Weaknesses • Critically dependent on data for existing conditions, so cannot be used where service does not already exist • Insensitive to other changes in the network such as improvements to a parallel freeway

SOURCE: Parsons Brinckerhoff, 2015

As is the case with virtually all synthetic approaches which rely on travel demand models, the Alameda CTC travel demand model is much more accurate for auto travel than for transit, especially bus transit. However, the model is validated (tested for accuracy) at the level of daily ridership by transit operator.[4] In other words, the model is expected to provide a good estimate of total daily ridership for each transit operator, but is not validated for more detailed levels of analysis, such as ridership on individual bus lines at different times of the day.

Many of the draft recommendations to the Alameda County transit network involve a combination of small-scale improvements to bus routes and specific roadways (e.g. transit signal priority, bus bulbs, transit queue jumps, etc.). Synthetic models are not sensitive to these types of changes even though there are examples of transit ridership gains as the result of transit speed and reliability improvements.[5] For the evaluation phase of this project, a combination of synthetic and incremental approaches will be utilized in order to capture the advantages of each analysis approach and overcome the limitations that either approach would have if used alone.[6]

[4] See Table 3-15 in Alameda Countywide Transportation Model Update – Model Documentation, Dowling Associates, August 2011
[5] For a case study of King County Metro Rapid Ride, see Technical Memorandum #5: Transit Network Methodology, Alameda Countywide Transit Plan, August 2015
[6] For further detail, see the Appendix, Draft Technical Memorandum #5.4, Proposed Modeling Approach, Alameda Countywide Transit Plan, August 2015.

2.3. Application of Performance Measures

Results from the evaluation of draft recommendations using quantitative and qualitative performance measures will be presented in a matrix format. The transit vision network will also be evaluated against existing conditions and baseline conditions networks. For each performance measure, results will be presented on a three-point scale (low, medium, high). Each performance measure will be assigned weights determined through discussions with Alameda CTC. Table 4 shows a sample evaluation matrix.

Table 4: Sample Evaluation Matrix

Project			Quantitative Performance Measures													
	Per Capita Transit Ridership	Percentage of Intra-County Trips on Transit	Net New Riders	Passenger Trips per Revenue Vehicle Mile	Miles of dedicated right-of-way	Capital cost per net new rider	Daily Transit Trips	Reduction in Transit Travel Times	Operating Cost per Net New Rider	Number of Transit Hubs Service, including Inter-regional hubs	Operating Cost per Boarding	Number of HH/jobs within half-mile of transit stops	Number of Communities of Concern affected	GHG Emissions	Zero Emissions Vehicles	Cost of mid-life overhaul and/or replacements before 2045 to be included in cost estimates
Project 1	1	3	2	1	2	2	3	2	1	2	1	3	3	1	2	3
Project 2	3	2	2	1	3	2	2	1	2	1	3	2	3	2	3	1
Project 3	2	2	1	1	2	2	3	2	3	2	2	3	2	3	3	2
Project 4	3	3	3	2	2	3	1	2	3		3	1	1	1	2	3
Project 5	1	1	2	3	1	2	1	1	3	1	2	2	2	1	3	2

Legend: 1 – Low Score; 2 – Medium Score; 3 – High Score

3.0. Appendix – Proposed Modeling Approach

Technical Memorandum

PARSONS BRINCKERHOFF

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To: Kara Vuicich, Alameda County Transportation Commission

From: Don Hubbard, TE, AICP, Parsons Brinckerhoff

Subject: Tech Memo 5.4, Proposed Modeling Approach

Date: August 15, 2015

The Alameda County Transportation Commission's (Alameda CTC's) Countywide Transit Plan and Alameda-Contra Costa County Transit District's (AC Transit's) Major Corridors Study, both entail the use of ridership forecasting to estimate potential relative benefits associated with recommended improvements. This memo describes the approach that we propose to take for this forecasting work and the reasoning behind the recommended approach.

Goals of the Forecasting Task

The forecasting is being undertaken to provide a means to compare the relative benefits of different proposed transit improvements. It must cover a variety of improvement types singly or in combination

- New routes
- Extensions of existing routes
- Changes in frequency of service
- Linear improvements (e.g. dedicated lanes for portions of route)
- Point improvements (bulb-outs, queue jumps, etc.)

General Approaches to Ridership Forecasting

There are two general approaches to transit ridership forecasting:

- ***Synthetic methods*** forecast ridership based on information on land uses, travel behavior, and the modes and routes available to travelers. These are usually combined into a 4-step model such as the Alameda CTC Travel Demand Model.
- ***Incremental approaches*** are based on observed transit usage and forecast changes using elasticities for whatever type of change is being made (fares, frequency, etc.).

A survey sponsored by the Federal Transit Administration (FTA) found that 63 percent of the surveyed MPOs used service elasticities to forecast ridership and 51 percent used 4-step travel demand models, with many using both in combination. The primary reason for using both is that each method has important limitations that can be overcome through the use of the other method. This can be seen in Table 1. We recommend using a combination of synthetic and incremental approaches in order to capture the advantages of each and overcome the limitations that either approach would have if used alone. It should be noted that FTA accepts both approaches so long as they are used appropriately and performed properly.

Table 1: Comparison of Synthetic and Incremental Approaches

Synthetic Methods (4-step models)	Incremental Methods (elasticities)
Advantages • Sensitive to changes in land uses and to transportation projects, including improvements in other modes • Can forecast ridership for new modes or extension of an existing mode to areas not previously served	Advantages • Use of route-level survey data eliminates the upstream error (land use data, income data, etc.) found in travel models. The base ridership will be accurate • Can be used to forecast changes for small-scale projects
Weaknesses • Intended to function at a large scale; incapable of forecasting effects of micro-scale projects, such as queue jumps • Provides reasonable forecasts for transit as a whole, but not for individual bus routes	Weaknesses • Critically dependent on data for existing conditions, so cannot be used where service does not already exist • Insensitive to other changes in the network such as improvements to a parallel freeway

The Alameda CTC Travel Demand Model

The Alameda CTC model was created in 2007 based on Metropolitan Transportation Commission's BAYCAST model. The mode split component of the Alameda CTC model was copied from the Valley Transportation Authority (VTA) model, which has more detail than the BAYCAST model. The model was recently updated to improve transit accuracy, make the land use forecasts consistent with the Sustainable Communities Strategy, and validate it to more recent data.

AC Transit and other bus routes are represented in the model as a series of points along the road system, some of which are designated as stops. Ridership is estimated based on comparison of the overall cost of using transit versus using some other mode, for each origin-destination pair. The costs of taking the bus include:

- If walk access, then walk time from home to bus stop. If kiss-and-ride access, then drive time. If park-and-ride access, then drive time and parking costs.
- Wait time at the bus stop, which is a function of service frequency. The model allows for different headways for peak- and off-peak hours
- Bus travel time, which is computed based on auto travel time. This varies by route but is generally 1.5 to 3.0 times the auto travel time, and includes dwell time at bus stops. This formulation allows the model to reflect the effect of congested conditions on both auto and bus travel times

Each model run generates two ridership figures. One is based on AM peak period conditions (traffic levels, headways, etc.) and is used to represent the six peak hours of the day (3 hours in the AM and 3 hours in the PM). The other figure is based on mid-day conditions (speeds, headways, etc.) and represents all off-peak hours.

As is the case with virtually all 4-step models, the Alameda CTC model tends to be more accurate for auto travel than for transit, especially bus transit. The model was validated (tested for accuracy) at the level of daily ridership by transit operator. In other words, the model is expected to provide a good estimate of total daily ridership for each transit operator, and does. The model also provides forecasts at more detailed levels of analysis, but the further the analysis moves away from the validation level the less reliable the forecast will be, and more care must be exercised in using the forecasts.

This can be seen in Table 2, which compares the model forecasts to Alameda CTC data for three routes that have been identified for possible improvements. The model's forecasts, at a very detailed level (for individual routes in individual time periods) range anywhere from 1 percent to 376 percent of actual ridership; a high margin of error. But, when both time periods and all three routes are combined the aggregate forecast has a low margin of error (11 percent off). For the entire AC Transit bus system, the model results are only 6.6 percent higher than observed ridership[1].

Table 2: Comparison of Alameda CTC Model Ridership to Actual Ridership for 3 Routes

Route	Location	Count				ACTC Model				Total	
		Southbound		Northbound		Southbound		Northbound			
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Count	Model
1	International South of Seminary	768	972	582	790	62	5	201	11	3,112	279
		Ratio of Model/Count >				*0.08*	*0.01*	*0.35*	*0.01*		*0.09*
1R	International South of Seminary	853	969	873	835	894	232	3,286	880	3,530	5,292
		Ratio of Model/Count >				*1.05*	*0.24*	*3.76*	*1.05*		*1.50*
97	Hesperian South of Turner	357	408	328	533	294	112	1,232	155	1,626	1,793
		Ratio of Model/Count >				*0.82*	*0.27*	*3.76*	*0.29*		*1.10*
Total		357	408	328	533	294	112	1,232	155	8,268	7,366
		Ratio of Model/Count >				*0.82*	*0.27*	*3.76*	*0.29*		*0.89*

Knowing this, the proposed approach is to be selective about how we use this model. Appropriate uses are:

- Percentage response to major changes in inputs - For example, the model may be somewhat off on its base forecast for off-peak ridership on a route, but can still give a reasonable forecast of the percentage increase in ridership from shortening the headways, or the percentage increase in ridership from a major land use change. The percentage increase is then applied to observed ridership.
- Indicating relative performance – The model can provide an accurate prediction of which of several alternate routes is likely to attract the highest ridership.
- Predicting ridership for new service to an area not currently served. For the introduction of new service, this is the most effective tool for capturing the potential ridership.

There are other types of analysis where a countywide 4-step model is not the preferred forecasting tool. Models of this type are not intended for very fine-grained analysis such as analyzing the effects of queue jumps or curb extensions, whose effects are small in relation to the model's margin of error. For that a different kind of analysis is needed.

Incremental Modeling

Incremental, or pivot-point, modeling is suited for analyzing relatively small-scale changes to transit services. Incremental analysis is done in three steps as follows:

[1] See Table 6.6 in *Alameda Countywide Transportation Model Update – Model Documentation*, July 2015

1) Compute the percent change in the independent variable (travel time, fare, etc.)

2) Multiply the percentage change in the independent variable by the elasticity of the dependent variable (usually ridership) to find the predicted percentage change in the ridership.

3) Apply the predicted percentage change in ridership to the observed ridership to find the predicted new ridership

For example, several other transit systems reported an observed elasticity of +0.33 for changes in service frequency during the AM peak hour.[2] So if a route had an existing ridership of 1,000 passengers and service frequency increased from 4 to 6 buses an hour (a 50% increase), then ridership would be expected to increase by 16.5% to 1,165 passengers. The advantage of this modeling system is that it can work for relatively small increments, including the small reductions in travel time from queue jumps and curb extensions. A previous memo went through a detailed example of how the change in ridership from curb extensions could be computed, and also described how the traveler benefits could be calculated in dollar terms for use in cost-benefit analysis (see Attachment A).[3]

Discussion Draft of Approaches by Project Type

Based on the preceding information we have identified some approaches for the various project types currently under consideration (see Table 3). These are summarized in the table below. The project types are listed in order from those most suitable for analysis using the Alameda CTC model to those least suitable.

[2] *TCRP Report 95: Traveler Response to Transportation System Changes*, TRB 2004

[3] Technical Memorandum: *Methodology for Evaluating Travel Benefits*, Parsons Brinckerhoff, May 8, 2015

Table 3: Recommended Residential Land Use Categories

Proposed Improvement	Main Effect of Improvement	Proposed Forecasting Technique
Route extensions	The route would serve areas not currently served, or not served by the route proposed for extension	Code the extensions into the Alameda CTC model to get a preliminary estimate of ridership. Then factor ridership up or down for the extension based on how closely the model matches observed trip-making for the existing portion of the route.
Dedicated transit lanes	Reduce travel times for transit riders	Add new nodes to the Alameda CTC model that will enable us to *hard-code* travel times that are independent of auto travel times. Revise the transit line file so that whatever routes would use the lanes would be assigned the new travel times. Run the model to compute the percentage change in ridership by line, and apply it to the latest ridership data. If the new lanes would be created by reducing existing auto lanes then auto dis-benefits would be considered.
Peak-hour bus lanes	Reduce travel times for transit riders, but only during peak hours	Use the same approach as for dedicated transit lanes, but disregard any changes occurring in the off-peak hours.
Bus Lanes in one direction of travel	Reduce travel times for transit riders, but only in one direction	Same approach as for dedicated transit lanes. However, some post-processing will be required to correct for the fact that the Alameda CTC model assigns transit trips for the AM peak period only, so it does not naturally capture the effect of a change in a single direction of travel.
Changes in service frequency	Reduced wait times for transit riders	A) Adjust the headways for the lines affected. Then run the model to compute the percentage change in ridership by line, and apply it to the latest ridership data. or B) Use the elasticity of ridership to service frequency to compute increases in ridership
Transit-preferential streets	Minor reductions in travel times for transit riders	A) Adjust the bus speed factor so that bus travel times are closer to auto travel times for the affected streets, or B) Use the elasticity of ridership to travel time to compute increases in ridership
Curb extensions	Minor reductions in travel times for transit riders	Estimate time savings from existing studies. Use the elasticity of ridership to travel time to compute increases in ridership.
Queue jumps	Minor reductions in travel times for transit riders	Estimate time savings from existing studies or intersection Level of Service (if known). Use the elasticity of ridership to travel time to compute increases in ridership.

Sensitivity and Expected Scope of Change

In order to get a preliminary indication of how sensitive ridership might be to changes in travel time, we ran a sensitivity test using the Alameda CTC model. The test consisted of doubling the service frequency across-the-board for all transit modes in the model. The results are shown in Table 4:

Table 3: Results of Alameda County Sensitivity Test for Service Frequency

Measure	Base Ridership	Ridership	Change in Ridership	% Change
Total Model Peak Transit Trips	1,498,512	1,730,542	232,030	15%
Total Model Off-Peak Transit Trips	2,019,846	2,837,114	817,268	40%
Peak Local Bus Trips	364,191	435,572	71,381	20%
Off-Peak Local Bus Trips	220,455	264,782	44,327	20%
Intra-Alameda County Peak Transit Trips	218,651	252,848	34,197	16%
Intra-Alameda County Off-Peak Transit Trips	287,394	444,901	157,507	55%
Intra-Alemeda Cnty Peak Local Bus Trips	55,443	66,220	10,777	19%
Intra-Alameda Cnty Off-Peak Local Bus Trips	33,939	41,685	7,746	23%
Alameda County Daily VMT	42,031,415	41,509,587	-521,828	-1.2%

Table 4 shows that local bus services, at least in the model, are relatively insensitive to what would in reality be a major change in transit operations. There is some nuance to the results; for example, the table shows that off-peak transit operations are more sensitive to reductions in headways than peak-period operations. Presumably, this is because the headways are already relatively short during peak periods so riders would gain relatively little from the change. A small, but measurable reduction was forecast for countywide daily vehicle miles of travel (VMT).

Our conclusion from this test is that the net changes in ridership resulting from the proposed improvements may be relatively small; in fact close to the margin of error of the county-wide model. So to the extent possible cross-checks would be performed to ensure that the results fall within a reasonable range based on observed data.

Our other conclusion from this test is that focusing exclusively on changes in ridership may tend to under-estimate the benefits of the proposed projects. In cases where the increase in ridership is small, the main benefit of the project will come from reduced travel times for existing passengers. So reductions in travel times may be a better measure of project performance than change in ridership.

Attachment A

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Technical Memorandum

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Project: ACTC Countywide Transit Plan (PB Project #13347A)

Subject: Methodology for Evaluating Travel Benefits

Date: May 8, 2015

The purpose of this memorandum is to describe the proposed methodology for computing the value of traveler benefits for various possible projects to improve bus performance. The methodology is described in reference to several sample calculations.

Benefits from Bus Curb Extensions and Queue Jumps

Bus curb extensions (mid-block bulb-outs) and queue jumps reduce delays for buses at individual sites on a route. If treatments occur at a number of locations and the locations selected had previously caused delays for the buses then the aggregate effect may be a noticeable reduction in bus travel time. However, the reduction in bus travel time is partially offset by increases in travel times for travelers in automobiles, which must also be accounted for.

To illustrate how the benefits of curb extensions can be estimated a calculation was performed using the example of a proposed set of curb extensions Along College Avenue, Broadway, and Embarcadero that are portions of a proposed service between downtown Berkeley and Brooklyn Basin (see Exhibit 1). The methodology for estimating the benefits of these improvements follows several steps, namely (the letters refer to places in Exhibit 2):

1) In this planning-level example the exact number of curb extensions is not known. The number of curb extensions (C) was therefore calculated by multiplying the length of the treated section (A) by the assumed distance between curb extensions (B).
2) The value of a curb extension or queue jump lies in buses' ability to resume travel without having to find a gap in the traffic in the adjacent lane. The amount of time saved per curb extension (F) is found by using the traffic volume in the adjacent lane (D) to reference a look-up table from the *Bus Rapid Transit Practitioners' Guide* (E).[1]
3) The total time saved on each segment (G) is found by multiplying the number of curb extensions (C) by the time savings per curb extension (F). This is then summed over the entire route (H).
4) If the reduction in travel time is substantial, then ridership may increase. The increase in ridership can be estimated by determining the reduction in travel time (H) as a percentage of the total travel time for the route (I). The percentage change in travel time (J) is then multiplied by the elasticity of ridership to travel time (K) to find the change in ridership (L).[2]
5) The number of riders that will benefit from the curb extensions (N) is found by applying the percentage increase (L) to the existing passengers per hour per route segment (M).

[1] *Bus Rapid Transit Practitioner's Guide*, Transit Cooperative Research Program Report 118, Federal Transit Administration, March 2007

[2] Note: This calculation is based on the entire route, and so may be an over-estimate of the change in ridership.

6) Total passenger time saved per segment (O) is found by multiplying the reduction in bus travel time (G) by the number of passengers affected in each route segment (N). This can be aggregated to find the total travel time saving for the route (P).
7) The value of the bus passenger's time saved (R), i.e. their benefit from the project, is found by multiplying the total time savings (P) by the average value of travelers' time (Q).
8) While a bus is stopped at a curb extension it blocks other traffic that would otherwise be using the lane. This traffic may be able to maneuver around the bus if there is another lane in the same direction and if usable gaps are available in the traffic using that lane. The delay (T) imposed on auto travelers (drivers and passengers) is estimated by multiplying the reduction in travel time for buses (G) times a factor relating bus delay to car delay (S).
9) Not all cars using the road in the peak hour will be affected; only those cars that happen to be behind a bus would be delayed. The delay imposed on auto travelers in each route segment (W) is computed by multiplying the increase in travel time for autos (T) by the number of cars in the lane (D), the number of travelers per car (U) and the percentage of cars affected (V). This delay is then aggregated for the entire route (X).
10) The value of the time lost for auto travelers (Y) is found by multiplying the total delay for auto travelers (X) by the value of traveler time (Q).
11) The net benefit of the improvements per peak hour (Z) is the benefit to bus travelers (R) minus the dis-benefit to auto travelers (Y). This can be multiplied by an annualization factor (AA) to convert the net benefits per peak-hour into net benefits per year (AB).

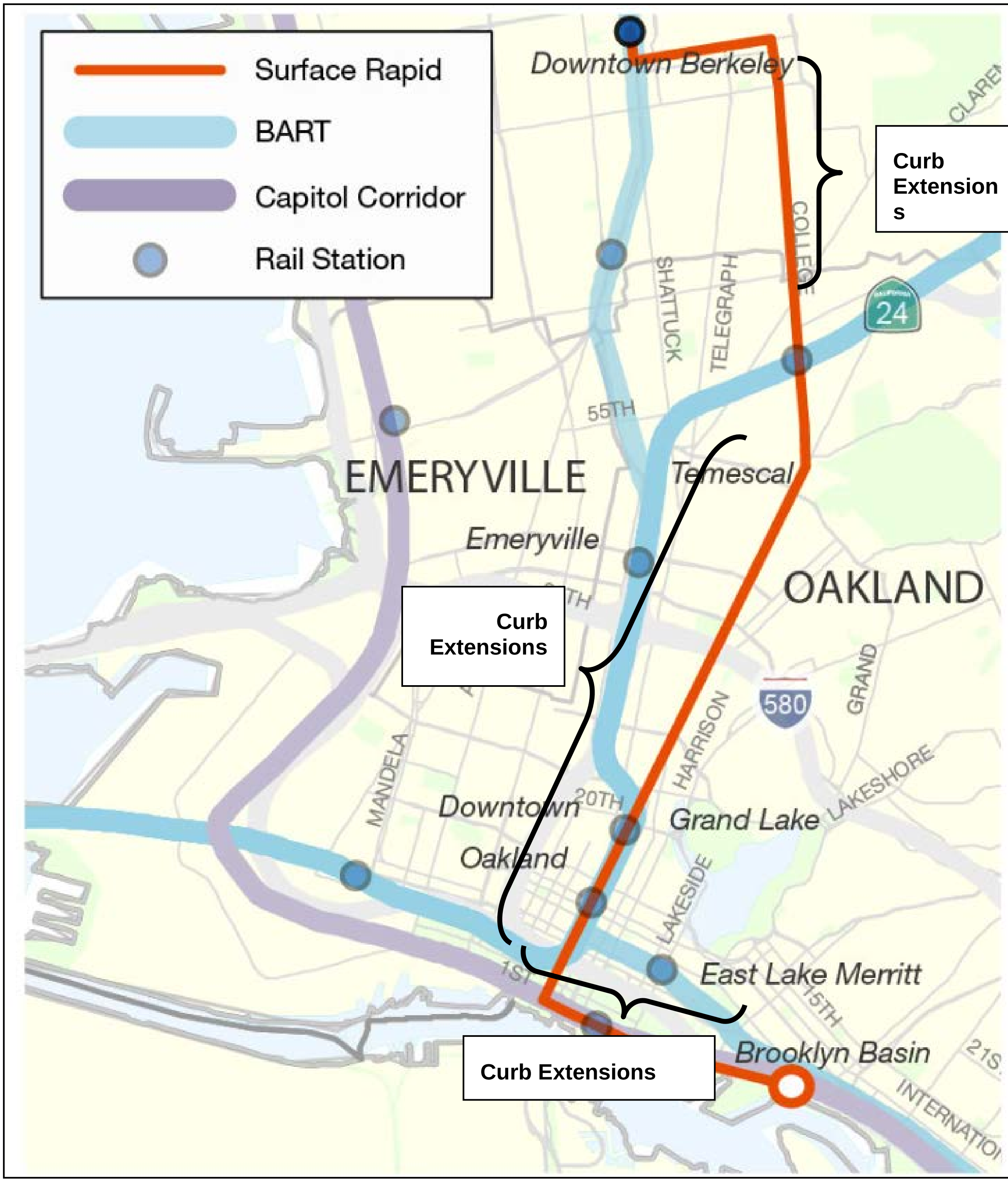

Exhibit 1 – Proposed Improvements

Estimate of Travel Benefits - Downtown Berkeley to Brooklyn Basin, Southbound

Items highlighted in yellow are inputs (dummy data)
Items highlighted in peach are inputs (real data)
Items highlighted in green are outputs
(reference cited in text)

Inputs & Assumptions

(B)	1.0	Assumed distance between bus bulbs (miles)
(I)	40	Average Bus Travel Time (minutes)
(J)=(H)/(I)	-4.1%	Reduction in Travel Time (%)
(K)	-0.2	Elasticity of Ridership to Travel Time
(L)=(J)*(K)	**0.8%**	Growth in Ridership
(S)	0.5	Seconds of car time added per second of bus time reduction
(U)	1.2	Assumed vehicle occupancy for cars

Average Bus Clearance Time (E)

Adjacent Lane Volume (veh/lane/hr)	100	200	300	400	500	600	700	800	900	1,000
Average Re-Entry Delay (Seconds)	1	2	3	4	5	6	8	10	12	15

Source: *Bus Rapid Transit Practictioner's Guide*, TCRP Report 118

Portion of Route	Length	Total Bus Bulb-Outs	Adjacent Lane Volume	Reduction in Bus Delay per Bulb-Out (Seconds)	Total Reduction in Travel Time (Seconds)	Average Passengers per Hour (before bump-up)*	Average Passengers per Hour (after bump-up)	Total Passenger Time Saved (Seconds/Hr)	Increased Travel Time for Autos (seconds /veh)	% of Cars Affected	Total Auto Traveler Time Added (Seconds/Hr)
	(A)	(C)=(A)*(B)	(D)	(F)	(G)=(C)*(F)	(M)	(N)=M*(1+L)	(O)=(G)*(N)	(T)	(V)	W=D*T*U*V
College Avenue SB	1.3	2	800	10	20	104	104.8	2,097	10	20%	1,920
Broadway SB	3.1	4	900	12	48	184	185.5	8,904	24	20%	5,184
Embarcadero EB	1.5	2	1,000	15	30	548	552.5	16,574	15	20%	3,600
		Total reduction in Bus Travel Time >			98	(H)		27,575	(P)		10,704 (X)

* Source: ACTC traffic model

Assumed value of passenger time ($/hour) > $5.00 (Q) — $5.00

Value of passenger time saved ($/hour) > **$38.30** (R)=(P)*(Q) — **$14.87** (Y)=(X)*(Q)

Net Benefts per Peak Hour (gains for bus riders minus losses for car travelers) > **$23.43** (Z)=(R)-(Y)

Annualization Factor > 400 (AA)

Net Benefts per Year (gains for bus riders minus losses for car travelers) > **$9,373** (AB)=(Z)*(AA)

Exhibit 2: Sample Calculation