Bay Area Plan

Strategy for a Sustainable Region

July 2013

Association of Bay Area Governments

Metropolitan Transportation Commission

Final Summary of Predicted Land Use Responses

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Summary of Predicted Land Use Responses

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1 Introduction

This appendix presents a technical overview of the Bay Area UrbanSim Land Use Model application, performed in support of the Association of Bay Area Government's (ABAG) and the Metropolitan Transportation Commission's (MTC's) 2013 Plan Bay Area environmental impact report (EIR). The document provides a brief overview of the technical methods used in the analysis, a description of the key assumptions made in the modeling process, and a presentation of relevant results for each EIR alternative.

2 Analytical Tools

This section provides a high-level overview of the Bay Area UrbanSim Land Use Model application. The model provides a consistent, theoretically-grounded means of forecasting land use change in the Bay Area for the different combinations of control totals and planning policies that are incorporated into the EIR alternatives. In addition, Bay Area UrbanSim is integrated with the MTC Travel Model to address the interactions between transport system changes and land use changes.[1] This section includes an overview of the model structure, simulation sub-models, a description of the interaction between UrbanSim and the Travel Model, and a brief introduction to the EIR alternatives.

Bay Area UrbanSim Land Use Model Application

UrbanSim is a modeling system developed to support the need for analyzing the potential effects of land use policies and infrastructure investments on the development and character of cities and regions. UrbanSim has been applied in a variety of metropolitan areas in the United States and abroad, including Detroit, Eugene-Springfield, Honolulu, Houston, Paris, Phoenix, Salt Lake City, Seattle, and Zürich. The application of UrbanSim for the Bay Area was developed by the Urban Analytics Lab at UC Berkeley under contract to MTC.[2]

The area included in the Bay Area model application includes all incorporated and unincorporated areas of the nine-county Bay Area.[3] This geographic area defined the scope of the data collection efforts necessary to define the modeling assumptions. The year 2010 was selected as the base year for the parcel-based model system.

Within UrbanSim there are several sub-models simulating the real-world choices and actions of households and businesses within the region. Households have particular characteristics such as income and number of children that may influence preferences for housing of different types at different locations. Businesses also have preferences that vary by industry and business size for building types and locations. Developers construct new buildings or redevelop existing ones in response to demand and planning constraints, such as zoning. Buildings are located on land parcels that have particular characteristics such as value, land use, topography, and other environmental qualities. Governments set

[1] An overview of the travel forecasting procedures is available in the *Summary of Predicted Traveler Responses* supplementary report.

[2] More information on UrbanSim is available at http://urbansim.org

[3] Additional information on Bay Area UrbanSim can be found at http://analytics.mtc.ca.gov/foswiki/Main/LandUseModel

policies that regulate the use of land through the imposition of land use plans, urban growth boundaries, environmental regulations, or through pricing policies such as development impact fees. Governments also build infrastructure, including transportation infrastructure, which interacts with the spatial distribution of households and businesses to generate patterns of accessibility at different locations that, in turn, influence the attractiveness of these sites for different consumers.

The Bay Area UrbanSim model system simulates these choices through the sub-models described below and shown in Figures 1, 2, and 3. Figures 1, 2 and 3 also show how the Travel Model and Bay Area UrbanSim interact. Several of the system models include algorithms that aim to match the total number of units (e.g. jobs, households) prepared by ABAG. These control totals are checked at the end of each model year run. In each of Bay Area UrbanSim's annual predictions, the model system steps through the following components:

1. The *Business Transition Model* (referred to as the *Employment Transition Model* in Figure 1) predicts new businesses being created within or moved to the region, and the loss of businesses in the region – either through closure or relocation out of the region. The role of this model is to keep the number of jobs in the simulation synchronized with aggregate expectations of employment in the region forecasted by ABAG.
2. The *Household Transition Model* predicts new households migrating into the region, the loss of households emigrating from the region, or new household formation within the region. The Household Transition Model accounts for changes in the distribution of households by type over time, using an algorithm analogous to that used in the Business Transition Model. In this manner, the Household Transition Model keeps Bay Area UrbanSim household counts synchronized with the aggregate household projection forecasted by ABAG.
3. The *Real Estate Development Model* simulates the location, type, and density of real estate development, conversion, and redevelopment events at the level of specific land parcels. This sub-model simulates the behavior of real estate developers responding to excess demand within land use policy constraints. The algorithm examines a subset of parcels each forecast year and builds pro formas comparing development costs and income. New structures are built in profitable locations.
4. The *Scheduled Development Events Model* provides an alternative means for the introduction of new buildings into the region. This component is simply a list of predetermined structures to be built in particular future years. These represent large, committed, public-private partnership projects and are shown in Table 1.
5. The *Business Relocation Model* (referred to as the *Employment Relocation Model* in Figure 1) predicts the relocation of business establishments (i.e. specific branches of a firm) within the region each simulation year. The Business Relocation Model predicts the probability that jobs of each type will move from their current location to a different location within the region or stay in place during a particular year.
6. The *Household Relocation Model* predicts the relocation of households within the region each simulation year. For households, mobility probabilities are based on the synthetic population from the MTC Travel Model. Drawn from Census data, these rates reflect the tendency for

younger and lower income households to move more often than their older and wealthier counterparts.

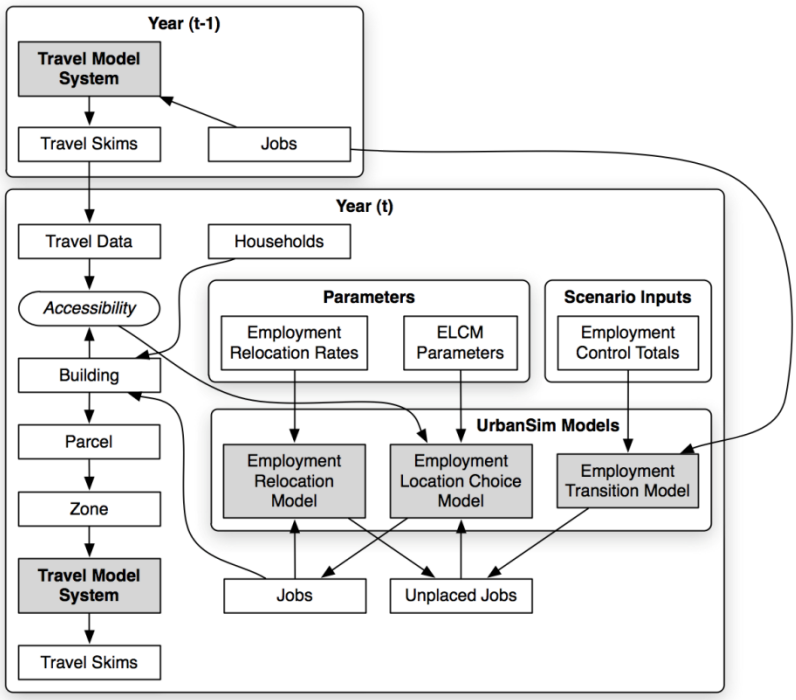

FIGURE 1: URBANSIM MODEL FLOW: EMPLOYMENT FOCUS

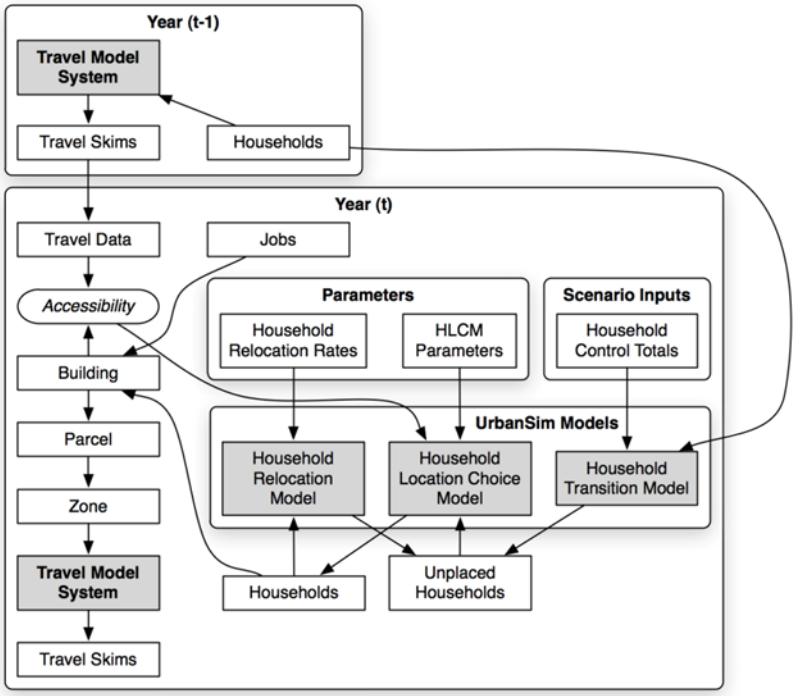

FIGURE 2: URBANSIM MODEL FLOW: HOUSEHOLD FOCUS

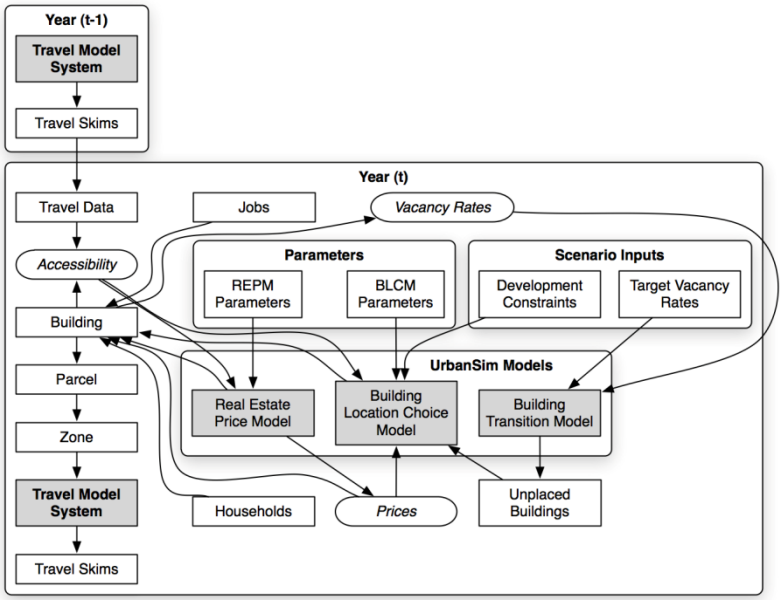

FIGURE 3: URBANSIM MODEL FLOW: REAL ESTATE FOCUS

7. The *Government Growth Model* uses a set of rules to project the employment in non-market sectors such as government and schools based on historical employment in those sectors and projected local, sub-regional, and regional population growth.

8. The *Business Location Choice Model* (referred to as the *Employment Location Choice Model* in Figure 1) predicts the location choices of new or relocating establishments. In this model, we predict the probability that an establishment that is either new (from the Business Transition Model), or has moved within the region (from the Business Relocation Model), will be located in a particular employment sub-market. Each job has an attribute of the amount of space it needs, and this provides a simple accounting framework for space utilization within sub-markets. The number of locations available for an establishment to locate within a sub-market will depend mainly on the total vacant square footage of nonresidential floorspace in buildings within the sub-market, and on the density of the use of space (square feet per employee). This sub-model simulates the behavior of businesses moving to suitable locations within the region.

9. The *Household Location Choice Model* predicts the location choices of new or relocating households. In this model, as in the business location choice model, we predict the probability that a

household that is either moving into the region (from the Household Transition Model), or has decided to move within the region (from the Household Relocation Model), will choose a particular location defined by a residential sub-market. This sub-model simulates the household behavior in selecting a neighborhood based on their socio-demographic preferences.

10. The *Real Estate Price Model* predicts the price per unit of each building. For residential units, the sale price is estimated for owner units, and the rent is estimated for rental units. UrbanSim uses real estate prices as the indicator of the match between demand and supply of land at different locations and with different land use types, and of the relative market valuations for attributes of housing, nonresidential space, and location. This role is important to the rationing of land and buildings to consumers based on preferences and ability to pay, as a reflection of the operation of actual real estate markets. Since prices enter the location choice utility functions for jobs and households, an adjustment in prices will alter location preferences. All else being equal, this will, in turn, cause higher price alternatives to become more likely to be chosen by occupants who have lower price elasticity of demand. Similarly, any adjustment in land prices alters the preferences of developers to build new construction by type of space, and the density of the construction.

TABLE 1: SCHEDULED DEVELOPMENT EVENTS

Scheduled Development Event
Alta Bates Oakland Expansion
Kaiser Oakland Expansion
MacArthur BART Transit Village Construction
South Hayward BART Transit Village Construction
Concord Community Reuse Construction
Lawrence Berkeley Lab 2 Construction
Pleasant Hill BART Transit Village Construction
Richmond BART Transit Village Construction
Walnut Creek Transit Village Construction
Hunters Point Naval Shipyard Construction
Mission Bay Construction
Moscone Center Expansion
Park Merced Redevelopment
San Francisco General Hospital Expansion
Transbay Terminal Redevelopment
Treasure Island Construction
Bay Meadows Construction
Kaiser Redwood City Expansion
Sequoia Hospital Expansion
Stanford Medical Center Expansion
Berryessa BART Transit Village Construction

EIR Alternatives

For the EIR analysis, UrbanSim was used to generate five different alternative land use scenarios for future growth in the Bay Area. Each of these uses similar control totals representing future economic and demographic change but employs different policies constraining or promoting particular types and intensities of real estate development in particular locations. The first alternative is called the No Project and represents the expected trajectory of the region without the implementation of the Proposed Plan or any of its alternatives. All policies in the No Project alternative are determined or extrapolated from existing base year plans and policies. The second alternative is called the Proposed Plan and uses a set of policy levers to achieve the spatial distribution of future households and employment envisioned by the *Jobs-Housing Connection Strategy*. Within UrbanSim, the Proposed Plan alternative starts with base year policies but modifies some of these to achieve its goal of focusing growth in defined compact, accessible, and politically-feasible locations called Priority Development Areas (PDAs).

Similarly, the other three alternatives modify existing policies in different ways to provide a range of potential futures that aim to accomplish the goals pursued within the Proposed Plan. The Transit Priority alternative modifies policies to focus growth to sites within one half mile of all high-frequency transit stops. The Enhanced Network of Connected Communities (or "Enhanced") alternative aims for a region more compact development pattern than the No Project alternative, but less focused than either the Proposed Plan or the Transit Priority alternatives. Finally, the Environment, Equity and Jobs (EEJ) alternative promotes housing growth in locations that are job rich and/or are "communities of opportunity" offering high quality schools and services to residents.

Travel Model Interaction

Bay Area UrbanSim and the Travel Model work as a system to capture the interaction between transportation and land use. Accessibility to a variety of urban features is a key driver in both household and business location choice. For instance, households often prefer locations near employment, retail, and similar households but avoid other features such as industrial land use. Business preferences vary by sector with some firms looking for locations popular with similar firms (e.g. Silicon Valley) while others desire locations near an airport or university. In all cases, the accessibility between a given location in the region (defined as a Transportation Analysis Zone or TAZ) and all other locations/TAZs is provided to UrbanSim by the Travel Model. These files represent overall regional accessibility for future years considering changing infrastructure. Updated measures of accessibility were provided to UrbanSim in the projection years 2018 and 2025 based on projects expected to be in place in 2020 and 2035, respectively.

Moving in the other direction, UrbanSim provides the Travel Model with a projected land use pattern and spatial distribution of activities for each year into the future. This pattern incudes the location of housing, jobs, and other activities that serve as the start and end locations for trips predicted by the Travel Model. This information was provided to the Travel Model at a TAZ level of aggregation for each future year examined. Overall, the linkages between the two models allow land use patterns to evolve in relation to changes in the transportation system and for future travel patterns to reflect dynamic shifts in land use.

3 Input Assumptions

This chapter describes the Bay Area UrbanSim base year database and assumptions for the various EIR alternatives. Key variables, data sources and processing steps are described, and selected variables are profiled or mapped to illustrate trends, and assess reasonableness. The year 2010 was selected as the base year for the parcel-based model system. The Bay Area UrbanSim application operates at the level of individual households, jobs, buildings, and parcels. Jobs and households are linked to specific buildings, and buildings are linked to parcels.

In the sections below there are tables of the base distribution of employment, population, and buildings in the Bay Area. In some cases, incomplete or inconsistent data was imputed. The base-year database contains around 2,600,000 households (not including group quarters), 3,400,000 jobs, 1,900,000 buildings, and 2,000,000 parcels based on information from the Census, economic surveys, and county assessor parcel files.

Most input assumptions are identical for all EIR alternatives, which allows for consistent comparisons across alternatives. As noted below, the external regional growth projections for one alternative are higher. But the great majority of variation is contained within the final section below which details the differences in policy assumptions across alternatives.

Base Year Spatial Database

Bay Area UrbanSim uses a detailed geographic model of the Bay Area. A geographic information system was used to combine data from a variety of sources to build a representation of each building and property within the region. These detailed spatial locations are grouped into TAZs to improve model flow and provide summary output. Because this database represents the current state of the Bay Area's land use pattern, it is used as an identical starting point for all five alternatives.

PARCELS

Parcels, or individual units of land ownership, provide a fundamental building block for the Bay Area UrbanSim model: in both the real world and the model they are the entity that is owned, sold, developed, and redeveloped by households and businesses. In a given year, each parcel is associated with 0, 1, or multiple buildings that provide space for activities. The UrbanSim parcel database includes information linking the parcels to zones they are within, buildings that are on them, their size, their monetary value, and their current planning constraints.

BUILDINGS

The base year database contains around 1,900,000 buildings categorized into 14 different types as seen in Table 2. Households and businesses are assigned to buildings and buildings are linked to a parcel. Each building has attribute information on its size, age, and value, among other things. The building database is modified by the Real Estate Development Model as it tears down buildings and constructs new buildings. The base year (2010) configuration for the buildings database is the same for all EIR alternatives. Figures 4 and 5 map out illustrative building attributes at the zonal level.

TABLE 2: BUILDING TYPES AND 2010 COUNTS

Building Type	*2010 Count*
Single Family Detached	1,479,666
Single Family Attached	207,088
Multi-Family	102,022
Office	37,105
Hotel	2437
School	3184
Light Industrial	21,491
Warehouse	10,999
Heavy Industrial	1539
General Retail	41,870
Big-Box Retail	1678
Mixed-Use Residential	7375
Mixed-Use Retail-Focus	1379
Mixed-Use Employment-Focus	735

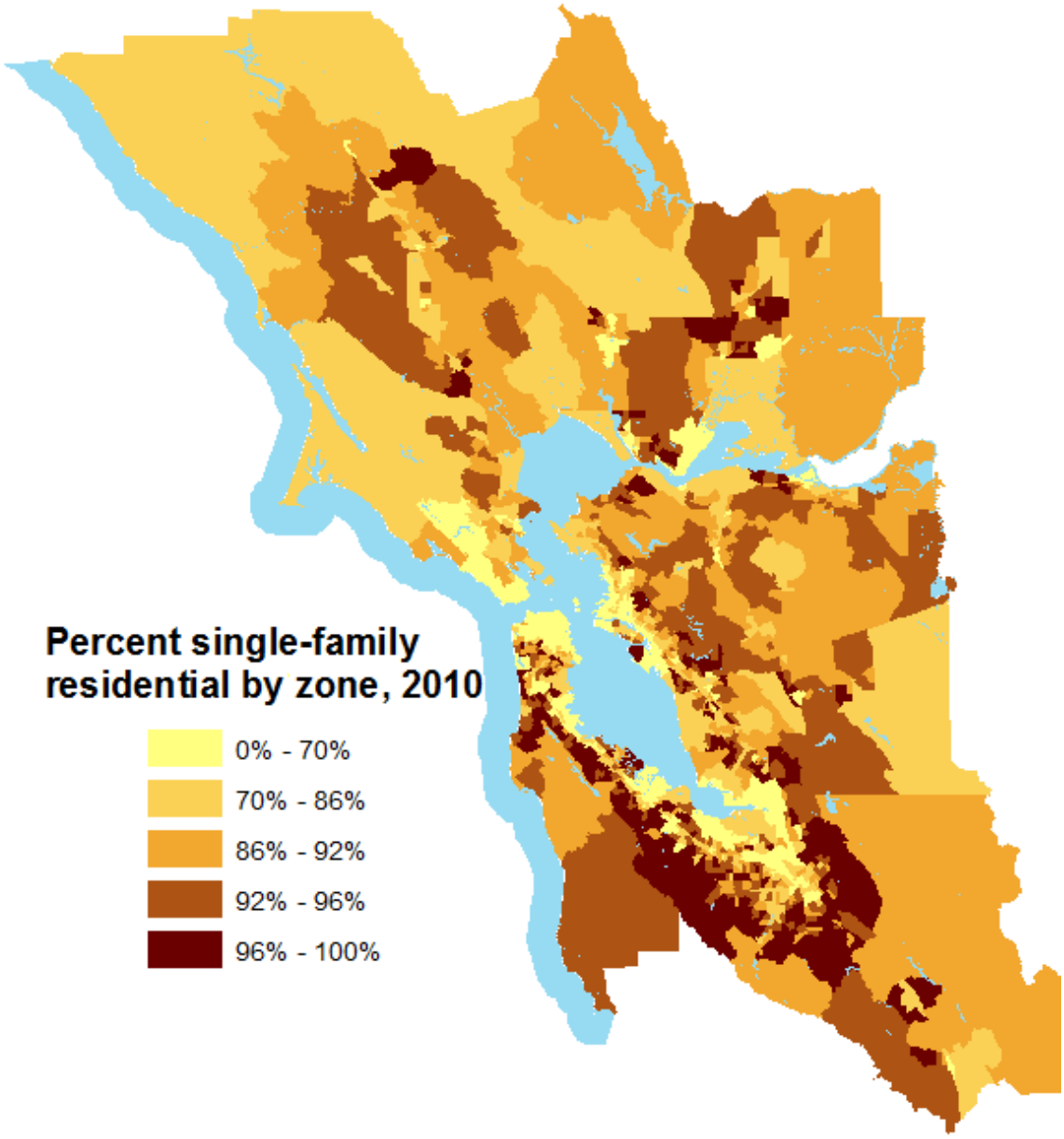

FIGURE 4: PERCENT SINGLE FAMILY RESIDENTIAL BUILDINGS, BY TAZ

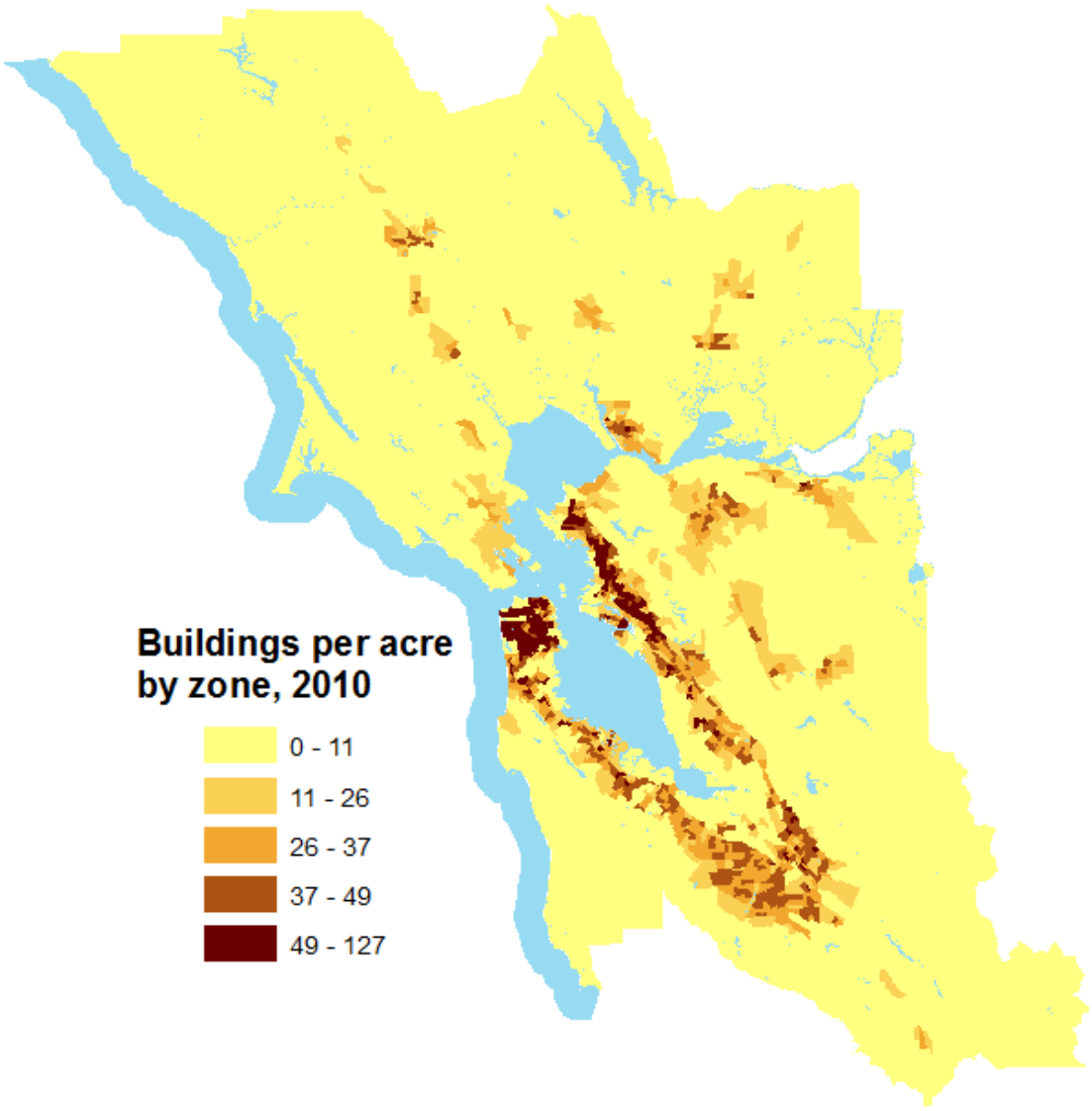

FIGURE 5: BUILDINGS PER ACRE, BY TAZ

Because buildings are a fundamental nexus in UrbanSim where the physical real estate market interacts with the households and employees who occupy the structures, a variety of key assumptions relate to buildings. While these assumptions greatly simplify the complexity of the region's land use market, they remain identical across EIR alternatives, allowing for consistent comparisons.

Two interrelated factors combine to determine how employees occupy buildings. First, workers in particular sectors use various types of buildings at different rates. For instance, many business service workers will use office buildings but a smaller number will occupy the same amount of light industrial space. The second step looks at the amount of square feet different types of workers use. Both of these use factors (types and amounts of space) were compiled on average for the entire region and assumed to be constant into the future. Details on space consumption rates can be found in the *Technical Documentation*.[4]

Finally, UrbanSim provides flexibility in the representation of subsidized construction. A separate component described above (the Scheduled Development Event Model) allows the construction of predetermined buildings in set future years. To be included in this list, the project must be over 500 units or one million commercial square feet, be built with a mixture of public and private funding, and be currently under construction or funded. This definition led to the inclusion of 49,914 new housing units and 22.4 million new commercial square feet (though the net amounts for both were moderately lower on account of redevelopment) between 2010 and 2040. The same list of assumed projects was used for all EIR Alternatives and can be seen in Table 1.

Regional Growth Projections

Projections for the region's overall rate of economic and demographic growth are developed by ABAG external to the land use modeling process.[5] Summary information on these inputs to the Bay Area UrbanSim model is presented below.

ANNUAL BUSINESS CONTROL TOTALS

The total number of employees by sector within the region is forecasted by ABAG and fed into UrbanSim. This information is used to generate new business establishments that in turn generate overall demand for commercial real estate. After new establishments are assigned locations by the Business Location Choice Model, the overall spatial distribution of employment provides input into the Travel Model's representation of personal travel.

ABAG's economic projections for the Bay Area are provided for the years 2010, 2015, 2020, 2025, 2035, and 2040 while intermediate years are interpolated. As seen in Table 2, the overall regional count of

[4] Please see http://analytics.mtc.ca.gov/foswiki/Main/LandUseModel

[5] Please see the *Plan Bay Area Forecast of Jobs, Population, and Housing* supplementary report for details.

employment is projected to grow from around 3.4 million jobs in 2010 to over 4.5 million jobs by 2040 for the No Project, Proposed Plan, Transit Priority, and EEJ alternatives. Figure 6 shows this 28.4 percent growth graphically. The Enhanced alternative assumes approximately 45,000 additional jobs by 2040. These control totals also project a changing sectoral distribution over the projection period: employment in agriculture and natural resources declines over the period while the fastest growing sectors are professional services and business services.

TABLE 3: HOUSEHOLD AND EMPLOYMENT REGIONAL CONTROL TOTALS

Year	*No Project; Transit Priority; and EEJ Alternatives*		*Proposed Plan*		*Enhanced Alternative*	
	Households	*Employment*	*Households*	*Employment*	*Households*	*Employment*
2010	2,608,023	3,385,300	2,608,023	3,385,300	2,608,023	3,385,300
2015	2,718,485	3,670,099	2,718,485	3,670,099	2,737,985	3,681,542
2020	2,833,671	3,987,140	2,837,715	3,987,140	2,871,765	4,011,206
2025	2,950,009	4,089,214	2,950,009	4,089,214	3,010,390	4,117,353
2030	3,070,910	4,196,576	3,070,910	4,196,576	3,152,645	4,229,016
2035	3,187,373	4,346,762	3,187,373	4,346,762	3,289,683	4,385,167
2040	3,308,120	4,505,218	3,308,111	4,505,218	3,431,742	4,550,000

ANNUAL HOUSEHOLD CONTROL TOTALS

The total number of households by income category within the region is forecasted by ABAG externally to UrbanSim.[6] This information is used to understand the overall demand for housing. In addition to the new households, the division of existing households into income categories is used to segment the population when considering relocation rates in the Household Transition Model. The forecasted new households and relocating households are allocated among the TAZs using the Household Location Choice Model. This spatial distribution of households is input into the Travel Model's representation of personal travel.

[6] Please see the *Plan Bay Area Forecast of Jobs, Population, and Housing* supplementary report for details.

ABAG's demographic projections for the Bay Area are provided for the years 2010, 2015, 2020, 2025, 2035, and 2040 while intermediate years are interpolated.

As seen in Table 3 above, the overall regional count of households is projected to grow from around 2.6 million households in 2010 to over 3.3 million households by 2040 for the No Project, Proposed Plan, Transit Priority, and EEJ alternatives. Figure 7 below shows this 22.2 percent growth graphically. The Enhanced alternative assumes approximately 124,000 additional households by 2040. These control totals also project a changing income distribution over the projection period: the share of households in each quartile (from lowest to highest income) is projected to shift from 28/21/25/26 percent in 2010 to 31/22/24/23 percent in 2040.

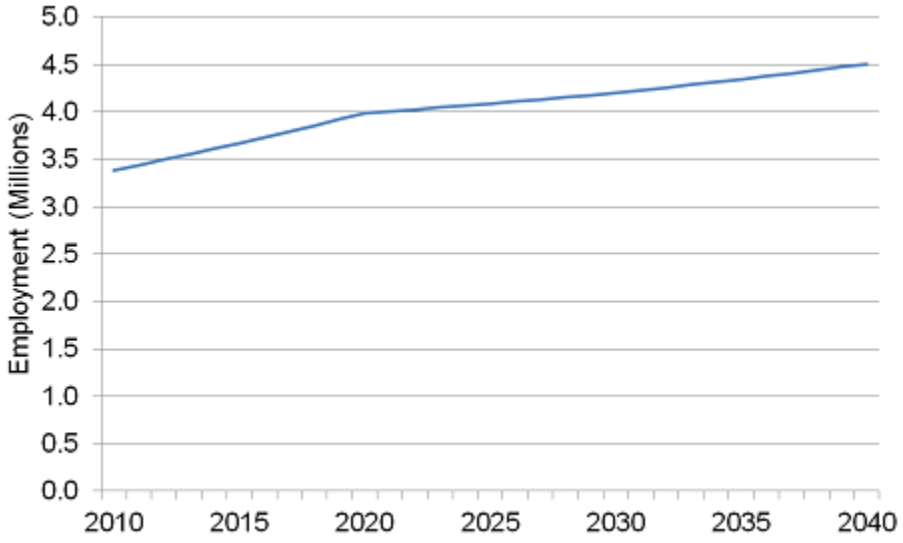

FIGURE 6: BUSINESS CONTROL TOTALS - TOTAL EMPLOYMENT, 2010-2040

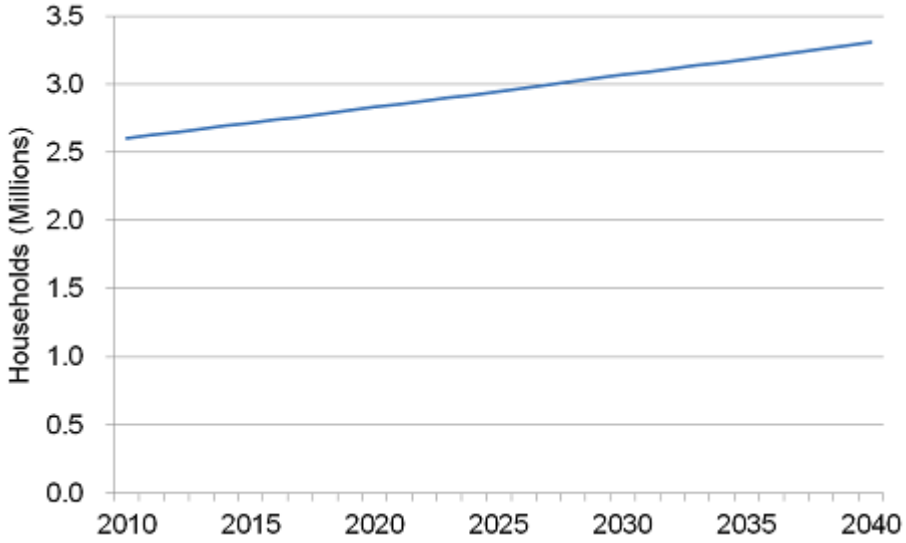

FIGURE 7: HOUSEHOLD CONTROL TOTALS - TOTAL HOUSEHOLDS, 2010-2040

Model Agents

Choices by key actors or agents in the Bay Area are the foundation of the UrbanSim Model. The three classes of agents are households choosing places to live, business establishments choosing locations to do work, and real estate developers choosing places to build new buildings. This section discusses inputs related to each agent. Because these represent the fundamentals of the urban economy, input values are consistent across EIR alternatives.

HOUSEHOLDS AND PEOPLE

UrbanSim represents each household individually. A 2010 household table with approximately 2,600,000 households is synthesized for the ABAG region from Census 2010 PUMS and SF3 tables using the PopGen population synthesizer.[7] This process creates a row for each household and gives each characteristics such as number of persons and income so that the overall averages for those characteristics conform to the Census information provided for that location. These households have a mean persons per household of 2.7, a mean number of household workers of 1.39, mean age of

[7] Additional information is available here: http://urbanmodel.asu.edu/popgen.html.

household head of 48.6 years, a mean household income of $81,937, and a mean number of household children of 0.53.

Figure 8 maps out household density at the zonal level. These households form the basis of the Household Location Choice Model.

Household characteristics are also used to set assumptions related to the probability of households moving within the region in a given year. This is used by the Household Relocation Model to select a set of households to remove from their home and who then must be assigned to new locations by the Household Location Choice Model. Bay Area-specific rates have been prepared using Census PUMS data. As seen in Table 4, the Bay Area rates break down the probabilities by household income and age of head of household categories. The rates stay constant from year to year. The annual Household Relocation Rates are the same for all EIR alternatives.

TABLE 4: HOUSEHOLD RELOCATION RATES

	Age of Household Head						
Household Income	*<17*	*18-24*	*25-34*	*35-44*	*45-54*	*55-64*	*>65*
<$10,000	0.02000	0.02000	0.02000	0.01485	0.01253	0.00691	0.00272
$10,000-$19,9999	0.02000	0.02000	0.01509	0.01558	0.01141	0.00820	0.00547
$20,000-$29,9999	0.01505	0.01505	0.01723	0.01170	0.00853	0.00518	0.00468
$30,000-$39,9999	0.02000	0.02000	0.01727	0.01328	0.01124	0.00660	0.00433
$40,000-$49,9999	0.02000	0.02000	0.01872	0.01192	0.00724	0.00697	0.00391
$50,000-$59,9999	0.02000	0.02000	0.01601	0.00968	0.00639	0.00459	0.00347
$60,000-$79,9999	0.02000	0.02000	0.01557	0.01088	0.00708	0.00411	0.00365
>$80,000	0.02000	0.02000	0.01672	0.00993	0.00435	0.00366	0.00361

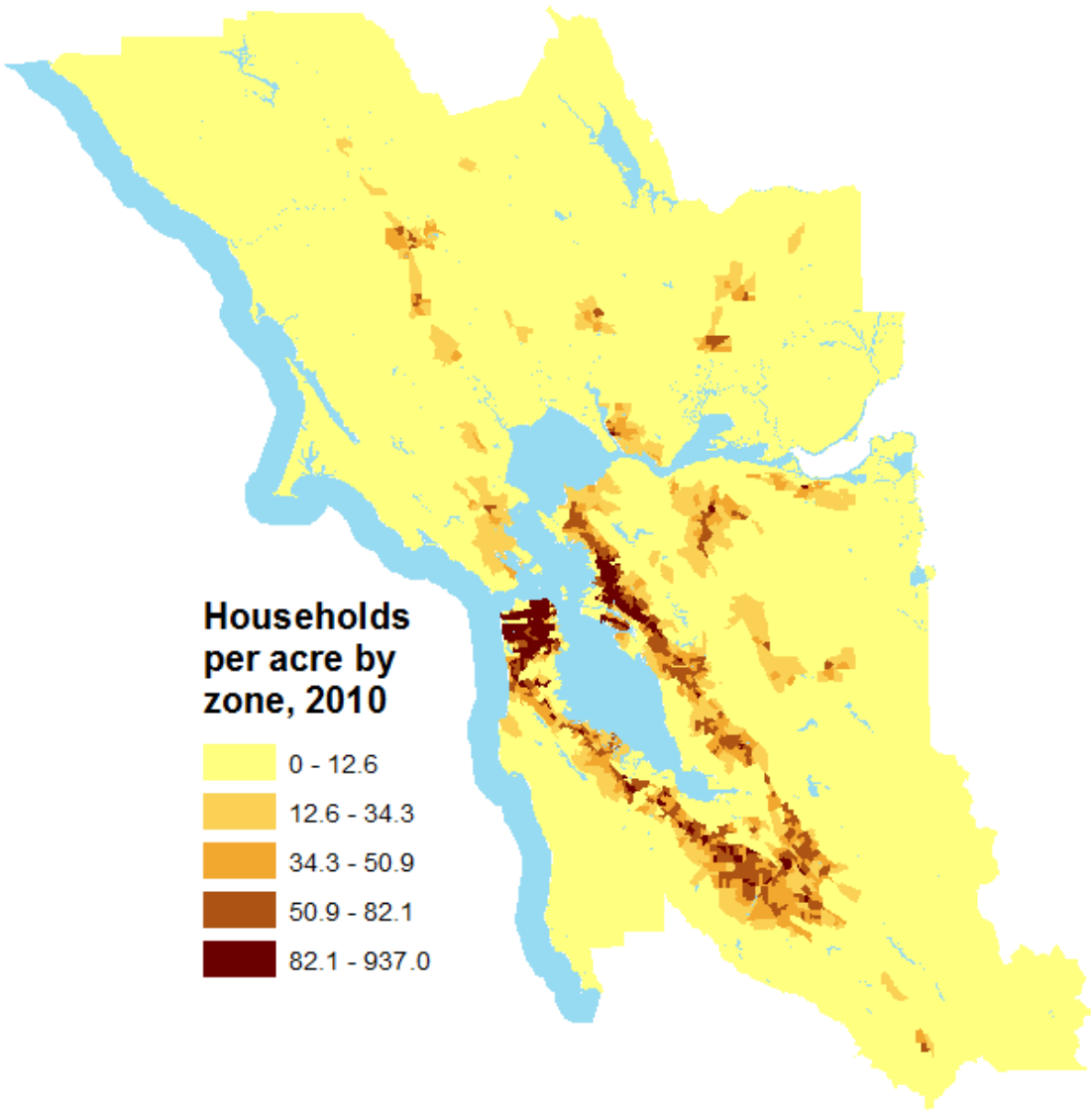

FIGURE 8: SYNTHESIZED HOUSEHOLDS PER ACRE, BY TAZ

ESTABLISHMENTS AND EMPLOYEES

Establishments are the other major class of agent in UrbanSim. They represent a unique location of employment for a business. For example, a one-off barbershop is one establishment and so is one particular location of the McDonald's restaurant company. Each establishment contains a number of employees. For the Bay Area UrbanSim model, the 2010 distribution of establishments and their employees are used as input. Future year projections are then made by modeling the movement of individual establishments.

The 2010 establishment database was built by combining establishment data from the NETS[8] and EDD[9] datasets and then transforming it to conform to ABAG's sub-regional employment totals.[10] Each establishment was assigned to one of the 28 sector classes[11] and associated with an appropriate building. Each of these sectors is modeled separately in the Employment Location Choice Model. Because no clear relocation trends were readily observable in historic data, a 2 percent chance of relocating was assumed for employment each year, regardless of sector. All employment assumptions (except the control totals as noted above) are the same for all EIR alternatives.

REAL ESTATE DEVELOPERS

The final UrbanSim agent is a special class of business: the real estate developer. Developers monitor the relationship between supply and demand for different types of buildings across the region and attempt to build new structures in locations where they can make a profit. They are driven by market forces so assumptions related the real estate developers are identical across the five EIR alternatives.

UrbanSim implements the Real Estate Developer Model as a stochastic pro forma model that explicitly treats these decisions the same way they are made in the real world. The pro forma combines information on costs and income over a proposed project's lifetime, allowing an assessment of overall profitability. The model examines a subset of parcels each year and fits different project concepts allowed under the site's zoning constraints. The developer chooses the project that maximizes profit and builds the project if it is profitable. After a construction period, these new buildings are available to households and businesses for occupation.

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[8] Additional information is available here: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1022962.

[9] Additional information is available here: http://www.labormarketinfo.edd.ca.gov.

[10] All employment databases contain slightly different counts due to different definitions, data collection strategies, and error. For more information on ABAG's regional control totals please see the *Plan Bay Area Forecast of Jobs, Population and Housing* supplementary report available on www.onebayarea.org.

[11] The employment classifications can be found at http://analytics.mtc.ca.gov/foswiki/Main/LandUseModel.

Land Use Policy Levers

Differences in the policy lever inputs are the fundamental means of representing the different EIR alternatives. The policies represent actions that MTC, ABAG, or partner agencies such as the cities and counties could take or seek legislation to allow. These input assumptions vary greatly across alternatives and, when combined with the more fundamental agents described above, produce model outputs.

ZONING

Current zoning was obtained for all parcels in the region as a representation of the land use controls in place during the base year. Zoning codes, general plans, and specific plans were processed to obtain a consistent indication of each jurisdiction's long term vision for land use type, residential dwelling units per acre, and commercial floor-area-ratio.[12] Cities and counties were offered the opportunity to review the data for accuracy. Adjustments to zoning were made in some locations to put protected land, government land, and transportation corridors off limits to development. Additionally, parcels containing structures built before 1900 was also deemed non-developable as a rough representation of historical protection ordinances until better data can be obtained.

All alternatives start with this basic zoning classification. For each alternative, zoning modifications are made for various subsets of parcels in the region. The No Project alternative assumes current land use regulations as captured in the base zoning do not change between now and 2040. In the Proposed Plan Alternative, zoning is modified to reflect the classification of ABAG's Priority Development Areas into various place-types (if these require intensities higher than existing zoning allows). For each PDA, the allowable building types are broadened and intensities increased. Similarly, in the Transit Priority alternative zoning is changed in the Transit Priority Project zones (TPPs) in order to encourage growth near transit.

The Enhanced alternative increases zoning intensities in the PDAs but to a lesser amount than the Proposed Plan alternative in order to create a slightly less dense but still focused land use pattern. The EEJ Alternative broadens use types and increases residential densities in a selection of both PDAs and TPPs in particular jurisdictions to encourage low income housing in job rich communities. Figure 10 provides an overview of zoning overlays by alternative.

[12] Zoning or general plan data was collected for all jurisdictions. Due to time constraints, specific plans were only collected for a limited subset of areas where such information was expected to exhibit a great deal of variation from the other planning information. In general, constraints on new development were drawn from the information source judged most likely to represent a jurisdiction's long term expectations for development maximums at each location.

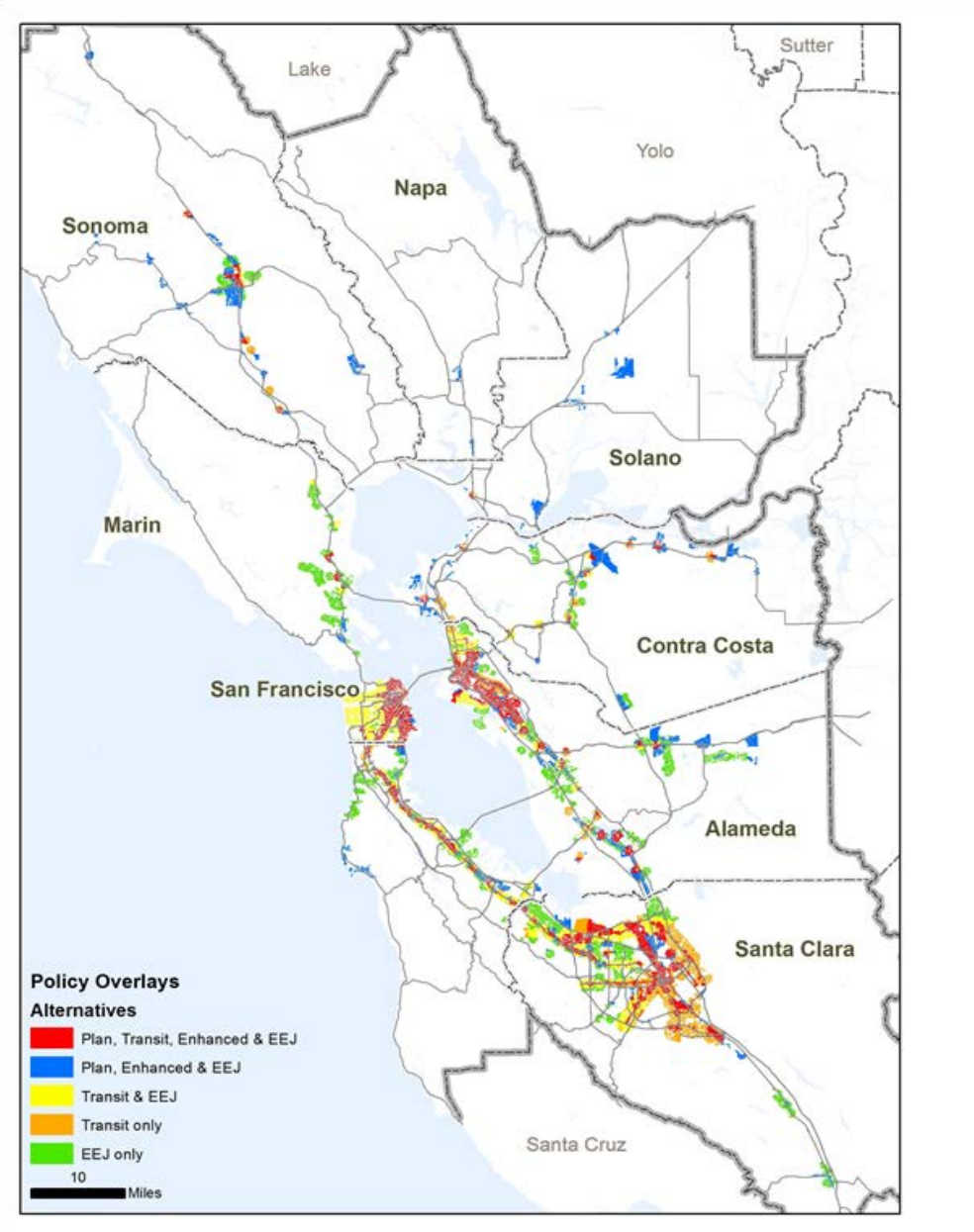

FIGURE 9: ZONING OVERLAYS ACROSS THE ALTERNATIVES

URBAN BOUNDARY LINES

For the purpose of building EIR alternatives, a consistent set of "Urban Boundary Lines" surrounding each city was established. These are meant to function like urban growth boundaries in the EIR alternatives that stress the implementation of regional urban growth boundaries. In some cases, the Urban Boundary Lines are drawn from true urban growth boundaries or urban limit lines. In other cases urban service lines that function much like urban growth boundaries are used. In some cases, cities have established no such lines. However, adjacent unincorporated county land is zoned to limit development and preserve agricultural and natural resource lands. In these areas, the current spheres of influence are used establish the Urban Boundary Line for EIR analysis.

The Urban Boundary Lines are treated two different ways across EIR alternatives. In the No Project alternative they are assumed to be weakly enforced meaning that some suburban growth will be allowed to spill out past them. In the other four alternatives, the enforcement is assumed to be strict meaning that all Urban Boundary Lines are strictly enforced as urban growth boundaries and suburban growth is not allowed beyond them. In all alternatives, low density rural residential growth is permitted beyond the Urban Boundary Line in locations where the base year zoning allows it.

In the No Project alternative, the amount and location of growth beyond the Urban Boundary Lines must be determined. (In the forecast this can be thought of as land that is expected to become incorporated during the next three decades, either through city expansion or the formation of new cities.) This is done by changing the zoning to suburban densities in particular locations and letting the UrbanSim modeling system decide how much growth to place in those locations based on its representation of the regional land market. 353.7 square miles of land was upzoned to typical suburban densities (i.e. the maximum housing units per acre and FAR were increased and single-family dwellings, retail, and office uses were added as allowable) for this alternative based the ratio of new incorporated land to population growth during the past three decades. Upzoned land was located within the region using a simple rule-based model that prioritized parcels that were near divided highways and had low slope within a five-mile radius (i.e. areas posited as most likely to incorporate). All land in this area was considered available in the base year. See Figure 11 for the assumed Urban Boundary Lines and their expansion in the No Project alternative.

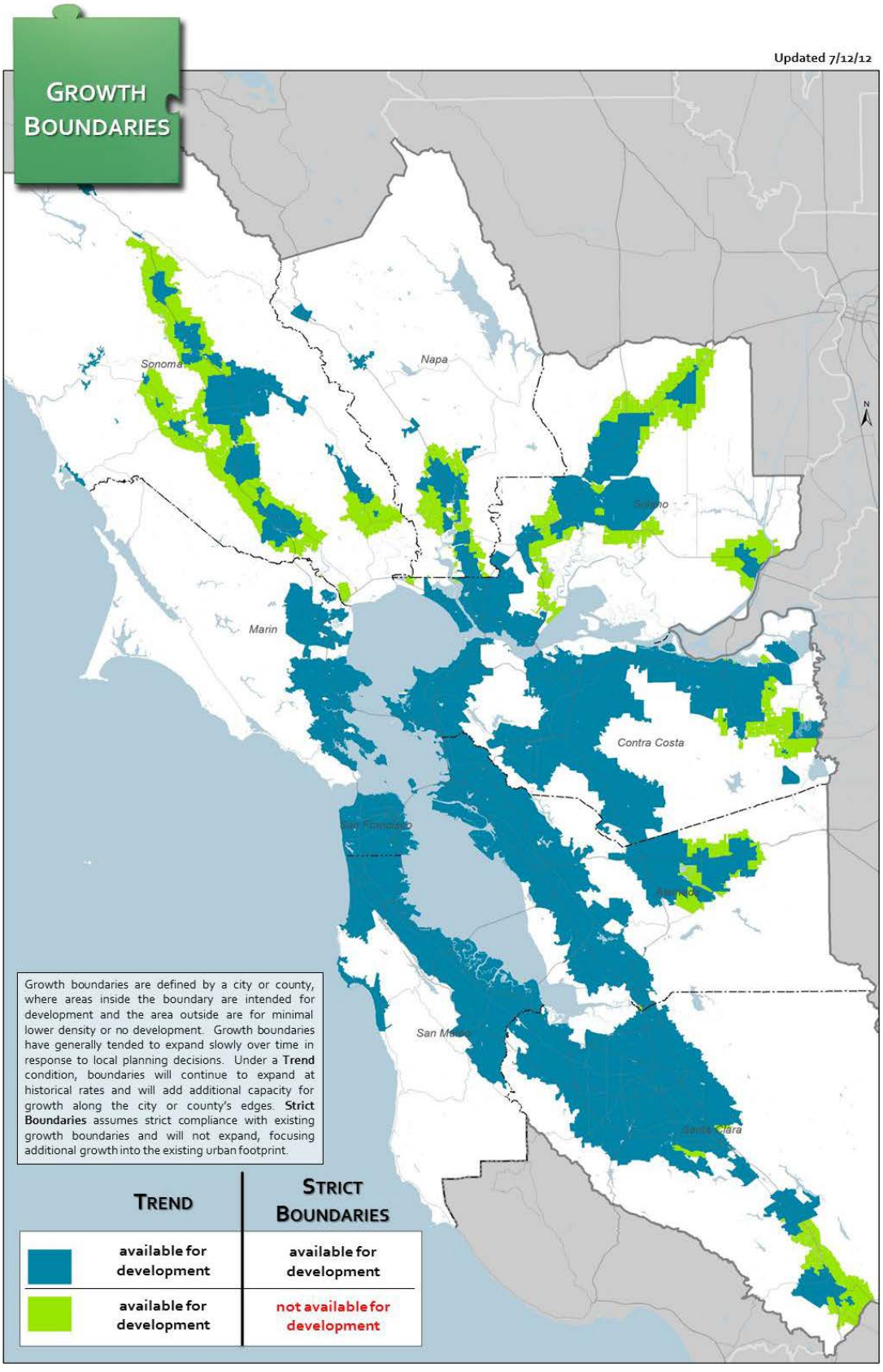

FIGURE 10: URBAN BOUNDARY LINES ACROSS THE ALTERNATIVES

CALIFORNIA ENVIRONMENTAL QUALITY ACT TIERING

To encourage land use planning and development that is consistent with a Sustainable Communities Strategy (SCS), Senate Bill (SB) 375 includes California Environmental Quality Act (CEQA) provisions that can be used by lead agencies to streamline projects that align residential development with transit. It is anticipated that most projects that are able to take advantage of the streamlining will qualify for a limited analysis EIR which would reduce the time required to complete the environmental review, and thus reduce the time it takes to construct a project. This time savings translates into a cost savings for the developer which makes development slightly more likely to occur within TPPs. However, the streamlining time savings is assumed to be modest: on the order of 1 to 3 months in the model. Because no data exists at this point in California or a similar context as to the exact value of this streamlining, a 1 percent savings has been assumed for appropriate projects. Although it is at the discretion of local jurisdictions to determine the appropriateness of using the streamlining provisions in SB 375, the model assumes that this benefit is offered to all projects that meet the density and intensity requirements and are within a TPP area. CEQA Tiering benefits are identical in the Proposed Plan, Transit Priority, and Enhanced alternatives, however, the areas which may qualify for streamlining are not identical since the alternatives vary in how and where they provide the minimum zoning necessary for streamlining. The CEQA streamlining benefits are not present in the No Project or the EEJ alternative.

ONE BAY AREA GRANT PROGRAM

The One Bay Area Grant (OBAG) program provides preferential subsidy over the next four years to cities that accept and build housing per the Regional Housing Needs Allocation (RHNA) process. The modeling approach here assumes all jurisdictions will comply with the mandatory complete streets policy and certified housing element requirements and that all OBAG funding is spent in the PDAs with an equal percentage of the county level funding going to each PDA. Additionally, for simplicity all funding is allocated in the model at the start of the modeled time period.

OBAG funding is represented as an increase in the attractiveness of PDAs to development. While some studies have attempted to capture the local impact of pedestrian and other TOD improvements on land values, no one has examined the overall impact of a regional program of this nature on property values or on redirecting the spatial distribution of new development. For now, we assume that the OBAG program results in an increase in profitability of $30,000 per residential unit for residential buildings and $4 per square foot for non-residential buildings in all PDAs. These values are in line with previous studies.[13] A better understanding of the precise impacts of the OBAG program will come after a few years of implementation.

[13] For example, please see CABE: *Paved With Gold: The Real Value of Good Street Design*. June 2007, available here: http://www.cabe.org.uk/files/paved-with-gold.pdf.

DEVELOPMENT SUBSIDIES

UrbanSim includes subsidies in its analysis in order to encourage development in particular locations consistent with the alternatives. The subsidies are representative of both financial and policy measures that could support or encourage growth. The Proposed Plan alternative uses a subsidy similar in magnitude to the Bay Area's former redevelopment program to support development in PDAs where the market is weak. The Enhanced alternative's subsidy is around half as costly because it aims for less growth in some of these weaker markets. Finally, the EEJ alternative is around three times as costly as the Plan in its efforts to promote housing in job rich locations lacking affordable housing. Commercial development is subsidized in both the Proposed Plan and Enhanced alternatives but it consumes less than one percent of the total subsidy. The Transit Priority alternative and No Project alternative contain no development subsidies. These subsidy levels were calculated from the amount of funding used to close the gap in the UrbanSim Real Estate Development Model to redirect an appropriate amount of development to particular locations in order to meet a desired regional vision for growth. This type and scale of funding would be consistent with recent California Senate proposals for a new and focused system of redevelopment agencies.

REGIONAL DEVELOPMENT FEES AND SUBSIDIES

In the Transit Priority alternative, a development fee is assessed for new residential and commercial development in high vehicle miles traveled (VMT) locations and transferred as a subsidy to areas of low VMT. Residential development fees are based on the average VMT generated by workers with homes in that TAZ. Commercial development fees are based on the average VMT for workers with jobs in that TAZ. In the area with the lowest VMT for each fee type, a subsidy is provided.

TPP REDEVELOPMENT

In the Transit Priority alternative, a new redevelopment program is implemented along the lines of replacement programs recently discussed in the California Senate. This policy assumed that the increase in commercial property taxes within TPPs could be redistributed to subsidize residential growth within TPPs in the same jurisdiction.

REDUCED PARKING MINIMUMS

In all of the alternatives except the No Project, the reduction of required parking minimums for new construction was reduced to encourage cheaper infill housing. Time limitations disallowed the collection of a full parking requirement database for the Bay Area. Instead, a subsidy of $4,000 per potential unit was applied to all parcels within the potentially upzoned area relevant to each alternative (the relevant zones are PDAs, TPPs, or some combination of the two as seen above in Figure 9). This number represents a back-of-the-envelope estimate of potential savings assuming that around one-fifth of new units would be able to be built with one fewer parking space.

4 Key Results

Selected land use model results are summarized and discussed here. The output presented is partial and intended to give a general sense of expected behavioral change across the Alternatives and through the projection years. Emphasis is given to results that 1) influence the Travel Model, 2) affect Plan Bay Area target results, and 3) provide a context for understanding the regional development change predicted for each alternative.

Regional Land Use Outcomes

The overall regional distribution of population and employment growth provides a simple means of comparing the land use model outcomes for the five EIR Alternatives. Figure 13 assigns the region's superdistricts into four large categories: the Big Three Cities (San Jose, San Francisco, and Oakland), the rest of the region's Urban area, the Suburban area, and the Exurban area.[14] Because the figures are based on superdistricts, the boundaries do not perfectly align with jurisdictional boundaries. Table 5 shows the regional share of households in 2010 and for each alternative in 2040. Table 6 shows the regional share of employment in 2010 and for each alternative in 2040.

[14] Boundaries are approximate due to pre-determined superdistrict boundaries and category labels are only intended to be descriptive.

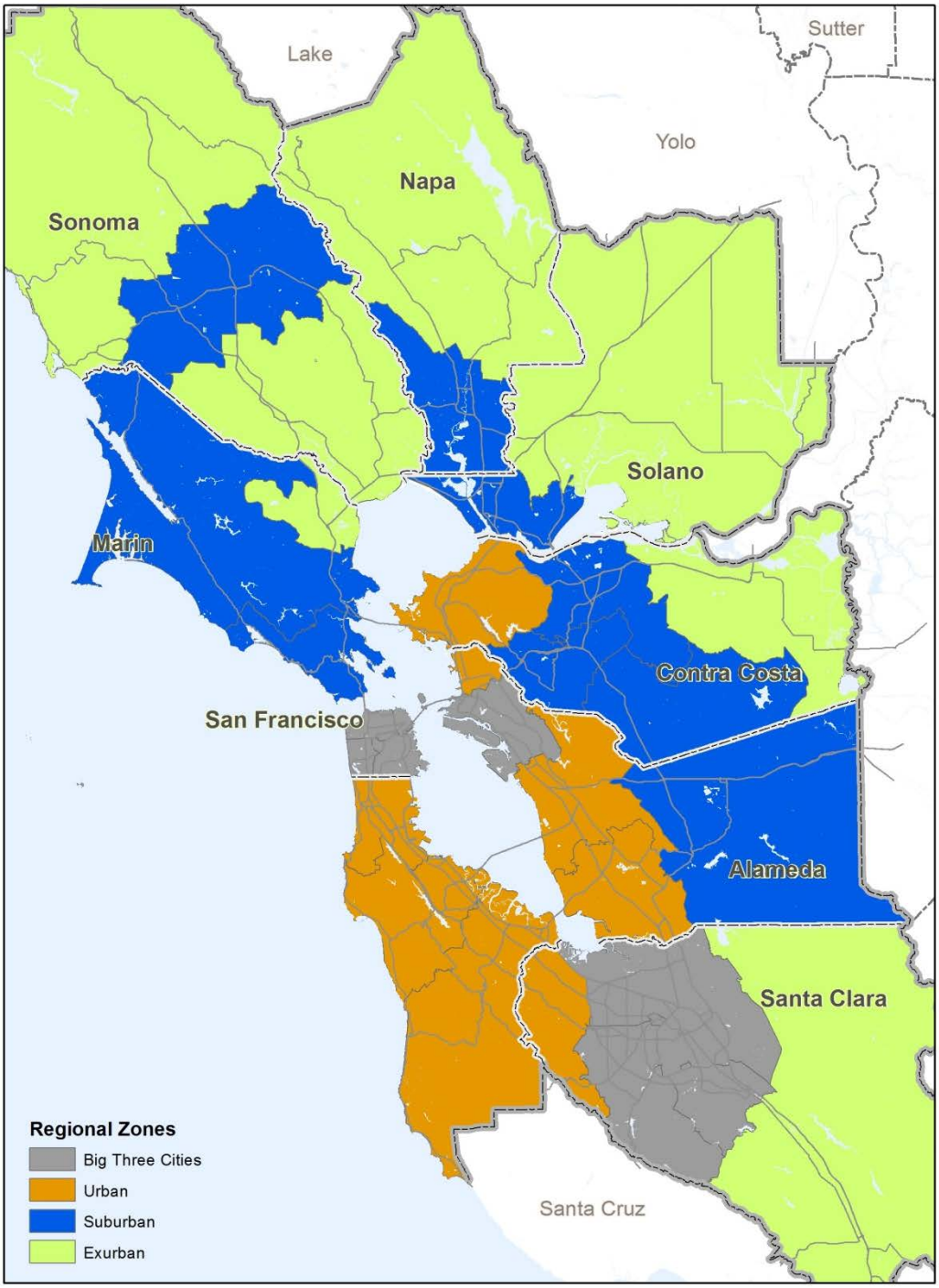

FIGURE 11: REGIONAL ZONES

TABLE 5: REGIONAL SHARE OF HOUSEHOLDS ACROSS ALTERNATIVES

Area		*Alternative 2040*				
	2010	*No Project*	*Proposed Plan*	*Transit Priority*	*Enhanced*	*EEJ*
Big Three Cities	39%	38%	42%	43%	40%	40%
Urban	27%	26%	27%	28%	27%	29%
Suburban	20%	20%	18%	17%	19%	19%
Exurban	13%	16%	13%	12%	13%	13%

TABLE 6: REGIONAL SHARE OF EMPLOYMENT ACROSS ALTERNATIVES

Area		*Alternative 2040*				
	2010	*No Project*	*Proposed Plan*	*Transit Priority*	*Enhanced*	*EEJ*
Big Three Cities	45%	44%	46%	44%	43%	45%
Urban	27%	28%	26%	28%	29%	28%
Suburban	19%	19%	19%	19%	18%	18%
Exurban	10%	10%	9%	9%	9%	9%

Small Zone Outcomes

While the regional distribution of households and employment will influence travel behavior, a more micro-level understanding of growth is also fundamental in understanding each alternative's ability to achieve transportation and other goals. PDAs are the zones created through a multi-year partnership with local jurisdictions that are seen as a preferred location for urban growth in the Proposed Plan. PDAs aim to provide transit and pedestrian accessibility to urban services. TPPs are zones defined by SB 375 as being within a half mile of high quality transit. TPPs cover a larger portion of the region and are more tightly focused on transit accessibility. Figure 14 show PDAs, TPPs and areas of overlap. Table 7 provides the share of households in PDAs and TPPs for 2010 and the alternatives in year 2040. Table 8 shows similar information for employment shares.

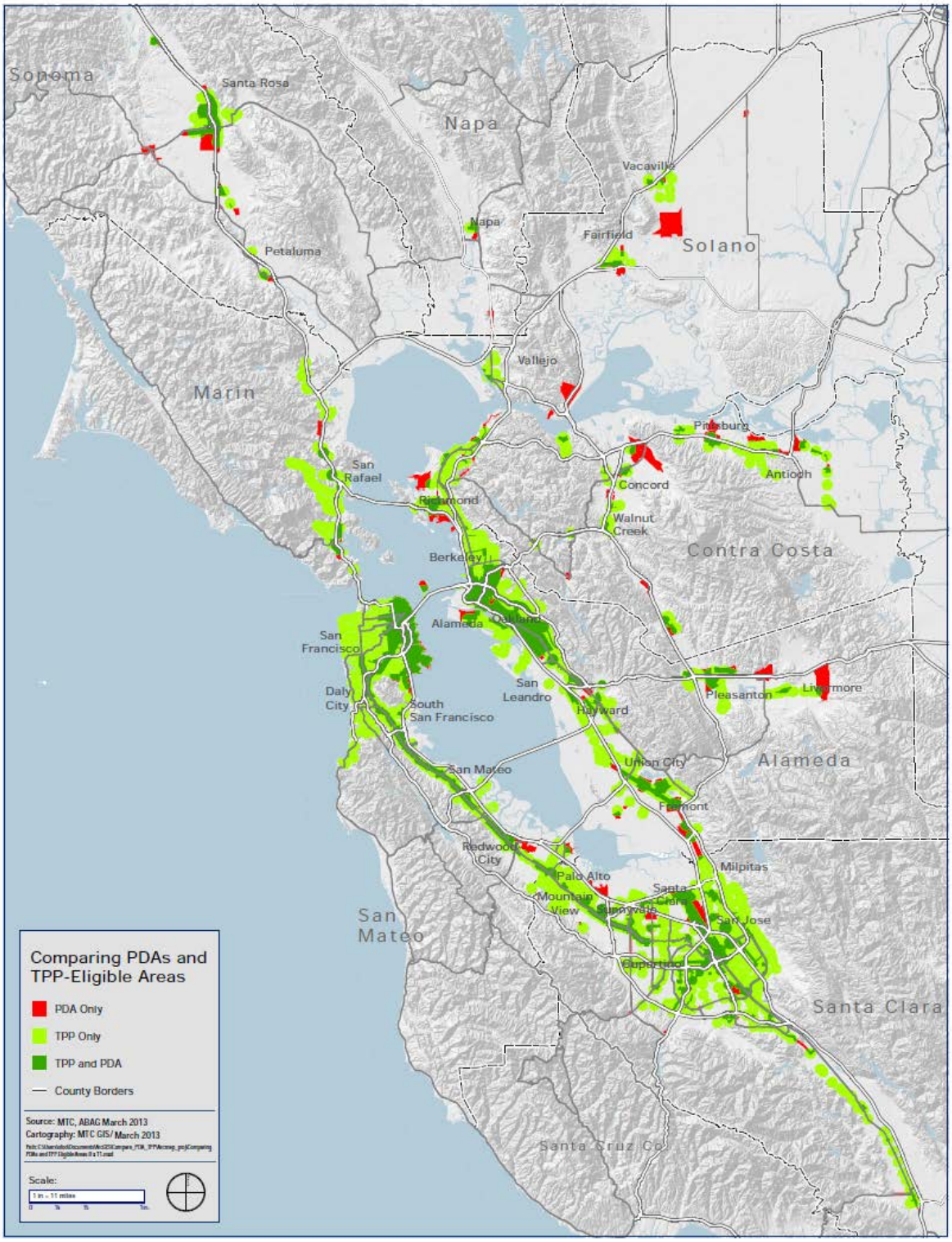

FIGURE 12: PDAS AND TPPS

TABLE 7: SMALL ZONE SHARE OF HOUSEHOLDS ACROSS ALTERNATIVES

Area		*Alternative 2040*				
	2010	*No Project*	*Proposed Plan*	*Transit*	*Enhanced*	*EEJ*
PDAs	22%	28%	37%	34%	30%	33%
TPPs	57%	57%	64%	66%	59%	60%

TABLE 8: SMALL ZONE SHARE OF EMPLOYMENT ACROSS ALTERNATIVES

Area		*Alternative 2040*				
	2010	*No Project*	*Proposed Plan*	*Transit*	*Enhanced*	*EEJ*
PDAs	47%	49%	52%	50%	49%	49%
TPPs	68%	68%	69%	69%	68%	69%

Greenfield Consumption

Most Plan Bay Area transportation targets indirectly track land use effects through travel behavior. An exception is greenfield consumption, the conversion of rural land into suburban or higher densities (a threshold of one residential unit per four acres is used to separate urban and rural for this analysis). The greenfield consumption target calculates growth outside the Urban Boundary Line described above. Because this line also ended up being a policy lever limiting outward expansion in four alternatives, those four alternatives saw no growth (at suburban or higher levels) beyond the line making comparisons difficult. Another way to examine the data is shown in Table 9, which calculates greenfield consumption outside of the 2009 Urban Footprint, an MTC classification of areas above suburban density seen in Figure 15. This measure again sees the No Project alternative with the most greenfield consumption but allows for more useful comparisons across the other alternatives.

TABLE 9: GREENFIELD CONSUMPTION ACROSS ALTERNATIVES

Measure	*Alternative*				
	No Project	*Proposed Plan*	*Transit*	*Enhanced*	*EEJ*
Greenfield consumption outside the UBL (acres)	21,840	0	0	0	0
Greenfield consumption outside the 2009 Urban Footprint (acres)	35,003	7,881	8,889	10,649	9,646

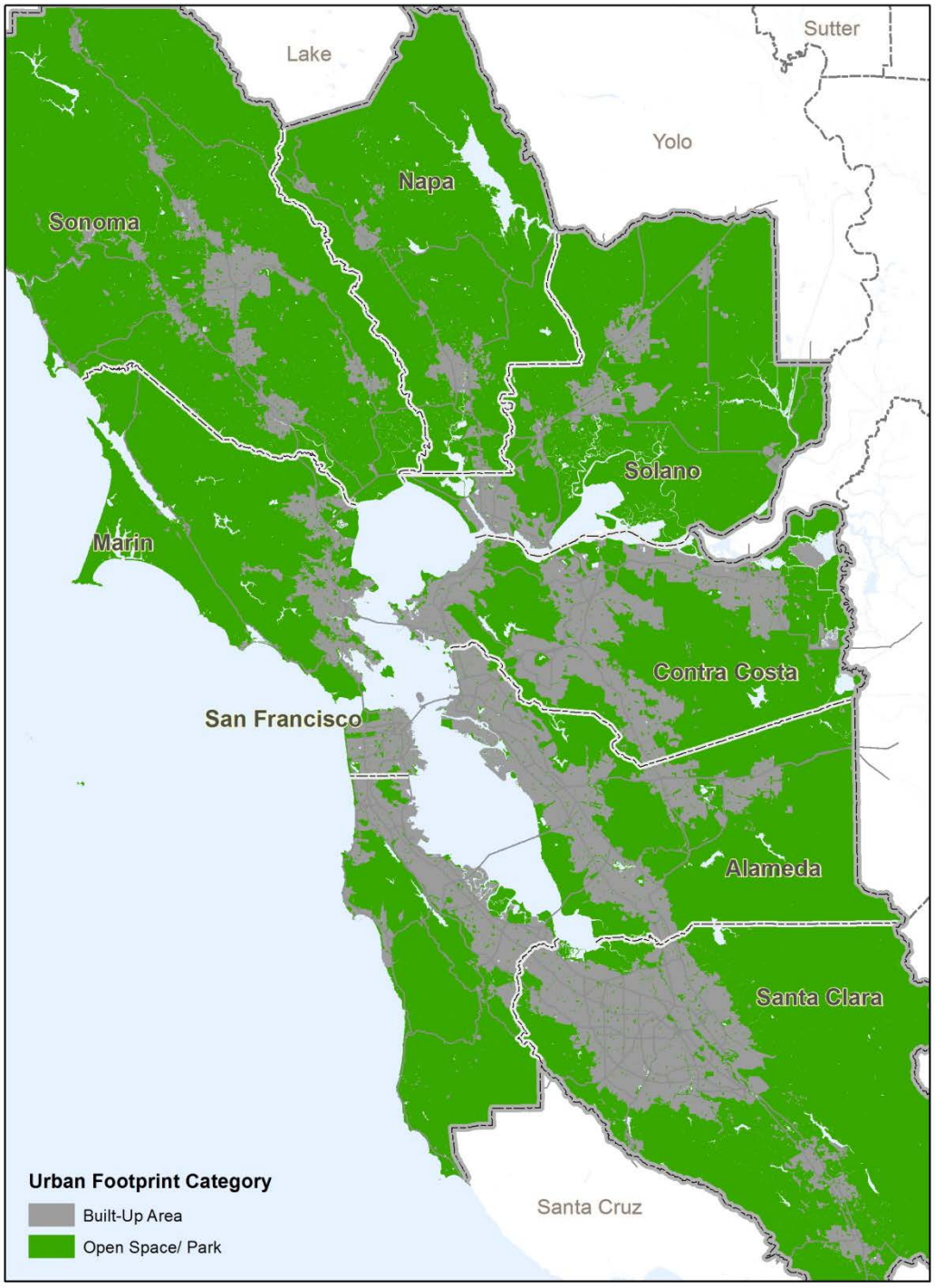

FIGURE 13: THE 2009 FOOTPRINT

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Appendix A

Explanation of Differences in Aggregate Regional Statistics

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1 Introduction

When comparing across alternatives, careful readers of the Plan Bay Area environmental impact report (EIR) may find unexpected differences in certain aggregate statistics. For example, the number of households simulated in the travel model differs slightly in each of the year 2040 alternatives. These differences are due to the use of sophisticated analytical tools – specifically an integrated land use/transportation modeling system. The purpose of this document is to provide detailed explanations for the differences revealed in the EIR.

The organization of the document reflects the sequence of steps taken in the analysis. These steps are as follows:

1. The analysis began with regional control totals put forward in the Association of Bay Area Government's (ABAG's) *Jobs/Housing Connection*[1]. The control totals are quantities that describe the entire Bay Area in 2040, including the number of households, jobs by industry classification, employed residents, and persons by age category. This information is presented in the next section, *2 Regional Control Totals*.
2. Certain EIR analyses require these regional control totals to be distributed to smaller geographies. The distribution of land use (i.e., population, households, jobs) through space is one of the key distinguishing features of the five alternatives. Section *3 Land Use Distribution* briefly notes the techniques used to perform this distribution for each of the five alternatives. Certain techniques introduce minor discrepancies in the regional control totals across alternatives; quantifications of these discrepancies are presented in this section.
3. Before analyzing the distribution results (i.e. the impact of locating people and jobs in certain locations), adjustments were made to remove the discrepancies which emerged from the distribution step. This process is described in *4 Land Use Outcomes*.
4. Finally, the MTC travel model generates a host of outcomes that are analyzed in the EIR. Prior to using the travel model, the land use distribution results are transformed into a detailed list of potential travelers. This list of agents are simulated in the travel model. The impact of this process on aggregate statistics is described in *5 Travel-related Outcomes*.

The document concludes with a summary section.

[1] Association of Bay Area Governments, *Plan Bay Area Jobs-Housing Connection Strategy.*

2 Regional Control Totals

Five alternatives are examined in the Plan Bay Area EIR. Detailed descriptions of these alternatives can be found therein. Here, the alternatives are referred to as follows:

1. No Project;
2. Proposed Plan;
3. Transit Priority Focus;
4. Enhanced Network of Communities (or, "Enhanced"); and,
5. Environment, Equity, and Jobs (or, "EEJ").

The analysis of these alternatives began with the Year 2040 "regional control totals" (i.e., the sum of certain quantities across the nine-county Bay Area) from the *Jobs/Housing Connection*. To illustrate the similarities and differences across the alternatives, Table 1 summarizes the Year 2040 estimates of households, persons, employed residents (i.e. workers), and employment (i.e. jobs).

TABLE 1: YEAR 2040 REGIONAL CONTROL TOTALS

Alternative	*Quantity*			
	Households	*Persons*	*Employed Residents*	*Employment*
No Project	3,308,000	9,196,000	4,350,000	4,505,000
Proposed Plan	3,308,000	9,196,000	4,350,000	4,505,000
Transit Priority	3,308,000	9,196,000	4,350,000	4,505,000
Enhanced Network of Communities	3,432,000	9,535,000	4,513,000	4,550,000
Environment, Equity, and Jobs	3,308,000	9,196,000	4,350,000	4,505,000

The regional control totals for the No Project, Proposed Plan, Transit Priority, and EEJ alternatives are identical and are consistent with ABAG's *Jobs/Housing Connection*; the control totals for the Enhanced alternative are different. Specifically, the Enhanced alternative includes approximately 124,000 additional households, 340,000 additional persons, 162,000 additional workers, and, 45,000 additional jobs. The intent of the increased control totals in this alternative is to assess the environmental impact of a Bay

Area in which local governments collectively offer a housing opportunity for approximately every family for which local governments collectively offer an employment opportunity. Said another way: what if the number of employed residents living in the Bay Area were approximately equal to the number of jobs in the Bay Area? The Enhanced alternative assumes the Bay Area builds enough housing to accommodate the 4.5 million employees expected, per the *Jobs/Housing Connection*, to work in the Bay Area in 2040. Making simple assumptions regarding average workers and persons per household, an additional 124,000 households, in which 340,000 persons reside, are estimated to live in the Bay Area. If more people live in the Bay Area, additional employment is likely to follow in the form of population-serving services, such as convenience stores, dry cleaners, elementary schools, etc. An input/output model estimated an additional 45,000 additional jobs would likely accompany the 124,000 additional households.[2] One could continue this loop (more jobs leads to more persons which leads to more jobs which leads to more persons, etc.) until some type of equilibrium is reached in which employed residents equal, exactly, employment; as a simplification, the referenced analysis stopped after a single iteration, which means housing opportunities still fall a bit short of employment opportunities. But the difference is small.

[2] For complete details, please see *Employment Findings from a "Housing Opportunities for Bay Area Workers" Scenario: What Happens When Bay Area Workers Are Provided Housing Opportunities*, Memorandum from Cambridge Systematics to MTC, dated June 19, 2012.

3 Land Use Distribution

In this section, a description of how the regional control totals presented in the previous section are distributed to smaller geographies throughout the Bay Area is provided. The distributional information is needed to conduct EIR analyses. Three approaches are used. The first, which is described in the *Jobs/Housing Connection* documentation, involved a "bottoms up" approach in which ABAG staff worked with local jurisdictions to assign growth to each city per either local general plans or priority development area (PDA) designations. This approach provided some, but not all, of the distributive information for the Proposed Plan alternative (details regarding the remaining information in the next paragraph). The second approach, which is described in ABAG's *Projections 2009*[3], provided some, but not all, of the distributive information for the Enhanced alternative.

To facilitate the detailed analysis required by an EIR as well as to efficiently create alternatives, a third distribution tool, the UrbanSim model, is also used. UrbanSim is described in detail elsewhere;[4] here a description of the impact of using UrbanSim on regional aggregate statistics is given. UrbanSim is used for two distinct purposes, as follows. For the No Project, Transit Priority, and EEJ alternatives, UrbanSim simulates the impact of land use and transportation projects/policies on land use outcomes. It is the sole method used to determine the land use distribution for these three alternatives. For the Proposed Plan alternative, UrbanSim is used to fill in land use details not available through the methodology developed for the *Jobs/Housing Connection*, including detailed land uses, densities, and intensities outside of PDAs. For the Enhanced alternative, UrbanSim is used to fill in neighborhood-scale land use details. The *4 Land Use Outcomes* section below describes the motivation and details of this approach.

The land use distribution step did not alter the aggregate statistics (shown in Table 2) for the Proposed Plan and Enhanced alternatives; it did alter the aggregate statistics for the No Project, Transit Priority, and EEJ alternatives. The reason is that UrbanSim simulates growth and development over time. In a given simulation year, a certain amount of demand for housing is communicated to developers. This demand is a function of the regional control totals derived by ABAG and presented in Table 1. The UrbanSim representation of developers may or may not determine that constructing enough housing (within restrictions placed on development by local governments via zoning codes) to meet demand is in their financial best interest. If the simulated developers fail to find a sufficient number of profitable projects, some amount of housing demand goes unmet. For the Plan Bay Area analysis, it is assumed that this outcome is a flaw in the model – i.e., deference is given to the ABAG regional control totals. To

[3] Additional details are available here: https://store.abag.ca.gov/projections.asp#pro09.

[4] See *Summary of Predicted Land Use Responses,* www.onebayarea.org.

correct for this presumed flaw, an adjustment was introduced to UrbanSim that uniformly (across the Bay Area) increases housing developer profit to encourage additional production. Given unlimited time and resources, this adjustment can be scaled until the number of simulated households perfectly matches the number of households in the regional control totals. In the absence of unlimited time and resources, the control totals implied by UrbanSim differ a bit – see Table 2 – from the regional control totals.

TABLE 2: YEAR 2040 AFTER LAND USE DISTRIBUTION AGGREGATE STATISTICS

Alternative	*Quantity*			
	Households	*Persons*	*Employed Residents*	*Employment*
No Project	3,199,000	8,863,000	4,364,000	4,475,000
Proposed Plan	3,308,000	9,196,000	4,350,000	4,505,000
Transit Priority	3,277,000	8,886,000	4,462,000	4,488,000
Enhanced	3,432,000	9,535,000	4,513,000	4,550,000
Environment, Equity, and Jobs	3,275,000	8,881,000	4,459,000	4,471,000

When comparing Table 2 to Table 1, the results for the Proposed Plan and Enhanced alternatives do not change, as noted above. The results for the No Project, Transit Priority, and EEJ alternatives are slightly different than the regional control totals (see also Table 5 in the *6 Summary* section for additional comparisons). The next section describes subsequent actions taken to ameliorate the impact of these differences on the EIR analyses.

4 Land Use Outcomes

UrbanSim simulates land use outcomes (i.e. buildings and their occupants) on individual parcels of land. As such, the native units describing the land use outcomes for the No Project, Transit Priority, and EEJ alternatives are parcels. There are about 2 million parcels in the nine county Bay Area. For the Proposed Plan, the *Jobs/Housing Connection* provides land use outcomes, including jobs and population, for PDAs, where applicable, as well as travel analysis zones (TAZs, which are geographies used by the travel model and identical to Census tracts for most of the Bay Area). The *Projections 2009* methods provide results for TAZs to inform the Enhanced alternative. Then, as alluded to above, UrbanSim filled in missing details in the Proposed Plan and Enhanced alternatives (additional details in the remainder of this section). As such, the native units describing the land use outcomes for the Proposed Plan alternative are PDAs, TAZs, and parcels. For the Enhanced alternative, the native units are TAZs and parcels.

Certain EIR analyses require a level of geographic specificity greater than the detail provided by the TAZ information. For example, small portions of several TAZs may be disproportionately impacted by expected sea level rise. The distribution of land uses within TAZs and PDAs is needed to conduct this analysis. However, the methods used to generate the Proposed Plan and Enhanced alternatives did not provide comprehensive information at geographies smaller than TAZs. To solve this problem, UrbanSim was used to first, across the entire region, adequately re-create the Proposed Plan and Enhanced alternatives. Specifically, UrbanSim was adjusted via calibration techniques (i.e. directed subsidies) to simulate a future in which the outcomes, when measured across collections of PDAs or TAZs, adequately re-create the results of the Proposed Plan and Enhanced alternatives. This process generated parcel-level results for the Proposed Plan and Enhanced alternatives, which can then be used for detailed analyses.

To provide an example of these different geographies, Figure 1 and Figure 2 show two different views of Downtown San Leandro. Figure 1 shows a Bing Map view; Figure 2 shows the same area with the PDA, TAZ, and parcel boundaries.

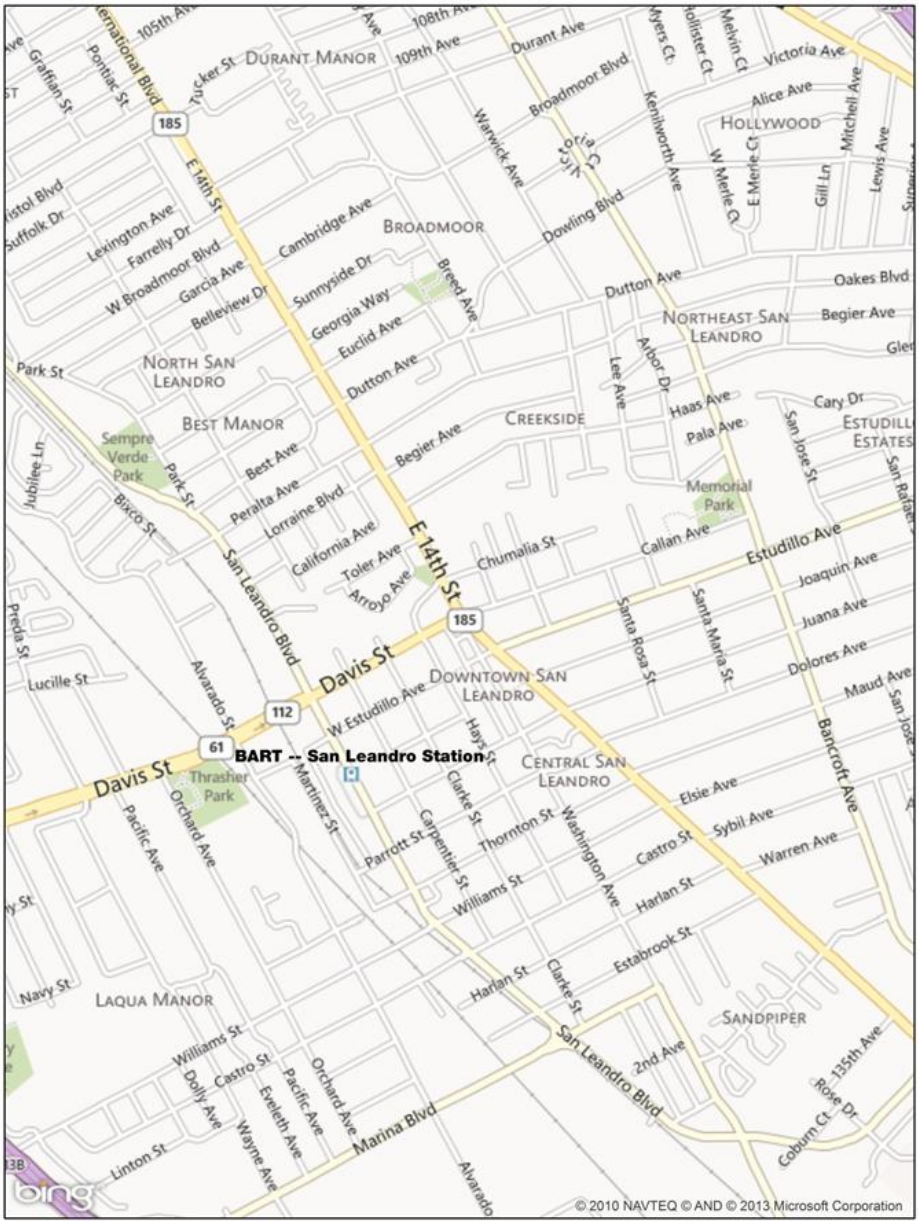

FIGURE 1: STREET MAP VIEW OF DOWNTOWN SAN LEANDRO

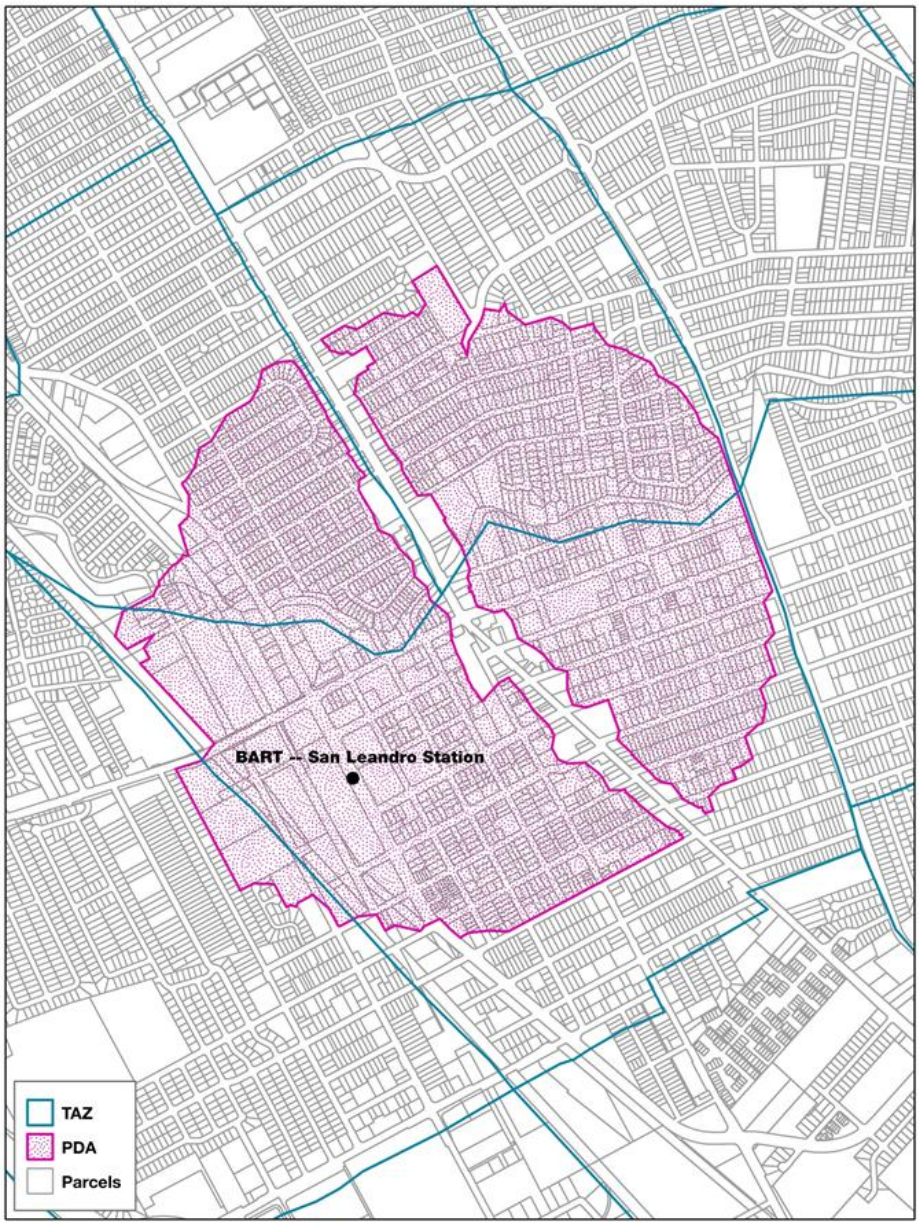

FIGURE 2: VIEW OF TAZ, PDA, AND PARCEL BOUNDARIES IN DOWNTOWN SAN LEANDRO

Following the regional control total and land use distribution steps, information is available for each of the five alternatives at various geographic scales, as noted above. In order to facilitate efficient EIR analyses, geographic information systems (GIS) techniques are used to consolidate the data into a single geography. Specifically, all of the relevant data is synthesized into one meter by one meter "rasters". A raster is an overlay unit of uniform size; separate rasters are created for each quantity of interest (e.g., households, population, jobs, employed residents). The Proposed Plan alternative rasters are constructed via the following steps:

1. For parcels within PDAs, the UrbanSim results are scaled up or down to match the PDA results from the *Jobs/Housing Connection* methods.
2. For parcels outside of PDAs, the UrbanSim results are scaled up or down to match the TAZ results from the *Jobs/Housing Connection* methods.
3. A single adjustment factor is applied to all of the parcels such that the aggregate results match the regional control totals presented in Table 1.
4. Rasters are constructed using these scaled parcels.

This approach explicitly assumes that the PDA- and TAZ-scale data from the *Jobs/Housing Connection* methods more accurately reflect the Proposed Plan alternative than the UrbanSim results. Said another way: UrbanSim only informs the distribution of land use outcomes *within* TAZs or *within* PDAs. The *Jobs/Housing Connection* methods inform the distribution of land use outcomes *across* TAZs and *across* PDAs and the total amounts of population, jobs and housing within each PDA.

The No Project alternative is informed by two pieces of information: the UrbanSim parcel results and the regional control totals of Table 1. Two steps, as follows, are therefore needed to create the No Project rasters:

1. A single adjustment factor is applied to all of the parcels such that the aggregate results match the regional control totals presented in Table 1.
2. Rasters are constructed using these scaled parcels.

For the No Project alternative, the UrbanSim results are used to inform the distribution of land use outcomes; the UrbanSim results do not inform the regional control totals. The parcel outcomes are proportionally factored up such that the differences between the UrbanSim results (Table 2) and the regional control totals (Table 1) are eliminated (see Table 5). In so doing, the households "lost" in the UrbanSim model are effectively restored, which allows EIR analyses to be performed with consistent regional control totals. Because the differences between the UrbanSim results and the regional control totals are small, any biases introduced by this approach are expected to be minor.

The Transit Priority and EEJ alternatives follow the same procedures as the No Project alternative: (1) the UrbanSim parcel results are scaled to match the regional control totals; then (2), rasters are built from the scaled parcel data. UrbanSim, therefore, informs only the distribution of land use outcomes, not the aggregate totals.

For the Enhanced alternative, three data sources provide information – regional controls, TAZ results, and UrbanSim. The raster creation steps are similar to the Proposed Plan alternative and are as follows:

1. The UrbanSim parcel results are scaled up or down to match the TAZ results from the *Projection 2009* methods.
2. A single adjustment factor is applied to all of the parcels such that the aggregate results match the regional control totals presented in Table 1.
3. Rasters are constructed using these scaled parcels.

All told, the raster data provided distribution information at a scale of one meter by one meter for the entire Bay Area for each of the five alternatives. The data allows information from several different analytical methods to be efficiently analyzed. The regional controls of Table 1 are maintained in the rasters.

Table 3 attempts to present the above text in a tabular form. The data sources for each of the alternatives is presented in a hierarchy from the most to the least accurate representation of the alternative.

TABLE 3: LAND USE RASTER HIERARCHY

Alternative	*Most to least accurate representation of the alternative →*			
No Project	Regional controls	UrbanSim		
Proposed Plan	Regional controls	PDA	TAZ	UrbanSim
Transit Priority	Regional controls	UrbanSim		
Enhanced	Regional controls	TAZ	UrbanSim	
Environment, Equity, and Jobs	Regional controls	UrbanSim		

5 Travel-related Outcomes

Travel-related outcomes are estimated by the MTC travel model. The mechanics of the travel model as well as summaries of travel-related outcomes are presented in detail elsewhere. Here, the impacts of the travel model on the disparate aggregate regional statistics across alternatives are discussed.

The travel model begins with the data provided by UrbanSim for the No Project, Transit Priority, and EEJ alternative. For the Proposed Plan and Enhanced alternatives, the travel model begins with the TAZ data generated by the *Jobs/Housing Connection* and *Projections 2009* methods, respectively. Unlike for analyses dependent only on the pattern and nature of land consumption, the characteristics of the persons living in different locations are important to the travel model. Specifically, when UrbanSim fails to locate all the expected households in the region, it tends to have more success locating households with more workers, rather than fewer. As such, the populations UrbanSim implies (see Table 2) tend to have a slightly higher number of employed residents than the regional control totals (see Table 1). However, the Alternatives have lower total populations relative to the regional controls. The presence of a slightly higher number of employed residents, who travel roughly twice as much as non-workers, suggests the UrbanSim populations may slightly overstate the environmental impact of the alternative relative to an alternative with employed residents equal to the regional controls. On the other hand, the presence of a slightly lower number of persons suggests that the UrbanSim populations may slightly understate the environmental impact of the alternative relative to an alternative with persons equal to the regional controls. When combined, the net impact of these opposing forces is likely very minor, but readers should be aware of these nuances when making highly detailed comparisons across the five alternatives.

Starting with the results from either UrbanSim (for the No Project, Transit Priority, or EEJ alternatives) or the *Jobs/Housing Connection* methods (Proposed Plan) or the *Projections 2009* methods (Enhanced), the travel model process begins with the generation of a synthetic population. Please see the *Summary of Predicted Traveler Responses* supplementary report for more details. The population synthesizer translates the TAZ-level data provided by these two sources into detailed lists of households and persons. This process results in slight differences between the land use distribution results (of Table 2), as discussed in more detail in the *Summary of Predicted Traveler Responses*. Table 4 presents the key quantities as used in the travel model simulation.

TABLE 4: YEAR 2040 TRAVEL MODEL SIMULATION AGGREGATE STATISTICS

Alternative	*Quantity*			
	Households[†]	*Persons*	*Employed Residents*	*Employment*
No Project	3,193,000	8,710,000	4,110,000	4,475,000
Proposed Plan	3,301,000	9,139,000	4,092,000	4,505,000
Transit Priority	3,270,000	8,919,000	4,203,000	4,488,000
Enhanced	3,424,000	9,472,000	4,239,000	4,550,000
Environment, Equity, and Jobs	3,268,000	8,904,000	4,198,000	4,471,000

[†] *Does not include individuals living in group quarters, which are considered households in the travel model.*

6 Summary

This document discussed how different analytical processes introduced minor discrepancies in aggregate regional statistics. Table 5 below summarizes the differences in one regional measure, households, across the analytical steps discussed in this document.

TABLE 5: HOUSEHOLDS ACROSS ANALYTICAL STEPS

Alternative	*Households at Each Analytical Step (Percent Difference from Regional Controls)*			
	Regional Controls	*Land Use Distribution*	*Land Use Outcomes*	*Travel-related Outcomes*[†]
No Project	3,308,000	3,199,000 (-3.3%)	3,308,000 (0.0%)	3,193,000 (-3.5%)
Proposed Plan	3,308,000	3,308,000 (0.0%)	3,308,000 (0.0%)	3,301,000 (-0.2%)
Transit Priority	3,308,000	3,277,000 (-0.9%)	3,308,000 (0.0%)	3,270,000 (-1.1%)
Enhanced	3,432,000	3,432,000 (0.0%)	3,432,000 (0.0%)	3,424,000 (-0.2%)
EEJ	3,308,000	3,275,000 (-1.0%)	3,308,000 (0.0%)	3,268,000 (-1.2%)

[†] *Does not include individuals living in group quarters, which are considered households in the travel model.*

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