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San Diego's Regional Planning Agency

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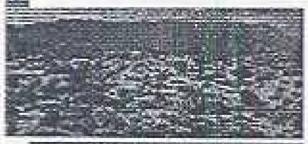

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# SAN DIEGO Association of Governments

Welcome

SANDAG serves as the forum for decision-making on regional issues such as growth, transportation, land use, the economy, the environment, and criminal justice. SANDAG is governed by a **Board of Directors** composed of mayors, council members, and supervisors from each of the San Diego region's 19 local governments.

## FEATURED PROJECTS

**_TransNet_: Local Tax Dollars for Transportation**
More than $3.3 billion in transportation projects is being funded through *TransNet* - the half-percent sales tax that was approved by the region's voters in 1987.

TransNet

**REGION2020: Creating Livable, Sustainable Communities**
The REGION2020 strategy has been developed to deal with the region's current sprawl-inducing development patterns, traffic congestion challenges, lack of adequate infrastructure, and the shortage of housing.

REGION2020

**Restoring the Region's Coastline**

The Regional Beach Sand Project has restored six miles of our coastline. More shoreline preservation and environmental monitoring efforts are underway.

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# 2020 CITIES/COUNTY FORECAST

## OVERVIEW
## VOLUME I

San Diego
ASSOCIATION OF GOVERNMENTS

401 B Street, Suite 800
San Diego, CA 92101
(619) 595-5300

**December 1998**

**Jeff Tayman**
**Terry Beckhelm**

# Board of Directors
## SAN DIEGO ASSOCIATION OF GOVERNMENTS

The San Diego Association of Governments (SANDAG) is a public agency formed voluntarily by local governments to assure overall areawide planning and coordination for the San Diego region. Voting members include the incorporated Cities of Carlsbad, Chula Vista, Coronado, Del Mar, El Cajon, Encinitas, Escondido, Imperial Beach, La Mesa, Lemon Grove, National City, Oceanside, Poway, San Diego, San Marcos, Santee, Solana Beach, Vista, and the County of San Diego. Advisory and Liaison members include Caltrans, U.S. Department of Defense, San Diego Unified Port District, San Diego County Water Authority, and Tijuana/Baja California/Mexico.

**CHAIRMAN:** Hon. Art Madrid
**VICE CHAIR:** Hon. Ramona Finnila
**SECRETARY-EXECUTIVE DIRECTOR:** Kenneth E. Sulzer



**Revised September 25, 1998**

# ABSTRACT

| | |
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| TITLE: | 2020 Cities/County Forecast<br>Overview, Volume I |
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### OVERVIEW

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# INTRODUCTION

# INTRODUCTION

## HISTORY

The San Diego Association of Governments (SANDAG) has produced short-range and long-range forecasts of growth in the region since 1971. Preparing the original elements of the Regional Comprehensive Plan in the early 1970's provided the impetus for population, employment, and land use forecasts. Designated as the Areawide Water Quality Management Planning Agency in 1975, SANDAG produced a baseline forecast (Series 4) predicated upon public policies being implemented through the general plans and the community plans of the region's jurisdictions. The Series 4 forecast was adopted by the SANDAG Board of Directors in October 1977, following the adoption of the jurisdiction-level forecast by each city in the region and the County of San Diego.

The SANDAG Board of Directors subsequently directed staff to update forecast every two years to examine the impacts of changes in public policies and economic conditions affecting population growth and distribution. The Series 5 and Series 6 forecasts followed and were adopted by the SANDAG Board of Directors in 1980 and 1984, respectively. The SANDAG Board of Directors next adopted the Series 7 forecast as an element of the Regional Comprehensive Plan in October 1989. The Series 8 Regional Growth Forecast, based on 1990 socioeconomic and land use data, covered the period 1995 to 2015. The SANDAG Board of Directors approved it for use in May 1995.

The 2020 Regional Growth Forecast is SANDAG's most recent forecasting effort. This forecast covers the period 1995 to 2020 and is based on 1995 land use, population, housing, income, and employment data. The SANDAG Board of Directors approved the 2020 Regionwide Forecast for use in July 1998. The subregional allocation, known as the 2020 Cities/County forecast, is currently under review, with approval by the SANDAG Board expected in the spring of 1999.

## USING THE FORECAST

When the local governing bodies and the SANDAG Board of Directors accept the forecast, the numbers are certified for use in all regional studies and plans described in SANDAG's Overall Work Program. The official forecast is used to prepare water and air quality strategies and housing and environmental studies. The forecast is also a key input to the Regional Transportation Plan and is used to conduct project reviews under the Intergovernmental Review process. Other uses include assessing growth impacts, projecting changes in service levels for public facilities and ascertaining needs for new or expanded (reduced) facilities.

## 2020 REGIONAL GROWTH FORECAST MODELS

The 2020 Regional Growth Forecast uses two distinct modeling systems. The regionwide forecast is produced with the Demographic and Economic Forecasting Model (DEFM). DEFM is described in detail in its own documentation series.

The 2020 Cities/County Forecast for jurisdictions, communities, and other geographic areas is done with the Urban Development Modeling System (UDM). UDM distributes the regional forecast to smaller geographic areas according to attractions and constraints provided by existing and planned land use policies, transportation networks, and population, housing, and economic concentrations.

## DOCUMENTATION

The 2020 Cities/County Forecast model documentation includes four volumes oriented to different audiences.

**Volume I, Overview**. Volume I is a general description of the 2020 Cities/County Forecast process, models, and data bases.

**Volume II, Technical Description**. The Technical Description focuses on the specifics of the UDM. It contains a detailed flow of model information, specific sector details, model equations and structure, and forecast parameters.

**Volume III, Database Description**. Volume III describes the numerous 2020 Cities/County Forecast databases including data sources, data file structures, and detailed discussions of data construction. It also includes the major assumptions that underlie the 2020 Regionwide Forecast.

**Volume IV, Programmer's Reference**. The Programmer's Reference is an informal document that outlines procedures to maintain the 2020 Cities/County Forecast models. It also details system requirements, program and script operational instructions, and runtime arguments.

# OVERVIEW

# OVERVIEW

This document provides a general description of the 2020 Regional Growth Forecast models, databases, and review process. SANDAG produces its forecasts in two phases, each phase with its own model and databases. Figure 1-1 illustrates the relationships between the 2020 Regional Growth Forecast models. The first phase uses the Demographic and Economic Forecasting Model (DEFM) to develop a regionwide forecast of over 700 variables, including population, employment, housing, income, and local government finances. The second phase, the 2020 Cities/County Forecast, uses the Urban Development Model (UDM) to allocate the regionwide forecast to progressively smaller geographic areas within the San Diego region.

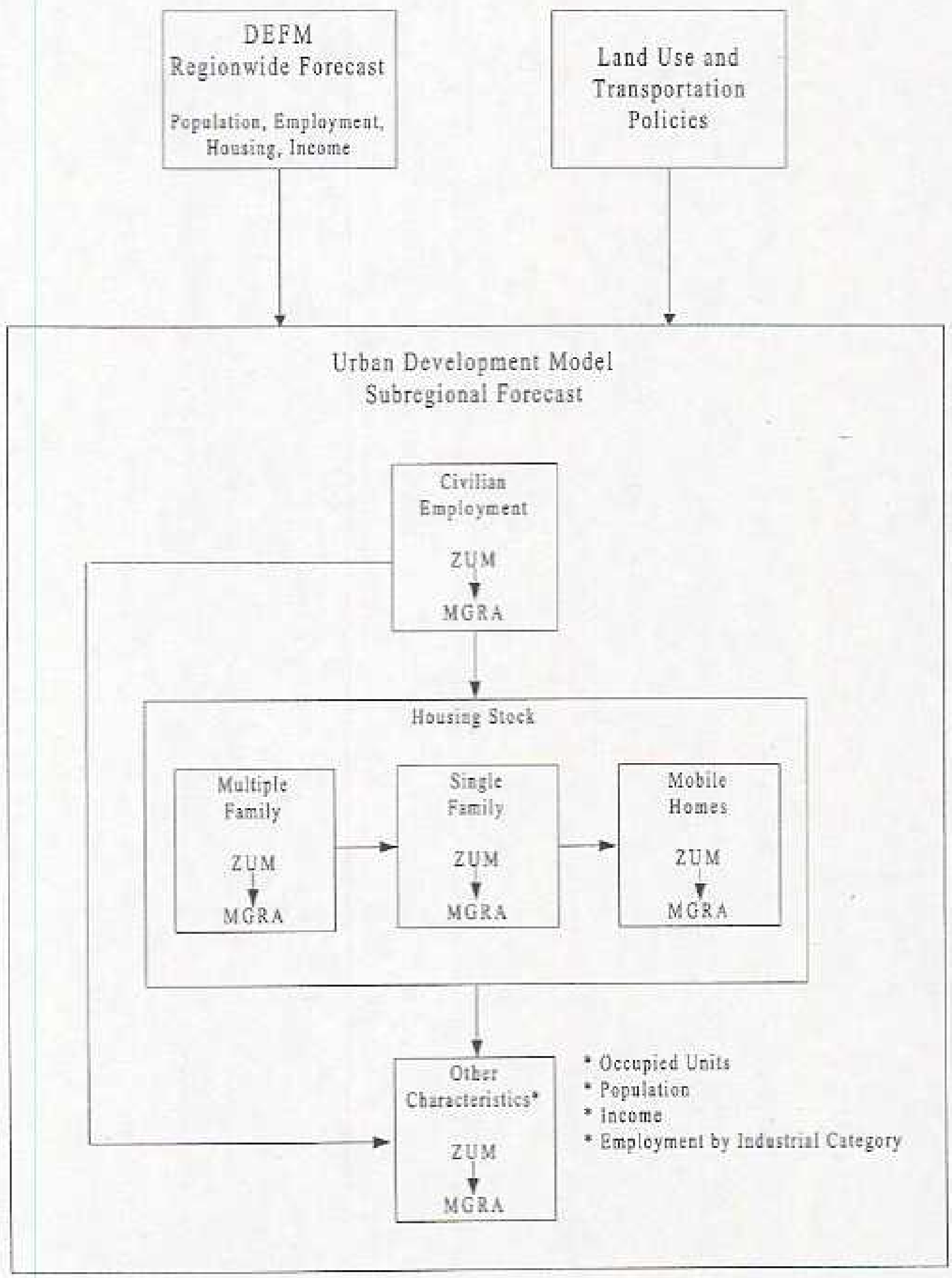
UDM has three major components. The first component allocates regionwide employment based on the existing and previously forecasted location of employment, land available for new employment opportunities, and the transportation system. The spatial distribution of employment is a key factor in determining the location of new housing stock (vacant plus occupied units) done in the second component of UDM. Along with forecasted employment, transportation accessibility to employment locations, and land available for housing opportunities are other factors that influence the location of housing stock. The final component of UDM provides a forecast of other demographic and economic characteristics including occupied units, population, household income, and employment by industrial classification. All components of UDM use a two-step allocation procedure. The first step allocates activities to 208 Zones for Urban Modeling (ZUM). The second step allocates the ZUM forecast to over 29,000 geographic areas based on census blocks.

## DEFM-REGIONWIDE FORECAST MODEL

DEFM is a blend of two widely used forecasting techniques: a cohort-component method for population change and econometric equations for economic factors. Changes in population are caused by natural increase (births minus deaths) and migration patterns. The cohort-component method uses information on age, sex, and ethnic composition and future trends in birth and death rates to forecast population changes due to natural increase. DEFM relates population change from migration to the future performance of the region's economy. In particular, job creation, wages, and the supply and demand of labor determine the future levels of migration.

The economic portion of DEFM consists of five sectors, construction, prices, employment and output, local revenues and expenditures, and income. DEFM links all five sectors directly to each other and to the cohort-component model through equations based on regionwide, state, and national economic trends. DEFM's equations and statistical procedures accurately reflect the many complex interrelationships that underlie the region's economy. Regression analysis of time series data from 1950 to 1997 quantifies the relationships between the many variables in DEFM.

**Figure 1-1**
**2020 Regional Growth Forecast Models**



Additionally, DEFM makes extensive use of cross-sectional data, including the U.S. census, wage rates, and local industry input/output relationships. Complete details of SANDAG's regionwide forecasting model is found in a SANDAG report entitled *Demographic and Economic Forecasting Model: Technical Description and Database.*

## UDM-2020 CITIES/COUNTY FORECAST MODEL

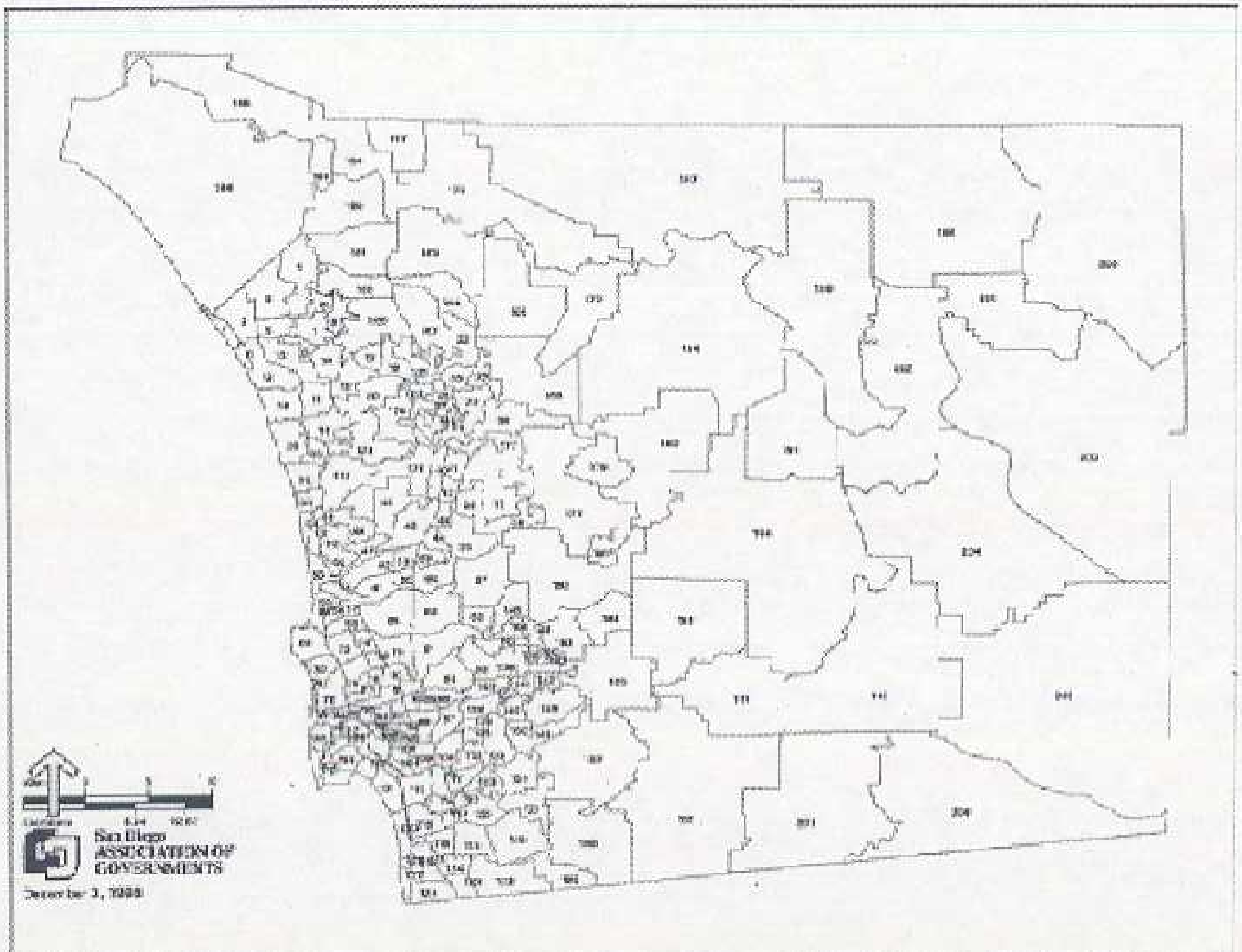
### Geographic Reference System

SANDAG uses a multilevel, nested geographic reference system. The foundation of the reference system is the Master Geographic Reference Area (MGRA). The 29,354 MGRAs are the combinations of census blocks, census tracts, community planning areas, city boundaries, spheres of influence, and zip codes. Blocks also are split using other criteria (e.g. ridgelines) to develop traffic analysis zones. Accordingly, MGRAs can aggregate to these standard geographic units, including subregional areas and major statistical areas, which are aggregations of census tracts. Because MGRAs are small, their aggregation can closely approximate any nonstandard or user-specified areas, such as school districts or fire districts. Along with the MGRAs, another geographic boundary system used in the subregional allocation process is the 208 Zones for Urban Modeling (ZUM). In general, ZUMs represent groups of census tracts. Within the City and County of San Diego, they adhere to community plan area boundaries. For the other jurisdictions, they adhere to current (1996) city boundaries. Figure 1-2 shows the ZUMs used in the 2020 Cities/County Forecast.

### UDM-Civilian Employment Component, ZUM Forecast

The ZUM forecast of civilian employment (excluding uniformed military employment) relies on the EMPAL modeling system developed by S.H. Putman and Associates. This modeling system consists of two components EMPAL and CALIB, which SANDAG modified to accommodate the specialized modeling requirements for the San Diego region. CALIB calibrates (fits the model to historical data) the equation used in EMPAL to determine future civilian employment. Because EMPAL's equation structure is nonlinear, CALIB uses a special method to develop estimates of the equation's parameters. The calibration process used in CALIB is analogous to regression analysis, but it uses a different mathematical algorithm. The report entitled 2020 Cities/County Forecast Volume II-Technical Description provides more details on the calibration procedure.

Figure 1-2
Zones for Urban Modeling



UDM uses a modified version of a singly constrained spatial interaction equation to determine the location of civilian employment. The modifications include a multivariate, multiparametric attractiveness function; a lagged variable included outside the spatial interaction formulation; and a procedure that allows for ZUM specific constraints. Civilian employment location is a function of the location of households (lagged five years); the distribution of existing and previously forecasted employment; the capacity for additional civilian employment (capacity calculations are described later in this document); and the travel time between ZUMs. UDM solves the equation in terms of the forecasted civilian employment share rather than directly as the number of jobs. The civilian employment share is the proportion of the region's civilian employment forecast that locates in a particular ZUM. UDM includes an option to modify the forecast shares with additive adjustment factors (Kfactors). Kfactors allow the incorporation of calibration error directly into the forecast and provide a way to inform the model of any special cases of ZUM attractiveness or unattractiveness (e.g., restricting development in sensitive habitat areas).

UDM converts the civilian employment shares into a civilian employment number by multiplying the shares by the regionwide civilian employment forecast, adjusted for site-specific activities. Site-specific activities inform the model of the exact locations and sizes of known developments completed after 1995, the base year of the 2020 Cities/County Forecast. UDM then creates the employment change in each ZUM by subtracting the base year employment from the employment forecast and applies any user-specified overrides. Unlike Kfactors, which allow the equation to determine civilian employment location in response to the adjusted attractiveness in one or more ZUMs, overrides specify a value for the civilian employment change in a ZUM. In general, UDM responds to these overrides by adjusting the forecast in ZUMs without overrides to match the regionwide civilian employment forecast.

UDM does not allow the civilian employment change to exceed the civilian employment capacity in any ZUM. If the civilian employment change exceeds a ZUM's capacity, UDM reallocates the excess jobs to ZUMs with capacity. This routine begins by determining the excess civilian employment growth in a ZUM. It sets the forecasted change equal to the civilian employment capacity for that ZUM. The algorithm next locates the closest ZUM with additional capacity. UDM defines the closest ZUM as having shortest time on the highway network. Capacity in this closest ZUM is consumed until all excess civilian employment is reallocated or until that ZUM reaches capacity. If there is still excess civilian employment, UDM searches for the next closest ZUM with additional capacity. UDM repeats the process until it reallocates all excess civilian employment from a ZUM. UDM then proceeds to the next ZUM with excess civilian employment and reallocates it in the same manner.

UDM also can adhere to a user-specified minimum change in civilian employment; that is, the civilian employment change must exceed a certain value. The routine begins by determining the civilian employment deficit in a ZUM. It sets the forecasted change equal to the user-specified minimum value and lowers the civilian employment change in the closest ZUM. To avoid an excessive reduction in the civilian employment, UDM reduces the civilian employment change by at most 10% or until the closest ZUM reaches its minimum value. If there is still a civilian employment deficit, UDM finds the next closest ZUM above its minimum constraint and repeats the adjustment. If UDM adjusts all target ZUMs and a deficit remains, it repeats the adjustment process, again starting with the closest ZUM. These iterations continue until all ZUMs with a deficit show the minimum value.

To facilitate the civilian employment allocation to MGRAs and a more accurate forecast of land consumption, UDM distributes the civilian employment change to six general land use categories. These categories are redevelopment (converting existing residential uses), infill (intensifying existing civilian employment land), vacant industrial, vacant commercial/services, vacant office, and vacant schools. UDM assigns the civilian employment change into these categories based on their relative capacities in a ZUM.

The ZUM civilian employment forecast is not complete at this point because it excludes site-specific information. As mentioned earlier, UDM adjusts the regionwide civilian employment forecast to remove the effect of site-specific employment before allocation to ZUMs. Therefore, to complete the ZUM civilian employment forecast, UDM adds or subtracts the site-specific civilian employment in a ZUM.

### UDM-Civilian Employment Component, MGRA Forecast

UDM next allocates the ZUM civilian employment change to MGRAs based on their development priority, defined as accessibility to residential and civilian employment activities. This priority is a weight that measures the combined amount of housing and civilian employment activities within 1/4 mile of the MGRA. A larger weight indicates a greater accessibility or a higher development priority of an MGRA. The MGRA allocation routine differs depending on whether the civilian employment change in a ZUM is positive or negative.

For ZUMs with a civilian employment loss, UDM identifies a candidate MGRA based on its land use characteristics and location within the region. Civilian employment losses can only occur on certain developed employment land uses (industrial, commercial/services, office, and schools) and in the urbanized areas of the region. UDM begins with the most accessible (according to the access weight) MGRA that meets the selection criteria. It checks for two conditions: 1) the ZUM civilian employment loss is not fully allocated; and 2) the MGRA base year civilian employment is greater than zero. If these checks are satisfied, UDM reduces the MGRA's employment. Otherwise, UDM goes to the next candidate MGRA in sorted order. UDM calculates the civilian employment loss as the minimum of the MGRA's civilian employment or the unallocated ZUM civilian employment loss. If the ZUM loss is the minimum, the allocation is complete. UDM increases the capacity in MGRAs that lose civilian employment so they have the opportunity to make-up for the loss later in the forecast.

For ZUMs with a civilian employment gain, UDM develops MGRAs according to their accessibility order. UDM's scheme begins by allocating the ZUM civilian employment gains to the most accessible MGRA with capacity, based on a comparison of the unallocated ZUM change and civilian employment capacity in that MGRA. If the civilian employment capacity is used up in that MGRA (i.e., it becomes fully developed) and unallocated ZUM employment change remains, UDM finds the next most accessible MGRA with capacity and allocates to it. This process continues until UDM completely allocates the ZUM civilian employment change (i.e., MGRA capacity is greater than or equal to the unallocated ZUM civilian employment change). UDM repeats this allocation process for each general employment land use category in a ZUM. If UDM places new employment on redevelopment land, it removes (demolishes) any existing residential housing stock.

UDM's land use accounting for civilian employment development is based on the type of development planned in an MGRA. Development on employment infill land requires no land use accounting because these areas do not change their land use. For vacant areas, UDM reduces the land use-specific vacant acres and increases the acres in the corresponding developed land use category. On redevelopment land, UDM reduces residential acres (e.g., developed single family) and increases acres in the specific developed civilian employment category (e.g., neighborhood shopping center). UDM determines the amount of acres shifted from the percent of the MGRA's capacity developed. If an MGRA is completely developed, all of its vacant and redevelopment acres are converted to the new civilian employment land use(s). For a partially developed MGRA, UDM computes the percent of its civilian employment capacity used and then applies that percent to the vacant or redevelopment acres to determine the number of acres changing use.

### UDM-Housing Stock Component, ZUM Forecast

The housing stock (vacant plus occupied units) component of UDM allocates single family stock, multiple family stock, and mobile homes. For each unit type, the ZUM allocation is first, followed by the MGRA allocation. As Figure 1.1 shows, UDM first allocates multiple family stock, then single family stock, and finally mobile homes. It follows this structure-type order because multiple family development occurring on land converting from single family or mobile home use causes the demolition of single family stock and mobile homes. Similarly, single family development occurring on land converting from mobile home used causes the demolition of mobile homes. To properly account for these lost units, UDM must determine them before allocating the regionwide forecast for any structure type. Remember that UDM determined residential units lost to employment redevelopment earlier in the program.

Four major premises underlie the ZUM forecast of single and multiple family housing stock.

1. Employment location is a primary determinant of residential location.
2. The longer the work trip, the less the likelihood that a person makes that trip.
3. The more land available for residential development, the greater the potential for residential growth.
4. Residential growth occurs only where local plans and policies identify additional capacity for residential development. Capacity is based on vacant residential land, residential density, and the additional growth potential due to redevelopment.

UDM captures the link between workplace location and residential location through commuting patterns and travel times within the region, furnished by SANDAG's transportation model. By using current and future trends in travel behavior, UDM can account for other factors that determine where people live within the region, such as land values, multiple worker households, income, and neighborhood preferences. In general, areas closer to employment opportunities are more attractive to employees as potential residences than are areas further away from their place of employment. Therefore, as available residential capacity closer to work places is consumed, new employees are forced to travel longer distances to find suitable residential locations.

UDM combines the transportation and land use factors (attractors) mathematically to determine the likelihood or probability that an employee at his or her place of work will reside in alternative residential locations around the region. This probability takes into account both highway and transit travel patterns, and UDM defines ZUM land use attractors as holding capacity expressed as housing stock changes. Combining these factors results in a 208 by 208 ZUM-to-ZUM matrix of probabilities that sum to 1.0 within each work place ZUM. The allocation of employees to their ZUMs of residence, from each work place ZUM, is based on the weighted average of the number of employees for each mode of travel and their associated probabilities of living in alternative residential ZUMs. These computations result in a 208 by 208 matrix containing the increment of employed residents in each residential zone from each employment zone. The final step accumulates the employed resident increment allocated from each work place ZUM.

UDM, using the mechanism just described, actually does two separate allocations of workers to their places of residence: workers living in single family housing stock and workers living in multiple family housing stock. To do this, UDM first computes the number of workers at the workplace ZUM who will live in each kind of unit, based on the regionwide share of new housing stock that is single family. UDM then produces separate allocation probabilities and employed resident matrices for workers living in each kind of unit. These matrices differ for each type of unit because UDM uses structure-type specific land use attractors. UDM then computes the employed residents living in single and multiple family units for each residential ZUM.

After UDM determines the employed resident forecast, it uses two rates for each ZUM to derive housing stock. UDM forecasts these rates using regionwide trends and other indicators including housing structure type. One rate, known as the employed residents per household rate, determines the number of households (occupied units) needed to accommodate the forecast of employed residents. The rate for each ZUM reflects characteristics that determine the typical number of workers in each house, such as local unemployment rates, multiple-worker households, labor force participation rates, age structure, and income. UDM applies the same rate to the single family and multiple family employed residents. (These household forecasts are interim and are finalized in the last component of UDM). Local vacancy rates, specific to each structure type, applied to the households determine the housing stock forecast for single and multiple family units. UDM controls these housing stock forecasts to their respective regionwide forecasts, which UDM adjusts for site-specific activity and units lost from redevelopment.

UDM does not allow housing stock change to exceed the housing stock capacity in any ZUM. If the housing stock change exceeds a ZUM's capacity, UDM reallocates the excess housing stock to ZUMs with capacity. The program does a separate reallocation for single and multiple family housing stock. This routine begins by determining the excess housing stock growth in a ZUM. It sets the forecasted change equal to the housing stock capacity for that ZUM. The algorithm next locates the closest ZUM with additional capacity. Capacity in this closest ZUM is consumed until all excess housing stock is reallocated or until that ZUM reaches capacity. If there is still excess housing stock, UDM searches for the next closest ZUM with additional capacity. UDM repeats the process until it reallocates all excess housing stock from a ZUM. UDM then proceeds to the next ZUM with excess housing stock and reallocates it in the same manner.

To facilitate the single and multiple family housing stock allocation to MGRAs and a more accurate forecast of land consumption, UDM distributes the housing stock change to general land use categories. For multiple family these three categories are redevelopment (converting existing employment, single family, and mobile home uses), infill (intensifying existing multiple family use), and vacant. For single family, the four categories are redevelopment (converting existing mobile home use), infill (intensifying existing single family use), vacant low density (≤ 1 unit per acre), and vacant urban (> 1 unit per acre). For each structure type, UDM assigns the housing stock change into these categories based on their relative capacities in a ZUM.

UDM then allocates mobile homes to ZUMs. UDM forecasts mobile homes by factoring base year mobile homes to the regionwide forecast, both quantities adjusted for site-specific activities and for mobile homes lost to redevelopment activities. To complete the housing stock forecast for each structure type, UDM adds or subtracts the site-specific housing in a ZUM. Finally, the ZUM forecast of total housing stock is the sum of the forecasts for each structure type.

### UDM-Housing Stock Component, MGRA Forecast

UDM next allocates the ZUM housing stock change to MGRAs in a manner similar to that described for civilian employment. UDM develops the MGRAs according to their accessibility order (development priority). UDM's scheme begins by allocating housing stock gains to the most accessible MGRA with capacity, based on a comparison of the unallocated ZUM change and housing stock capacity in that MGRA. If the housing stock capacity is used up in that MGRA (i.e., it becomes fully developed) and unallocated ZUM housing stock change remains, UDM finds the next most accessible MGRA with capacity and allocates to it. This process continues until UDM completely allocates the ZUM housing stock change (i.e., MGRA capacity is greater than or equal to the unallocated ZUM housing stock change). UDM does this allocation process separately for single and multiple family housing stock and for their general land use categories in a ZUM. If UDM places new multiple family units on redevelopment land, it demolishes any single family housing stock or mobile homes. If UDM places new single family units on redevelopment land, it demolishes any mobile homes.

To complete the MGRA housing stock forecast, UDM allocates the ZUM mobile home forecast. UDM forecasts mobile homes by factoring base year mobile homes to the ZUM forecast, both quantities adjusted for site-specific activities and mobile homes lost to redevelopment activities. Finally, the MGRA forecast of total housing stock is the sum of each structure type.

UDM's land use accounting for residential development also is based on the type of development planned in an MGRA. Development on single or multiple family infill land requires no land use accounting because these areas do not change their land use. For vacant areas, UDM reduces the land use-specific vacant acres and increases the acres in the corresponding developed land use category. On multiple family redevelopment land, UDM reduces single family or mobile homes acres and increases multiple family acres. On single family redevelopment land, UDM reduces mobile homes acres and increases single family acres. UDM determines the amount of acres shifted according the percent of the MGRA's capacity developed. If an MGRA is completely developed, all of its vacant and redevelopment acres are converted to the new residential land use(s). For a partially developed MGRA, UDM computes the percent of its residential capacity used and then applies that percent to the vacant or redevelopment acres to determine the number of acres changing use.

### UDM-Other Characteristics Component, ZUM Forecast

UDM uses the civilian employment and housing stock forecasts as inputs for the allocation of the other characteristics. Again, UDM does ZUMs first and then allocates the ZUM other characteristic forecasts to MGRAs. The other characteristics that UDM forecasts are occupied units by structure type (single family, multiple family, and mobile homes), household and group quarters population (e.g., population living in nursing homes, college dorms, prisons, or military barracks), employed residents, household income distribution, and civilian employment by industrial category. UDM produces eight household income categories, <$10,000; $10,000-$14,999; $15,000-$24,999; $25,000-$34,999; $35,000-$49,999; $50,000-$74,999; $75,000-$99,999; and $100,000+, and 10 civilian employment categories, Agriculture and Mining; Construction; Manufacturing; Transportation, Communications, and Utilities; Wholesale Trade; Retail Trade; Services; Finance, Insurance, and Real Estate; Government; and Self-Employed and Domestic Workers. UDM also provides a forecast of uniformed military employment. Changes in uniformed military employment are external to the model and are treated as site-specific activities.

UDM uses several rates for each ZUM to forecast household population, employed residents, and occupied units by structure type. These rates are employed residents per household (ERHH), vacancy rates specific to each structure type, and persons per household (PPH). To forecast these rates, UDM first calculates their base year values for each ZUM, and then assumes that ERHH and PPH change at the same percentage as the regionwide rates. The procedure for developing the future PPH is similar to that just described, but it also takes into account that the rate of change in PPH varies according to the ZUM's PPH value. In particular, ZUMs with higher than average household sizes tend to decrease faster and increase slower than the regionwide change and visa versa for ZUMs with lower than average household sizes.

UDM first does a forecast of occupied units for each structure type and then adds them to produce total occupied units. The procedure is the same for single family, multiple family, and mobile home occupied units. First, UDM applies a vacancy rate (specific to each structure type) to the ZUM housing stock forecast by structure type, generating an initial forecast of occupied units by structure type. UDM then controls the initial forecasts to the regionwide forecast for each structure type.

UDM next forecasts household population and employed residents by multiplying the total occupied units in a ZUM by PPH and ERHH, respectively. UDM controls these initial ZUM forecasts to the regionwide forecast of household population and employed residents. To complete the total population forecast, the group quarters population is added to the household population. UDM forecasts both civilian and military group quarters population for each ZUM. A civilian group quarters population forecast is developed by factoring base year civilian group quarters population to the regionwide forecast, both quantities adjusted for site-specific activity. Changes in military group quarters population are external to the model and are treated as site-specific activities.

UDM's household income forecast uses a modified lognormal probability function that describes the distribution of households across income groups. The shape of this income distribution function is based upon three parameters, median income, standard deviation of the income distribution, and a nonlinear calibration factor. The calibration factor more accurately describes the distribution for extremely low-income households and for extremely high-income households. The user can opt not to use the modified lognormal curve and can chose the base year income distribution for either the ZUM or the region. UDM first develops an initial forecast of the income distribution for each ZUM using one of the three options. If UDM uses the modified lognormal curve, the parameters for a ZUM are forecast as follows. Median income changes at the same percentage as the regionwide median. Forecasts for the other two parameters are based on their historical trends and regionwide changes. UDM then adjusts the initial ZUM forecast of the household income distribution to match the occupied units forecast in the ZUM and to match the regionwide household income distribution forecast. An iterative proportional adjustment method controls the initial ZUM income distributions. UDM does the controlling by first matching to the ZUM occupied units forecast and then by matching to the regionwide income distribution forecast. UDM carries out this computational adjustment sequence for several iterations until it reaches convergence with both the ZUM and regionwide forecast. UDM then computes the median income forecast for each ZUM.

Like for household income, UDM begins with an initial distribution of the civilian employment change for the 10 industrial categories in each ZUM. Several conditions determine the computation of this initial distribution of changes. First, civilian employment categories with a regionwide decrement are distributed using the ZUM's base year civilian employment in that category relative to the region's base year civilian employment in the same category. To maintain the proper accounting, UDM increases the ZUM civilian employment change (control) by subtracting the allocated decrements from it. The distribution of the adjusted ZUM control into the remaining civilian employment categories depends on direction of the ZUM control before the adjustment was made for the allocation of the regionwide civilian employment decrement(s). If that preadjusted control is negative, UDM uses the ZUM's base year relative (share of the total) distribution of the civilian employment categories. If it is positive, UDM uses a weighted average of the ZUM's base year relative distribution and the relative distribution of the regionwide changes. UDM bases the weights on the size of the ZUM's civilian employment increment relative to its base year civilian employment. This method in effect defaults to the regionwide distribution in a ZUM with little or no base year civilian employment or a civilian employment increment equal to or greater than its base year civilian employment. The allocation to civilian employment sectors is influenced primary by the base year distribution in a ZUM with a small increment relative to its base year civilian employment. UDM adjusts the initial ZUM forecast of the civilian employment by category to match the overall civilian employment change in the ZUM and to match the regionwide forecast of civilian employment in each category. The iterative proportional adjustment method just described controls the initial ZUM employment distributions.

### UDM-Other Characteristics Component, MGRA Forecast

UDM first does a forecast of occupied units for each structure type and then adds them to produce total occupied units in an MGRA. The procedure is the same for single family, multiple family and mobile home occupied units. First, UDM applies a vacancy rate (specific to each structure type) to the MGRA housing stock forecast by structure type, generating an initial forecast of occupied units by structure type. UDM then controls the initial forecasts to the ZUM forecast for each structure type. UDM derives the vacancy rate forecast by taking the base year MGRA rate and adjusting it for the change in the ZUM rate. If an MGRA's base year housing stock is 20 or fewer, UDM uses the ZUM vacancy rate forecast.

UDM forecasts household population and employed residents by multiplying the total occupied units in a MGRA by PPH and ERHH, respectively. UDM then controls these initial MGRA forecasts to the ZUM forecast for household population and employed residents. UDM derives the PPH and ERHH forecasts by taking the base year MGRA rates and adjusting them for the change in the ZUM rates. If an MGRA's base year housing stock is 20 or fewer, UDM uses the ZUM PPH and ERHH forecasts. To complete the total population forecast, the group quarters population is added to the household population. UDM forecasts both civilian and military group quarters population for each MGRA. A civilian group quarters population forecast is developed by factoring base year group quarters population to the ZUM forecast, both quantities adjusted for site-specific activity. Changes in military group quarters population are external to the model and are treated as site-specific activities.

UDM then allocates the ZUM household income distribution forecast to MGRAs. The household income distribution allocation to MGRAs is the most complicated algorithm in UDM. It requires many passes through the MGRAs; separate allocations of losses and gains; and a probabilistic method for determining the allocation. This allocation also must match both the changes in occupied units in the MGRA and in the income distribution categories for the ZUM. UDM uses three steps to allocate the ZUM household income distribution to MGRAs. First, UDM allocates ZUM decrements (losses) in any income category. UDM then allocates MGRAs with occupied unit decrements. Finally, UDM allocates positive changes in both the ZUM income distribution and MGRA occupied units to the household income categories in the MGRAs. We describe each of these steps below.

For ZUM decrements, UDM lowers the base year MGRA income data until the ZUM decrement(s) are completely allocated. It does this with a method that removes occupied units in proportion to the MGRA's share of the ZUM's occupied units in the particular income category. To insure proper accounting, UDM increases the MGRA change in occupied units by the number of units removed from any income category.

For MGRA occupied unit decrements, UDM lowers the adjusted base year MGRA income data (from step 1) until the MGRA decrement(s) are completely allocated. It does this with a method that removes units in proportion to the income category's share the occupied units in an MGRA. To insure proper accounting, UDM increases the ZUM changes by the number of units removed from each income category.

Finally, UDM distributes positive changes in both the ZUM household income distribution and MGRA occupied units. The first step calculates a cumulative probability distribution of the ZUM changes. This distribution determines the allocation of MGRA occupied units into the income categories. In other words, UDM assumes that new units in an MGRA take on the income characteristics of the ZUM. A loop controls the allocation of MGRA occupied units into the income groups. The loop begins at one and ends with the number of MGRA occupied units to be allocated. Each time through this loop, UDM selects a random number between 1 and 100 and compares this random number to the values in the probability distribution. A random number less than or equal to the probability distribution value determines the appropriate income category to receive an allocation. Once the income category is determined, UDM adds one to the adjusted base year MGRA income data in that income category (from steps 1 and 2). To insure proper accounting, it also subtracts one from both the MGRA occupied units change and the ZUM change for the same income category. When UDM finishes the loop, all MGRA occupied units are allocated to the appropriate income category. If during this loop any ZUM change is completely allocated, UDM recalculates the probability distribution to prevent additional units from being allocated to that income group(s). UDM applies this allocation routine to each MGRA with a positive change in occupied units.

UDM's last major function is to allocate the ZUM forecast of civilian employment by industrial category to the MGRAs. It does this allocation using the same routine and logic just described for the household income distribution.

## 2020 CITIES/COUNTY FORECAST INPUTS

UDM requires a detailed set of inputs for each MGRA. These data include land use, employment capacity, housing capacity, employment, household income, population, and housing. Land use information incorporates existing land uses, current general and community plans, constraints to development, and areas of potential redevelopment or infill. These factors are combined to show the precise location of future activities within the region, and the employment and housing capacities indicate the growth potential of an area. These capacities are based on future land use and development density. Employment, income, population, and housing estimates provide the starting point for the 2020 Cities/County Forecast. In addition to these MGRA inputs, UDM requires transportation information including travel times between ZUMs and the share of workers using transit.

### Land Use Inputs

All land use input data are collected by SANDAG, converted to digital form, mapped, and then corroborated by the planning staffs of the region's 19 jurisdictions. In addition to the local jurisdiction planners, other sources are consulted to provide land use inputs. One is the San Diego Unified Port District, whose plans are, in most cases, identical to or compatible with those of the affected cities. Also consulted for their plans are the Centre City Development Corporation and the four major universities: USD, UCSD, SDSU, and CSUSM.

Developing the land use inputs database is the most labor-intensive task in the forecasting process, and requires almost one year to complete. The region is divided into 97 planning areas to make collecting and checking the data more manageable. For cities other than San Diego, the planning areas are contiguous with their city boundaries, or, where applicable, their sphere of influence boundary. Within the City of San Diego and the unincorporated area, community plan area boundaries are used. For each subarea, six computer-generated maps are produced. A SANDAG analyst meets at least once with the planner(s) for each area to explain the maps and the inputs gathering process. Below is a summary of the purpose of each map and the specific information requested from the local planners.

Map 1 shows the general (or community) plan. Its purpose is to produce an accurate database of all planned land uses, including any recent changes or amendments. The planners are asked where within the plan's residential density ranges does development typically occur by policy. Is that a gross or net density? Is development intended to be phased in over some specific timetable? The planners also are asked for details regarding mixed-use plan categories and Specific Plan Areas (areas without detailed planned land uses).

Map 2 shows existing land uses. Its purpose is to produce an accurate database of how land is currently being used (e.g., single family homes, regional shopping center). This information is from SANDAG's 1995 Generalized Land Use Inventory, which is based on previous inventories, satellite imagery, aerial photos, and field checks. The planners are asked to review for completeness and accuracy.

Map 3 shows constraints to development. Its purpose is to identify vacant areas where development will not occur at least until the year 2020. Typical constraints include steep slopes (25% or greater), public lands, flood areas, airport noise contours, future freeway rights-of-way, wetlands, and preserves. The planners add any other areas treated as off-limits to future development such as riparian habitat, transmission line easements, or habitat conservation areas, and remove constraints that do not preclude development.

Map 4 shows potential redevelopment areas. Its purpose is to identify currently developed areas that have the potential to change their land use. This map is the result of overlaying the general or community plan information from Map 1 to the existing land uses from Map 2 and highlighting any apparent discrepancies. A common example is single family development in an area where the plan allows multiple family densities. For each area identified, the planners are asked to determine whether or not that land is likely or has the potential to redevelop to the underlying plan category. Agricultural land is included on the redevelopment map if it overlays to a general plan category other than agriculture. Unless the planners specifically indicate that these lands will remain in agriculture, they are allowed to develop according to the underlying plan category.

Map 5 shows potential infill areas. Its purpose is to identify currently developed areas that have the potential to intensify their land use. An example is adding more single family units to a single family area through lot splits. This map indicates areas where the current housing unit density is less than the three-quarter point of the density range allowed by the general plan. For example, if a plan category specifies a range of 3-6 units per acre, this map shades all areas of that category where the current density is less than five units per acre. The planners are asked whether or not that land is likely or has the potential to infill.

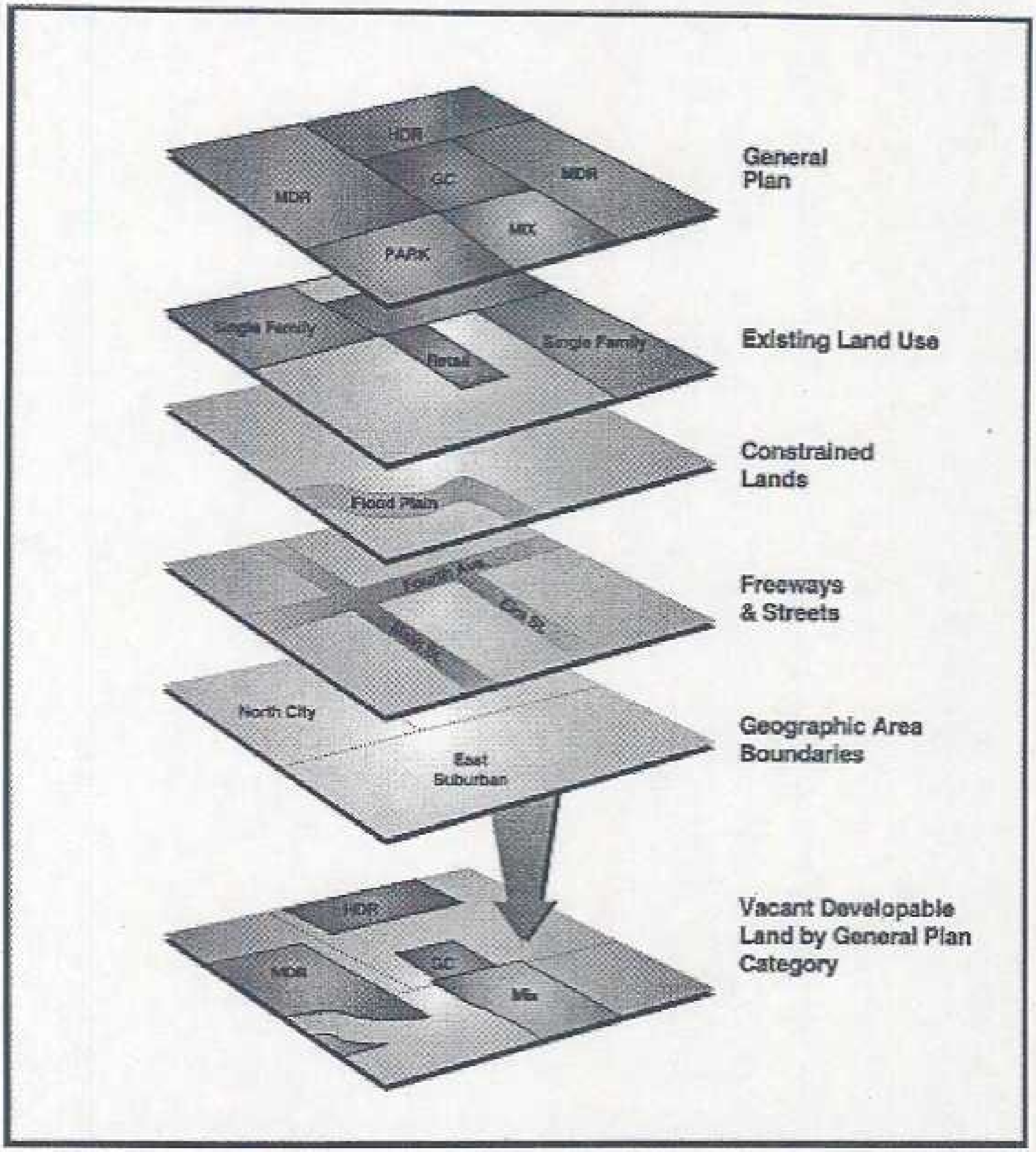
The last map, Map 6, shows site-specific projects. Its purpose is to be certain that all recent development projects are included in the forecast. These are limited to major projects (more than 20 units for residential and more than five acres for non-residential) for which construction was begun or completed since mid-1995. This also includes projects that have not yet begun construction, but have final approval and are certain to be built. The planners are asked to provide information regarding each project including, project name, project completion date, number of units, type of units (i.e., single family, multiple family, or mobile homes), employment type (e.g., light industrial, retail, services), square footage of non-residential projects, and, if known, the number of employees.

After the local planners review the mapped data, their changes are incorporated into the various databases. Using SANDAG's geographic information system, these databases are then overlaid to each other to identify where the future development can occur and the type of development (See Figure 1-3). Beginning with the general plan, the overlay process "removes" developed land, constrained land, and land set aside for future streets and freeways. The result is a spatial database of land that is both vacant and developable, or has the potential to redevelop or infill. These are the only areas where the UDM places future activity. A detailed description of the land use is found in a SANDAG report entitled *2020 Cities/County Forecast Land Use Inputs*.

### Employment and Housing Stock Capacities

Capacity reflects the potential amount of change in an area. UDM uses the employment and housing stock capacity information in two ways. First, it helps determine the location of future growth. Second, it provides a ceiling on the amount that an area can grow. Capacity calculations, for areas that have land available to accommodate future activities, are based on the land use inputs. These inputs specify the amount of land available (acres), the anticipated use of that land, and its development density. In general, capacity is determined by multiplying the acres by the appropriate density. For residential areas, the density comes directly from the general or community plan. Residential densities are usually expressed as a range, so a density range factor specifies the actual density for residential development. This factor, which represents the point within the density range where development occurs, is obtained during the collection of the land use inputs. Employment capacities are based on 1995 regional employment densities specific to 35 different employment land uses. Since employment densities are usually much higher in the urban core, separate densities are used to determine the employment capacity in downtown San Diego. Most capacities represent gains in activity. Although, in redevelopment areas a capacity is negative if it reflects the activity that is replaced during the land use conversion.

Figure 1-3
2020 Cities/County Forecast
Land Use Overlay Process



### Employment

SANDAG's 1995 Employment Inventory provides employment data for the 2020 Cities/County Forecast. The inventory consists of more than 91,000 work sites, their employment size, their geographic attributes, and their Standard Industrial Classification (SIC) codes. The employment inventory starts with a site-level employment file purchased from a private vendor. Obsolete and erroneous records are purged and the file is enhanced with other sources, such as previous employment inventories, telephone directories, the Chamber of Commerce, and activity center locations. Firms with 300 or more employees are telephoned to confirm their employment levels. When the file complete and up-to-date, it is address-matched to obtain MGRA and other geographic attributes for each site. Finally, the employment size for each site is adjusted to match regional employment estimates provided by the State Employment Development Department.

### Population, Housing, and Household Income

These data reflect July 1995 estimates for a variety of demographic and economic characteristics. Estimates are prepared for housing stock, occupied units, household population, group quarters population (e.g., persons living in jails, nursing homes, and military barracks), employed residents, and household income. The housing variables are stratified into single family units, multiple family units, and mobile homes. The estimates are derived from SANDAG's annual population, housing, and household income estimates, which are developed for January 1. The July estimates reflect an interpolation between the January 1, 1995 and January 1, 1996 estimates.

### Transportation

Transportation policy assumptions, developed with the assistance of Caltrans and various transit agencies and advisory committees, are essential to UDM. Existing and planned freeways, roads, and transit networks are incorporated into subregional connectivity patterns. The future transportation networks used in the 2020 Cities/County Forecast are based on the 1995 Regional Transportation Plan (RTP). ZUM-to-ZUM accessibility patterns and the proportion of workers using transit are derived from these networks and from SANDAG's transportation models. The statistical parameters for the travel time probability distributions used in UDM are based on the 1995 Travel Behavior Survey conducted by SANDAG, calibrated to 1995 traffic counts.

## THE CAPACITY PROBLEM AND LAND USE ALTERNATIVES

The land use inputs data collected from the 19 local jurisdictions represent land use and growth policies as they currently exist. The Series 8 Regional Growth Forecast, released in 1995, indicated that for the first time the existing policies would not accommodate the forecasted regionwide growth in population and housing. Consequently, the final Series 8 Forecast included a procedure called "general intensification" whereby the planned residential densities were slightly increased in an across-the-board manner in order to produce a forecast to the 2015 horizon year.

The 2020 Cities/County Forecast faces this same capacity issue. Under existing policies, there is not enough land planned for urban-level residential use, which is defined as a density of at least one unit per acre. One solution is to again employ the general intensification procedure. However, both the Regional Growth Management Technical Committee (the region's planning directors) and the SANDAG Board of Directors feel a more proactive, planning-based approach to the problem is more appropriate. Therefore, as part of the 2020 Cities/County Forecast SANDAG evaluated the policies contained in the Land Use Distribution Element of the Regional Growth Management Strategy. The Land Use Distribution Element recommends that each jurisdiction:

1. Locate its highest residential densities within walking distance of transit stations, along bus corridors, and within its traditional town center;
2. Encourage mixed use development, thereby providing more residential choices to its citizens and;
3. Where possible, include residential development within large employment areas.

In order to simulate the implementation of these policies, seven Land Use Distribution Element "templates" are applied in a general fashion around the transit stations and within the town centers shown in Figure 1-4. Each template provides a different combination of redevelopment, land use mix and residential/employment densities, depending on the existing characteristics of that particular area (see Table 1-1). SANDAG in conjunction with local planning staffs assigned an appropriate template to each of the current and future transit stations, as well as to the 12 town centers.

An existing policy forecast, based on the land use inputs described in this report, was compared to three alternative forecasts that include the Land Use Distribution Element recommendations. The results of this evaluation are clear: any manner of implementing the Land Use Distribution Element policies produced a substantially better forecast in terms of land consumption, housing prices, traffic congestion and several other quality of life factors. The full analysis is available in a SANDAG report entitled *2020 Cities/County Forecast Land Use Alternatives*.

**Figure 1-4**
**Land Use Distribution Element Sites**

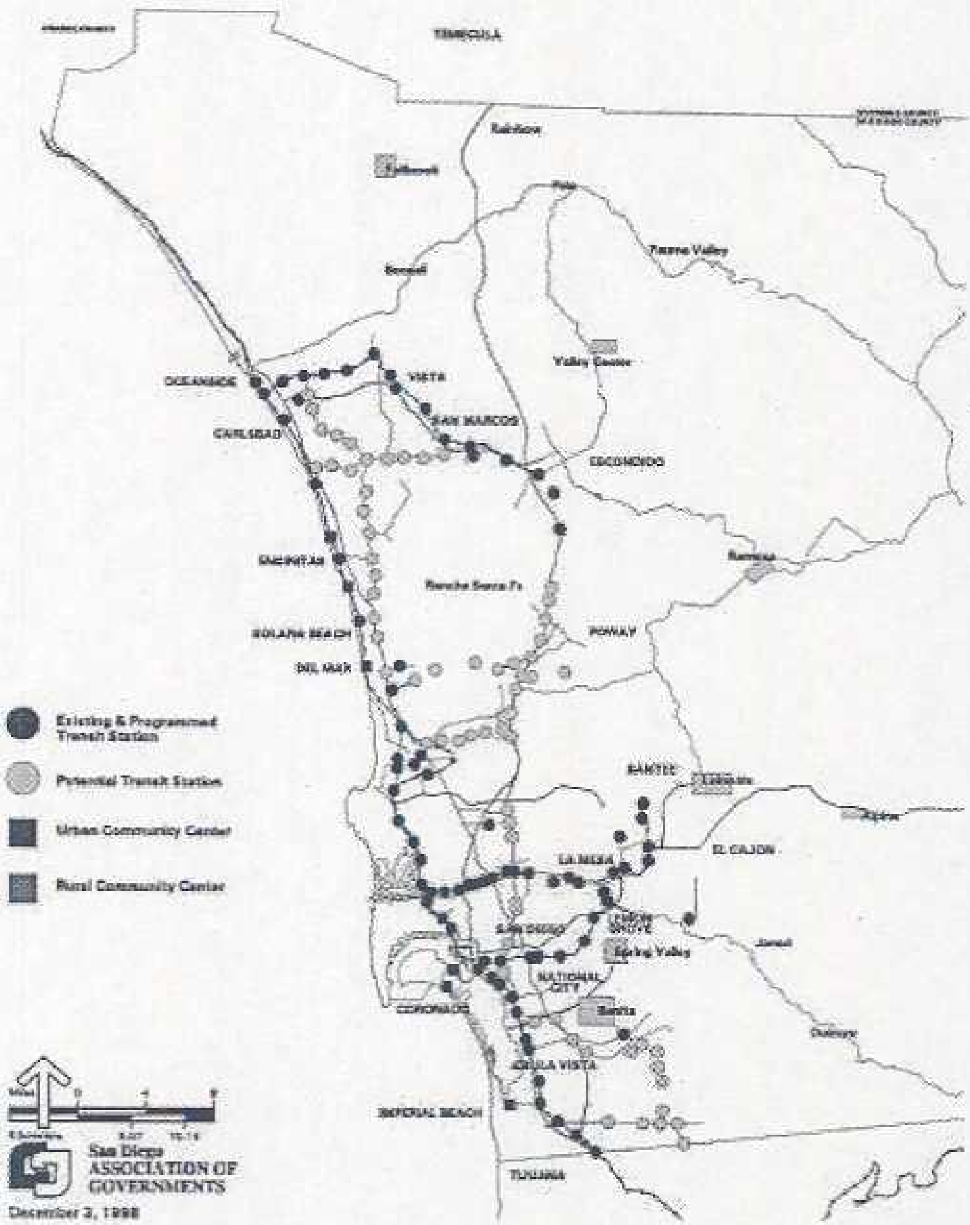


Table 1-1
Land Use Distribution Element Site Templates

| Templat e | % to be Redeveloped | % Mix of Houses/ Office/Retail | Residential Density[1] | Employment Density[2] | Examples |
|---|---|---|---|---|---|
| 0[3] | n/a | n/a | n/a | n/a | Otay Ranch<br>Rio Vista West |
| 1 | 30 | 75/ 10 / 15 | 50 | 100 | Washington St. LRT Station Barrio Logan |
| 2 | 20 | 50/ 30 / 20 | 30 | 100 | University Towne Center |
| 3 | 40 | 50/ 25 / 25 | 30 | 60 | El Cajon Transit Center<br>Lemon Grove - Broadway |
| 4 | 0 | 75/ 15 / 10 | 25 | 40 | Santee Town Center |
| 5 | 0 | 35/ 15 / 50 | 25 | 40 | Rancho Del Oro Drive |
| 6 | 70 | 50/ 20 / 30 | 20 | 40 | Vista-Sycamore<br>University Avenue Corridor<br>Chula Vista – E Street |

[1] *Housing units per acre.*
[2] *Civilian employees per acre.*
[3] *Current plan consistent with Land Use Distribution Element Polices.*

## REVIEW AND ACCEPTANCE

Over the years, SANDAG has built a solid reputation for the accuracy and reliability of its Regional Growth Forecast. A major reason for this success is the extensive external review of both the regionwide and Cities/County forecast. The guidance, expertise, and insights of the committees, local staffs, policy-makers, and other groups that review the forecast are indispensable to the development of accurate information for regional decision-making. The objective of this extensive review and acceptance process is to gain consensus on the most likely path of future growth in the San Diego region and in its jurisdictions and communities. Reaching consensus is important because it enables all plans to be based on agreed upon policy directions regarding residential and non-residential growth.

In July 1998, the SANDAG Board accepted the preliminary 2020 Regionwide Forecast for distribution, review, and use in the 2020 Cities/County Forecast 1998. Two months later, the SANDAG Board accepted the land use alternatives report for distribution and requested the preparation of a preliminary 2020 Cities/County Forecast based on these recommendations from that report:

1. Implement the policies of the Land Use Distribution Element in the 18 cities;
2. Develop residential land at the top end of the density ranges expressed in the general and community plans of the cities; and
3. Use the County community plan area and sponsor group area 2020 population targets as the basis of the forecast in the unincorporated area.

Every city council and the County Board of Supervisors will review the preliminary 2020 Cities/County Forecast, along with many other groups from both the private and public sectors. A final 2020 Cities/County Forecast will be prepared that incorporates the comments received. That revised forecast will be acted on by the SANDAG Board for inclusion in the Regional Growth Management Strategy.