Working Paper 592

CUF Model Simulation Results: *Alternative Futures for the Greater Bay Area Region*

John D. Landis

with Peter Hall, Michael Teitz,
Ted Bradshaw, Edmund Egan, Ayşe Pamuk,
Qing Shen, and David Simpson

Research for the California Urban Futures (CUF) project has been funded by the California Policy Seminar and the University of California Transportation Center.

University of California at Berkeley
Institute of Urban and Regional Development

CUF MODEL SIMULATION RESULTS:
Alternative Futures for the Greater Bay Area Region

John D. Landis
with Peter Hall, Michael Teitz, Ted Bradshaw,
Edmund Egan, Ayse Pamuk, Qing Shen, and David Simpson

I. INTRODUCTION: THE CHALLENGE OF GROWTH PLANNING

The current recession notwithstanding, many knowledgeable forecasters project that California could add 8-10 million new residents by the year 2010. Ten years into the next millennium, California's population could, quite possibly, be closing in on the 40 million mark. A significant share of the state's growth, perhaps as much as 30 percent, will occur in the fourteen counties that comprise the San Francisco Bay Area and the Sacramento-Stockton-Modesto urbanized area.

While there is some agreement as to *how much* California is likely to grow, there is much less agreement as to the *quality* of that growth. Questions about the location, direction, and pattern of future development abound. Foremost is the question of where new development should occur: in already-developed cities and towns, or at the periphery of existing metropolitan areas, or in previously undeveloped areas in the form of "new towns"?

A second set of questions focuses on the appropriate density for new development, particularly residential development. Should residential densities be determined by private developers responding to market forces? Or should public policy encourage higher residential densities as a way of conserving open-space and promoting more intense use of *existing* infrastructure capacity?

A third set of questions involves the issue of regional planning. Can appropriate development regulations be adopted and implemented by multiple local governments, or is some form of county or regional coordination essential?

Answering these questions requires information and technical capabilites that do not yet exist. These include:

- A detailed, accurate, and accessible information base showing where, why, and how development is occurring, as well as how new development is impacting the natural and social environment.
- A process for conceptualizing alternative development futures and for articulating the policies that would produce those futures.
- An ability to analyze and evaluate the environmental, social, and economic implications of those alternative futures.

This research has been funded by the California Policy Seminar and the University of California Transportation Center. A more extensive report on the development and use of the CUF model is available from the California Policy Seminar.

The California Urban Futures project is an attempt to fill this void. The project has involved three related efforts: (1) the development of a realistic *planning model* capable of simulating how specific growth planning policies would affect the location, pattern, and density of new development in the Greater San Francisco Bay Region; (2) construction of a set of realistic yet different *growth policy scenarios* linking appropriate regulatory policies, incentives, and infrastructure investments; and (3) use of the planning model to simulate how the different growth policy scenarios would affect the *location, pattern, and density of new development* in the Greater San Francisco Bay Region in the year 2010, and to present the results in a visual, easy to understand form.

This working paper summarizes the results of those efforts. It is organized into six parts. Part Two summarizes the California Urban Futures (CUF) Simulation Model, and explains how the model may be used to develop and test alternative growth policy scenarios. Part Three presents eight alternative development scenarios, as well as the specific policies that could be used to achieve those futures. Part Four presents the results of three sets of scenario simulations: a "Business-as-Usual" alternative; a "Maximum Environmental Protection" alternative; and a "Compact Cities" alternative. Part Five examines how the three growth policy scenarios would affect the pattern, location, and density of new development of four regional growth "hotspots." Part Six examines the environmental and land conversion implications of the three development scenarios.

II. THE CALIFORNIA URBAN FUTURES MODEL

Defining the Study Region

The California Urban Futures Model is designed to forecast alternative growth futures for the Greater San Francisco Bay Region — henceforth referred to as the Greater Bay Region. The Greater Bay Region consists of 14 northern California counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, and Yolo (see Map 1).

To our knowledge, this is the first time these 14 counties have been grouped together as a single region. Historically, they have been considered to be part of four different urban areas: (1) the nine-county San Francisco Bay Area;[1] (2) the Sacramento area; (3) the Stockton-Modesto area; and (4) the Santa Cruz-Monterey area. In recent years, however, more and more people have come to live in one of these areas but work in another. The economies, social fabrics, and development forms of these various areas are becoming ever more integrated, leading to a blurring of the traditional regional definitions described above.

Units of Analysis

The detailed workings and design principles of the California Urban Futures Model are presented in detail by Landis (1992). The CUF Model is designed around two very different units

Map 1: 14-County Greater Bay Region Study Area

of analysis: incorporated *cities* (and counties), and *Developable Land Units* (DLUs). Population growth, the demand side of the CUF Model, is projected for cities. Development potential, the supply side of the CUF Model, is calculated in terms of DLUs.

The choice of cities as a primary unit of analysis reflects the policy orientation of the CUF Model. Under California law, control of development and land uses rests solely in the hands of incorporated city and county governments. By contrast, municipal utility districts, regional authorities, census-designated places, and villages and towns (to the extent that they exist in California) do not have control over land uses and/or development. As of January 1991, there were more than 150 city and county governments in the Greater Bay Region having direct control over local land uses and development.

Incorporated cities also have some measure of land use control over directly adjacent, unincorporated areas. Such areas, known as *spheres-of-influence,* are established and updated by county Local Agency Formation Commissions, or LAFCOs. Spheres-of-influence were originally intended as flexible urban limit lines; they were to be the areas into which growing cities would eventually expand, and to which cities could economically provide local public services.

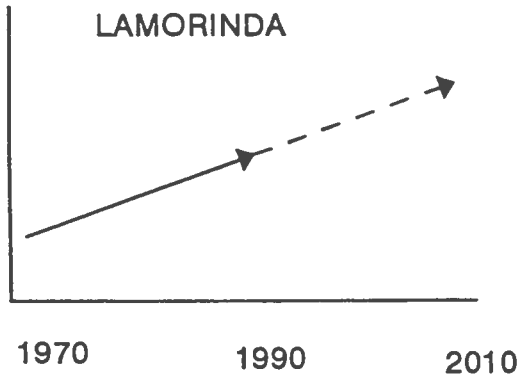
Developable Land Units (DLUs) are the second primary unit of analysis in the CUF Model. DLUs are currently undeveloped (or underdeveloped) areas inside and outside cities and are available for development or redevelopment. DLUs are *polygon constructs* generated by the GIS component of the model and are described according to the geometric union and/or intersection of various environmental, market, and policy attributes. An example of a DLU would be an undeveloped site with steep slopes, served by sewers, zoned for light industrial, that is less than 500 meters from a major freeway. In urbanized areas, DLUs begin to approximate collections of developable parcels.

An Overview of the CUF Model

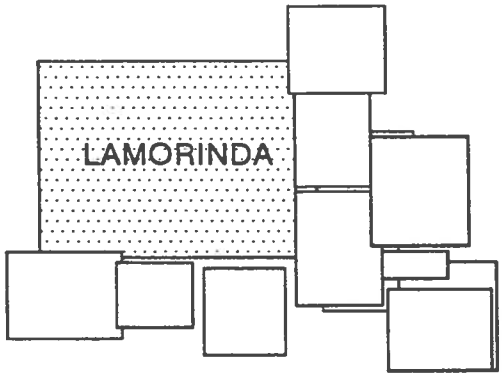
Seen in a nutshell, the CUF Model simulates future growth by determining how much new development to allocate to each DLU during every model period as a function of population growth in each city and county, the characteristics of each DLU, and a series of user-specified decision-rules. Thus, the structure of the CUF Model incorporates four related sub-models, shown schematically in Figure 1:

1. *The Bottom-Up Population Growth Sub-Model.* This sub-model is the demand side of the CUF Model: it generates five-year population growth forecasts for each city and county in the study region. This sub-model consists of two regression equations of population growth in the cities and counties of the ten-county San Francisco Bay Area.[2] Both equations are essentially trend lines. That is, they predict current city and county population as a function of past population levels, and as a function of local policies that promote or retard growth.

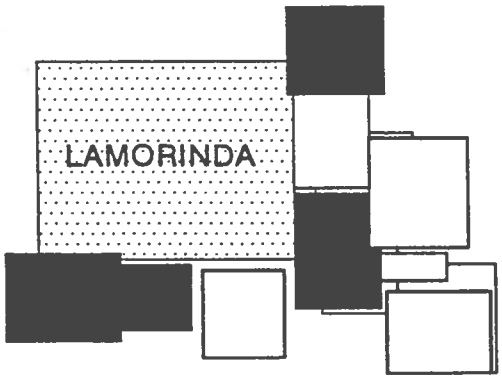
Figure 1: CUF Model Logic



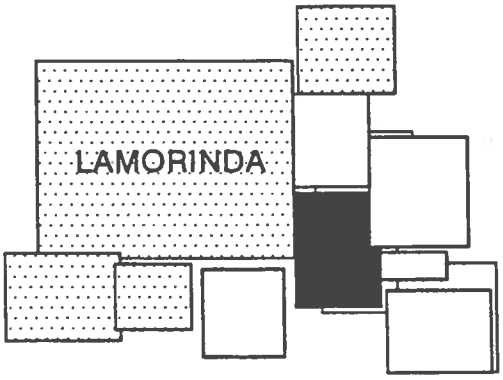
1. Bottom-Up Population Forecasing Model



2. Spatial Database



3. Spatial Allocation



4. Annexation/Incorporation Model

2. *The Spatial Database.* This GIS-based sub-model is the supply side of the CUF Model: it generates and updates the geometry, location, and attributes of each DLU. It is also the primary tool for displaying the spatial pattern of growth.

   The spatial database consists of a series of map layers that describe the environmental, land use, zoning, current density, and accessibility characteristics of all sites in the study area. These various layers can be analyzed individually, or merged into a single DLU layer that includes all the relevant attribute information for each resulting polygon. The spatial database currently includes the following map layers: (1) Roads and highways; (2) Census tracts; (3) City boundaries; (4) Streams and water bodies; (5) City spheres-of-influence; (6) 500-meter slope polygons; (7) Highway corridors or buffers; (8) Urbanization buffers or corridors; (9) Wetland locations; (10) Agricultural land quality; and (11) Earthquake faults. Table 1 lists the data layers and sources that are included in the spatial database.

3. *The Spatial Allocation Sub-Model.* The spatial allocation sub-model is a series of decision rules for allocating future population growth (as projected using the bottom-up population growth sub-model) to the thousands of developable land units (as generated through the spatial database). In economic terms, the function of the spatial allocation sub-model is to "clear the market" —to match the demand for developable sites (as manifest through city and county population growth) to the supply of developable sites (as described by the attributes, size, and location of DLUs).

   Unlike most economic models of the development process, the spatial allocation sub-model works by mimicking the way private sector developers screen available sites according to their likelihood of development and ultimate profit potential. This logic is incorporated into the spatial allocation model in the following steps:

   i. All undeveloped DLUs in a county are scored according to their potential profitability if developed.

   ii. DLUs that are unsuitable for development due to environmental, ownership, or public policy reasons are eliminated from consideration.

   iii. Within each city and its sphere-of-influence, the remaining DLUs (those that could be developed) are sorted from high to low in order of their potential profitability.

   iv. Forecast population growth for each city is allocated to the DLUs within each city sphere-of-influence in order of DLU profit potential (high to low); and at population densities consistent either with current zoning and general plan requirements, or at "up-zoned" population densities comparable to other developed areas in the city. After it has allocated as much population growth as will fit into the DLU with the highest profit potential, the model moves to the next most profitable DLU, and does the same. The allocation process within a city is complete either when all forecast population growth is allocated, or when there is insufficient undeveloped land in the city to accommodate forecast growth.

   v. The same logic as above is used to allocate forecast county population growth (plus any unallocated spill-over growth from individual cities) to unincorporated county DLUs.

   The potential for spill-over development is one of the most interesting parts of the model. Spill-over occurs when there is insufficient developable land in a city or county to accommo

Table 1: Spatial Database Map Layers and Their Sources

Map Layer	Source
1. City and County Boundaries	1990 Census TIGER File
2. City Sphere-of Influence Boundaries	Digitized from maps provided by County Local Agency Formation Commissions (LAFCOs)
3. Major Freeways and State Roads	1990 Census TIGER File
4. Local Roads	1990 Census TIGER File
5. Current Urbanized Areas	California Farmland Mapping Project
6. Agricultural Land Quality	California Farmland Mapping Project
7. Slope	U.S. Geological Service
8. Publicly owned Lands	State of California
9. Wetlands	U.S. Fish and Wildlife Dept.
10. Earthquake Faultlines	Digitized from U.S.G.S. Maps

date that city/county's forecast population growth. In such cases, the unallocated increment of population growth is accumulated for potential re-allocation (or spill-over) into a neighboring municipality, unincorporated area, or county.

4. *The Annexation-Incorporation Sub-Model.* This model is a series of decision rules for annexing newly developed DLUs to existing cities, or for incorporating clusters of DLUs into new cities.

III. ALTERNATIVE DEVELOPMENT SCENARIOS AND POLICIES

Using the CUF Model to simulate alternative development scenarios is basically a two-step process. The first step is to articulate a testable set of development policies. Testable development policies can be entirely local, as, for example, the direction to "simulate the growth of the Greater Bay Region assuming every city and county in the region continues to pursue its present zoning and development policies independently of every other city and county." At the opposite extreme, one could use the CUF Model to test how a single, region-wide set of growth policies would affect future development patterns.

Our initial intention in developing the CUF model was to use it to test the development implications of different sets of *outside* growth policies— that is, policies *put forth by groups other than ourselves*. It quickly became apparent, however, that all such existing outside policies— whether put forth by environmental interest groups, business groups, or regional agencies— would be too vague to test. Lacking a coherent set of outside growth policies to test, we developed eight of our own. These eight policy sets, or scenarios, fall into three broad groups: (1) *Business-as-Usual*: assuming the continuation of current local growth policies; (2) *Environmental Protection*: assuming increasing levels of environmental protection, coordinated across existing city and county governments; and (3) *Compact Growth*: assuming county-wide policies designed to promote compact and contiguous development forms. These policy scenarios are explained in greater detail below.

Two Business-as-Usual Scenarios

The two business-as-usual scenarios are *baseline* scenarios. They reflect a development process that is guided by existing local government policies (in terms of which uses are permitted where) and by the preferences of the marketplace (in terms of development densities, and preferred locations).

1A. *Scenario 1A: Business-as-Usual:* This policy scenario assumes that current local development policies (chiefly zoning ordinances and general plans) will remain in place, largely unmodified, through the year 2010. It also assumes that the densities of new home development will be determined by private developers according to the economics and preferences of the marketplace. Development will continue to be permitted in unincorporated areas beyond existing city spheres-of-influence. Should there be insufficient developable land in a city sphere-of-influence to accomodate projected population growth for that city, the excess would "spill-over" into nearby unincorporated areas.

1B. *Scenario 1B: Business-as-Usual/No Spill-over:* This policy scenario is similar to 1A but for one exception: any potential "spill-over" growth from incorporated cities would not be accepted in adjacent county areas. The purpose of Scenario 1B is to determine whether there are any cities in the Greater Bay Region which will not be able to accomodate their projected population growth within their current zoning requirements and spheres-of-influence.

Four Environmental Protection Scenarios

The four environmental protection scenarios incorporate sequentially increasing levels of environmental protection. DLUs are precluded from development solely on the basis of their environmental sensitivity, and not on the basis of other policy aims (such as the creation of a greenbelt).

2A. *Scenario 2A: Slope and Wetland Protection:* This scenario assumes the adoption of region-wide policies to protect steeply sloped areas and existing wetlands. Specifically, it would prohibit new development on designated wetlands and on hillsides having slopes in excess of 15 percent. In other respects, it is similar to Scenario 1A.

2B. *Scenario 2B: Agricultural Land Conservation:* This scenario adds to Scenario 2A, above, by prohibiting the development of prime and unique agricultural lands located beyond existing city spheres-of-influence or, in cases where local spheres-of-influence are tightly drawn to 1,000 meters beyond existing city boundaries. Such a policy could be implemented at the regional or county level.

2C. *Scenario 2C: Environmental Protection plus Slightly Higher Densities:* This scenario builds on Scenario 2B above, by further restricting the development of close prime and unique agricultural lands (limiting the development of agricultural lands beyond existing spheres-of-influence, or within 1,000 meters of existing city boundaries, whichever is less); and by requiring that the average density of new home construction be equivalent to existing average residential densities. In other words, cities would grow at their historical densities, rather than those determined in the marketplace. The extent to which such policies, to be administered locally, might really promote greater densities (as compared to market densities) would vary by city.

2D. *Scenario 2D: Maximum Environmental Protection:* This policy scenario is similar to 2C above, but even more stringent. Development would be prohibited on all lands designated as "prime agricultural,""unique,""of locally designated importance," and "of state designated importance."

Two Compact-Cities Scenarios

In order to make more efficient use of existing public infrastructure, and to further protect sensitive environmental resources, many interest groups have advocated trying to focus development into existing urban areas or into planned "new towns." The following two compact growth scenarios propose exactly these policies:

3A. *Scenario 3A: Compact Cities:* This policy scenario is based on the concept that new residential development should only occur in and around existing urban areas. To promote such a goal, this scenario assumes the region-wide adoption of three sets of polices: (1) that all new

residential development occur at an average density of 4,500 persons per square kilometer or greater; (2) that all cities adopt a policy of accommodating 20 percent of their projected population growth in the form of "infill" (developable or redevelopable parcels within city boundaries); and (3) that counties adopt policies designed to direct new development in unincorporated areas to within 1,000 meters of existing city boundaries, or within city spheres-of-influence. In terms of environmental protection, this scenario is similar to 2C, above.

3B. *Scenario 3B: Compact Cities/New Towns:* This policy scenario is similar to 3A, above, in all respects except one: the growth of unincorporated areas would occur at or around designated "new towns" instead of being channeled into existing spheres-of-influence. These "new towns" are identified as existing, unincorporated clusters of residential development.

From a policy implementation perspective, all these policy scenarios are reasonable. Even the most stringent policy scenario, 3A, calls for what are only modest increases in residential densities (rising, in the Bay Area, from an average of 5.5 units per acre to 7.5 units per acre) and infill levels. Such changes could be readily accomplished by adopting "density floors" as part of local zoning ordinances.[3] Although prohibitions on the development of steep slopes and wetlands (Scenarios 2A through 3B) may seem extreme to some, in reality the most steeply sloped and/or the wetland parcels are not particularly attractive to residential developers. Thus, such prohibitions would have only a marginal effect on overall land supplies.

Depending on the city and county, restrictions on the development of prime and unique agricultural lands would affect substantially more land area than would restrictions on the development of wetlands or hillsides. In counties such as Contra Costa, Solano, and Napa, and throughout the Central Valley, many of the sites otherwise suited for development are also in agricultural use.

While these various policy scenarios may be substantively feasible, they may not be politically feasible —at least not yet. Discussions of regional government aside, there are currently no agencies or institutions in either the Bay Area or the Central Valley able to coordinate zoning and land use policies among cities, let alone among counties. Except for a few places such as Contra Costa County and the city of San Diego, California cities and counties continue to pursue land use policies and zoning in isolation from one another. Indeed, many California communities still compete with each other to attract revenue-rich land uses.

Still, political winds do shift: the fact that an otherwise beneficial policy is not politically feasible under the current system of metropolitan governance should not rule out its consideration.

Simulating the Policy Scenarios

Computer models are not very good at interpreting policies. In order to simulate the policy scenarios outlined above, they must first be transformed into a set of "rule inputs" which may applied to the database of potentially developable sites. Each scenario consists of four sets of development policy or "rule-inputs":

1. *Development prohibitions:* This is a list of site, location, or policy criteria that determine whether an area may be developed or not. An example of a development prohibition rule would be: *eliminate from development consideration all those sites (DLUs) that are classified as wetlands.* Scenarios 2A through 3B all involve specific development prohibition rules.

2. *"Infill shares":* These are the shares of each city's projected population growth which will be allocated back within city boundaries as "infill" development. Infill shares vary from 0 percent, indicating that all projected population growth will occur outside of previously developed areas, to 100 percent, indicating that all projected population growth will occur within previously developed areas. Infill shares may be based on historical trends, or may be set according to local, county, or regional policies. For example, Scenarios 1A through 2D stipulate that the share of each city's population growth occurring as infill development between 1990 and 2010 will be the same as between 1980 and 1990. By contrast, Scenarios 3A and 3B require that a minimum of 20 percent of projected 1990-2010 population growth occur as infill development in every incorporated city.

3. *Housing allocation densities:* These are the average densities at which new residential development is projected to occur. Housing allocation densities may be determined in the market, or through local, county, or regional policies. Scenarios 1A through 2B, for example, stipulate that new residential development will occur at the current market-based average. This average, which varies by city, was obtained by sampling the lot sizes of single-family homes built in Northern California between 1985 and 1990. Scenarios 2C and 2D, by contrast, stipulate that new residential development should occur at an average residential density equivalent to historical densities, which, again, vary city by city. Initially, we presumed that historical city densities would exceed market densities; that is, that the market has led to a greater degree of urban sprawl. Surprisingly, however, this is not always true. In many cities, market-based densities exceed historical densities, indicating that the market is responding to higher land and housing prices by reducing lot sizes, and thereby reducing overall land consumption for a given level of housing production. Scenarios 3A and 3B require that the average densities of all new residential development, regardless of location, exceed 4,500 persons per square kilometer.

4. *Spill-over rules:* These are the rules which govern where, if at all, spill-over growth (population growth that cannot be accommodated in a particular city) is to be allocated. Spill-over growth need not be accommodated — it may be ignored. Or it may be re-directed into cities with remaining development potential. It may be directed to certain parts of the county (e.g. "new towns"), or to particular sites depending on its attractiveness to private developers. Spill-over growth is ignored under Scenarios 1B and 3A (this is equivalent to saying that the county or region cannot accommodate some level of growth). Under Scenarios 1A and 2A through 2D, any spill-over growth is allocated to unincorporated county lands beyond city spheres-of-influence. And in Scenario 3B, spill-over growth is allocated to sites in and around designated "new towns."

Table 2 summarizes the eight scenarios according to their policy "rule" inputs.

Table 2: Summary of Policy Input "Rules" by Scenario

Scenario	Development Prohibitions	Residential Allocation Density	Infill based on	Unincorporated Pop. Growth	City Spillover (if any)
"Business as Usual"					
1A. All Growth Accomodated	None	1985-90 Market*	1980-90 share*	to Uninc. Areas	to Uninc. Areas
1B. Spill-over Not Accomodated	None	1985-90 Market*	1980-90 share*	to Uninc. Areas	Not Allowed
"Environmental Protection"					
2A. Steep Slopes & Wetlands Protected	15% Slope & Wetlands	1985-90 Market	1980-90 share*	to Uninc. Areas	to Uninc. Areas
2B. Development on Ag. Lands Limited	Prime Ag. within S-O-I	1985-90 Market	1980-90 share*	to Uninc. Areas	to Uninc. Areas
2C. & Must be within Urban Limit Lines	Prime Ag. within S-O-I	Avg. City Density*	1980-90 share*	to Uninc. Areas	to Uninc. Areas
2D. Maximum Environmental Protection	No Ag. land	Avg. City Density*	1980-90 share*	to Uninc. Areas	Not Allowed
"Compact Cities"					
3A. Compact Cities	2C, above	Countywide Minimum	20% minimum	to Uninc. Areas	Not Allowed
3B. Compact Cities & New Towns	2C, above	Minimum	20% minimum	to "New Towns"	to "New Towns"

*Notes: * varies by city*

IV. CUF MODEL SIMULATION RESULTS

This section reports the results of the CUF Model simulations for three scenarios: *Scenario 1A: Business-as-Usual; Scenario 2D: Maximum Environmental Protection; and Scenario 3A: Compact Cities*. With few exceptions, the simulation results for Scenario 1B: Business-as-Usual/No Spill-over do not differ from the simulation results for Scenario 1A. Similarly, the simulation results for Scenario 3B: Compact Cities/New Towns are essentially similar to the simulation results for Scenario 3A: Compact Cities. The simulation results for Scenarios 2A through 2C differ from those of 2D: Maximum Environmental Protection mostly in matters of degree.

Scenario 1A: Business-as-Usual

Scenario 1A: Business-as-Usual assumes that regional development patterns will continue to be shaped through a patchwork of local general plans and zoning regulations, and that no attempt will be made to coordinate land use or environmental regulations across existing units of government. Development would be prohibited from publicly owned and controlled lands such as parks and military facilities. The development of particular hillside and wetland areas would be governed by the dictates of the marketplace; specifically, those areas would be developed according to the relative profit of doing so. The average densities of new residential development would also be determined in the marketplace, and accordingly would vary city by city. There would be no blanket limitation on the development of privately owned agricultural parcels. Cities would encourage "infill" development at the same rate as during the 1980s. Development would continue to be permitted in unincorporated areas beyond existing city spheres-of-influence. Should there be insufficient developable land in a city's sphere-of-influence to accommodate projected population growth for that city, the excess would "spill-over" into nearby unincorporated areas.

Table 3 summarizes how much additional land area would be needed (by county) to accommodate projected population growth for the year 2010, under a the *Business-as-Usual* scenario. In the ten-county extended San Francisco Bay Area, a total of 103,090 acres of currently undeveloped land would be required to accommodate projected population growth for the year 2010; in the Sacramento-Stockton-Modesto Area, 59,923 acres of currently undeveloped land would be required to accommodate projected new development. Given current policy and market trends, new development in the extended San Francisco Bay Area will occur at an average density of 17.3 persons per acre. New development in the Sacramento-Stockton-Modesto Area will occur at 17.9 persons per acre, a level significantly higher than that in the Bay Area.

Projections of additional land consumption vary sharply by county. In the extended Bay Area, for example, a combination of significant population growth and fairly low average densities would mean that 23,375 additional acres of Contra Costa County and 20,509 additional acres of Sonoma County would be developed by the year 2010. By contrast, in Santa Clara County, where

Table 3: Simulation Results by County for Scenario 1A: Business-as-Usual (Compared with Existing Development Forms)

Region/County	1990 Population	Forecast Population Growth 1990-2010	Existing Developed Acreage	Additional Acreage Required for Development	Additional Required Acreage as percent of Existing	Percent Newly Developed Land in City "Sphere-of-Influence"	Average Incremental Density (Persons per/Acre)
Extended San Francisco Bay Area	6,345,300	N/A	N/A	N/A	N/A	N/A	N/A
Alameda	1,276,255	258,030	135,732	12,306	9.1%	90	20.97
Contra Costa	803,732	305,322	132,841	23,376	17.6%	97	13.06
Marin	230,096	107,533	40,500	4,991	12.3%	100	21.54
Napa	110,765	81,948	18,705	8,772	46.9%	27	9.34
S. n Francisco	723,959	N/A	N/A	N/A	N/A	N/A	N/A
San Mateo	649,623	58,847	72,573	49	0.1%	100	N/A
Santa Clara	1,592,523	362,234	177,121	11,861	6.7%	100	30.54
Santa Cruz	229,704	151,858	27,552	13,146	47.7%	15	N/A
Solano	340,421	158,027	42,847	8,080	18.9%	96	19.56
Sonoma	388,222	302,724	60,292	20,509	34.0%	23	14.76
Sacramento-Stockton-Modesto Area	2,033,451	1,072,800	242,578	59,923	24.7%	N/A	17.90
Sacramento	1,041,209	398,261	133,483	27,972	21.0%	42	14.24
San Joaquin	480,628	262,478	43,094	11,639	27.0%	88	22.55
Stanislaus	370,522	349,537	43,885	16,630	37.9%	92	21.02
Yolo	141,092	62,524	22,115	3,682	16.6%	79	16.98

Source: CUF Model Output

new residential densities are considerably higher than in either Contra Cost or Sonoma Counties, a greater increment of population growth may be accommodated on far less land (11,860 additional acres). Higher average densities would also lead to comparatively less land development in Alameda County (12,306 acres) and Marin County (4,991). Exactly the opposite would be true in Napa County, where, as a result of low residential densities, more than 8,772 additional acres would be developed by the year 2010 despite only modest population growth.

Nearly half of the land required to accommodate projected population growth in the Sacramento-Stockton-Modesto Area will be in Sacramento County— this despite the fact that population growth in Sacramento County will account for only about 38 percent of the region's population growth. This is because Sacramento County is likely to develop at significantly lower densities than either San Joaquin or Stanislaus counties, the other two fast-growing counties in the region. Given the continuation of current trends and current policies, Sacramento County will develop at an incremental density of 14.2 persons per acre—a level far below that of San Joaquin County (22.6 persons per acre) or Stanislaus County (21.0 persons per acre). Yolo, the fourth county in the region, will also develop at comparatively low population densities (17.0 persons per acre). What's behind such sharp differences in density? During the past few years, planners and elected officials in San Joaquin and Stanislaus counties have been busy encouraging (and in some cases requiring) builders to develop at higher densities, and in locations adjacent to existing development. In Sacramento and Yolo counties, by contrast, planners have placed much less emphasis on higher densities and development in those areas already incorporated.

Acreage totals and gross densities can be difficult things to understand. To put the various land conversion estimates into context, we compared them with existing levels of urbanization. The biggest relative gainers (under the *Business-as-Usual* scenario) would be Santa Cruz and Napa counties, which would see their urbanized land totals rise by 47.7 percent and 46.1 percent, respectively, by the year 2010. Other counties with big percentage gains would be Stanislaus (+37.9 percent), Sonoma (+34 percent), and San Joaquin (+27 percent). At the other end of the spectrum, projected new development by the year 2010 would increase the amount of urbanized are land by only .1 percent in San Mateo County, and by 6.7 percent in Santa Clara County. Increases in urbanization levels in the remaining counties would range from 16.6 percent (Yolo County) to 21 percent (Sacramento).

The ability of individual cities to accommodate additional residential development within their existing spheres-of-influence will also vary by county. In Marin and Santa Clara Counties, for example, all projected new residential development could be accommodated within existing city spheres-of-influence. Similarly, under the *Business-as-Usual* scenario, more than 90 percent of projected residential development in Alameda, Contra Costa, and Solano Counties could be accommodated within existing sphere-of-influence boundaries. By contrast, because they do not contain ade-

quate growing room, existing city spheres-of-influence in Napa and Sonoma counties could accommodate only 27 percent and 23 percent, respectively, of projected new residential development.

In Stanislaus and San Joaquin counties, where sphere-of-influence boundaries are used as policy mechanisms to guide new development, 92 percent and 88 percent of anticipated new residential development will occur within existing sphere boundaries. In Sacramento County, by way of contrast, only 42 percent of new residential development will occur within existing sphere-of-influence boundaries. Continuing a long-standing trend, the majority of the county's expected new residential development will occur in currently unincorporated outside existing spheres. In Yolo County, nearly 80 percent of projected new residential development will occur within existing sphere-of-influence boundaries.

Map 2 shows the spatial pattern of likely development in Northern California under a *Business-as-Usual* scenario. In Alameda County, new residential development will occur primarily along the edges of existing cities. New development densities will be higher in the county's southern cities of Hayward, Union City, and Fremont, and lower in the county's central cities of Dublin and Pleasanton. New residential development in Livermore in eastern Alameda County will occur at a mix of densities.

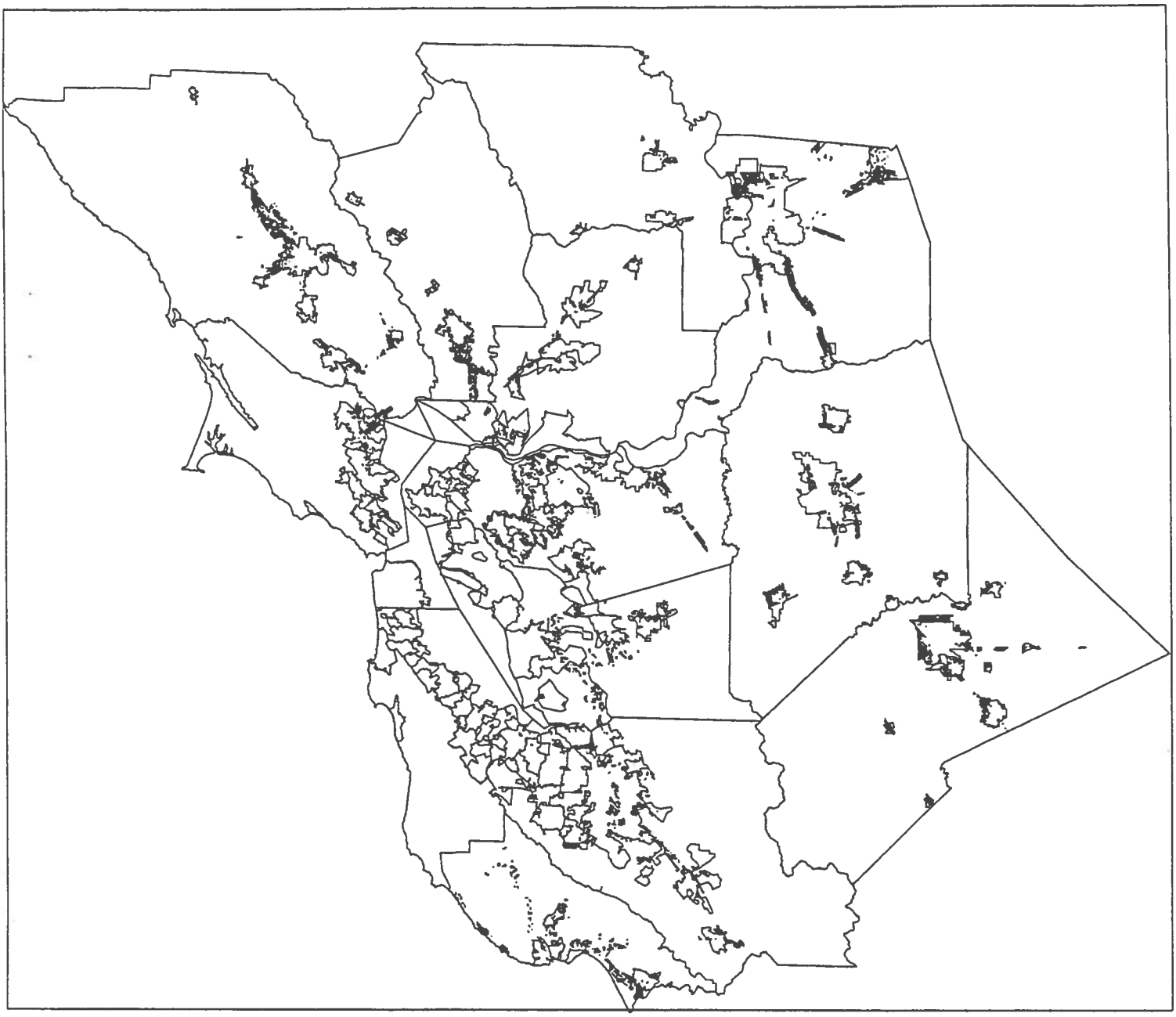
New residential development will also occur along the edges of existing cities in western and central Contra Costa county. In the eastern part of the county, however, new home development is likely to occur along the spine of Highway 4, south of Antioch. Interestingly, because of the emphasis put on housing affordability opportunities and smaller lot sizes, new residential development is likely to occur at higher densities in the eastern part of Contra Costa County than in the Western part.

What little additional residential development occurs in Marin County will occur as multi-family development along U.S. 101, and as lower-density single-family development along the edges of Novato and San Rafael.

Most of the projected growth that occurs in Napa County will occur south of the city of Napa, along Highways 12 and 29, and at fairly low densities. New residential development in the county's other cities will be more limited, and will occur at low densities.

Given a continuation of current trends and policies, almost all of the new residential development that occurs in San Mateo County will take the form of infill development. Altogether, we anticipate that only 49 acres of non-infill land will be needed for development in San Mateo County by the Year 2000.

The majority of new development in Santa Clara County will also take the form of infill. Assuming that current policies protecting the Coyote Valley remain in place, most of the low-density residential development that occurs in Santa Clara County will happen in Morgan Hill, Gilroy, and Los Gatos.



Map 2: Location of New Development in 2010
Under Scenario 1A

In Santa Cruz, by contrast, almost all the residential development that occurs will be at lower densities. Given current policies, Santa Cruz County will continue to be popular as a residential area for job-rich but housing-poor Santa Clara County. As a result, most of the new housing development that occurs in Santa Cruz County will be along Highways 17 and 101.

New residential development will also follow highway corridors (Interstates 80 and 680) in Solano County. Fairfield, the county's growth center of the 1970s and early 1980s, will continue growing, as will Vacaville, the growth center of the 1990s.

Both development policies and market realities encouraged the development of higher density, single-family housing in Sonoma County during the 1980s. Given a continuation of current policies, this trend should continue through the 1990s and beyond. Much of the new residential development that occurs in Sonoma County will be north of Santa Rosa, along Highway 101. In the southern part of the county, Petaluma will also continue growing. Further away from the Highway 101 corridor, new residential development will occur at slightly lower densities.

The growth of individual cities and counties notwithstanding, what is perhaps most interesting about Map 2 is that it shows just how much land is really available for development, and how comparatively little would actually be developed, even under a "laissez-faire" approach to development regulation. Moreover, even in the absence of specific policies designed to promote contiguous development, most new development can be expected to occur at the edges of existing cities. This is not because private developers dislike leapfrog development and urban sprawl. Rather, it is because the combination of lower development costs, higher home prices, and greater market acceptance tend to favor sites adjacent to transportation facilities and existing development over distant and isolated sites.

Scenario 2D: Maximum Environmental Protection

Scenario 2D: Maximum Environmental Protection assumes the region-wide adoption of environmental protection policies which would prohibit the development of hillsides and wetlands. Also prohibited would be development of prime and unique agricultural lands located outside existing city spheres-of-influence, or 1,000 meters beyond existing city boundaries, whichever is less. These policies could be coordinated across existing city and county governments, or directly pursued by a new regional agency.

Environmental protection policies may not, by themselves, prevent urban sprawl. Indeed, by occasionally deterring contiguous development, they may in fact contribute to it. Thus, in order to reduce overall land consumption, Scenario 2D also stipulates that cities and counties must amend their zoning ordinances and general plans to provide for "density floors." The notion of a density floor means that the average density of every new residential development would have to exceed some specific level. In this scenario, that level is arbitrarily set to the current average residen-

tial density of each city. The effect of this policy would be to prevent additional development from occurring at significantly lower densities than historically. Another way of thinking about such a program of density floors is as an "anti-downzoning" policy. Consistent with the land and environmental conservation theme of Scenario 2D, any city-based population growth that could not be allocated within the corresponding city sphere-of-influence would remain unallocated. Such a policy would, in essence, turn existing sphere-of-influence boundaries into fixed urban limit lines.

Implementing *Scenario 2D: Maximum Environmental Protection* would lead to both more and less land conversion than *Scenario 1A: Business-as-Usual*, depending on the county (Table 4). In Contra Costa County, for example, land conversion would decline from 23,376 acres under *Scenario 1A: Business-as-Usual* to 19,051 acres under *Scenario 2D: Maximum Environmental Protection*. In Napa County, 6,252 acres would be needed under *Scenario 2D: Maximum Environmental Protection* to accommodate projected population growth for the year 2010, as compared with 8,772 acres under *Scenario 1A: Business-as-Usual*. Comparing land conversion in Santa Clara, Solano, and Sonoma counties also reveals declines in land consumption for Scenario 2D, when compared with Scenario 1A.

By contrast, urban land conversion would increase in Alameda and Marin counties under Scenario 2D. This is because the policies proposed under Scenario 2D would pre-empt sites in those counties which, had they been developed (as under Scenario 1A), would have been developed at higher densities.

A similar pattern emerges in the Sacramento-Stockton-Modesto area. Because it would shift development outward from parcels that are environmentally sensitive but contiguous to existing development, *Scenario 2D: Maximum Environmental Protection* would actually result in greater land consumption in Sacramento and Yolo counties than would *Scenario 1A: Business-as-Usual*. In the former case, the difference in required land between the two scenario is quite small —less than 400 acres. In the latter case, the difference is far more significant: 1,500 acres.

By contrast, land consumption in both Stanislaus and San Joaquin counties would decline significantly under *Scenario 2D: Maximum Environmental Protection*. This is because the development displaced from lower-density, environmentally sensitive sites would be re-directed to less-sensitive and higher-density sites.

This same result —that environmental protection policies may either encourage or discourage land consumption, depending on the county— is also evident by comparing incremental densities and development locations. For example, in Contra Costa, Napa, Santa Clara, San Joaquin, Solano, Sonoma, and Stanislaus counties, the average densities of new development are higher under Scenario 2D than under Scenario 1A. By contrast, in Alameda, Napa, Sacramento, and Yolo counties, they are somewhat lower.

Table 4: Comparison of Simulation Results for Scenario 1A with Scenario 2D: (Maximum Environmental Protection)

Region/County	Forecast Population Growth: 1990-2010	Additional Acres Required for Development		Average Growth Density in persons per acre		Percent Newly Developed Land within Existing City Spheres of Influence	
		Scenario 1A	*Scenario 2D*	*Scenario 1A*	*Scenario 2D*	*Scenario 1A*	*Scenario 2D*
Ext. San Francisco Bay Area	*N/A*	103,090	91,872	17.3	19.4	*N/A*	*N/A*
Alameda	258,030	12,306	12,602	21.0	20.5	90	90
Contra Costa	305,322	23,376	19,051	13.1	16.0	97	93
Marin	107,533	4,991	5,708	21.5	18.8	100	100
Napa	81,948	8,772	6,252	9.3	13.1	27	23
San Francisco	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
San Mateo	58,847	49	49	*N/A*	*N/A*	100	100
Santa Clara	362,234	11,861	8,031	30.5	45.1	100	100
Santa Cruz	151,858	13,146	14,282	11.6	10.6	15	11
Solano	158,027	8,080	6,375	19.6	24.8	96	90
Sonoma	302,724	20,509	19,521	14.8	15.5	23	21
Sacr.-Stockton-Modesto Area	1,072,800	59,922	55,598	17.9	19.3	*N/A*	*N/A*
Sacramento	398,261	27,972	28,367	14.2	14.0	42	41
San Joaquin	262,478	11,638	9,291	22.6	28.3	88	55
Stanislaus	349,537	16,630	12,750	21.0	27.4	92	48
Yolo	62,524	3,682	5,189	17.0	12.0	79	46

Source: CUF Model Output

By redirecting new development, additional environmental protection policies will also alter the share of new development that will occur within existing sphere-of-influence boundaries. In the cases of most Bay Area counties, this shift is quite small. In two Sacramento-Stockton-Modesto Area counties, however, these shifts are more significant. In San Joaquin County, for example, the shift from *Scenario 1A: Business-as-Usual* to *Scenario 2D: Maximum Environmental Protection* would reduce the share of new development that would occur within existing spheres-of-influence from 88 percent to 55 percent. In Yolo County, by contrast, such a policy shift would have the opposite effect of shifting new development into existing spheres-of-influence.

Scenario 3A: Compact Cities

Scenario 3A: Compact Cities builds on many of the environmental protection aspects of Scenario 2D. It embodies the view that new residential development should only occur in and around existing urban areas. To promote such a goal, Scenario 3A assumes the region-wide adoption of three sets of policy objectives: (1) that all new residential development should occur at an average density of 4500 persons per square kilometer or greater; (2) that all incorporated cities should adopt a policy of accommodating 20 percent of their projected population growth in the form of "infill" (developable or re-developable parcels within city boundaries); and (3) that counties should adopt policies designed to direct new development in unincorporated areas to within 1,000 meters of existing city boundaries, or within city spheres-of-influence.

Like *Scenario 2D: Maximum Environmental Protection*, above, *Scenario 3A: Compact Cities* requires the region-wide implementation of specific policies but does not require that they be implemented by a regional government. It is conceivable (although perhaps not likely) that existing city and county governments could work cooperatively to promote contiguous development patterns.

If implemented, the policies proposed under *Scenario 3A: Compact Cities* would result in significant reductions in land consumption when compared with *Scenario 1A: Business-as-Usual*. These reductions would come from two sources. First, cities in which infill development is currently non-existent would be required to steer 20 percent of their projected growth into infill sites. This would significantly reduce pressures for land consumption at the urban fringe. Second, cities in which the only form of new development is very low density housing would be required to promote a greater mix of residential densities. As with Scenario 2D, such a requirement could take the form of density floors, averaged across larger projects.

Comparing *Scenario 3A: Compact Cities* with *Scenario 1A: Business-as-Usual* shows a 35 percent reduction in land conversion in the extended San Francisco Bay Area, and 16 percent reduction in the Sacramento-Stockton-Modesto Area (Table 5). Because the same number of new residents would be accommodated in less land, incremental densities would rise: to 26.9 persons

Table 5: Comparison of Simulation Results for Scenario 1A with Scenario 3A: Compact Cities

Region/County	Forecast Population Growth: 1990-2010	Additional Acres Required for Development		Average Growth Density in persons per acre		Percent Newly Developed Land within Existing City Spheres of Influence	
		Scenario 1A	*Scenario 3A*	*Scenario 1A*	*Scenario 3A*	*Scenario 1A*	*Scenario 3A*
Ext. San Francisco Bay Area	*NA*	103,090	66,445	17.3	26.9		
Alameda	258,030	12,306	8,624	21.0	29.9	90	89
Contra Costa	305,322	23,376	11,935	13.1	25.6	97	100
Marin	107,533	4,991	2,693	21.5	39.9	100	100
Napa	81,948	8,772	3,830	9.3	21.4	27	29
San Francisco	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
San Mateo	58,847	49	49	*N/A*	*N/A*	100	100
Santa Clara	362,234	11,861	10,230	30.5	35.4	100	100
Santa Cruz	151,858	13,146	6,721	11.6	22.6	15	17
Solano	158,027	8,080	5,090	19.6	31.0	96	95
Sonoma	302,724	20,509	17,272	14.8	17.5	23	21
Sacr.-Stockton-Modesto Area	1,072,800	59,922	50,335	17.9	21.3	*N/A*	*N/A*
Sacramento	398,261	27,972	23,079	14.2	17.3	42	41
San Joaquin	262,478	11,638	9,316	22.6	28.2	88	95
Stanislaus	349,537	16,630	14,851	21.0	23.5	92	92
Yolo	62,524	3,682	3,089	17.0	20.2	79	85

Source: CUF Model Output

per acre of new residential development in the Bay Area (up from 17.3 persons per acre), and to 21.3 persons per acre in the Sacramento-Stockton-Modesto Area (up from 17.9 persons per acre).

Among Bay Area counties, land consumption would be reduced by more than 50 percent in Contra Costa, Santa Cruz, and Napa counties, and by a third or more in Marin, Alameda, and Solano counties. The reduction in land conversion— although readily observable— would be less significant in Santa Clara and Solano counties.

Following the downward trend in land consumption, incremental development densities would rise the most in Contra Costa, Santa Cruz, and Napa counties. In spite of its emphasis on more compact development forms, *Scenario 3A: Compact Cities* would shift relatively little development back into existing city spheres-of-influence. Compared with *Scenario 1A: Business-as-Usual*, the share of new development that would occur in existing spheres-of-influence would rise slightly in Contra Costa, Napa, and Santa Cruz counties, and fall slightly in Alameda, Solano, and Sonoma counties.

Because development forms are already fairly compact in three of the four counties of the Sacramento-Stockton-Modesto Area, *Scenario 3A: Compact Cities* would have a lesser effect in this area than in the Bay Area. Compared with *Scenario 1A: Business-as-Usual*, urban land conversion would fall 20 percent in San Joaquin County, 18 percent in Sacramento County, 17 percent in Yolo County, and 11 percent in Stanislaus County. Average incremental densities would increase by two to three persons per acre in all four counties. Finally, as in the Bay Area, *Scenario 3A: Compact Cities* would shift relatively little development back into current spheres-of-influence.

V. A CLOSER LOOK AT FOUR GROWTH HOT-SPOTS

One of the best features of the CUF Model is its ability to zoom-in from the regional level down to the local level. In this section, we report on how *Scenarios 1A: Business-as-Usual, 2D: Maximum Environmental Protection, and 3A: Compact Cities* would affect local patterns of development in four fast-growing counties: Contra Costa, Sacramento, Solano, and Sonoma.

Contra Costa County

If present trends continue, Contra Costa County will grow by more than 300,000 persons between 1990 and 2010. Under current policies (*Scenario 1A: Business-as-Usual*), an additional 23,376 acres of land will be required to accommodate this level of growth. Under *Scenario 2D: Maximum Environmental Protection*, the amount of undeveloped land required to accommodate projected population growth would fall by 18.5 percent, to 19,051 acres. Under *Scenario 3A: Compact Cities*, the amount of required land would be reduced by 48.9 percent, to 11,934 acres.

The shift from business-as-usual (Scenario 1A) to policies promoting environmental conservation (Scenario 2D) would play out differently in different parts of the county (Table 6). The wide

Table 6: Comparison of Simulation Results for Contra Costa County

Cities	Sphere-of-Influence Size (acres)	Currently Developed Acreage	Additional Acreage Required for Development		
			Scenario 1A	*Scenario 2D*	*Scenario 3A*
			Bus. as Usual	*Max. Env.Protect.*	*Compact Cities*
Antioch	18,586	8,290	2,001	1,073	1,384
Brentwood	7,776	1,201	138	4	134
Clayton	3,860	1,362	542	542	319
Concord	26,523	16,027	1,544	591	939
Danville	12,740	6,123	3,009	3,002	1,465
El Cerrito	3,025	2,918	N/A	N/A	N/A
Hercules	4,774	2,305	504	448	419
Lafayette	10,200	6,603	2,546	1,434	1,077
Martinez	12,169	7,890	2,488	1,344	1,037
Moraga	6,007	2,986	1,570	1,462	664
Orinda	8,241	5,647	2,552	1,665	961
Pinole	4,383	3,312	446	433	391
Pittsburg	14,836	8,398	908	562	822
Pleasant Hill	6,123	5,584	479	261	336
Richmond	20,099	15,337	290	260	249
San Pablo	1,971	1,971	1	0	0
San Ramon	12,944	5,669	N/A	N/A	N/A
Walnut Creek	15,050	11,394	2,645	778	706
Unincorporated Contra Costa	N/A	*19,824*	*1,714*	*5,191*	*1,029*
Contra Costa Total	**189,306**	**132,841**	**23,376**	**19,051**	**11,934**

Source: CUF Model Output

spread adoption of policies consistent with *Scenario 2D: Maximal Environmental Protection* would reduce the amount of land developed over the next 20 years by a third or more in Antioch, Brentwood, Concord, Lafayette, Martinez, Orinda, Pittsburg, Pleasant Hill, San Ramon, and Walnut Creek. Where might this displaced development go? In some communities, it would go into slightly higher development densities; compared with Scenario 1A, new development densities would rise by about three persons per acre across the county. The majority of this development, however, would be displaced from environmentally sensitive areas inside city spheres of influence, to less sensitive areas in other parts of Contra Costa County. According to Table 6, development of unincorporated Contra Costa County would increase from 1,714 acres under *Scenario 1A: Business-as-Usual*, to 5,191 acres under *Scenario 2D: Maximal Environmental Protection*.

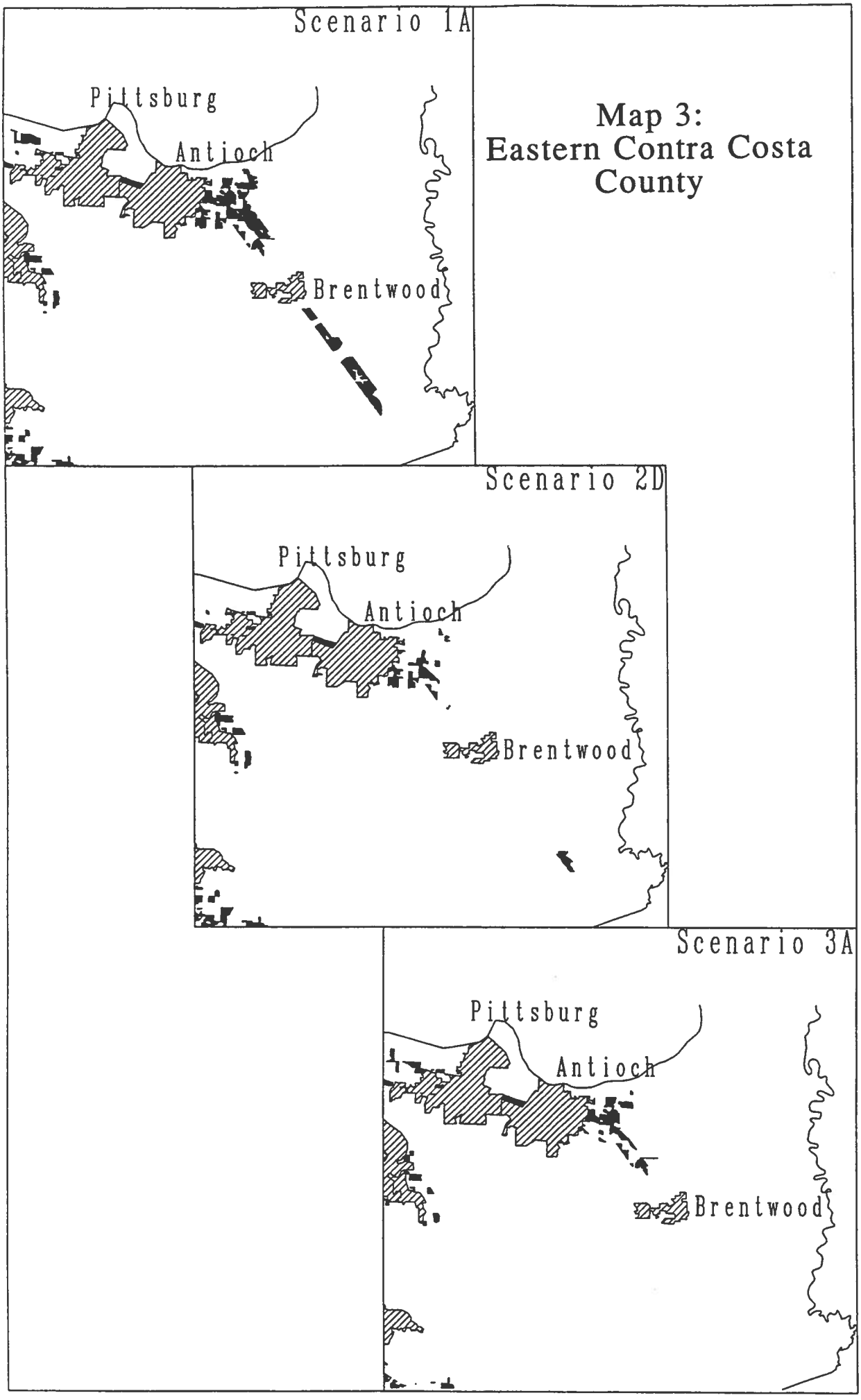
Shifting from business-as-usual (Scenario 1A) to policies favoring compact growth forms (Scenario 3A), would also reduce land consumption, but in a far different pattern. The adoption of policies consistent with *Scenario 3A: Compact Cities* would reduce the amount of land developed over the next 20 years by 30 percent or more in Concord, Danville, Lafayette, Martinez, Moraga, Orinda, Pleasant Hill, San Ramon, Walnut Creek, and unincorporated Contra Costa County. All of the displaced development would go into higher densities. County-wide, development densities would rise from an average of 13.1 persons per acre under *Scenario 1A: Business-as-Usual* to 25.6 persons per acre under *Scenario 3A: Compact Cities*.

Map 3 shows how the different policy scenarios would affect development patterns in eastern Contra Costa County—the focal point of anticipated population growth. Under *Scenario 1A: Business-as-Usual*, development would extend southeastward along Highway 4 from Antioch past Brentwood. Under *Scenario 2D: Maximal Environmental Protection*, the Highway 4 corridor (which includes some of the region's best agricultural land) would remain relatively undeveloped. Under *Scenario 3A: Compact Cities*, development would occur between Antioch and Brentwood, but would not extend beyond Brentwood.

Sacramento County

If present trends continue, Sacramento County will add nearly 400,000 persons during the next 20 years, making it the growth center of the Greater Bay Region. Under current policies (*Scenario 1A: Business-as-Usual*) an additional 27,972 acres of land will be required to accommodate this level of growth. Under *Scenario 2D: Maximum Environmental Protection*, the amount of undeveloped land required to accommodate projected population growth would rise slightly, to 28,367 acres. Under *Scenario 3A: Compact Cities*, the amount of required land would be reduced by 17.4 percent, to just over 23,000 acres.

Sacramento is unique among the 14 counties of the greater Bay Area Region counties in that most of its residents live in unincorporated areas. Regardless of the policies pursued, this will con-



Map 3: Eastern Contra Costa County

tinue to be the case. And indeed, most of the county's projected new development will also occur in unincorporated areas (Table 7). Under *Scenario 1A: Business-as-Usual*, new development in unincorporated areas will exceed 16,000 acres, and account for 58.5 percent of county-wide urban land conversion. Under *Scenario 2D: Environmental Protection*, new development in unincorporated areas would rise to 19,251 acres, and account for 67.8 percent of county-wide urban land conversion. Under *Scenario 3A: Compact Cities*, new development in unincorporated areas would fall to 13,500 acres, and account for just over 58.5 percent of county-wide urban land conversion.

Among incorporated cities, the shift from business-as-usual (Scenario 1A) to policies promoting environmental conservation (Scenario 2D) would significantly conserve land in Galt, Isleton, and Sacramento. It would have no effect on land conversion in Folsom.

The choice of policy alternative would have a far greater effect on the spatial distribution of urban land conversions than on the total amount (Map 4).

Solano County

If present trends continue, Solano County will grow by 158,000 persons between 1990 and 2010 —making it one of the fastest growing counties in the Region. Solano County will attract households whose workers commute to Sacramento and to other parts of the Bay Area, as well as those who work in Solano County itself. Under current policies (*Scenario 1A: Business-as-Usual*), an additional 8,080 acres of land will be required to accommodate this level of growth (Table 8). Under *Scenario 2D: Maximum Environmental Protection*, the amount of undeveloped land required to accommodate projected population growth would fall by 21.1 percent, to 6,375 acres. Under *Scenario 3A: Compact Cities*, the amount of required land would be further reduced by 37.0 percent, to 5,090 acres.

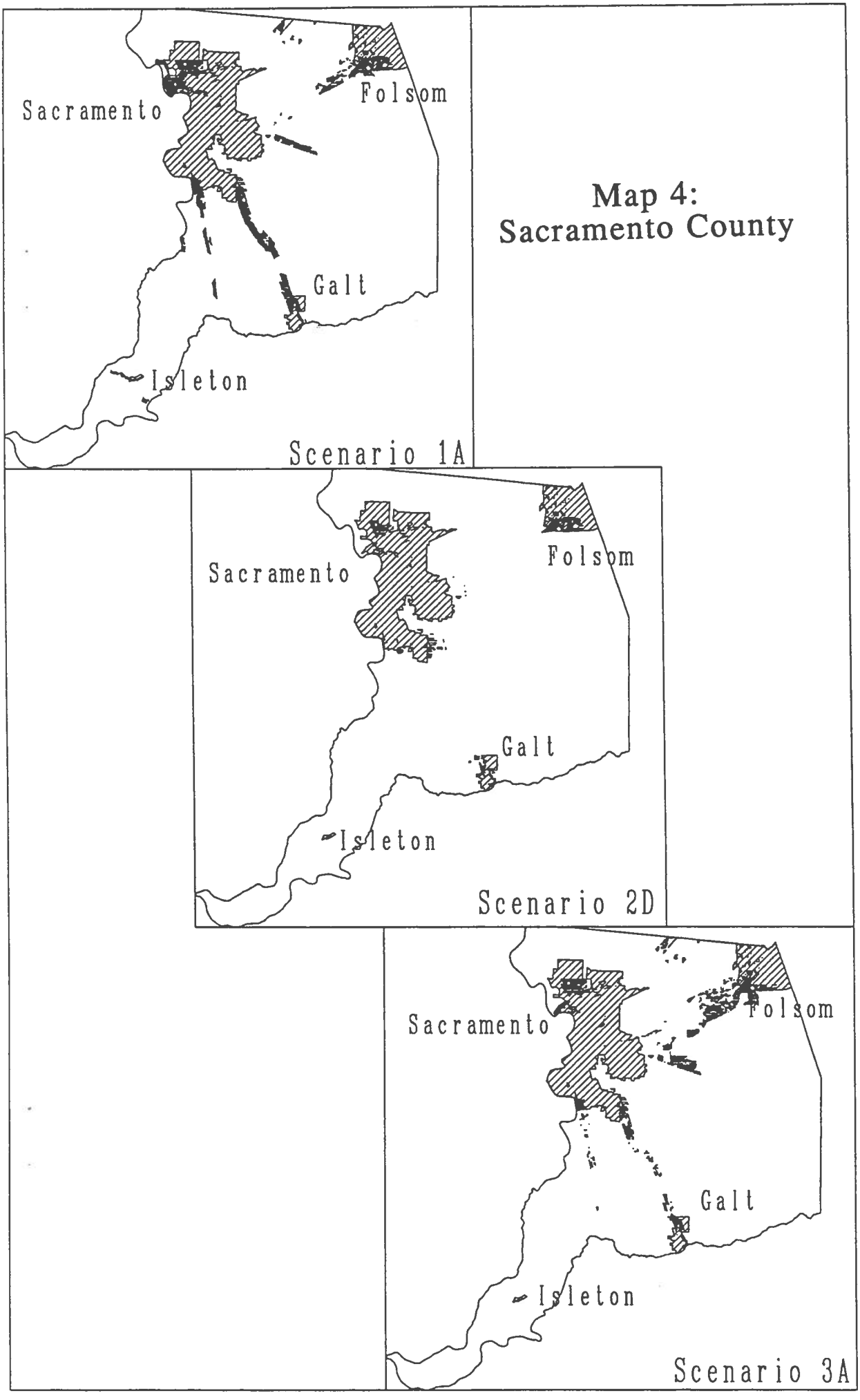
Under *Scenario 1A: Business-as-Usual*, the focus of land conversion in Solano County will continue to be in Fairfield (+2,417 acres of newly developed land area), Benicia (+2,142 acres), and Vacaville (+1,309 acres). New urban development will exceed 700 acres in both Dixon and Vallejo. New development in Suisun City and unincorporated Solano County will be less than 400 acres, while in Rio Vista all new development will take the form of infill.

Shifting from a business-as-usual approach (Scenario 1A) to policies that favor environmental preservation (Scenario 2D) will reduce land consumption in Fairfield, Benicia, and Vacaville by 37.4 percent, 15.0 percent and 33.4 percent, respectively. The development "displaced" by such policies would appear in the form of higher densities (county-wide, the average density of new development would rise from 19.6 persons per acre to 24.8 persons per acre), and as unincorporated development. The latter would rise from 382 acres under *Scenario 1A: Business-as-Usual* to 1,592 acres under *Scenario 2D: Maximal Environmental Protection*.

Table 7: Comparison of Simulation Results for Sacramento County

Cities	Sphere-of-Influence Size (acres)	Currently Developed Acreage	Additional Acreage Required for Development		
			Scenario 1A	*Scenario 2D*	*Scenario 3A*
			Bus. as Usual	*Max. Env.Protect.*	*Compact Cities*
Folsom	15,204	4,062	3,816	3,816	2,792
Galt	7,146	1,263	1,528	1,019	1,148
Isleton	284	108	16	4	7
Sacramento	71,635	53,901	6,244	4,277	5,631
Unincorporated Sacramento Cnty	*N/A*	*74,149*	*16,368*	*19,251*	*13,500*
Sacramento Total	**94,269**	**133,483**	**27,972**	**28,367**	**23,079**

Source: CUF Model Output



Map 4:
Sacramento County

Table 8: Comparison of Simulation Results for Solano County

Cities	Sphere-of-Influence Size (acres)	Currently Developed Acreage	Additional Acreage Required for Development		
			Scenario 1A	*Scenario 2D*	*Scenario 3A*
			Bus. as Usual	*Max. Env.Protect.*	*Compact Cities*
Benicia	15,004	4,611	2,142	1,821	1,121
Dixon	8,230	1,420	732	0	458
Fairfield	34,547	12,521	2,417	1,512	1,608
Rio Vista	3,786	717	0	0	0
Suisun City	5,627	1,534	387	125	242
Vacaville	21,766	7,124	1,309	871	777
Vallejo	26,257	11,992	711	454	546
Unincorporated Solano County	*N/A*	*2,929*	*382*	*1,592*	*338*
Solano Total	**115,216**	**42,847**	**8,080**	**6,375**	**5,090**

Source: CUF Model Output

Shifting to policies that favor compact growth forms (Scenario 3A), could reduce total urban land conversion even further. Compared to a business-as-usual approach, land conversion would fall by 33.5 percent in Fairfield, by 47.7 percent in Benicia, by 40.6 percent in Vacaville, and by 11.5 percent in unincorporated Solano County. All of the displaced development would be accounted for in the form of higher densities, which would rise from an average of 19.6 persons per acre to 31.0 persons per acre.

Map 5 graphically compares the three scenarios for central Solano County. Under *Scenario 1A: Business-as-Usual,* new urban development would line Interstate 80 corridor from Fairfield to Vacaville. Under *Scenario 2D: Maximal Environmental Protection*, new development would continue to line I-80 in Vacaville, but would occur in a more clustered form in Fairfield. The situation would be reversed under *Scenario 3A: Compact Cities*: development would be more highly clustered in Vacaville, but somewhat more dispersed in Fairfield.

Sonoma County

Sonoma County was not one of the Bay Area Region's growth centers during the 1970s and 1980s, but it will be during the 1990s. If present trends continue, Sonoma County will add another 303,000 residents between 1990s and 2010. Given current local development policies (Scenario 1A), an additional 20,509 acres of land will be necessary to accommodate this level of growth (Table 9). Land consumption totals in Sonoma County are not likely to be that responsive to land use policy changes, unlike some other Bay Region counties. The adoption of environmental protection policies (Scenario 2D), for example, would reduce the amount of land required only by about 5 percent (to 19,520). Implementing compact growth policies would have a slightly greater effect: compared to current policies, land consumption would fall by about 16 percent.

Most Sonoma cities[4] have already adopted ordinances to limit their growth and expansion. This means that most of Sonoma County's new growth will occur in unincorporated areas (Map 6). Under *Scenario 1A: Business-as-Usual*, land conversion in unincorporated Sonoma County will account for 77 percent of new land development in the county. Most of this development will occur either north of Santa Rosa along Highway 101, or west of Santa Rosa toward Sebastopol. Among incorporated cities, pressures for land conversion will be strongest in Santa Rosa (+2,574 additional acres developed by 2010), Healdsburg (+694 acres), and Petaluma (+614 acres).

Shifting to environmental protection policies (Scenario 2D) will reduce the development of unincorporated Sonoma County by less than 2 percent, compared to current policies. Shifting to compact growth policies (which would steer development back into cities) would reduce the development of unincorporated Sonoma County by another 12 percent. Among Sonoma cities, the adoption of *Scenario 2D: Maximal Environmental Protection* would increase land consumption in Cloverdale and Healdsburg (compared to Scenario 1A), but decrease land consumption in

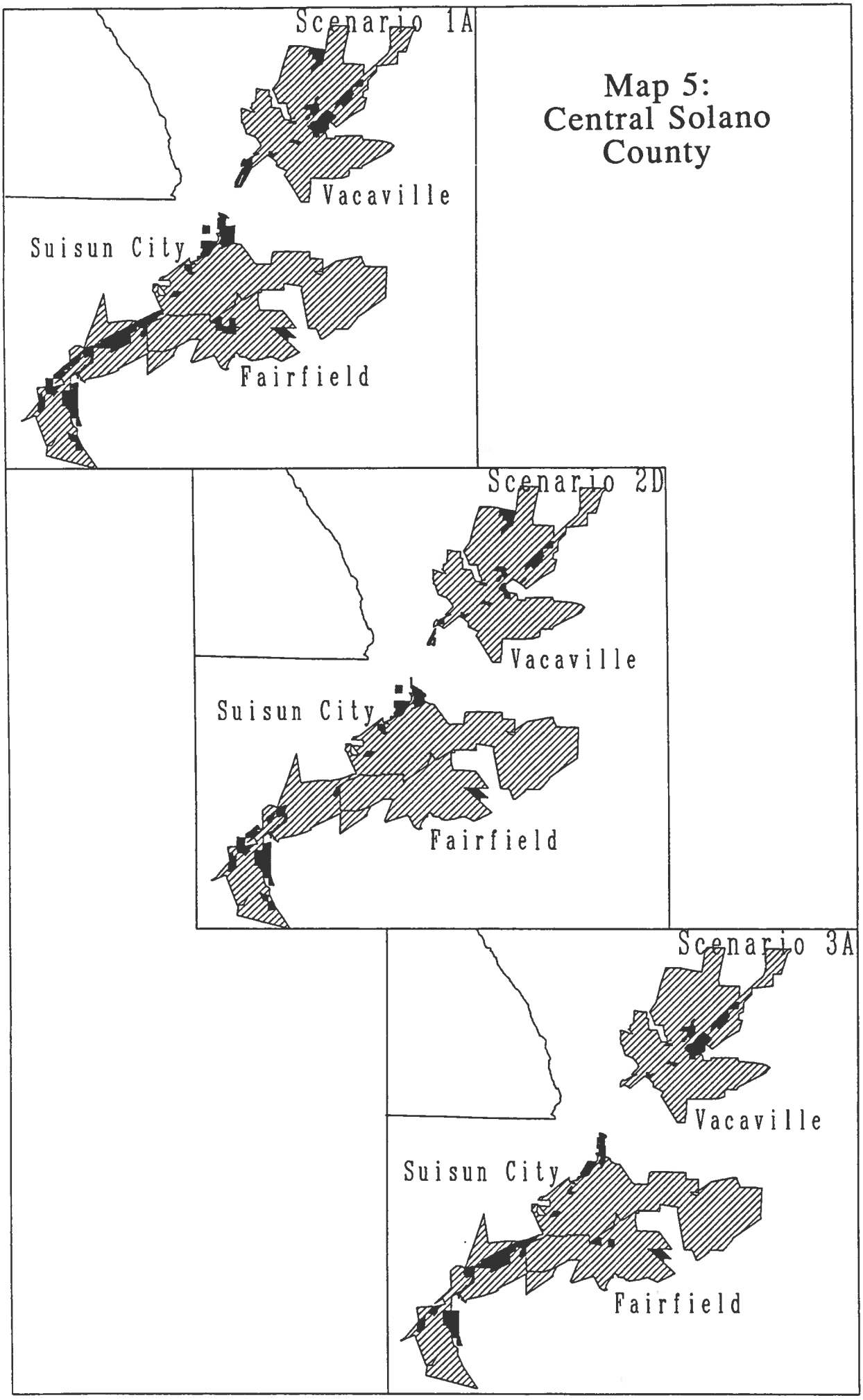
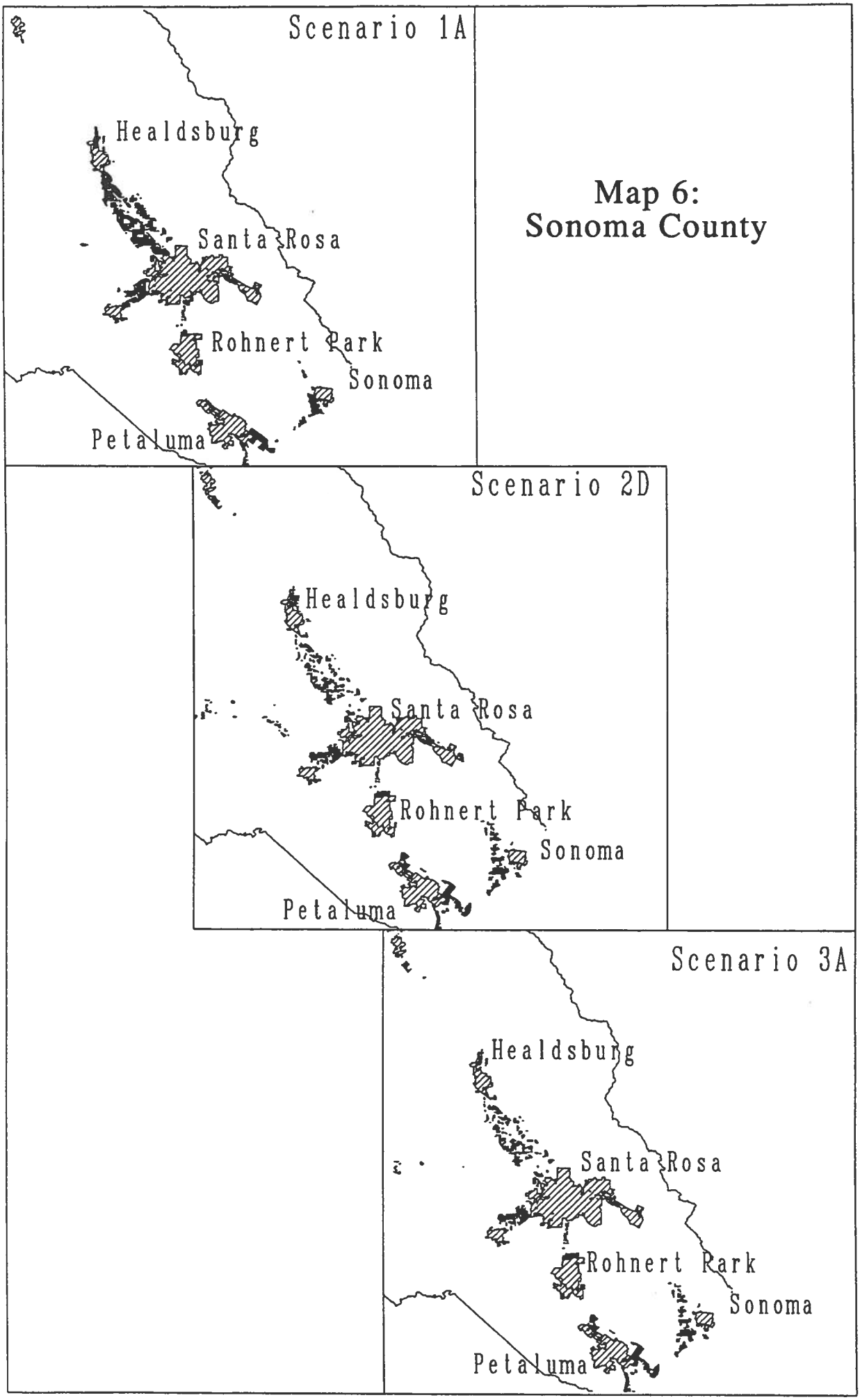

Scenario 1A
Vacaville
Suisun City
Fairfield
Map 5:
Central Solano
County
Scenario 2D
Vacaville
Suisun City
Fairfield
Scenario 3A
Vacaville
Suisun City
Fairfield

Table 9: Comparison of Simulation Results for Sonoma County

Cities	Sphere-of-Influence Size (acres)	Currently Developed Acreage	Additional Acreage Required for Development		
			Scenario 1A *Bus. as Usual*	*Scenario 2D* *Max. Env.Protect.*	*Scenario 3A* *Compact Cities*
Cloverdale	2,392	908	296	369	199
Cotati	2,240	902	82	82	82
Healdsburg	3,503	1,948	694	819	531
Petaluma	11,041	6,573	614	557	625
Rohnert Park	4,100	3,496	360	227	360
Santa Rosa	28,478	19,581	2,574	1,873	1,822
Sebastopol	1,895	1,581	93	60	79
Sonoma	2,832	1,494	112	63	72
Unincorporated Sonoma County	*N/A*	*23,809*	*15,685*	*15,471*	*13,502*
Sonoma Total	**56,481**	**60,292**	**20,509**	**19,520**	**17,272**

Source: CUF Model Output


Scenario 1A
Healdsburg
Santa Rosa
Rohnert Park
Sonoma
Petaluma
Map 6:
Sonoma County
Scenario 2D
Healdsburg
Santa Rosa
Rohnert Park
Sonoma
Petaluma
Scenario 3A
Healdsburg
Santa Rosa
Rohnert Park
Sonoma
Petaluma

Petaluma, Rohnert Park, Sebastopol, Santa Rosa, and Sonoma. Compared to current policies, adoption of *Scenario 3A: Compact Cities*, would significantly reduce land conversion in all Sonoma cities, except for Cotati and Petaluma—both of which already limit growth.

While the overall amount of urbanization would fall under Scenarios 2D and 3A, the pattern of development would change only slightly. Under both *Scenario 2D: Maximal Environmental Protection* and *Scenario 3A: Compact Growth*, new development would be shifted to the Valley of the Moon (near Sonoma) and the two highway corridors north and west of Santa Rosa would be developed less intensely. Compared to current policies, the effect of environmental protection and/or compact growth policies would be to shift development southward toward Rohnert Park, Petaluma, and Sonoma.

VI. THE CONVERSION OF ENVIRONMENTALLY SENSITIVE LANDS

Growth invariably affects the natural environment. Urban development consumes land previously used for farming, forestry, or open space. It disrupts local ecosystems, and adds to air and water pollution. How growth impacts the natural environment depends on much more than the amount of growth; it also depends on the form, pattern, and location of growth. For example, growth policies that promote new development close to existing urban areas will generate far different environmental impacts than growth policies that encourage decentralization. Because it simultaneously projects the amount, density, and location of new development, the CUF Model is uniquely suited to examining the environmental impacts associated with different development forms.

Table 10 summarizes how much land of different types would be developed in the greater Bay Region under each of scenarios *1A: Business as Usual*; *2D: Maximal Environmental Protection*; and *3A: Compact Cities*. Six different land characteristics are included in Table 10: (1) the amount of acreage projected to be developed within 1,000 meters of existing urban development; (2) the acreage of projected development on hillsides with slopes of 5 percent or more; (3) the amount of wetland acreage projected to be developed; (4) the amount of land designated as prime agriculture projected to be developed; (5) the amount of agricultural land projected to be developed that is currently designated as being of state importance; and (6) the amount of agricultural land projected to be developed currently designated as being unique.

Development Within 1,000 Meters of an Existing Urban Area

Regardless of the policy scenario chosen, most of the new development projected for the greater Bay Area will occur within 1,000 meters of existing urban development. Compared to *Scenario 1A: Business-as-Usual*, compact growth policies (Scenario 3A) will tend to increase the level of contiguous urban development, while environmental preservation policies (Scenario 2D) will tend to reduce the amount of contiguous development.

Table 10: Environmental Characteristics of Developed Land for Scenarios 1A, 2D, and 3A, by County

County	2010 Scenario	Additional Acreage Required	Characteristics of Newly Developed Land: within 1000m of Urban Area	> 5% Slope	on Desig. Wetlands	on Prime Agric. Land	on Agric. Land of State Import.	on Unique Agric. Land
Alameda	Scenario 1A : Bus.-as-Usual	12,306	12,041	9,148	225	161	89	21
	Scenario 2D: Max. Env. Protect	12,602	11,475	8,651	0	0	0	0
	Scenario 3A: Compact Cities	8,624	8,473	6,711	0	111	10	262
Contra Costa	Scenario 1A : Bus.-as-Usual	23,376	22,135	5,520	2,392	1,525	1,463	252
	Scenario 2D: Max. Env. Protect	19,051	12,931	2,263	0	0	0	0
	Scenario 3A: Compact Cities	11,934	10,205	919	0	314	680	10
Marin	Scenario 1A : Bus.-as-Usual	4,991	4,991	482	1,497	0	0	10
	Scenario 2D: Max. Env. Protect	5,708	5,708	865	0	0	0	0
	Scenario 3A: Compact Cities	2,693	2,693	329	0	0	0	10
Napa	Scenario 1A : Bus.-as-Usual	8,772	8,181	25	796	880	368	259
	Scenario 2D: Max. Env. Protect	6,251	6,103	237	0	0	0	0
	Scenario 3A: Compact Cities	3,830	3,830	0	0	257	51	0
Sacramento	Scenario 1A : Bus.-as-Usual	27,972	25,244	0	1,636	5,748	4,794	689
	Scenario 2D: Max. Env. Protect	28,367	8,886	0	0	0	0	0
	Scenario 3A: Compact Cities	23,079	21,754	0	0	1,607	974	186
San Joaquin	Scenario 1A : Bus.-as-Usual	11,639	11,639	0	132	10,445	0	0
	Scenario 2D: Max. Env. Protect	9,291	5,286	0	0	0	0	0
	Scenario 3A: Compact Cities	9,316	9,177	0	0	7,824	0	0
Santa Clara	Scenario 1A : Bus.-as-Usual	11,861	11,858	1,188	678	5,197	112	37
	Scenario 2D: Max. Env. Protect	8,030	7,996	998	0	0	0	0
	Scenario 3A: Compact Cities	10,229	10,194	570	0	5,013	98	34

Continued Next Page

Table 10: Environmental Characteristics of Developed Land for Scenarios 1A, 2D, and 3A, by County (Continued)

County	2010 Scenario	Additional Acreage Required	Characteristics of Newly Developed Land					
			within 1000m of Urban Area	> 5% Slope	on Desig. Wetlands	on Prime Agric. Land	on Agric. Land of State Import.	on Unique Agric. Land
Santa Cruz	Scenario 1A : Bus.-as-Usual	13,146	12,790	465	0	2,085	290	642
	Scenario 2D: Max. Env. Protect	14,282	13,697	986	0	0	0	0
	Scenario 3A: Compact Cities	6,721	6,465	365	0	86	12	0
Solano	Scenario 1A : Bus.-as-Usual	8,080	8,080	0	343	1,945	31	54
	Scenario 2D: Max. Env. Protect	6,375	5,046	0	0	0	0	0
	Scenario 3A: Compact Cities	5,090	5,080	0	0	1,468	14	37
Sonoma	Scenario 1A : Bus.-as-Usual	20,509	19,691	48	1,662	4,507	1,821	644
	Scenario 2D: Max. Env. Protect	19,520	18,659	60	0	0	0	0
	Scenario 3A: Compact Cities	17,272	16,406	47	0	360	141	1
Stanislaus	Scenario 1A : Bus.-as-Usual	16,630	15,177	0	0	12,627	57	331
	Scenario 2D: Max. Env. Protect	12,750	6,333	10	0	0	0	0
	Scenario 3A: Compact Cities	14,850	12,511	0	0	10,294	40	82
Yolo	Scenario 1A : Bus.-as-Usual	3,682	3,682	0	1,048	2,415	110	73
	Scenario 2D: Max. Env. Protect	5,189	4,702	0	0	0	0	0
	Scenario 3A: Compact Cities	3,088	3,088	0	0	1,504	34	72
Total	**Scenario 1A : Bus.-as-Usual**	**162,964**	**155,510**	**16,874**	**10,409**	**47,534**	**9,134**	**3,013**
	Scenario 2D: Max. Env. Prote	**147,416**	**106,823**	**14,071**	**0**	**0**	**0**	**0**
	Scenario 3A: Compact Cities	**116,726**	**109,878**	**8,942**	**0**	**28,837**	**2,053**	**693**

Source: CUF Model Output

To illustrate, consider the cases of Alameda and Stanislaus counties. In Alameda County, 98 percent of new development will occur within 1,000 meters of an existing area under both *Scenario 1A: Business-as-Usual* and *Scenario 3A: Compact Growth*. By contrast, under *Scenario 2D: Maximal Environmental Protection*, the share of Alameda County's growth that would occur within 1,000 meters of an existing urban area would fall to 91 percent. In Stanislaus County, the pursuit of environmental protection policies without also encouraging compact growth would reduce the share of new development contiguous to existing urban areas from 91 percent to 50 percent. Although the magnitude of this effect differs sharply between counties, the dynamics are generally the same: by protecting close-in environmentally sensitive sites from the developers' bulldozer, environmental preservation policies will tend to displace growth outward, where it will occur at slightly lower densities.

Regionwide, shifting from current policies (*Scenario 1A: Business-as-Usual)* to environmental protection policies (*Scenario 2D: Maximal Environmental Protection)* would reduce the amount of land developed within 1,000 meters of existing urban areas from 155,510 acres to 106,823 acres. Shifting to policies that favor compact growth (*Scenario 3A: Compact Growth)* would also reduce the amount of land developed within 1,000 meters of existing urban areas to 109,878; however, most of this reduction in land consumption would come from higher densities.

Hillside Development

For the purposes of this analysis, we will define hillsides as areas having a slope of 5 percent or more. In general, except when they have no alternative, private developers prefer not to build on hillsides. Homes built on hillsides cost more to build than homes built on flat sites, and require more extensive and costly infrastructure. Because of unfavorable economics, only a small share of projected new home development in the greater Bay Area Region will occur on hillsides, *even without further development regulation*. Even in Marin and Santa Clara counties, both of which lack level development sites, hillside development will account for less than 10 percent of newly developed residential acreage by the year 2010. The hillside acreage consumed by new home development will be similarly minimal in Napa, Sacramento, San Joaquin, Santa Cruz, Solano, Sonoma, Stanislaus, and Yolo counties. Regionwide, hillside development would total 16,874 acres under *Scenario 1A: Business-as-Usual*, 14,071 acres under *Scenario 2D: Maximal Environmental Protection*, and 8,942 acres under *Scenario 3A: Compact Cities*.

Only two counties, Alameda and Contra Costa, will continue to experience pressure for hillside development. In the case of Alameda County, most of the level sites in fast-growing communities (e.g., Dublin, Fremont, and Pleasanton) have already been developed. As a result, sites with only moderate slopes—that is, less than 10 percent—will face continued development pressure. Hillside development will be somewhat less prevalent in Contra Costa County. Under

Scenario 1A: Business-as-Usual, roughly a quarter of residential development in Contra Costa County will occur on hillsides with slopes of 5 percent or more.

Hillside protection ordinances such as those contemplated under *Scenario 2D: Maximal Environmental Protection* (i.e., prohibiting development on hillsides of 15 percent or more) would have significantly different impacts in Alameda and Contra Costa counties. In Alameda County, such protections would reduce the amount of hillside development from 9,148 to 8,651 acres. Their effect would be greater in Contra Costa County, where the amount of hillside development would be reduced from 5,520 to 2,263 acres.

Under *Scenario 2D: Maximum Environmental Protection*, the amount of hillside development in Marin, Napa, and Sonoma Counties would actually increase, albeit only slightly. In these counties, development precluded from valley agricultural sites (generally vineyards) would be displaced outward to more hilly terrain.

Wetlands Development

The term "wetlands" covers a wide variety of site types. Some wetlands are almost continually underwater. Other wetlands are wet for only a few days a year. Development of this latter wetland type is not particularly costly, and requires only minimal drainage improvements and re-grading.

Cost issues aside, not all wetland areas in the greater Bay Area Region are threatened by urban development. Three counties — San Francisco, Santa Cruz, and Stanislaus — include virtually no wetland areas. In three other counties — Alameda, Santa Clara, and Solano — the number of wetland acres threatened by imminent urban development is quite small. Existing environmental protection policies limit the development of bayfront wetland areas in Napa and San Mateo counties. Only in Contra Costa, Marin, Sacramento, San Joaquin, Sonoma, and Yolo Counties does urban development currently threaten large amounts of wetland acreage. Under *Scenario 1A: Business-as-Usual*, almost 2,400 acres of wetlands in Contra Costa County would be converted to residential uses by the year 2010. Under the same scenario, 1,662 wetland acres in Sonoma and 1,636 wetland acres in Sacramento County would be developed. And in Marin, Yolo, and Napa counties, the pursuit of current policies would mean the ultimate development of 1,497, 1,048, and 796 acres of wetlands, respectively.

Under scenarios 2D *(Maximal Environmental Protection)* and 3A *(Compact Cities)*, none of these wetland areas would be available for development. Implementation of either of these two policy scenarios would preserve more than 10,000 acres of wetland area throughout the greater Bay Area.

Agriculturally Sensitive Lands

Because of the importance of agriculture to the California economy, the urbanization of agricultural lands has long been a major public policy concern within the state. Two issues have dominated the agenda. The first is a timing issue; namely, that as a result of local tax assessment practices and private land speculation, many agricultural parcels are *prematurely* (and perhaps unnecessarily) converted to urban uses. The second issue focuses on the typical patchwork and non-contiguous pattern of farmland conversion, and on the threat that such a pattern poses to the viability of remaining farmlands. Currently—and despite occasional policy initiatives to the contrary—the protection of agriculturally sensitive lands is entirely a matter of local zoning policy.

In 1986, the California Farmland Mapping Project inventoried all lands suitable for agricultural use in California and divided them into five categories:[5] (1) prime agriculture; (2) agricultural lands of state importance; (3) agricultural lands of local importance; (4) unique agricultural lands; and (5) field and grazing lands. As noted in Part III, this inventory is a key layer in the CUF Model's spatial database.

As in the case of wetlands, the threat to agricultural lands varies widely by county. And, not surprisingly, it is in the Central Valley that urbanization poses the biggest threat to agricultural lands. In San Joaquin County for example, more than 89 percent of projected urban development under *Scenario 1A: Business-as-Usual* would occur on prime agricultural lands, unique agricultural lands, and agricultural lands of state importance. In Stanislaus County, more than 85 percent of projected new development will occur on agriculturally sensitive lands. In Yolo and Sacramento counties, 71 percent and 44 percent, respectively, of projected urban development will occur on agriculturally sensitive lands. Among Bay Area counties, agriculturally sensitive lands are most at risk under *Scenario 1A: Business-as-Usual* in Sonoma County (6,972 acres, or 34 percent of newly developed land), Contra Costa County (3,240 acres, or 14 percent of newly urbanized land), Santa Cruz County (3,017 or 23 percent), and Solano County (2,030 acres, or 25 percent of newly-developed land). Only in Alameda, Marin, San Francisco, and San Mateo counties does urbanization not pose a significant threat to agriculturally sensitive lands.

Scenario 2D: Maximum Environmental Protection assumes the adoption of policies that would prohibit the development of agriculturally sensitive lands. If adopted, such policies would substantially alter the pattern of new development, especially in the Central Valley. Generally speaking, new development in Sacramento, San Joaquin, and Stanislaus counties would be shifted eastward, from the fertile and flat areas between Interstate 80 and Highway 99 toward the Sierra foothills. In none of these counties, however, would prohibiting the development of agriculturally sensitive lands impose an absolute limit on the supply of developable sites. Development would also be shifted westward in Contra Costa County, away from the agriculturally sensitive lands surrounding Brentwood and Oakley, and toward Antioch, Pittsburg, and Concord.

Under *Scenario 3A: Compact Cities*, local governments would require developers to build at somewhat higher residential densities and in locations contiguous to existing development. The extent to which such policies would also serve to preserve agriculturally sensitive lands will vary by county. In Stanislaus County, adopting policies consistent with Scenario 3A would result in the preservation of 3,587 acres of agriculturally sensitive land. Similar policies adopted throughout San Joaquin County would result in the preservation of 2,621 acres of agriculturally sensitive land. The same policy shift in Sacramento and Yolo counties would result in the preservation of 8,464, and 988 acres of agriculturally sensitive land. Adopting compact growth policies would save 6,470 acres of agriculturally sensitive land in Sonoma County, 2,236 acres of farmland in Contra Costa County, 3,829 acres of agricultural land in Santa Cruz County, 1,200 acres of agricultural lands in Napa County, but only 500 acres of farmland in Solano County. Region-wide, the shift to a compact cities strategy would preserve 28,000 acres of prime, unique, or state-important farmland.

Regionwide, shifting from current policies (*Scenario 1A: Business-as-Usual*) to policies favoring environmental protection (*Scenario 2D: Maximal Environmental Protection*) would save nearly 60,000 acres of agriculturally sensitive lands —most of which is currently classified as prime agricultural lands. Shifting to policies that favor compact growth forms (*Scenario 3A: Compact Cities*) would save about 21,800 acres of agriculturally sensitive lands throughout the region.

V. CONCLUSIONS: GROWTH CHOICES

Whether Californians like it not, their state is going to grow, possibly by as many as 10 million more people by the year 2010. For California in general, and the greater Bay Area Region in particular, the question is not *whether to grow* but *how to grow*. Should growth continue as it has during the last 20 years, guided only by the economics of the developer and a patchwork set of local development regulations? Or should growth take a different form, guided by principles of environmental protection, or higher densities, or contiguous development?

The purpose of this research is not to offer a definitive answer to these questions. Rather, it is to give substance to alternative policies and alternative futures so that policymakers and laypersons alike can answer these questions for themselves, and thus make informed choices. Making informed choices requires having an understanding of cause and effect: an understanding that says, "if you do this today, then this is likely to happen next week or next month or next year."

The California Urban Futures Model is much more than a "super number-cruncher." It is also a window into the processes of growth and development in the greater Bay Area Region. As such, it yields fresh insights into the growth planning choices facing the region:

1. There is ample developable land to accommodate projected population growth in the greater Bay Area Region without unduly harming environmentally sensitive lands.

2. Because growth potential, land forms, and the economics of development vary widely by city and by county, any single set of development policies, applied uniformly throughout the greater Bay Area Region, will have different effects in different locations. For example, the same environmental protection policies that reduce urban land conversion in one county may increase it another.
3. The fact that growth can be *physically accommodated* does not mean that there are not *growth choices* to be made. In many greater Bay Area Region cities, policy-makers will have to choose which sites and locations are to be developed and which are to be protected. As this report demonstrates, the technology exists to help make such choices in an informed and consistent way.
4. Policy-makers need to understand that growth, like money, is fungible. Restricting growth in one jurisdiction will almost always cause that growth to spill over into another jurisdiction. When framing development policies, land use planners need to take explicit account of the possibilities and effects of spill-over growth.

NOTES

[1]The San Francisco Bay Area has traditionally been defined to include Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties; the Sacramento area includes Placer, Sacramento, and Yolo counties; the Stockton-Modesto urban area includes San Joaquin and Stanislaus counties; and the Santa Cruz-Monterey urban area includes Santa Cruz and Monterey counties.

[2]The "Bottom-Up Growth Model" was not used to develop population growth forecasts for Sacramento, San Joaquin, Stanislaus, or Yolo counties. For those four counties, we used the population growth forecasts prepared by the Sacramento Area Council of Governments (SACOG).

[3]Most zoning codes limit maximum allowable site densities, but say little about minimum densities. The idea of a zoning "floor" is that for specific sites, the average density cannot go below a certain level.

[4]Including Cotati, Petaluma, Rohnert Park, and Santa Rosa.

[5]The farmland mapping project was undertaken by the California Department of Conservation. Land was classified on the basis of current use, soil quality, and slope.

REFERENCES

California Department of Finance; Population Research Unit. *Population Estimates for California Cities.* 1970-1990.

California Senate Office of Research. 1989. *Does California Need a Policy to Manage Urban Growth?* Sacramento, California Legislature.

Council on California's Competitiveness. 1992. *California's Jobs and Future.* Sacramento.

Center for the Continuing Study of the California Economoy. 19091. *California Population.* Palo Alato.

Glickfeld, Madelyn, and Ned Levine. 1991. *Growth Controls: Regional Problems —Local Responses.* Cambridge: Lincoln Institute of Land Policy.

Landis, John. 1992a. "Does Growth Control Work? A New Assessment." *Journal of the American Planning Association* 58(4): 489-518.

____. 1992b. "Regional Growth Management." In *California Policy Choices*, Vol. 8, John Kirlin, ed., University of Southern California: School of Public Administration. Sacramento Center.

____. 1992c. *"BASS II: A New Generation of Urban and Regional Forecasting Models.* Working Paper No. 573, Institute of Urban and Regional Development. Berkeley: University of California at Berkeley.

Misczynski, Dean. 1986. "The Fiscalization of Land Use." In *California Policy Choices*, Vol. 3, John Kirlin and Donald Winkler, eds., University of Southern California: School of Public Administration. Sacramento Center.

Teitz, Michael. 1990. "California's Growth: Hard Questions: Few Answers." In *California Policy Choices*, Vol. 6, John Kirlin and Donald Winkler, eds., University of Southern California: School of Public Administration. Sacramento Center.

U.S. Census Bureau. 1990. *1990 Census of Population and Housing.*

U.S. Census Bureau. *County Business Patterns* (various years).