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The Future of Infill Housing in California: Opportunities, Potential, and Feasibility

John D. Landis
University of Pennsylvania, jlan@design.upenn.edu

Heather Hood
University of California

Guangyu Li
University of California

Thomas Rogers
University of California

Charles Warren
University of California

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NOTE: At the time of publication, the author Dr. John Landis was affiliated with the University of California. Currently, November 2007, he is a faculty member in the School of Design at the University of Pennsylvania.

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We use this schema to generate local, county, and statewide estimates of infill housing potential. These are then carefully evaluated in terms of their parcel size and financial feasibility, the likelihood that construction will displace existing low-income renters, and the contribution to cumulative overdevelopment. We conclude with a brief discussion of state-level policy changes that would reduce barriers to market-led infill housing construction.

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John D. Landis, Heather Hood, Guangyu Li, Thomas Rogers, and Charles Warren
University of California–Berkeley

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Keywords: Community development and revitalization; Infill; Urban policy

Introduction

Infill is the new urban development approach that is not very new. City planners and policy officials have been trying to encourage central-city development in various forms since the early 1940s. Federal involvement in this issue dates from the Housing Act of 1949, which authorized funding for urban renewal. The subsequent implosion of urban renewal dampened federal enthusiasm for redevelopment, but local planners and policy makers have never given up on trying to attract people and businesses to central-city neighborhoods. These efforts are chronicled in Abbott (1996), Frieden and Sagalyn (1989), Robertson (1995), and Wolman, Ford, and Hill (1994). But whereas prior efforts have mostly focused on bringing businesses, jobs, and a tax base back to central cities, more recent efforts undertaken under the rubric of "smart growth" have focused on encouraging residential development in both central cities and older suburban neighborhoods.

Conceptually at least, infill housing development and smart growth are natural partners, since each additional housing unit built in a central-city or older suburban neighborhood reduces the demand for housing at the urban edge (Danielson, Lang, and Fulton 1999). Indeed, while attempts in the name of smart growth to contain sprawl at the urban edge have met with resistance from developers, home buyers, and many suburban officials, everybody, it seems, likes infill housing.

And they should. Infill housing makes three types of policy sense (Northeast-Midwest Institute and Congress for the New Urbanism 2001; Suchman 1997; Urban Land Institute 2001). First, encouraging additional infill development reduces development pressures on outlying farmland, open space, and habitat. Second, encouraging additional infill development, particularly near transit lines and in neighborhoods that are currently or potentially "walkable," may help slow the inevitable increase in automobile travel, both on freeways and on local roads. Third, and perhaps most important, many older neighborhoods are in dire need of new investment. Some of them are demographically and economically stable but suffer from years of inattention and underinvestment. Others have become focal points of demographic and economic flux. Regardless of the particular situation, the increased private investment that is at the core of infill housing development can provide the additional financial and human resources that these communities will increasingly require.

As appealing as infill development may be in theory, it can be less appealing in practice. Done without good planning—that is, when it is not linked to appropriate improvements in infrastructure and public services—additional infill development becomes a formula for increased local traffic congestion, overcrowded schools and parks, and buildings that ignore the history and character of existing neighborhoods. Done too quickly and without adequate safeguards, additional infill becomes a formula for gentrification, as existing residents are displaced to make way for new homes they cannot afford to rent or to buy. Done without reference to a viable financial model and private developers' need to earn a reasonable rate of return, infill becomes simply a pipe dream. These and other difficulties are extensively discussed in Farris (2001) and Fulton (2001). More recently, the U.S. Supreme Court's ruling in *Kelo v.*

City of New London,[1] which affirmed the local use of eminent domain powers for speculative redevelopment, has triggered a national backlash against all forms of redevelopment, including infill.[2]

Still, for all the rhetoric and public policy interest, pro-infill development policies remain surprisingly ad hoc. This is partly because of the sour aftertaste of urban renewal[3]; partly because many cities would rather spend their scarce redevelopment dollars on economic development projects; partly because the

[1] In *Kelo v. City of New London*, 125 S. Ct. 2655 (2005), the U.S. Supreme Court affirmed the right of municipalities to use the power of eminent domain to transfer land from one private owner to another in order to further local economic development. In a 5-to-4 decision, the court held that the general benefits a community derives from economic growth qualify such redevelopment plans as a permissible "public use" under the Takings Clause of the Fifth Amendment. The case arose because New London, CT, condemned a tract of single-family homes in the Ft. Trumbull neighborhood for use as part of a comprehensive redevelopment plan. Two things were particularly unusual about this plan. The neighborhood being condemned was not blighted (as is usually the case for areas acquired for redevelopment), and the proposed plan was essentially speculative. It lacked commitments or even interest from potential buyers, businesses, or private developers.

Opinion polls taken in the wake of *Kelo* found that the public overwhelmingly disapproved of the ruling (93 percent in a *Christian Science Monitor* poll). Respondents in most other polls, depending on the question, reacted negatively in the 65 percent to 97 percent range.

The long-term effects of *Kelo* are unclear. Eight states (Arkansas, Florida, Illinois, Kentucky, Maine, Montana, South Carolina, and Washington) prohibit the use of eminent domain for economic development except to eliminate blight. Alabama has since banned takings like those authorized by *Kelo*. Similar legislation has been proposed in another 16 states. Although the controversy over *Kelo* has died down a bit, communities and redevelopment agencies across the United States remain wary of any initiatives that might be construed as sanctioning the use of eminent domain to acquire residential properties that are not blighted (Broder 2006).

[2] As of this writing, legislatures in two dozen states have introduced bills prohibiting or substantially limiting the ability of local governments to use eminent domain for nonpublic or private purposes. The most stringent of these, California's Proposition 90, which faces the voters in November 2006, couples restrictions on the use of eminent domain with provisions allowing landowners to make inverse condemnation claims (as under Oregon's Measure 37) for a wide variety of planning actions and land use regulations.

[3] Controversial from its start, the Urban Renewal program enabled participating municipalities to use their eminent domain powers to acquire large areas of substandard and blighted housing, assemble small properties into marketable lots, and then sell them at a discounted price to private developers. The heavy-handedness with which urban renewal was applied, its use in the service of highway construction programs, the resulting displacement of hundreds of thousands of low-income households from long-standing and viable residential neighborhoods, and—most of all—the failure of the private sector to use cleared and consolidated parcels led to a mounting backlash against the program.

Discontinued by executive order in 1970, urban renewal was replaced in 1974 by the Community Development Block Grant (CDBG) program, which focused on the redevelopment and reuse of existing properties rather than demolition of substandard housing. Criticisms that CDBG funds were failing to reach the urban poor resulted in the passage in 1977 of the Urban Development Action Grant (UDAG) program, which provided federal funding to public-private partnerships engaged in "bricks and mortar" commercial and residential construction programs targeted at severely distressed urban neighborhoods. Criticized by the incoming Reagan administration for being expensive and unnecessary, UDAG was converted to an economic development program during the early 1980s before being eliminated entirely in 1988.

practical problems of site assembly, site clearance, and owner holdouts that plagued urban renewal remain unresolved; and partly because few municipalities have undertaken the background work necessary to systematically understand potential infill development opportunities or the barriers to meeting them.

This article tries to fill these gaps. It reports on the results of a study undertaken for the California Business, Transportation, and Housing Agency by researchers at the University of California to assess potential infill opportunities across the state. This effort was organized around four tasks (the results of the first three are reported here, while the fourth is discussed in Landis et al. 2006):

1. Developing a statewide, parcel-based inventory of potential infill sites. Two types of infill parcels are considered: vacant sites and previously developed or *refill* sites. The inventory is the building block on which the subsequent estimation of housing unit potential is based.

2. Estimating the potential of these sites to accommodate additional housing in appropriate locations at appropriate densities.

3. Identifying current market, design, financing, and policy gaps preventing the development of appropriate infill housing and proposing possible state policy initiatives to close those gaps.

4. Estimating the current and projected demand for infill housing and locations by different demographic groups.

This assessment is directed at two audiences. Its purpose is to help California policy makers, local officials, private and nonprofit builders, community groups, and other interested stakeholders better understand the range of appropriate infill opportunities in their communities. For other readers, it presents a replicable approach using publicly available data to realistically estimate and evaluate infill sites and housing potential at multiple spatial scales.

The California context

Nowhere is enthusiasm for infill greater than in California, where state officials and legislators, regional agencies, local governments, organizations, environmental groups, and even home builders have all jumped on the infill bandwagon.[4] Despite its ill-deserved reputation as the world capital of sprawl,

[4] In 2002, the California Legislature passed AB 857, requiring the Governor's Office of Planning and Research to prepare a policy report suggesting specific steps the state might take to encourage additional infill development as a means of protecting farmland and open space.

California has already done a credible if unappreciated job of accommodating infill development, particularly in its coastal cities and counties (Johnson and Hayes 2003). An analysis of 1990 and 2000 census data indicated that infill housing accounted for between 20 and 35 percent of new homes built in California during the 1990s, depending on how infill is counted. Among individual counties, infill accounted for more than 40 percent of new housing units constructed in San Francisco, Yolo, Los Angeles, Santa Clara, Merced, Orange, Stanislaus, and San Mateo during the 1990s. Except in San Francisco, most infill housing construction during this time occurred on vacant and/or previously cleared sites and not on refill sites (Johnson and Hayes 2003).

Pushed by state housing element law and the California Department of Housing and Community Development, local governments are attempting to inventory potential development sites and include them in updates to their general plans. All of California's major councils of government—including the Association of Bay Area Governments (ABAG), the Sacramento Area Council of Governments (SACOG), the San Diego Association of Governments (SANDAG), and the Southern California Association of Governments (SCAG)—have completed regional "visioning" processes designed to discourage sprawl and encourage additional infill development.[5] More recently, the California Legislature has tackled infill directly. In 2002, the legislature passed a number of pro-infill bills limiting the ability of intervener groups to use the California Environmental Policy Act (CEQA) to stop infill housing projects.

Still, with California growing at a rate of 5 million people per decade, there is a general sense that more needs to be done. A study undertaken by the Institute of Urban and Regional Development for the Bay Area Council in 2000 (Sandoval and Landis) put the infill capacity of the nine-county San Francisco Bay Area at between 500,000 and 700,000 additional housing units. A similar study prepared in 2004 for Orange County and western Riverside County by the Center for Demographic Research at California State University, Fullerton, (2004) also found significant infill potential.

[5] A joint effort by five regional agencies, ABAG's visioning process was originally known as the *Smart Growth/Regional Livability Footprint Project* (2002); the resulting plan is now known as the *Smart Growth Alternative*. SANDAG has prepared a similar regional plan (2004). SACOG's recently completed smart growth visioning process, known as the *Blueprint Project* (2005), is moving toward adoption and implementation. In Southern California, SCAG's visioning process, initially known as the *Compass Project* and now as the *Compass 2% Strategy* (2005), is also moving toward implementation.

Identifying potential sites

The traditional approach to inventorying infill sites is to undertake a site-by-site survey. Although this is feasible for a city or even a small county, it is impractical for a state or metropolitan area, since there are simply too many potential sites to consider. Instead, it is necessary to draw on existing parcel databases and to use parcel attribute and location information to identify appropriate sites, as well as to filter out inappropriate ones.

Specifically, this study used county tax assessor records collected and compiled by First American Real Estate Solutions, a private firm. A single download of data records for 4 million potential infill parcels, including parcels that were sold or reassessed as recently as May 2004, was obtained from First American Real Estate Solutions in July 2004.

In theory, county tax assessor records are both comprehensive and up-to-date. They are supposed to include every legal parcel in a county—no matter how small—and are updated whenever a parcel is bought, sold, subdivided, or combined. Each record includes the parcel area, the principal land use, the assessed value of the land and any improvements, and, most important for this study, an accurate address. However, there is commonly a lag in updating this information, and some counties are more current than others. Consequently, some existing parcels are missing from this database, and some of the parcels indicated as vacant may have since been developed. Records are supposed to be checked regularly for completeness and accuracy by each tax assessor, and for the most part they are. Still, errors do slip through, and a major part of this study involved trying to eliminate duplicates and records with clearly erroneous parcel sizes or land use information. Table A.1 summarizes the principal digital data sources used in this assessment.

Infill = vacant + underutilized parcels

This assessment identifies infill sites as vacant and/or potentially redevelopable parcels located within existing urban neighborhoods. Following the definition commonly used by county tax assessors, a *vacant parcel* is defined as one that has no inhabitable structure or building or is not currently used for extractive purposes such as mining or oil drilling. Parcels with structures too small to be inhabited or parcels with structure values of less than $5,000 (measured in constant 2004 dollars) are also deemed to be vacant. To be counted as ready for infill, a vacant parcel must also be urban, privately owned, and available and feasible for potential development. This last criterion purposely excludes all public lands as well as undeveloped farmland, range, and forestland owned by public conservancies. In addition, it excludes sites with slopes in excess of 25 percent but not sites on which development is likely to be difficult for regulatory or political reasons or lack of community support (sites in wetlands or flood zones, prime agricultural sites, or sites not slated for development under local general plans). Thus, not all of the identified parcels will be appropriate for development.

Refill parcels, also known as redevelopable parcels, are privately owned, previously developed parcels with a structure valued at $5,000 or more, but for which the improvement-value-to-land-value (I/L) ratio is less than 1.0 for commercial and multifamily properties and less than 0.5 for single-family properties.[6] County tax assessors use transaction values as reported to county deed recorders to estimate improvement values and land values whenever a property is sold.[7]

Using I/L ratios to identify potential refill parcels has advantages and disadvantages. On the positive side, it makes maximum use of available tax assessor's data and thus avoids the need to individually consider each parcel and land use. It also has a strong theoretical and empirical basis: Urban parcels whose improvement values are less than their land values are generally regarded by landowners, developers, and redevelopment officials as economically underutilized.

There are also disadvantages to using I/L ratios to identify potential refill sites. Under the terms of Proposition 13, passed by California voters in 1978, properties are reassessed only when they are sold or substantially remodeled—or, in the case of some commercial properties, wholly refinanced. Because of this, we worried that many parcels in long-standing single ownership might be inappropriately viewed as potential infill parcels simply by virtue of their low

[6] The vast majority of commercial properties in California have an I/L ratio in excess of 4.0. Most residential properties have an I/L ratio above 3.0. Because redevelopment of any type—but especially residential redevelopment—is so controversial, we were continually cognizant of the dangers of labeling otherwise viable properties as potential refill sites. To err on the safe side, we compared I/L ratios with structure age. For commercial properties, those with I/L ratios of 1.0 or less were overwhelmingly more than 50 years old (that is, raising the I/L ratio above 1.0 yielded substantial numbers of commercial properties that were less than 50 years old). For single-family residential properties, raising the I/L ratio above 0.5 yielded many single-family homes that were either larger than 1,500 square feet or less than 40 years old. While many such structures might be regarded as economically underutilized on the basis of their I/L ratios and location, we deemed it unlikely that they would also be regarded as either physically underutilized or obsolete on the basis of their age and size.

[7] County tax assessors in California use several methods to decompose residential property values into their land and structural components. In growing areas, they commonly compare the transaction prices of "paper" lots (subdivided but not improved), improved homesites, and finished homes. In established neighborhoods, they sometimes use regression analysis to partition property values into land and improvements (and other categories). Finally, many county assessors use a form of residual analysis in which the hard and soft costs of residential construction are subtracted from market sales prices to estimate underlying land values. (See footnote 23 for a fuller explanation of hard and soft costs.)

land and structure assessments. This turned out to be less of a problem than we had originally thought. By comparing the I/L ratios of similar (and in some cases identical) structures over time, we determined that there was little evidence of bias in the way county tax assessors value land vis-à-vis structures. Thus, while the two components of the I/L ratio—improvement values and land values—have increased dramatically since 1978, the I/L ratio itself has proven to be reasonably stable within individual counties.

Defining infill counting areas

Whether a parcel should be counted as a potential urban infill site depends on its location as well as its availability for development or redevelopment. On the one hand, most people would count an empty parcel in central Los Angeles or downtown San Francisco as a potential urban infill site. On the other, most people would probably agree that a parcel located in a rural community far from an existing urban area should not be considered as a potential infill site, regardless of its I/L ratio or improvement status. Recognizing that one person's urban neighborhood may be another person's suburb, the study used detailed census data and digital maps from the California Farmland Mapping and Monitoring Project (CFMMP) to delineate three sets of boundaries for tabulating potential infill sites. Known somewhat awkwardly as counting areas (to indicate that they are used to capture and count potential infill sites), these boundaries include the following:

1. *Largest infill counting areas (LICAs)*. These consist of 2000 census blocks falling within incorporated cities (regardless of density) and unincorporated areas having an average residential density of 2.4 dwelling units per acre or more. Areas with average residential densities below 2.4 dwelling units per acre tend to be overwhelmingly suburban and usually include significant swaths of undeveloped, greenfield land. The logic of using city boundaries to identify and count infill parcels stems from the fact that the administration of policies and programs designed to encourage infill is likely to occur on a citywide basis.

2. *Middle infill counting areas (MICAs)*. These consist of 2000 census blocks having a gross residential density in excess of 2.4 units per acre and commercial and industrial areas contained by the CFMMP's 2000 urban footprint. MICAs typically include most central-city neighborhoods, many older suburban neighborhoods, and some higher-density, newer suburban neighborhoods.

3. *Smallest infill counting areas (SICAs)*. These are the types of locations people commonly associate with infill development. In coastal counties,

> SICAs consist of 2000 census blocks having a gross residential density in excess of 4.0 units per acre—the minimum density required to facilitate regular pedestrian activity. In inland counties, SICAs consist of 2000 census blocks with a gross residential density greater than 3.2 units per acre. SICAs typically include most central-city neighborhoods, some older suburban neighborhoods, and a very few higher-density, newer suburban neighborhoods. SICAs should, by virtue of their higher residential densities, be walkable: That is, their housing densities are high enough that there are a significant number of potential trip destinations within an easy walking distance of a quarter of a mile. However, "should be" and "are" are very different matters. Many neighborhoods that should otherwise support pedestrian travel because of their higher densities and mixture of different activities are, in fact, cut off from each other by wide streets with high traffic volumes, by subdivision barriers and sound walls, and by a local street pattern that favors cul-de-sacs over connectivity.

The boundaries of these counting areas are not mutually exclusive: LICAs subsume MICAs and SICAs, and MICAs subsume SICAs. At a county or municipal level, the degree to which LICA, MICA, and SICA boundaries differ depends chiefly on the age and density of the housing stock.[8] Statewide, SICAs include one-fifth of the land area of LICAs.

Additional exclusions

A quick perusal of the initial vacant and refill parcel inventory revealed a number of problems. The initial inventory substantially overcounted single-family homes. Depending on the county, it also overcounted condominium units.[9] Certain types of land uses were included in the refill inventory despite being unsuitable for residential development. Last, there were a number of apparent errors relating to misreported parcel sizes in some assessment records. Faced with these problems, several additional site exclusion conditions were applied to prune the initial inventory:

[8] The choice of counting area was of particular interest to the state policy makers and infill advocates who served on the project's Technical Advisory Committee. Concerned that potential state policies promoting infill development would have to be implemented on a citywide basis, state and local policy makers pushed for the most inclusive LICA definition. Infill advocates, however, hoping to use pro-infill policies to focus higher-density development in walkable urban neighborhoods where it could be conveniently served by transit, favored the more restrictive SICA definition.

[9] California county tax assessors commonly list every condominium unit as a separate record, along with an undivided estimate of the total underlying parcel value. This has the effect of drastically lowering condominium I/L ratios and rendering almost all condominium units available for potential refill.

1. *Imposing a single-family home improvement threshold.* To reduce the overcounting of single-family homes, the study excluded those for which the assessed structure value was within the top 60 percent of structure assessments within each county.
2. *Excluding cemeteries, private golf courses, and country club parcels.* Although there are examples of private golf course and country club parcels being redeveloped as housing, the number of opportunities for this type of refill development is quite limited.
3. *Excluding parcels larger than five acres currently in active resource or agricultural use.*[10] California's urban communities still include many active farms, ranches, and private woodland areas. In addition to their resource value, such sites are widely regarded as an important source of neighborhood open space. They also provide vital links with community traditions. Conservancies protect some of these properties, while zoning protects others. A five-acre threshold was applied to determine which of these parcels should be considered for infill development.
4. *Excluding parcels adjacent to Superfund sites.* California includes 94 designated Superfund sites. Projects adjacent to them typically face numerous liability questions that detract from their marketability and potential to attract financing.
5. *Excluding multiple listings of condominium parcels.*

Estimates of California's infill parcel and acreage potential

Infill is inherently local, so the task of estimating a statewide total, particularly in a state as large and diverse as California, is an inexact exercise. Still, as an estimate of how many parcels and how many acres could conceivably be available for infill development, a single total is both useful and compelling. On the basis of this assessment, California has roughly 495,000 potential infill parcels comprising approximately 220,000 acres of land (table 1). These totals were calculated by counting up all vacant and underutilized parcels within the state's LICAs—that is, within existing city boundaries and/or in unincorporated places with a residential density of 2.4 or more units per acre. As noted, all of these parcels must be regarded as *potential* infill sites since the study did not evaluate their market status or their owner's intentions regarding future development.

[10] Local politics and community preferences aside, there is no reason why these parcels could not or should not be developed for urban uses, including housing.

Table 1. California's Potential Infill Inventory

	LICAs		MICAs		SICAs	
	Number	%	Number	%	Number	%
All potential infill parcels	494,580	100	446,800	100	344,980	100
Vacant parcels	56,590	11	35,200	8	18,690	5
Refill parcels	437,990	89	411,600	92	326,290	95
Currently in multifamily residential use	180,800	37	165,330	37	143,240	42
Currently in single-family residential use	173,020	35	165,600	37	131,000	38
Currently in commercial use	26,580	5	25,370	6	18,660	5
Currently in industrial use	17,470	4	16,640	4	5,830	2
Currently in another developed use	40,120	8	38,660	10	27,560	8
All potential infill acreage	220,100	100	158,030	100	83,660	100
Vacant acreage	64,050	29	27,070	17	7,570	9
Refill acreage	156,050	71	130,960	83	76,090	91
Currently in multifamily residential use	63,800	29	50,190	32	36,890	44
Currently in single-family residential use	29,630	13	25,490	16	18,580	22
Currently in commercial use	14,280	6	12,770	8	6,760	8
Currently in industrial use	23,530	11	21,070	13	3,410	4
Currently in another developed use	24,810	12	21,440	14	10,450	13
Average parcel size (acres)	0.4		0.4		0.2	
Average vacant parcel size	1.1		0.8		0.4	
Average refill parcel size	0.4		0.3		0.2	
Currently in multifamily residential use	0.4		0.3		0.3	
Currently in single-family residential use	0.2		0.2		0.1	
Currently in commercial use	0.5		0.5		0.4	
Currently in industrial use	1.3		1.3		0.6	

Moving from the LICAs to the MICAs reduces the number of potential infill parcels by about 10 percent and the amount of infill acreage by about 28 percent. Further restricting the set of potential infill sites to the SICAs—neighborhoods with densities high enough to make them potentially walkable—reduces the statewide number of vacant and refill parcels to about 345,000 and the amount of potential infill land area to approximately 84,000 acres.

Most potential infill sites in California are refill sites: That is, they are already developed. Refill parcels account for 89 percent of potential infill sites within the LICAs, 92 percent of potential infill sites within the MICAs, and 95 percent of potential infill parcels within the SICAs. In terms of land area, refill parcels account for 71 percent, 83 percent, and 91 percent of potential LICA, MICA, and SICA infill acreage, respectively. Since vacant sites are generally easier to develop than refill sites, which must be cleared and possibly cleaned up, increasing development on refill sites presents significant challenges and therefore realistically reduces the residential potential on these sites.

Adding to the challenge, most potential infill sites are small. The average LICA refill parcel is just four-tenths of an acre, while the average SICA refill parcel is only two-tenths of an acre. Vacant infill sites are a bit larger, but barely: The average vacant LICA parcel is just over an acre, while the average vacant SICA parcel is four-tenths of an acre. Some smaller parcels may be appropriate for lot consolidation, but this cannot be determined from tax assessor's data.

The largest share of refill acreage is in multifamily residential use, which accounts for 29 percent of LICA and 44 percent of SICA infill acreage. Single-family homes account for another 13 and 22 percent, respectively, of LICA and SICA infill acreage. These last percentages introduce a conundrum that will permeate this article. To the degree that so many economically underutilized refill sites are in single-family or multifamily residential use, one can conclude that most such properties are providing affordable housing to hundreds of thousands of California households. Since new affordable housing cannot be developed anywhere in coastal California without sizable subsidies, it generally would not make sense to demolish older affordable housing units to make way for new, less affordable units, even if there is a net gain in the number. Seen from this perspective, aggressively redeveloping undervalued single-family and multifamily properties risks neighborhood gentrification and the displacement of low- and moderate-income families; housing replacement strategies are therefore critically needed.

Much has been made of the possibility of recycling older commercial buildings and shopping centers into new housing. Statewide, a total of only 6 percent of LICA infill acreage and 8 percent of SICA infill acreage is in commercial use. Turning to underutilized industrial sites (which have their own problems as potential housing refill sites because of the possibility of toxic contamination and a lack of residential services), only 11 percent of LICA and 4 percent of SICA infill acreage consist of this type of property. On the positive side, commercial and industrial refill parcels are generally larger than residential sites, making them somewhat easier to develop from a design, if not from a financial or neighborhood use, perspective.

Regional infill estimates

The Southern California Region[11] includes half of California's population and, on the basis of the parcel inventory produced for this study, over 70 percent of its potential infill parcels and half of its potential infill acreage (table 2) These percentages are based on parcels inside the state's LICAs. In terms of numbers, we estimate that Southern California's LICAs include 350,000

Table 2. Potential Infill Parcels and Acreage by Region and Infill Counting Area

	LICAs	MICAs	SICAs
Infill parcels			
Southern California	349,900	329,200	263,900
San Diego County	38,000	34,800	25,800
San Francisco Bay Area	71,400	60,600	42,900
San Joaquin Valley	13,300	9,200	2,800
Greater Sacramento Region	5,700	4,100	2,100
Central Coast	7,600	6,500	4,600
Nonmetropolitan counties	4,800	1,400	500
Infill acreage			
Southern California	109,300	87,500	53,200
San Diego County	37,100	28,200	15,500
San Francisco Bay Area	35,100	23,500	9,700
San Joaquin Valley	17,400	10,900	2,100
Greater Sacramento Region	5,800	3,300	1,000
Central Coast	4,400	1,600	1,400
Nonmetropolitan counties	9,900	2,100	300
Percentage of vacant acreage			
Southern California	19	10	6
San Diego County	11	7	4
San Francisco Bay Area	37	23	15
San Joaquin Valley	65	61	51
Greater Sacramento Region	56	44	32
Central Coast	30	15	5
Nonmetropolitan counties	76	67	52
Average infill lot size (acres)			
Southern California	0.38	0.32	0.24
San Diego County	0.98	0.81	0.60
San Francisco Bay Area	0.49	0.39	0.23
San Joaquin Valley	1.31	1.18	0.74
Greater Sacramento Region	1.02	0.80	0.48
Central Coast	0.58	0.25	0.30
Nonmetropolitan counties	2.06	1.45	0.67

[11] For this study, the Southern California Region comprises Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties, but not San Diego County.

parcels and 109,300 acres.[12] Regardless of counting area, according to this assessment, the vast majority—more than 80 percent—of potential infill sites in the Southern California Region are refill lands. Potential infill parcels in the Southern California Region tend to be on the small side, averaging less than half an acre for LICAs and a quarter of an acre for SICAs. This combination of small size and prior development status poses significant design and financial challenges to would-be developers of infill housing.

Why do Southern California and especially Los Angeles County have such a large share of the infill inventory? For one thing, the region is highly urbanized, making its three types of counting areas quite large. For another, it includes many older and undervalued structures located on parcels in otherwise accessible and desirable neighborhoods (this is especially true for the city of Los Angeles).

California's second largest urban region, the nine-county San Francisco Bay Area,[13] has 20 percent of the state's population, but only 15 percent of its potential infill parcels and acreage. In terms of numbers, the Bay Area's LICAs comprise 71,400 potential infill parcels and 35,100 potential infill acres; its SICAs comprise 43,000 potential infill parcels and 9,700 acres. One in three Bay Area LICA infill parcels is vacant, double the share found in Southern California. Bay Area infill parcels are comparable in size to their Los Angeles–area counterparts, averaging 0.49 acres for LICAs and 0.23 acres for SICAs.

Elsewhere in the state, San Diego County has 38,000 potential infill parcels and 37,100 potential infill acres in its LICAs. Potential parcels there average almost an acre, more than double the average size of potential infill parcels elsewhere in Southern California. All else being equal, this means that it should be somewhat easier to develop infill housing in San Diego County.

The 200-mile-long San Joaquin Valley Region[14] has 10 percent of California's population, but only 3 percent of its potential infill parcels. What these parcels lack in numbers, however, they make up in size. The typical parcel is 1.3 acres, versus less than half an acre in Southern California and the Bay Area. The other difference is that the potential infill parcels in the San Joaquin Valley tend to be vacant rather than developed: Fully 65 percent of potential infill parcels in the valley's LICAs are vacant, versus 19 percent in the Southern California Region and 37 percent in the San Francisco Bay Area.

[12] Parcel numbers and acreage totals are rounded to the nearest hundred.

[13] The San Francisco Bay Area comprises Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.

[14] The San Joaquin Valley Region comprises Fresno, Kern, Kings, Mariposa, Merced, San Joaquin, Stanislaus, and Tulare Counties.

The infill picture in the Greater Sacramento Region[15] is similar to that found in the San Joaquin Valley. Infill parcels in the former are characteristically larger and more likely to be vacant than parcels in Southern California and the San Francisco Bay Area.

Transit-accessible infill parcel and acreage estimates

Infill housing is most convenient when located near a rail transit station, a bus line, or a ferry terminal. Infill residents who can walk to public transportation make much less use of their cars, thereby reducing traffic, and ultimately may see less reason to own a car at all.[16] Statewide, approximately 8,000 acres of potential infill land are within easy walking distance (defined as a third of a mile) of a rail transit station or ferry terminal.[17] This is only 4 percent of all potential infill acreage in California. Another 25,600 potential infill acres, or 12 percent of the potential inventory, are within a quarter of a mile of a high-frequency bus line (defined as bus rapid transit [BRT] lines and conventional bus lines with peak headways (frequencies) of 10 minutes or less and off-peak headways of 20 minutes or less). Just under 20,000 potential infill acres are located within a quarter of a mile of a moderate-frequency bus line (defined as lines with peak headways of 20 minutes or less and off-peak headways of 30 minutes or less). A final 7,600 acres of potential infill land are located within a quarter of a mile of a low-frequency bus line.

Not surprisingly, there are tremendous differences in the amount of transit-accessible infill land between regions and individual counties. Because of its extensive bus system and new rail transit system, Los Angeles County has the largest amount of transit-accessible infill acreage of all types, followed by San Diego and Santa Clara Counties. San Francisco's Muni bus system and two rail transit systems (BART and Muni Metro) blanket the entire city, but because of its small land area, high building values, and lack of vacant land, transit-accessible infill opportunities in San Francisco are few and far between.

Estimates of infill housing potential

This section explores the housing potential of California's infill inventory. The key word in this sentence is *potential*: that is, how many housing units

[15] The Greater Sacramento Region comprises El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba Counties.

[16] For a good summary of the relationships between mode choice, residential densities, and proximity to transit, see Cervero and Kockelman (1997) and Cervero and Radisch (1996).

[17] These estimates were contained by comparing the locations of infill parcels with a statewide rail and bus transit route map from the California Department of Transportation.

could theoretically be built, not how many should be built or how many are feasible. These issues are addressed in later sections.

At current residential densities, California's nearly 500,000 potential infill sites could be expected to accommodate about 1.5 million additional housing units. This number corresponds to roughly 25 percent of the state's projected need for housing units over the next 20 years.[18] If infill housing is to comprise a larger share of the state's housing production, thereby reducing development pressures on farmland and open space, then new housing densities must rise above prevailing levels.

In fact, most new infill housing in California *should* occur at higher-than-prevailing densities as developers search for creative ways to balance consumer demands for close-in housing with higher urban land costs. Counteracting market-based pressures for higher densities is the desire of many residents to maintain the character of their neighborhoods. In the absence of clearly articulated policies promoting higher densities in appropriate locations, the status quo generally wins. Thus, any consideration of increasing infill housing production above the 1.5 million units mentioned earlier must overcome numerous development constraints, as well as legitimate resident concerns about the potential for increased traffic or reduced levels of public services. Such an accounting must necessarily vary community-by-community and neighborhood-by-neighborhood.

Neighborhood-consistent infill housing densities

This assessment explores the potential for additional infill housing units based on the concept of *neighborhood-consistent infill housing densities*. This concept is intended solely to generate useful and consistent estimates of state, regional, county, and local infill housing potential. It is not intended to be prescriptive or to dictate to local governments how and at what densities they should plan for infill housing development. Rather, it is intended to provide an opportunity for planners and policy makers to understand what may be possible with respect to infill housing development, while recognizing that decisions about individual projects are best left to local government.

There are two ways to approach the task of identifying neighborhood-consistent infill housing densities. The first is to ask: What are current neighborhood densities, and how much additional density is appropriate? The second is to ask: What final, or build-out, densities are appropriate and prefer-

[18] California's annual housing production needs during the 2000–2020 period have been estimated to be in the range of 170,000 to 225,000 per year. The lower estimate was developed by Myers and Pitkin (2001), the higher one by Landis et al. (2000) in a study undertaken for the California Department of Housing and Community Development.

able for particular neighborhoods? The first approach takes an *increase-density-from* perspective, while the second takes an *increase-density-to* perspective. Planners, designers, and smart growth advocates tend to favor the second approach. Residents and local elected officials, to the degree that they favor higher densities at all, tend to favor the first. This study charts a middle ground by specifying prospective infill densities based on current parcel and neighborhood densities (this is the *increase-density-from* perspective), on the land use character of existing neighborhoods (to the degree that they have one), and on the availability and quality of transit service (this is the *increase-density-to* perspective).

The degree to which individual parcels gain additional density and thus add additional housing units depends first on current neighborhood densities. All else being equal, parcels located in lower-density neighborhoods gain less density and fewer housing units, while parcels located in higher-density neighborhoods gain more density and more housing units. The effect is to ground future infill densities within current neighborhood conditions and thus current neighborhood character.

The transit service quality dimension is also extremely important. Significant increases in housing densities in the absence of good transit service or a pedestrian-friendly urban form will necessarily result in more local traffic congestion, since all additional residents must use their cars for every trip. Walkable neighborhoods or those that have or will have good transit service can thus accommodate higher densities, while neighborhoods lacking such services may be limited in their ability to accommodate additional density.

Table 3 summarizes the set of prospective infill densities. These are expressed as percentages of current neighborhood densities. We recognize that communities such as San Francisco, downtown Los Angeles and San Diego, Oakland, Long Beach, and Sacramento already include densely developed neighborhoods. As a result, the study also specifies a set of *maximum densities*. Because valuable infill sites might be underdeveloped, *minimum densities* are also specified. Where new housing units replace older ones, the *net addition* is reported as a percentage increase in residential density.

Four separate and distinct types of neighborhoods are identified:

1. *Intense mixed-use neighborhoods*. These would have been called downtowns or central business districts 20 years ago, but more recently they are located in suburban communities as well. They consist of areas in which commercial (retail and office) land uses predominate, but residential buildings with a gross density of 25 or more dwelling units per acre are also found. This nearby combination of different land uses and densities makes

Table 3. Neighborhood-Consistent Housing Density Percentages by Neighborhood Type, Transit Service Quality, and Parcel Type

Neighborhood and Site Character	How Identified	Frequency of Bus Service	Vacant and Commercial/ Industrial Density (%)	Residential Density (%)	Minimum Densiity (Dwelling Units per Acre)	Maximum Density (Dwelling Units per Acre)
Downtown/intense mixed-use neighborhood	Intense mixed-use neighborhoods include predominantly commercial land uses and have a gross residential density of 10 units per acre or more.	High	250	150	40	80
		Moderate	200	100	30	60
Within one-third of a mile of a rail transit station	Identified from state and local transit maps	Any	200	100	30	60
Predominantly retail or office area	Based on the majority or plurality land use as identified from ABAG, SANDAG, and SCAG digital land use maps. Elsewhere, identified from a statewide general plan map prepared by the University of California–Davis, Information Center for the Environment (2004)	High	200	100	30	60
		Moderate	150	50	20	40
Commercial/industrial neighborhood		High	200	100	30	60
		Moderate or Low	150	50	20	40
High-density residential neighborhood	Those with a net residential density of at least 15 dwelling units per acre	High or Moderate	200	100	20	50
		Low	150	50	20	30
Medium-density residential neighborhood	Those with a net density of 5 to 15 dwelling units per acre	Any	150	50	10	20
Low-density residential neighborhood	Those with a net density of less than 15 dwelling units per acre	High	150	50	5	8
		Moderate or Low	125	25	4	6
Not previously classified and currently in nonresidential use	Based on individual parcel characteristics	All	150	50	10	20
Not previously classified and in multifamily use	Based on individual parcel characteristics	All	50	50	20	40
Not previously classified and in single-family use	Based on individual parcel characteristics	High or Moderate	50	50	5	8
		Low	25	25	4	6

Note: High-frequency bus service has peak headways of 10 minutes or less and off-peak headways of 20 minutes or less. Moderate-frequency bus service has peak headways of 10 to 20 minutes and off-peak headways of 20 to 30 minutes. Low-frequency bus service has peak headways of 20 minutes or more and off-peak headways of 30 minutes or more.

it possible for pedestrian trips to substitute for some auto trips, thereby reducing the congestion associated with higher densities. Downtown-like neighborhoods are divided into those served by high-frequency bus transit and/or fixed-rail transit and those served by moderate-frequency bus service. Areas served by high-frequency bus service are those within a quarter of a mile of one or more bus lines having peak headways of 10 minutes or less and off-peak headways of 20 minutes or less. Residents who live in such areas count on being able to walk to a nearby bus or rail stop and not have to wait for more than a few minutes. The vacant/nonresidential density factor for parcels within intense mixed-use neighborhoods with high-quality bus or rail service is 2.5, while the residential density factor is 1.5.[19] The maximum and minimum densities for these parcels are 80 housing units per acre and 40 housing units per acre, respectively.

2. *Rail and ferry transit-served neighborhoods.* These areas are within a third of a mile of an existing or committed heavy-rail or light-rail transit station, a ferry terminal, or a BRT stop. Prior research suggests that rail transit riders can reasonably be expected to walk up to a third of a mile from their home to a nearby station, and we make the same assumption for ferry and exclusive busway BRT riders (see Cervero and Gorham 1995, Cervero and Kockelman 1997, and Cervero and Radisch 1996). Altogether, California's six urban rail transit (BART, Los Angeles Metro, Sacramento Light Rail, the San Diego Trolley, San Francisco Muni Metro, and Santa Clara Light Rail), ferry, and exclusive busway systems have nearly 300 existing and planned stations. Not all rail transit systems provide high-frequency service. The Capital Corridor, ACE (Altamont Commuter Express), and Los Angeles Metrolink systems provide frequent service only during weekday commuting hours, and Caltrain (which runs from San Jose to San Francisco) provides limited off-peak and weekend service. Still, the presumption is that with rights-of-way and station facilities already in place, service on all of these systems could potentially be increased if there were sufficient demand, much of it coming from prospective infill development. The vacant/nonresidential density factor for parcels within a third of a mile of a fixed-rail/dedicated busway station is 2.0, while the residential density factor is 1.0. The study established maximum and minimum densities for these parcels of 60 and 30 housing units per acre, respectively.

[19] These density ranges are similar to those put forward in recent regional visioning efforts, including ABAG's *Smart Growth/Regional Livability Footprint Project* (2002), SACOG's *Blueprint Project* (2005), SANDAG's *Regional Comprehensive Plan* (2004), and SCAG's *Compass 2% Strategy* (2005).

3. *Retail, office, and industrial neighborhoods.* These predominantly commercial or industrial neighborhoods are identified in one of two ways: Where detailed and current land use maps were available (for the Bay Area, the Southern California Region, and San Diego County and its cities), a geographic information system was used to identify areas in retail or office use or in industrial use and then combine them into districts. Where such maps were not available, commercial and industrial locations were identified using the statewide digital general plan map developed at the University of California–Davis's Information Center for the Environment (2005).[20] Suggested density percentages for vacant and nonresidential sites in these neighborhoods range from a high of 200 percent for sites with high-quality transit service to a low of 150 percent for sites with lower-quality transit service. Corresponding residential density percentages for these locations range from 50 to 100 percent. Maximum and minimum densities range from 60 dwelling units per acre to 20 dwelling units per acre, depending on the availability and quality of transit service.

4. *Residential neighborhoods.* Many of the sites available for potential infill development are in residential neighborhoods. This is especially true of older suburban communities developed in the 1930s, 1940s, 1950s, and in some cases even the 1960s, with many homes and apartment buildings that are now functionally and economically obsolete and lack historical character or significance. While there may be an argument from a market perspective for making these neighborhoods denser, the degree of densification must be carefully considered and should reflect the existing residential character. The model in this case should be enough additional density to improve neighborhood quality but not so much as to adversely impact existing residents. Suggested density percentages for vacant and nonresidential sites in these neighborhoods range from a high of 200 percent for sites in existing high-density areas (those with net densities in excess of 15 units per acre and high-quality transit service) to a low of 125 percent for sites in existing low-density areas (those with less than 5 units per acre and a lack of good-quality transit service). The corresponding residential density percentages for these locations range from 25 to 100 percent. Minimum densities range from just 4 units per acre in low-density neighborhoods all the way up to 20 units per acre in high-density neighborhoods.

[20] To preclude counting planned, but as-yet undeveloped, commercial and industrial development projects, only those general plan areas within the 2000 CFMMP urban footprint were considered.

Maximum densities vary from just 6 units per acre in low-density neighborhoods to 50 units per acre in high-density ones.

California's infill housing potential

If all the potential infill sites located in the state's LICAs were developed or redeveloped at the neighborhood-consistent densities indicated in table 3, California could accommodate approximately 4 million additional infill units (table 4). This is numerically equivalent to 20 years of housing production based on a statewide production level of 200,000 units per year, although infill housing and suburban housing are qualitatively different products and California needs more of both types. Three-quarters of this development potential (or about 3 million of those 4 million new homes) could take the form of refill. The rest is for vacant parcels.

If all of the parcels were to be developed for residential uses, limiting infill housing development to the MICAs reduces the state's estimated infill housing potential to about 3.6 million units. Compared with the housing unit potential of the LICAs, most of the reduction in MICA potential occurs through a reduction in the number of vacant sites. Further limiting infill housing development to the SICAs or walkable urban neighborhoods would reduce the state's estimated infill housing potential to about 2.1 million units.

Some 20 percent of LICA infill housing potential is associated with multifamily properties. This proportion rises to 32 percent for the SICAs. If nothing else, these percentages indicate the vulnerability of California's multifamily neighborhoods to potential redevelopment and possible gentrification. Indus-

Table 4. California's Infill Housing Unit Potential

	Housing Unit Potential in the LICAs		Housing Unit Potential in the MICAs		Housing Unit Potential in the SICAs	
Types	Number	%	Number	%	Number	%
All infill parcels	3,998,200	100	3,558,300	100	2,146,600	100
Vacant parcels	933,900	23	650,700	19	233,800	10
Refill parcels	3,064,300	77	2,907,600	81	1,912,700	90
Currently in multifamily residential use	787,900	20	742,600	21	680,800	32
Currently in single-family residential use	302,600	8	295,800	8	266,100	12
Currently in commercial use	458,000	11	437,500	12	312,600	15
Currently in industrial use	725,900	18	685,400	19	148,100	7
Currently in other use	789,900	20	746,300	21	505,100	24

trial sites comprise the next largest source of potential refill units, at least among the LICAs and MICAs. Among the SICAs, office and retail sites provide the next largest source of potential refill units.

Regional infill housing potential

Given its much greater availability of sites, it is not surprising that the Southern California Region by itself accounts for 60 to 70 percent of California's infill housing potential (table 5). On the basis of the neighborhood-consistent densities identified earlier, we estimate that the Southern California Region could accommodate an additional 2.3 million, 2.2 million, and 1.5 million infill housing units within its LICAs, MICAs, and SICAs, respectively. Most of this new housing development potential would occur in Los Angeles County within existing walkable neighborhoods and along major bus lines, and at densities ranging from 25 to 30 dwelling units per acre. This represents a substantial degree of densification. Elsewhere in Southern California, San Diego County could accommodate an additional 220,000 to 422,000 potential infill housing units. Unlike much of Los Angeles County, where ubiquitous transit service could facilitate higher densities, most of San Diego County's potential infill housing construction is likely to occur at densities comparable to today's.

Table 5. Infill Housing Potential and Density by Region and Infill Counting Area

	LICAs	MICAs	SICAs
Infill housing unit potential	3,998,200	3,558,300	2,146,550
Southern California	2,333,700	2,171,400	1,502,400
San Francisco Bay Area	751,700	657,800	358,800
San Diego County	421,800	376,600	221,500
San Joaquin Valley	246,200	250,300	26,800
Nonmetropolitan counties	118,100	31,600	4,100
Greater Sacramento Region	73,400	51,400	16,450
Central Coast	53,300	19,200	16,500
Average infill density (units per acre)			
San Francisco Bay Area	21.3	27.9	37.0
Southern California	18.7	21.9	25.0
San Joaquin Valley	14.0	16.1	12.5
Greater Sacramento Region	12.6	15.4	15.8
Central Coast	12.0	12.0	11.9
Nonmetropolitan counties	11.9	14.9	11.8
San Diego County	11.4	13.3	14.2

These estimates reintroduce the question of why Southern California in general and Los Angeles County and the city of Los Angeles in particular have such a large share of the infill housing potential. First and foremost, if only by virtue of its size, Southern California contains a majority of the state's potential infill sites. The land area of the six-county Southern California Region, for example, is more than five times that of the San Francisco Bay Area. Second, by state standards, average densities throughout Southern California, but especially in its coastal communities, are fairly high. This means that the neighborhood-consistent density percentages presented in table 3 are applied to a higher base. Third, in terms of land use mix and residential densities, if not urban design, much of the city of Los Angeles and the surrounding cities should be walkable and thus able to support higher densities. Fourth, in terms of bus headways, much of the Los Angeles Basin enjoys high-quality transit service and should therefore be able to support higher-density housing.

A side-by-side comparison of two Southern California cities, Glendale (in Los Angeles County) and Riverside (in Riverside County), should help clarify these points. As of 2000, Riverside had 30 percent more residents than Glendale (255,000 versus 194,000) but less than half of its infill housing potential (20,000 versus 45,100 potential dwelling units). Because most Glendale neighborhoods are older than their Riverside counterparts, Glendale has many more potential refill sites (6,000 versus 600). Glendale's current residential density is more than double that of Riverside, so any increase in the infill densities starts from a higher base. Last, on the basis of its current mix of land uses and superior bus transit service, Glendale should be able to support higher future densities than Riverside. In Glendale, for example, prospective infill housing could be constructed at a neighborhood-consistent average density of 30 units per acre; the comparable rate for Riverside is only 12 units per acre. Adding all of these factors together—the much greater number of potential infill sites, higher initial density, and ability to support greater densities—Glendale's infill housing potential is roughly double that of Riverside. Telescope this simple two-city comparison up to the regional level and the tremendous infill housing potential of Los Angeles becomes more understandable.

The infill potential of the San Francisco Bay Area, although sizable, is far less than that of the Southern California Region. Altogether, the nine-county San Francisco Bay Area could accommodate between 360,000 and 752,000 potential infill housing units at average densities ranging from 37 to 21 units per acre. The lower housing unit estimates and higher density estimates are for the region's SICAs, while the higher housing unit estimates and lower density estimates are for the LICAs.

The eight-county San Joaquin Valley Region has half the Bay Area's population but only about a third of its infill housing potential. This is because the former's infill inventory is so much smaller, its current average densities are so much lower, and it lacks the pedestrian-friendly urban form and transit service necessary to serve higher-density development. Altogether, the San Joaquin Valley Region could accommodate between 27,000 and 246,000 infill housing units. The infill potential of the Greater Sacramento Region is even lower, principally due to its small inventory. The overall estimate is that the six-county Greater Sacramento Region could accommodate between 16,000 and 73,000 infill housing units in its SICAs and LICAs, respectively.

Infill housing potential by transit accessibility and service frequency

Much has been made in the literature and in legislation of the potential contribution of rail transit–accessible development[21] toward meeting California's (and America's) future housing needs. (See, for example, Transit Cooperative Research Project (2004) and Reconnecting America: Center for Transit-Oriented Development 2004). In California at least, this attention is merited. Statewide, we estimate that more than 550,000 additional infill units could be accommodated on potential sites within walking distance (a third of a mile or less) of existing heavy-rail systems such as BART or the Red Line in Los Angeles and light-rail systems such as the San Diego Trolley or the one in Santa Clara County. Altogether, rail transit–accessible infill accounts for 14 percent of California's total infill housing potential.

The great potential of rail transit–accessible sites to accommodate infill housing is not due to their large number or size, but rather to the fact that so many of them are located in higher-density neighborhoods. Thus, the "density bump" associated with proximity to rail transit serves only to further increase the density potential. Not surprisingly, the counties with the most rail transit–accessible infill housing potential are those with the most infill sites and the most transit stations.

Turning from rail to bus transit, more than 25,600 acres of potential infill land throughout California are within a quarter of a mile of a bus line offering high-frequency service. Altogether, it is estimated these sites could potentially accommodate nearly 1.1 million infill housing units. As exceptional as this total sounds, most of it is in just one county: Los Angeles. The Los Angeles County Metropolitan Transportation Authority (MTA) has been a national

[21] The term *transit-accessible development* is used to indicate development that is within easy walking distance of a transit station or stop, as opposed to *transit-oriented development*, which is specifically designed to connect to a transit facility.

leader in implementing high-frequency bus service, including BRT, and approximately 900,000 potential infill units, almost half of the potential units in Los Angeles County, could be constructed on sites that are within a quarter of a mile of one of MTA's high-frequency bus lines.[22] Beyond Los Angeles County, the potential for high-frequency bus transit–accessible development is much more modest.

The picture is more balanced geographically for infill sites within walking distance of bus lines offering only moderate-frequency service. Statewide, there are approximately 19,200 acres of infill land within a quarter of a mile of a moderate-frequency bus line, and these sites could accommodate 543,100 infill units. A little less than half of these potential units (260,000) are in Los Angeles County. As significant as these numbers and percentages may seem, it remains to be seen whether bus service with 10- to 20-minute peak headways and 20- to 30-minute off-peak headways is frequent enough to attract a substantial ridership, particularly during off-peak periods. The half-million-plus potential infill units within a quarter of a mile of such lines may be desirable for many reasons, but whether their residents will be frequent bus riders is not known.

Infill feasibility issues

Identifying site potential may be the first step toward increasing the production of infill housing, but it is by no means the last. To be practical, infill housing projects must also be feasible from a physical, financial, and regulatory perspective and must garner community acceptance. Physical feasibility requires that an infill parcel be of sufficient size and shape to be buildable. Financial feasibility requires that a project generate enough cash flow or revenue to cover its development costs. Regulatory feasibility requires that potential projects be consistent with local general plans and zoning ordinances (allowing for the possibility of an amendment or zoning change) and that they pass muster under the local entitlement process. Community acceptance requires that the impact on existing residents be recognized and addressed.

Physical feasibility issues

Lots are like people in that each is unique. As experienced builders know, every lot presents unique physical challenges affecting its developability. Some

[22] San Francisco is even more exceptional since almost all of its potential infill units are within walking distance of a rail transit station or high-frequency bus line. However, additional bus service would be needed to accommodate a significant increase in ridership resulting from new infill development.

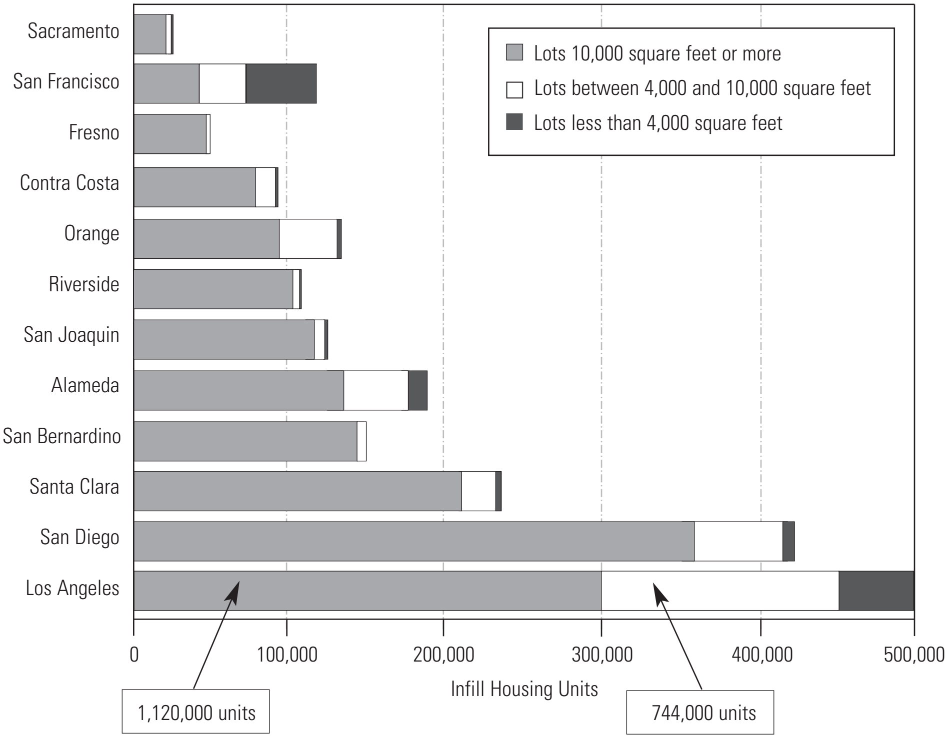
lots are steeply sloped, while others have unstable soils. Underground pipelines encumber some lots, while others are contaminated. Many physical constraints can be mitigated with alternate designs or construction technologies, usually at some cost; others are more difficult to address.

Other factors being equal, larger lots are inherently easier to develop than smaller ones. At some size point, typically 2,000 to 2,500 square feet or less (depending on the lot configuration), the challenge of designing a marketable housing project that also meets local parking and regulatory requirements becomes so great as to render the lot almost impossible to build on. This is the reason why lots smaller than 2,500 square feet were excluded from the inventory. Lots only slightly larger than 2,500 square feet are also difficult to develop. Not until a lot is about 5,000 square feet (a little more than one-eighth of an acre) do the constraints on designing marketable infill projects start to recede.

Statewide, imposing a minimum feasible lot size threshold of 4,000 square feet reduces the infill potential by only 3 percent for the LICAs and 5 percent for the SICAs. Among individual counties, San Francisco alone is adversely affected by a 4,000-square-foot threshold: About 40 percent of its potential infill lots are less than 4,000 square feet. Raising the minimum feasible lot size threshold from 4,000 square feet to 10,000 square feet would have a much more limiting effect on infill potential, eliminating an estimated 1.1 million units statewide.

Figure 1 summarizes the number of potential infill housing units by lot size for selected California counties. Those with the greatest number of potential infill units on small lots (parcels smaller than 10,000 square feet) are Los Angeles (744,000), San Francisco (74,400), San Diego (62,300), Alameda (52,300), Orange (38,000), and Santa Clara (22,000). These estimates are based solely on lot square footage and ignore the effects of lot shape or the potential for parcel assembly. Eliminating small and irregularly shaped parcels would further reduce infill potential. Parcel consolidation, however, offers the possibility of increasing infill potential. Still, the implications of this analysis are clear: In Los Angeles and San Francisco Counties (and to a lesser extent in Orange, Alameda, and San Diego Counties), the inventory of infill parcels is dominated by small lots that are more difficult to develop. Promoting the construction of infill housing in these counties will require developing new designs and models of small-lot units covering a variety of configurations and densities.

Figure 1. Infill Housing Potential by Lot Size for Selected Large Counties (LICAs)



Financial feasibility issues

Infill housing must be economically as well as physically feasible. This section uses a technique known as land residual analysis to assess the economic feasibility of developing rental and ownership housing on each site in the infill inventory. Land residual analysis compares the cost of constructing a given project *exclusive of land costs* with its estimated market value. For rental projects, market value is estimated on the basis of current market rents, vacancy rates, operating expenses, and the real estate market "capitalization rate." For ownership projects, market value is estimated from comparable sales. The difference between estimated market value and construction cost is assumed to be the residual land value. If the calculated residual value exceeds the cost of land, then the project is deemed financially feasible. If the calculated residual value is less than the cost of land or is negative, then the project is deemed financially unfeasible. These calculations are similar to those used for a highest and best use analysis, except that only one use—rental housing—is considered. The inputs into a residual analysis fall into two categories: (1)

construction parameters and costs and (2) sales or operating revenues and sales or operating costs.[23] These parameters, costs, and revenue estimates were assembled for every potential infill parcel and housing development and then used to estimate a residual land value. Table A.2 illustrates the use of these parameters and the calculation of a residual value for archetypal infill projects in four locations throughout California.

Of the nearly 4 million potential infill units statewide, fewer than 1.1 million were judged to be even minimally financially feasible. Forty-four

[23] Specific input parameters include the following:

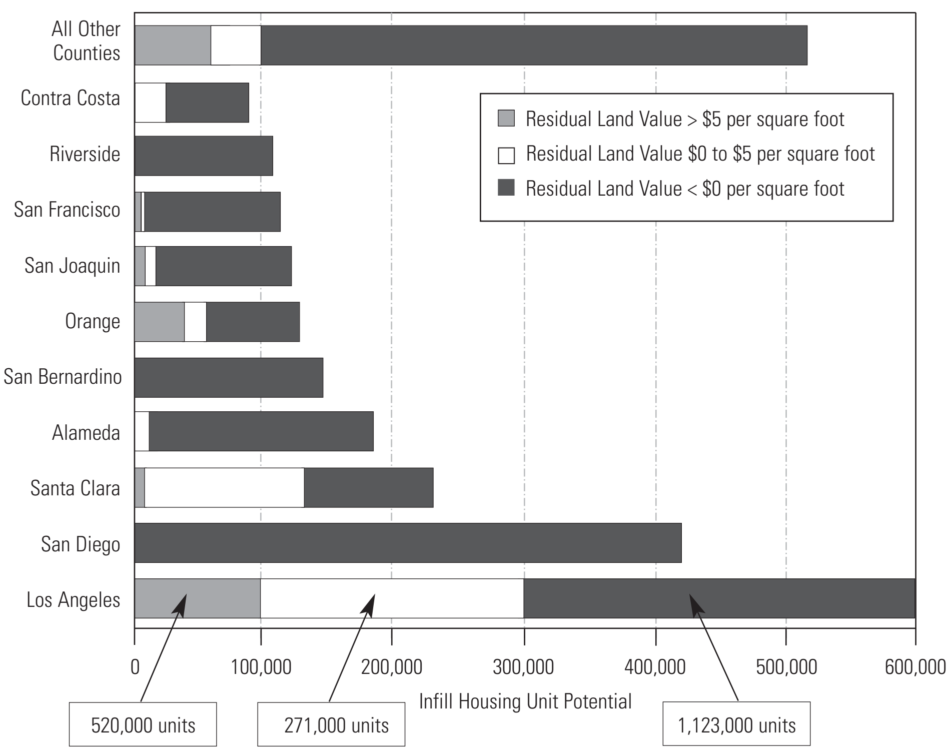
1. *Hard construction costs.* These are the costs for labor and materials to construct the project and are usually expressed on a per square foot basis. We used construction cost estimates for high-rise, mid-rise, and low-rise apartment buildings as listed in the *Construction Cost Estimating Guide* (RS Means 2005), which also lists local cost adjustment factors ranging from 1.25 in San Francisco to 1.0 in many rural counties.
2. *Soft costs.* These are the costs of nonconstruction services and fees involved in project development. We used a 35 percent soft cost factor (soft costs are calculated as 35 percent of hard costs) for San Diego, Alameda, San Diego, San Francisco, San Mateo, and Santa Clara Counties to reflect the higher regulatory costs associated with these areas. Elsewhere, we used a 30 percent soft cost factor.
3. *Average unit size and common area percentage.* For the purposes of this analysis, we assumed that every project consisted solely of two-bedroom units, each sized at 800 square feet. Most apartment projects include a mixture of one-, two-, and three-bedroom units. We further assumed that common areas (hallways, stairs, landings, elevators, laundry rooms, recreational rooms, and storage areas) would add another 10 percent to the total size of each project.
4. *Parking requirements and parking construction costs.* Parking ordinances in most California cities require one parking space per bedroom, up to a maximum of two spaces. Parking construction costs can be as low as $1,500 per space for surface parking or a high as $25,000 per space for underground, structured parking.
5. *Gross rent.* This includes contract rent and tenant-paid utilities. We obtained 2004 rent estimates for California's major apartment markets from RealtyRates.com (2005), an on-line subscription service that collects quarterly rent and operating data from a sample of investment-grade commercial properties.
6. *Vacancy loss ratios.* These reflect the loss in rental income attributable to unoccupied units and are commonly expressed as a share of rental income. Among California's major apartment markets, we used the vacancy loss ratios reported by RealtyRates.com (2005). Elsewhere, we used a flat vacancy loss ratio of 5 percent.
7. *Operating cost ratios.* These reflect the monthly and annual costs to the owner of operating an apartment unit and typically include property taxes, common area utilities, insurance, maintenance costs and allocated reserves, and management and security costs. Among California's major apartment markets, we used the operating cost ratios reported by RealtyRates.com (2005), which were typically in the 30 to 35 percent range. Elsewhere, we used a flat operating cost ratio of 30 percent.
8. Subtracting total vacancy losses and operating costs from rental income yields net operating income or NOI. Dividing NOI by the capitalization rate (or cap rate), the rate at which the local real estate market capitalizes current income into market value, yields an estimate of project value in the current market. Cap rates are estimated from actual market transactions and vary with interest rates, property type, and local supply-demand balance. Among California's major apartment markets, we used cap rates as reported by RealtyRates.com (2005). Elsewhere, we used a flat cap rate of 8 percent. Further explanations of these parameters can be found in Landis et al. (2006).

percent of these 1.1 million units were associated with residual values of less than $5 per square foot, making them marginally feasible at best.

There are 27 counties, including San Diego, San Bernardino, Riverside, and Sacramento, where no potential infill units were judged to be financially feasible (figure 2) or, to put it another way, where typical rents on new units would likely not cover construction costs.

The presence of San Diego, Riverside, and Sacramento Counties on this list—counties where new rental construction is *currently occurring*—points to a significant limitation of the residual analysis method as used in the study. Until now, we have assumed that all new apartment units in a community would rent for the same typical or median amount; this is unlikely. Depending on their location and quality, some units will rent for far more than the median, while others will rent for less. The median rent is simply a construct based on the actual distribution of rents. So, while a representative new apartment project that charges the median rent may not be financially feasible, projects that charge higher than median rents may be *very* feasible.

Figure 2. Infill Housing Potential by Residual Land Value for Selected Large Counties (LICAs)



Still, the broad conclusion to be drawn from figure 2 is clear. Given current rent levels and construction and development costs in most parts of California (including predevelopment costs, entitlement costs, and fees), most potential infill rental units may not be financially feasible without changes or incentives. This is not to say that they cannot become financially feasible in the future. If and when infill living takes greater hold in the marketplace, development and entitlement costs are brought more into line with prevailing rents, or financial assistance is provided to lower such costs, it is quite possible that many infill projects will be able to pass this critical market test.

Potential for the preemption and gentrification of low-cost housing

Approximately 30 percent of California's infill inventory consists of parcels occupied by apartment buildings, many of which provide affordable housing to low-income families. Redeveloping such parcels in the name of expanding the supply of infill housing presents a huge dilemma. On the one hand, additional housing supplies of any type will help contain prices and rents and thus promote increased affordability for all households. But this is a long-term effect, and whether increased housing supplies at the top of the market will ultimately filter down to promote increased housing affordability at the lower end remains an open question. In the short term, the demolition of existing affordable rental units to make way for additional market-rate units would have a disastrous effect on affordability and in the absence of appropriate subsidies would result in the displacement of hundreds of thousands of low-income families.

Exactly how great is this danger? To find out, the study tabulated the number of potential infill housing units on parcels in multifamily use and in census block groups in which the median rent was below the median rent for each county. These are locations in which many low-income renters reside; for them, increased infill development could result in the loss of affordable housing. These tabulations are presented for selected large urban counties in table 6. It is important to note that they are tabulations of the number of potential infill units and not the number of existing affordable units that could be demolished.

The potential for infill-generated displacement varies widely by county. Among the LICAs, the potential for displacement is greatest in Los Angeles County, where existing and affordable multifamily structures could be replaced by as many 281,000 additional infill units; in San Diego County, where these structures could be replaced by as many as 41,000 additional units; and in Alameda, San Francisco, Orange, and Santa Clara Counties, where these structures could be replaced by roughly 9,000 to 19,000 additional units.

Table 6. Infill Housing Unit Potential among Existing Multifamily Properties in Low-Rent Census Blocks, for LICAs and Selected Counties

County	Infill Housing Potential (Units)	Housing Unit Potential among Existing Multifamily Properties in Low-Rent Census Blocks	
	Number	Units	%
Los Angeles	1,914,207	280,994	15
San Diego	421,801	40,704	10
Alameda	188,066	19,312	10
San Francisco	116,322	13,581	12
Orange	131,465	12,962	10
Santa Clara	231,778	9,252	4
Riverside	107,520	5,038	5
Contra Costa	93,902	3,069	3
San Mateo	23,824	1,734	7
San Bernardino	150,440	1,714	1
Sacramento	23,508	1,693	7
Ventura	30,063	1,505	5
Santa Barbara	26,837	1,475	5
Santa Cruz	15,984	1,324	8
Sonoma	41,528	1,255	3
San Joaquin	124,317	692	1
Monterey	5,155	655	13
Kern	23,833	586	2
Yolo	22,824	503	2

Not surprisingly, most of the apartment units at risk from potential infill developments are in older and more central neighborhoods. Among Los Angeles County's SICAs, nearly 274,000 new infill housing units could potentially be built through the redevelopment of older and undervalued apartment buildings. Indeed, statewide, more than 90 percent of existing apartment units in affordable census tracts at risk from potential development are in older and more central locations.

Among individual cities, the potential for infill-caused displacement is greatest in Los Angeles, San Diego, San Francisco, Long Beach, Inglewood, Oakland, much of San Jose, and Berkeley. Not surprisingly, these are the communities in which California's poorest urban residents are concentrated. In the city of Los Angeles alone, nearly 200,000 infill dwelling units could potentially be built on sites currently occupied by affordable apartment buildings. In the city of San Diego, the demolition and replacement of apartment buildings in lower-income areas could yield nearly 30,000 additional infill homes.

We focus on these numbers to highlight the inherent tension between encouraging infill development in older urban neighborhoods desperately in need of new investment and the potential displacement danger such developments would pose to the current residents of these same neighborhoods. Simply put, these numbers make clear the need to balance pro-infill development policies with programs capable of ameliorating their potential for gentrification and displacement. Infill can be a powerful force for city building, but not at the expense of existing residents with the fewest housing options and opportunities.

Potential for preemption of economic development

Along with its 12 million additional residents, California will likely add about 6 million jobs over the next 25 years.[24] Many of these new jobs will be accommodated in new office parks and shopping centers to be built in suburban locations. Many more, however, will be accommodated in infill locations. Table 1 indicated that approximately 9 percent of California's infill inventory and 17 percent of its infill acreage are currently in commercial or industrial use. These percentages correspond to 44,000 potential infill parcels and 38,000 potential infill acres. At a typical urban density of 20 to 30 employees per acre, this acreage could accommodate 760,000 to 1.1 million additional workers.

Regardless of how much total acreage is actually needed to accommodate future job growth, history would indicate that all of California's cities and counties will likely want to make sure they have zoned or otherwise reserved enough acreage to accommodate their projected job and commercial/retail growth. What would be the effect on infill housing potential of reserving existing commercial and industrial refill sites for economic development instead of housing? To make this question more realistic, we further limited the set of potential refill parcels reserved for economic development to ones larger than 10,000 square feet. Statewide, excluding these parcels from the inventory would reduce the infill housing potential by about a million units for the LICAs and 400,000 units for the SICAs.

As always, these totals vary widely by county. About half a million potential housing units or roughly a quarter of Los Angeles County's infill potential would be lost if existing commercial and industrial refill sites were not available for reuse as housing. Elsewhere in Southern California, more than half of Orange County's 131,500 potential infill housing units would be preempted by

[24] Between 1980 and 2000, California added two new residents for each new job (State of California Department of Finance 2004). We assume that this ratio will continue into the future.

new commercial or industrial development. The county where infill housing development is most likely to be at odds with economic development is Santa Clara, where fully 61 percent of the 231,800 potential infill housing units could be lost to prospective commercial or industrial redevelopment (see table 6).

Impacts on neighborhoods and community character

Significant infill development, like any new development, has the potential to substantially change the character of existing communities. The degree of change will depend on many things, including the amount of infill development, its density, the effort made to integrate the design and character of new development with existing communities, and the attention paid to community issues. The concern that infill projects be developed in a manner sensitive to their community and neighborhood character led to the development of the *neighborhood-consistent density* approach presented earlier.

Still, even when individual projects pay attention to community character and context, the cumulative effect of many such developments on a neighborhood may be an issue, especially when these changes occur over a short period. To better appreciate potential cumulative impacts, the study calculated the percent change in community densities associated with achieving the full infill potential of the top five infill cities in each of California's major urban regions (table 7).

Concerns over the possible cumulative impacts of infill development on community character are especially valid in Los Angeles County, with its large number of potential infill sites, its high residential densities (at least by California standards), and its extensive rail and bus service. Regardless of whether infill development occurs citywide (within the LICAs), or is limited to denser neighborhoods (within the SICAs), the impacts on community character would likely be noticeable.

Infill development poses a still sizable but somewhat less onerous challenge in the San Francisco Bay Area. In San Francisco, for example, a full build-out of all potential infill properties with housing would cause citywide average residential densities to rise by as much as 30 percent. While perhaps noticeable, such an increase would not necessarily impact urban services, especially if new residents could be accommodated near the city's extensive rail and bus transit system. Elsewhere in the Bay Area, reducing the density of new infill development below its maximum or limiting future infill projects to existing urban neighborhoods would result in smaller and less noticeable increases in community density.

Infill development is likely to be more consistent with the character of existing neighborhoods in the San Joaquin Valley because cities there are not

Table 7. The Top Five Infill Cities in Each Urban Region: Infill Housing Potential, Average Infill Densities, and Effects on Community Densities

Region		Cities and Census Designated Places	Current Average Density (Dwelling Units per Acre)		Potential Infill Housing Units		Average Infill Density (Dwelling Units per Acre)		Percent Change in Community Density	
			LICAs	SICAs	LICAs	SICAs	LICAs	SICAs	LICAs	SICAs
Southern California Region and San Diego County	1	Los Angeles	19.6	24.7	969,400	805,900	33.9	39.5	72	60
	2	San Diego	8.2	11.7	258,300	15,190	12.7	15.5	55	32
	3	Long Beach	16.6	19.2	67,800	53,600	23.2	25.3	40	31
	4	Glendale	19.8	23.7	45,100	38,800	32.0	36.3	61	53
	5	Santa Monica	24.7	25.8	44,200	43,600	47.6	49.4	92	91
San Francisco Bay Area	1	San Francisco	66.8	68.9	116,200	106,000	89.2	89.9	34	31
	2	San Jose	19.2	23.2	108,000	37,200	26.6	26.3	38	13
	3	Oakland	27.5	39.0	65,156	48,800	38.8	51.1	41	31
	4	Sunnyvale	22.4	28.3	32,074	13,500	35.7	35.4	60	25
	5	Santa Clara	17.9	23.4	26,255	7,100	29.8	27.6	66	18
San Joaquin Valley	1	Stockton	9.9	17.9	49,600	6,400	16.0	19.3	60	8
	2	Fresno	12.3	12.4	38,400	5,900	15.5	12.9	26	4
	3	Tracy	5.5	12.8	25,600	700	13.2	13.2	141	4
	4	Bakersfield	13.2	14.3	16,200	1,700	15.6	14.6	18	2
	5	Manteca	10.5	12.3	15,700	900	20.3	12.9	93	5
Greater Sacramento Region	1	West Sacramento	7.5	12.0	15,700	1,000	17.3	12.9	129	7
	2	Sacramento	16.4	20.9	14,800	7,500	17.8	21.8	9	5
	3	Woodland	13.8	9.6	4,900	1,200	17.8	10.3	29	7
	4	Roseville	9.8	8.9	4,600	200	11.2	9.0	14	1
	5	Loomis	3.7	NA	4,500	0	11.1	NA	200	0
Central Coast	1	Santa Barbara	11.0	13.1	9,800	5,200	14.0	14.9	26	14
	2	Santa Maria	10.5	11.9	7,300	1,500	13.9	12.7	32	7
	3	Santa Cruz	9.4	10.5	5,700	2,500	11.9	11.7	26	11
	4	Watsonville	10.0	12.5	4,000	1,000	13.5	13.6	34	9
	5	Salinas	12.6	9.3	3,100	300	13.6	9.4	8	1

NA = Not available.

as dense as their coastal counterparts, have smaller supplies of infill land, and have a much lower level of transit service. The situation is similar in the Greater Sacramento Region.

This discussion again highlights the double-edged nature of infill development. Undertaken on a citywide basis wherever vacant or underutilized parcels are available, infill development has the potential to add significantly to local, county, and regional housing supplies. At the same time, and in the absence of good local planning, the cumulative impact of such development on existing neighborhoods could be significant, even if individual projects are developed at neighborhood-consistent densities. And while focusing infill development in existing higher-density neighborhoods could lessen its impact, doing so would also restrain its potential contribution to meeting California's future housing needs. If cities and counties are to encourage increased infill development, they must actively plan for it at the neighborhood level and not rely solely on the permitting process as applied to individual projects to deal with critical issues of cumulative impact and community character.

Conclusions and caveats

If each and every one of California's 500,000 infill parcels were developed to its fullest potential with housing, the resulting 4 million housing units would meet all of the state's 20-year projected demand while simultaneously saving more than 350,000 acres of undeveloped suburban land from the developer's bulldozer. These impressive estimates are subject to many caveats and qualifications, almost all of which serve to reduce the supply of potential sites and thus the number of potential units, some drastically.

First, the land inventory totals underlying the estimates are based on an analysis of county tax assessor's parcel data and not on individual site inspections. Arguments can be made that these calculated inventory estimates are either too high or too low. On the overestimate side, some of the parcel size, land use, and land and structure assessment information in the data files may be incorrect or outdated, resulting in the overcounting of potential refill parcels. The quality of the parcel data varies by county. Land and structure assessments based on older transactions are particularly problematic because, under Proposition 13, properties are not reassessed unless they are sold or substantially changed or renovated. It is quite possible that many of the potential infill parcels identified as economically underutilized, and therefore ripe for redevelopment, may be neither physically deteriorated nor economically undervalued. This is likely to be particularly problematic for properties that were renovated but not reassessed.

Problems may also arise from the computerized address-matching procedures used to locate parcels. These approximate the locations by interpolating individual parcel addresses between the address ranges at the beginning and end of each block and can occasionally mislocate parcels relative to city and counting area boundaries. Parcels may be located inside private conservancies or subject to conservation easements, or they may be subject to localized physical or environmental constraints that are not likely to be identified until the particular site enters the permitting process. Without further and individualized site analysis, the extent of any of these problems is not known.

It is also possible that we may have underestimated the supply of potential infill parcels and acreage. This analysis limits potential refill development to nonresidential and residential parcels with I/L ratios of less than 1.0 and 0.5, respectively. In fact, much of the infill development that has occurred and continues to occur throughout California is on parcels with higher I/L ratios, that is, on parcels that are not as economically underutilized as these. There are a number of reasons why this might be the case. Redevelopment is typically more opportunistic than systematic. If a development proposal is deemed feasible from a regulatory, market, and financial perspective, it will tend to be pursued, regardless of whether other, potentially better opportunities are available elsewhere. Moreover, it may make great sense for developers to prefer parcels with higher I/L ratios if, once developed, those parcels command higher rents or housing prices in the marketplace than parcels with lower ratios. This would be especially true in popular and up-and-coming neighborhoods where there is a proven market or where higher-density development is favored. As in the case of so-called “in-law units” and “granny flats,” it may be possible for residential property owners to add to the stock of housing without partially or completely redeveloping their sites. Last, this analysis does not include parcels in public ownership, whether surplus school sites or military bases, public works yards, or public transit properties. Although many such sites do appear in tax assessor’s databases, their assessed values, whether for land or structures, are often suspect. To the degree that some of these sites might become available, they should be included in the infill inventory.

A second set of issues concerns the availability of potential parcels. We have no information on which, if any, of the identified sites are or might be made available by their current owners for sale or development. The current lack of development activity in many neighborhoods that are otherwise ripe for redevelopment suggests that owners of potentially developable sites do not see them as such. In the absence of incentives or regulatory changes, private development or redevelopment of such sites is unlikely to be initiated.

In a related vein, given California's very high development and construction costs, particularly in coastal markets, less than 1 million of the state's nearly 4 million potential infill housing units would pass a minimum threshold of financial feasibility if developed as rental housing. Nor does this analysis consider the infrastructure improvements or expansions necessary to accommodate additional infill development. If increased infrastructure costs were to fall entirely on the subject property, they would likely render its development economically unfeasible. In the absence of such improvements in the form of schools, parks, and roadway capacity, it is doubtful that neighboring property owners would support increased infill. Moreover, brownfield sites often entail remediation that is revealed only after construction has begun.

Third, the process used to identify potential sites did not consider current general plan or zoning designations. Many of the identified sites carry current zoning designations that would not permit residential uses: A total of 9 percent of the potential inventory and 17 percent of the estimated acreage is in commercial or industrial use. If these sites were reserved for future economic development and therefore preempted from residential use, California's infill housing potential would fall by about a million units.

Another 30 percent of the infill inventory consists of parcels occupied by apartment buildings, many of which provide affordable housing to low-income families. Redeveloping such parcels in the name of smart growth and expanding the supply of infill housing presents a huge dilemma. On the one hand, additional housing supplies of any type will help moderate price and rent increases and thus promote increased affordability for housing consumers in general. On the other hand, this is a long-term effect, and whether increased housing supplies at the top of the market will ultimately filter down to promote increased housing affordability at the lower end remains to be seen. In the short term, the demolition of existing affordable rental units to make way for additional market-rate units would have a disastrous effect on housing affordability and, in the absence of appropriate subsidies, would result in the displacement of hundreds of thousands of low-income families.

Fourth, many of the infill lots identified in this assessment are extremely small or have environmental or other physical constraints to their development. Eliminating those infill lots that are smaller than a quarter of an acre would reduce California's infill housing potential by more than a million units.

Fifth, infill development, like any new development, has the potential to alter the character of existing communities. Even when individual projects pay attention to community character and context, the cumulative effect of many such developments on a neighborhood or community may be considerable, especially when such changes occur over a short time.

Last, and in a slightly different vein, we question whether there truly is enough market demand to justify an additional 4 million units of infill housing. Throughout this article, we, like many others, have assumed that infill housing and suburban housing are interchangeable. This is not likely to be the case. Whether intended for rental or purchase, most new infill housing units are much smaller than their suburban competitors. They have fewer rooms and less storage space and accommodate fewer cars. Compared with newer suburban communities, the quality of local public services—particularly public schools and parks—is generally inferior in infill neighborhoods. The match between the potential supply of infill housing and the demand for housing forms and locations is discussed in greater detail in Landis et al. (2006).

Taking all of these factors and qualifications into account, a more realistic assessment would put California's current infill housing potential in the range of about 1.5 million units. Numerically and percentage-wise, this constitutes a significant expansion over recent infill production levels.

Policy suggestions

What would it take to boost infill production above this 1.5-million-unit level? We conclude with a series of policy suggestions aimed at making the infill development process easier, simpler, fairer to existing low-income residents, and more encouraging of private and nonprofit developer innovation. Although generated in a California context and directed toward California policy makers, many of these suggestions cross state lines.

1. *Require cities and counties to specifically identify potential infill housing sites and infill programs and strategies as part of their housing elements.* California housing element law requires local governments to inventory parcels appropriate for future residential development. It does not require that they focus on infill housing or otherwise promote its construction. California law should be amended to require that residential site inventories (and accompanying development standards, permit processing, and implementation programs) more directly identify potential infill sites.

2. *Improve the amount and quality of available information on potential infill development opportunities.* Information on the range of infill development opportunities is increasingly available.[25] The one critical piece of information that is still missing concerns the extent and severity of toxic contamination in potential infill sites. Such assessments are undertaken on

[25] The Web site <http://www.infill.org> is a map-based browser for identifying potential infill sites anywhere in California.

an ad hoc basis in the predevelopment phase of particular projects. Moving them forward to the comprehensive or neighborhood planning stage would make it possible to consider brownfield remediation needs on a more comprehensive basis and thus reduce the risks associated with infill development.

3. *Undertake a comprehensive review of the effectiveness of national and state brownfield remediation and liability laws with an eye toward potential reforms.* In a related vein, federal and state laws intended to increase the flow of brownfield sites into the development process by more clearly assigning liability and remediation responsibilities and by limiting downstream liability exposure have not worked (Boyd, Harrington, and McCauley 1996). For developers interested in infill sites, it is simply not possible to accurately estimate potential litigation or site remediation costs. This has had a chilling effect on infill land transactions of all types. With the federal government largely uninterested in local development issues, it is time for states like California that are interested in infill development to make their own assessment of the efficacy of current laws on brownfield liability and remediation—and to change them accordingly.

4. *Create new sources of infrastructure and off-site improvement financing for infill projects.* Above all, money talks. Contrary to the conventional wisdom, most infill sites are infrastructure deficient, especially compared with their newer suburban counterparts. Development impact fees also tend to be much lower in older communities than in newer ones, thus reducing the funding available to upgrade infrastructure for infill. One way to overcome this problem would be for states to authorize the creation of a tax increment financing–like mechanism to be used to upgrade infrastructure and public facilities in older neighborhoods. To avoid the *Kelo*-like specter of urban renewal, this should be decoupled from the use of eminent domain.

5. *Streamline the development entitlements process and in particular CEQA to reduce the regulatory uncertainty associated with infill housing projects.* Per acre, per unit, and per square foot of constructed space, infill development typically costs more than suburban development. These higher costs are magnified by the greater risks associated with infill development. In California, the major source of increased risk is CEQA, which decouples project-level reviews from plan- and zoning-based reviews. This dramatically reduces the importance, value, and usefulness of planning. The solution to this problem is to undertake some project-level and cumulative impact assessment activities as part of the up-front planning process and to

allow infill projects that are consistent with approved plans or environmental assessments to be approved on an “as of right” basis.

6. *Establish a permanent funding source to help low-income households displaced by new infill development.* Perhaps the biggest challenge facing proponents of infill development is how to avoid displacing existing low- and moderate-income households and how to ensure that their housing circumstances and cost burdens do not worsen materially if displacement does take place. Funding is also needed to ease the burden of the transition to affordable replacement housing. State and local governments interested in promoting infill housing should partner to create and fund programs to provide housing allowances to low-income families whose affordable rental units have been lost to private refill activity. Modeled in part on the successful HOPE VI (Housing Opportunities for People Everywhere) relocation assistance program, these allowances could be used to make up the difference between a low-income tenant’s current (presumably affordable) rent payment and market rents, as well as to secure affordable housing elsewhere in the same community or to return to the same site once construction has been completed. Funding for such a program could be derived from multiple sources, including local trust funds, impact fees, and—where appropriate—local redevelopment agencies.

Directions for future research

The findings generated by this work suggest several issues for investigation. The first and most obvious is to determine how well this macrolevel identification and analysis square with actual on-the-ground infill opportunities. This could be done by selecting a representative sample of the sites and investigating the specific design, economic, market, and community acceptance constraints confronting their potential infill development. The application of a more detailed financial feasibility model incorporating local (as opposed to county-average) rent levels would be especially welcome.

A second study might focus on identifying the specific infrastructure investment and funding needs associated with different infill land uses and densities in different locations. Third, while many analysts (including ourselves) talk about the need to develop programs to better manage the adverse displacement and gentrification impacts associated with market-led infill development, little analysis has been done to date on how such programs might actually work and how they might be funded. Last, greater attention must also be paid to the demand side of the infill equation. We should not make the mistake of assuming that “if we build it, they will come.”

Before promoting infill housing as a smart growth alternative to suburban housing, we must do a much better job of identifying the demographic and socioeconomic dimensions of the demand for infill housing and distinguish whether, how, and for whom this demand differs from the demand for other forms of housing.

Appendix

Table A.1. Key information sources

Data	Source	How Used	Limitations
County tax assessor's parcel information	First American Real Estate Solutions	To serve as a basis for the infill inventory	Includes addresses only, not parcel boundaries
GDT street maps	GDT Corporation	To locate parcels via address matching	No limitations
City and place boundaries	U.S. Bureau of the Census TIGER files	To contain infill sites	Current as of 2002
Population and housing characteristics by place, census tract, and census block	2000 census	To profile characteristics of the population and estimate densities	Current as of 2000
Census tract and block boundaries	U.S. Bureau of the Census TIGER files	To contain infill sites	Current as of 2002
Current land use maps	ABAG, SACOG, SCAG, and SANDAG	To establish neighborhood land use character	Not available for the Central Valley and the Central Coast counties
Superfund sites	U.S. Environmental Protection Agency	To screen out adjacent parcels	Indicate the site center-point and not its boundaries
Rail and bus transit routes, stations, and stops	California Department of Transportation	To identify the level of transit service	May not include the most recent changes
Statewide general plan map	University of California–Davis Information Center for the Environment	To identify the current general plan and zoning designations	Lacks detail for many cities

Table A.2. Calculation of residual land values: Four prototypical examples

Design information	San Diego High-Rise Apartment	San Jose Mid-Rise Apartment	Sacramento Garden Apartment	Riverside Apartment Complex
Lot size (acres)	1	2	4	8
Density (units per acre)	120	65	40	25
Average unit size (square feet)	800	800	800	800
Common area percentage	10%	10%	10%	5%
Parking ratio (spaces per unit)	1	1.5	2	2
Parking type	Underground and podium	Podium	Garage and carport	Surface
Units developed	120	130	160	200
Constructed square feet	105,600	114,400	140,800	168,000
Parking spaces constructed	120	195	320	400
Unit costs				
Hard construction cost per square foot	$130	$120	$100	$85
Soft costs/construction costs	35%	35%	30%	20%
Parking construction cost per space	$20,000	$15,000	$8,000	$2,000
Project construction costs				
Hard construction cost	$13,728,000	$13,728,000	$14,080,000	$14,280,000
Soft costs	$4,804,800	$4,804,800	$4,224,000	$2,856,000
Parking construction costs	$2,400,000	$2,925,000	$2,560,000	$800,000
Total construction costs	$20,932,800	$21,457,800	$20,864,000	$17,936,000
Total construction cost per unit	$174,440	$165,060	$130,400	$89,680
Operating information				
Gross rent per unit per month	$2,200	$2,000	$1,200	$900
Vacancy rate	5%	5%	5%	5%
Expense ratio	35%	30%	30%	25%
Capitalization rate	7.5%	8.0%	8.0%	8.5%
Calculation of residual value				
Net operating income (NOI)	$1,900,800	$2,028,000	$1,497,600	$1,512,000
Estimated market value (NOI/capitalization rate)	$25,344,000	$25,350,000	$18,720,000	$17,788,235
Residual land value	$4,411,200	$3,892,200	–$2,144,000	–$147,765
Residual land value per unit	$36,760	$29,940	–$13,400	–$739
Residual land value per square foot	$101.27	$44.68	–$12.30	–$0.42

Source: ABAG 2002; California Department of Transportation (unpublished data); First American Real Estate Solutions 2004; GDT Corporation 2004; SACOG 2005; SANDAG 2004; SCAG 2005; University of California–Davis, Information Center for the Environment 2005; U.S. Bureau of the Census n.d., 2004; and U.S. Environmental Protection Agency n.d.

Note: GDT is now part of the TeleAtlas corporation.

Authors

John D. Landis is a Professor in the Department of City and Regional Planning at the University of California–Berkeley. Heather Hood is the Director of University of California–Berkeley's Center for Community Innovation. Guangyu Li, Thomas Rogers, and Charles Warren are Graduate Researchers in the Department of City and Regional Planning at the University of California–Berkeley.

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