Title

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Journal

Journal of Urbanism, 7(3)

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Publication Date

2014

Routledge
Taylor & Francis Group

Journal of Urbanism: International Research on Placemaking and Urban Sustainability

ISSN: 1754-9175 (Print) 1754-9183 (Online) Journal homepage: https://www.tandfonline.com/loi/rjou20

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To cite this article: Jake Wegmann & Karen Chapple (2014) Hidden density in single-family neighborhoods: backyard cottages as an equitable smart growth strategy, Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 7:3, 307-329, DOI: 10.1080/17549175.2013.879453

To link to this article: https://doi.org/10.1080/17549175.2013.879453

Journal of Urbanism, 2014
Vol. 7, No. 3, 307–329, http://dx.doi.org/10.1080/17549175.2013.879453

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Hidden density in single-family neighborhoods: backyard cottages as an equitable smart growth strategy

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Secondary units, or separate small dwellings embedded within single-family residential properties, constitute a frequently overlooked strategy for urban infill in high-cost metropolitan areas in the United States. This study, which is situated within California's San Francisco Bay Area, draws upon data collected from a homeowners' survey and a Rental Market Analysis to provide evidence that a scaled-up strategy emphasizing one type of secondary unit – the backyard cottage – could yield substantial infill growth with minimal public subsidy. In addition, it is found that this strategy compares favorably in terms of affordability with infill of the sort traditionally favored in the 'smart growth' literature, i.e. the construction of dense multifamily housing developments.

Keywords: Secondary units; micro-infill; smart growth; affordable housing; single-family neighborhoods

Introduction: the smart growth–housing development disconnect

As the negative social, environmental, and economic consequences of suburban sprawl have become better understood, a broad consensus in favor of smart growth goals has emerged, at least within environmental design fields (cf. Duany, Plater-Zyberk, and Speck 2001; Burchell 2005). Smart growth, or higher-density and walkable development clustered in urban centers that offer transportation alternatives, has even become a key component of efforts to reduce greenhouse gas emissions.

However, smart growth development is not likely to become the prevalent built form in North American core cities in the near future. Due to the long-lived nature of highway infrastructure and existing building stock, the complexity of planning regulations, and the difficulty of obtaining the approval of existing communities, smart growth practitioners have struggled to scale-up urban infill strategies. Instead, they have typically focused on the low-hanging fruit: medium-density new urbanist and transit-oriented developments (TODs) in greenfield areas or along arterial streets, on redeveloped former public housing sites, waterfront, and formerly industrial sites, or grayfield sites (Arrington and Cervero 2008; Dunham-Jones and Williamson 2009).

Furthermore, large-scale, dense developments built in infill locations are startlingly and increasingly expensive (Glaeser, Gyourko, and Saks 2005). Time-consuming process-oriented land-use approval procedures favor large-scale entities pursuing large projects and diminish the role of smaller players without ready access to capital (Schleicher 2013). High costs mean not only that infill residential development tends to be

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above market rate, but also that subsidizing the construction of affordable housing is a very expensive proposition. Though affordable housing advocates often push for inclusionary housing in high-density residential projects or TOD, in many cases the policies needed to bring about these results ultimately yield a disappointingly low number of affordable units in relation to the political capital expended to realize them.

In this article, we argue that the current state of land-use regulation at the local level in high-cost US metropolitan regions exacerbates a *smart growth–housing development disconnect*, which thwarts implementing smart growth residential development across existing urban communities and at affordable cost. Yet, an overlooked approach might actually be more effective at connecting smart growth to housing development and affordability: intensifying development in single-family detached residential neighborhoods through the construction of *secondary units*. Such small-scale infill is not only a more efficient supply mechanism than developer-built multifamily development, but also supports sustainable urbanism by contributing to place diversity, defined by Talen (2006) as place vitality, economic health, social equity, and ecological sustainability. Secondary units, or apartments added to low-density residential properties via either micro-infill or the partitioning of existing structures, can potentially add as much or more density, at a fraction of the cost, as large-scale development. Because secondary unit development is readily implementable in higher-income neighborhoods, the strategy contributes to neighborhood diversity and helps meet fair housing goals. By adding small rental units to neighborhoods dominated by large, homeowner-occupied, units, the strategy provides flexibility. For instance, more families are able to age in place. This in turn leads to more ecological (and fiscal) sustainability by relying on existing infrastructure in places otherwise unlikely to redevelop.

This paper uses the case of the East Bay of the San Francisco Bay Area to determine the extent to which secondary units can act as an equitable smart growth strategy by providing significant housing development at relatively low cost. California's heated conversation about smart growth makes it a particularly relevant site for analyzing alternative strategies. There, an emergent policy framework under state law – the regional Sustainable Communities Strategies (SCS) under State Bill 375 – requires the metropolitan planning organization (MPO) representing each urbanized region in the state to plan for emissions reductions from automobiles, and to propose the land-use policy and transportation infrastructure changes needed to realize them. We begin by examining the literature on the role of single-family neighborhoods and secondary units as housing provision strategies and their potential role in smart growth. Then, after a description of the methodological approach, we analyze the potential to scale-up a strategy predicated on one particular type of secondary unit, the backyard cottage, and the extent to which such a strategy can serve to bolster the stock of affordable housing. A conclusion offers policy implications and thoughts for further research.

Smart growth, single-family neighborhoods, and secondary units

To clarify the relationship between smart growth and housing development, we turn to three bodies of scholarship: the literature on the changing nature of demand in the housing market, research connecting smart growth and housing cost, and the discussion of secondary units in particular.

Demand-side factors

Studies summarizing research on the impact of current and near-term demographic changes in US society on housing markets, on the one hand, and consumer preference

surveys, on the other, tell curiously contradictory stories. By now, it is well-established that the aging of the US population, along with the declining share of households with children, is reshaping the housing market and will do so to an accelerating degree in coming years (Myers and Pitkin 2009). The Center for Transit Oriented Development (2004, 2007) reports that projecting forward from current trends, the nationwide demand for housing located near transit will double by 2030. Even California, which in recent decades experienced robust population growth and featured a younger-than-average population largely as a result of foreign immigration, will see the emergence of a dramatic mismatch between an existing stock of large houses on large parcels and the demand for small housing units in compact, walkable, and transit-accessible urban and suburban settings (Nelson 2011). Meanwhile, the share of renter households, already high in California, will increase substantially over the next two decades under even the most conservative assumptions (Nelson 2011).

But these results are belied by studies that reveal what American adults want, or at least what they say they want, from their housing units and neighborhoods. Consumer preference surveys show a consistent favoring of low-density, suburban neighborhoods over compact, neo-traditional, and other 'alternative' neighborhood types (Baldassare 2004; Morrow-Jones, Irwin, and Roe 2004; Myers and Gearin 2001). But households without children and retirement-age households are more likely to value being able to walk to public transit and shopping districts, and to commute to their jobs without driving. They are also more receptive to smaller lots and units (Myers and Gearin 2001). Even so, 70–80% of baby boomers express a preference for staying in their (mostly large lot, single-family) houses as they age (Kochera, Straight, and Guterbock 2005; Koppen 2009). These apparent contradictions may suggest latent demand for a lifestyle that combines the tranquility of traditional neighborhoods mostly composed of single-family houses with a desire for at least some of the urban amenities, such as public transit and walkable convenience retail, that can only be supported at higher residential densities (Antoninetti 2008).

Smart growth and affordability

Much research has explored whether land-use controls intended to advance the goals of smart growth have an impact on housing prices, and if so whether housing prices are increased or lowered as a result. This is a crucial question, since placing housing units in walkable neighborhoods and near transit stops will fail to make a large-scale regional impact on smart growth goals, including decreasing automobile travel, if the vast majority of such units are so expensive that they serve only a rarefied stratum of the overall population (Ross 2011). Nelson et al. (2004) have argued that the relationship between growth management policies (often enacted in the name of smart growth) and housing prices varies greatly according to the particular *regime*, or mixture of local- and regional-scale land-use policies, that prevails in a given metropolitan area. Later work by Pendall, Martin, and Puentes (2009) classified the nation's metropolitan areas into four broad regulatory regimes. The regime prevalent in the San Francisco Bay Area – one in which housing development is not only steered into certain sub-regions, consistent with smart growth principles, but is also heavily regulated *within* those sub-regions – is clearly associated with high housing prices (Pendall, Martin, and Puentes 2009).

Within metropolitan regions, such as the Bay Area, in which heavy restrictions on both infill and peripheral housing growth exist, *inclusionary housing*, or the practice of localities mandating that housing developers provide or financially contribute to below-market housing in return for permission to build market rate developments, is often

touted as a means of ensuring that smart growth-style development is equitably distributed (Calavita, Grimes, and Mallach 1997). Because units are often built in higher-income neighborhoods where market-rate housing is profitable, inclusionary housing can also serve as a fair housing strategy, integrating neighborhoods. Some commentators (cf. Powell and Stringham 2005) oppose inclusionary housing, seeing it as a de facto tax on the cost of new housing that results in a trickle of below-market units available only to a lucky few while broadly driving up the costs of already-expensive new housing for most others. Empirical studies (Knapp, Bento, and Lowe 2008; Schuetz, Meltzer, and Been 2009) have demonstrated little relationship between inclusionary housing policies and housing prices within their host jurisdictions. At most, there is evidence that such policies modestly shift the housing stock towards denser, multifamily forms than would otherwise be the case (Pendall 2009). At any rate, while they may offer various benefits, there is little evidence to suggest that inclusionary housing policies are anywhere close to sufficient to ensure a broad distribution of housing affordability in a strong market region with strict land-use regulation, such as the San Francisco Bay Area.

Regional fair-share housing requirements, enacted by state legislatures or via judicial fiat, have been deployed in certain metropolitan regions as another means of attempting to ensure that affordable housing is sufficiently available and evenly distributed across a metropolitan region. Such systems, however, have proved to be weak and reversible in some cases, such as in the Twin Cities region, due to the combination of ongoing local pressure to downzone land and the lack of financial incentives for compliance (Goetz, Chapple, and Lukermann 2005). The strongest regional fair share schemes tend to be *retrospective*, in which jurisdictions are held accountable for past affordable housing production during a given time period (Lewis 2005). *Prospective* systems, such as the Regional Housing Needs Allocation (RHNA) system in California (discussed below), only require that jurisdictions plan for, not ensure the completion of, affordable housing, and the enforcement mechanisms ensuring compliance with even these limited requirements are weak (Lewis 2005).

Past research on secondary units

For the purposes of this paper, a *secondary unit* is a self-contained dwelling unit, complete with its own kitchen and at least one bathroom, located on the same property as a single-family house, and which is significantly smaller than and otherwise subordinate in design to the main dwelling (Figure 1). In addition, a secondary unit has its own entrance that can be accessed without passing through the main house. A secondary unit can take various forms, including living space within the main house that has been partitioned into a separate apartment with its own entrance from the exterior; formerly non-livable space (such as a garage) that has been converted into an apartment; or purpose-built habitable space, such as a backyard cottage. Secondary units are often referred to via various technical, regionally specific or other colloquial names, including accessory dwelling units (ADUs), coach houses, mother-in-law apartments, and granny flats.

The literature on secondary unit housing in the United States is perhaps most notable for its paucity, which may reflect the near impossibility of gleaning information about secondary units from publicly available data sources. However, estimates of the prevalence of secondary unit housing carried out by Gellen (1985) and others, in a widely varied selection of geographical scales and locations, indicate that secondary units exist in far greater numbers than their near absence from the planning literature would warrant, from 2% to 25% of all housing stock within the cities studied (Wegmann and Nemirow 2011).

Although this suggests that secondary units are an established supply mechanism, it should be noted that most of these existing units are unpermitted, and that the barriers posed by permitting dampens this mode of housing provision. As will be discussed at greater length below, these barriers include height limits, setback requirements, permitting fees, onerous process requirements, and, perhaps most crucially, off-street parking requirements (Chapple et al. 2011).

As the graying of the US population intensified in the 1980s, numerous researchers (cf. Gellen 1985; Varady 1990; Howe 1990) began viewing the introduction of secondary units as an 'aging in place' strategy that, through extra income generation and perhaps the availability of on-site caregivers, would allow single-family homeowners to remain in their homes and communities longer than they otherwise could. Secondary units, seen in this light, help maintain the viability of single-family housing even as homeowning households pass through varying phases of their life cycles.

Studies examining secondary unit housing through what might be called a smart growth lens have been much more scattered. Antoninetti (2008) recounts the largely ineffectual attempts on the part of the State of California to prod local governments to loosen land-use restrictions on secondary units. As a result, jurisdictions such as San Diego, with almost no production of legal secondary units whatsoever, appear to be much more common in California than those, most notably Santa Cruz, that have implemented local land-use and other reforms enabling production to greatly increase.

It is only recently that some scholars have begun to make explicit connections between secondary units and a smart growth agenda. Dunham-Jones and Williamson (2009) point to the regularization of existing or the insertion of new secondary units as two among several strategies for retrofitting residential neighborhoods, whether for the purposes of staving off inner suburban decline or responding to strong housing market pressures. Talen (2006) pinpoints the insertion of secondary units into existing residential neighborhoods as

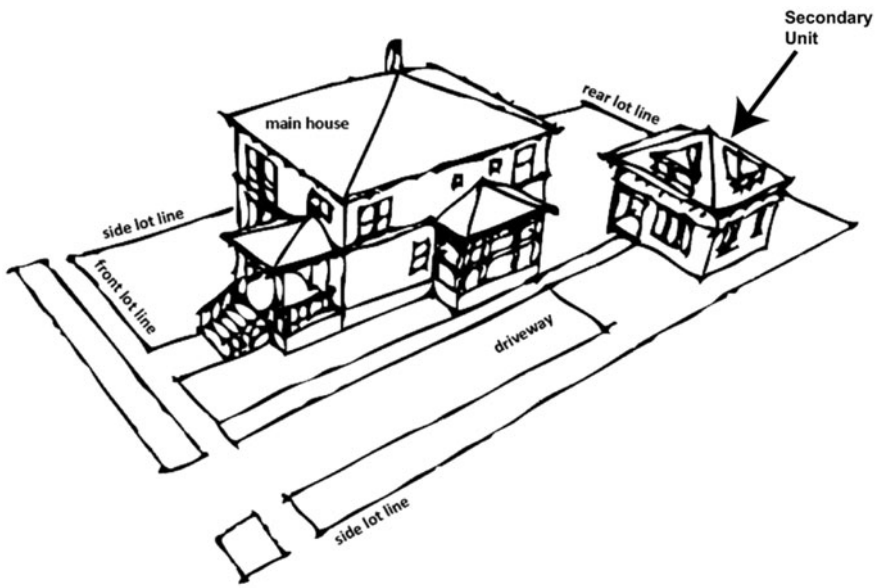

Figure 1. Example of a secondary unit (in this case, a backyard cottage). Source: Santa Cruz Accessory Dwelling Unit Manual. http://www.cityofsantacruz.com.

a means of fostering normative goals that are consistent with smart growth. But links between secondary units and smart growth have mostly remained unnoticed in the planning literature.

Geography and methodology

The San Francisco Bay Area has, for decades, ranked as one of the US metropolitan areas with the most robust housing demand and also the most constrained supply (Landis et al. 2006). It is therefore a near-perfect example of a region in which we would expect secondary units not only to exist in substantial numbers, but also to be economically viable as a housing production strategy. Indeed, previous studies have established the high incidence of secondary units within Bay Area cities (SPUR 2001; Cabansagan 2011).

The sub-region of the East Bay examined in this paper, what we label the 'Flatlands,' is an 11.5 square-mile area situated within parts of Alameda and Contra Costa Counties, and includes most of the flat-lying portions of the cities of El Cerrito and Berkeley, as well as much of North Oakland. It can be thought of as the northern portion of a second-tier urban core for the region that flanks the most densely populated area, San Francisco (with just over 800,000 people living at just under 17,200 people per square mile), on the other side of the San Francisco Bay. Because of the Flatlands' plentiful rapid transit access, bus service, numerous pedestrian-oriented shopping districts, and moderately high population density (just under 11,700 people per square mile, as compared with fewer than 6300 in the Bay Area), recent regional planning efforts have targeted many of its neighborhoods for major urban intensification efforts over the next three decades (US Census Bureau 2010, 2012a; Association of Bay Area Governments 2012). And yet, as will become clear below, the Flatlands are realizing only a fraction of their infill potential. This sub-region perfectly exemplifies the smart growth–housing development disconnect within the Bay Area.

In this paper, while the Flatlands comprise the primary geographic focus, we also rely upon data on secondary unit housing collected from two other geographic areas that are used to support calculations made at the scale of the Flatlands. One of these geographies, the 'Station Areas,' consists of the areas lying within a 0.5-mile radius of five rapid transit

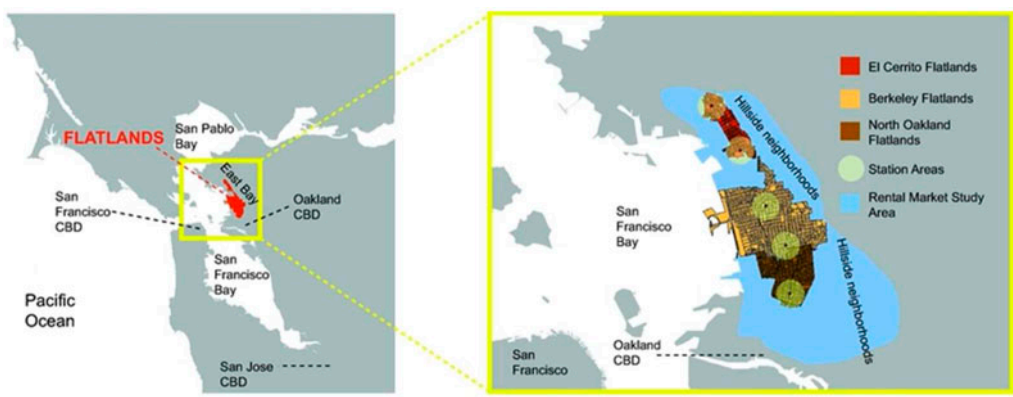

Figure 2. Location of the Flatlands within the San Francisco Bay Area (left); and (right) the Flatlands in relation to two additional geographies: the Station Areas and the Rental Market Study Area.

rail stations arranged along a corridor of about 8 miles in length. The other, the 'Rental Market Study Area,' incorporates the entirety of both the Flatlands and the Station Areas. It is a larger area that includes some of the hillside areas adjacent to the Flatlands (generally excluded from the analysis because of the difficulty of building secondary units and the disproportionately large lot sizes). The significance of these two additional geographies is discussed in the following section. The extent of the Flatlands, Station Areas, and Rental Market Study Area are depicted in Figure 2.

Data gathering methods

To plumb the state of the existing market for secondary units within the Flatlands, evaluate its future potential, and assess its relevance as a housing affordability strategy, we employed two primary quantitative data gathering methods:[1]

(1) An online and written survey (the 'Homeowner Survey'), solicited via mail and the internet, sent to 2529 owner-occupants residing on properties, lying within the Station Areas, that are classified as single-family residential by the county tax assessor. We obtained 515 responses, of which 81 were from homeowners reporting having at least one secondary unit on their property.
(2) An analysis of 338 advertisements soliciting renters for rental apartments, located within the Rental Market Study Area, placed on the Craigslist website during a three-month period in the spring and summer of 2011 (the 'Rental Market Analysis'). All 174 usable advertisements for secondary units (identified by means of telltale phrases in the advertisements as well as visual clues from attached photographs[2]) were included in this data set. The remaining 164 entries were advertisements for apartments that were not secondary units.[3]

As previously noted, the geographic scales at which the Homeowner Survey and the Rental Market Analysis are conducted do not coincide precisely with the primary geography analyzed in this article: the Flatlands. These incongruities are a consequence of the infeasibility of surveying the entirety of the Flatlands and of the need to collect a sufficient number of online rental advertisements, respectively. Nonetheless, the two supplemental geographies of the Station Areas and the Rental Market Study Area are sufficiently similar to the Flatlands that it is not unreasonable to apply data collected from both to analyses at the scale of the Flatlands. (Similarities between the Station Areas and the Flatlands in terms of population demographics and the age and composition of the housing stock are elucidated in greater detail in Table 1).

In addition, we used parcel data purchased from CoreLogic to analyze the effect of existing land-use regulations on the ability of a homeowner to build a detached cottage unit in the backyard, and the effects of some moderate changes in land-use regulations (as explained in greater detail below). Because the parcel data alone were insufficient to analyze the feasibility of development, we also relied on three techniques: (1) using geographic information system (GIS) software; (2) examining the parcels with Google Earth; and (3) visiting a sample of the parcels in the field and recording observations. The parcel-level analysis methodology is detailed in Appendix A.

Finally, in preparation for gathering our data, we conducted unstructured interviews with planning staff and elected officials from the cities located within the Flatlands and Station Areas: El Cerrito, Berkeley and Oakland (in both the Station Areas and the Flatlands), and Albany and Richmond (in the Station Areas but not the Flatlands). While

this paper does not report the results of these interviews in detail, much of the material presented herein has been shaped by the insights we gained from them.

A portrait of the Flatlands and the Station Areas

Table 1 has a portrait of the population characteristics and housing stock of the Flatlands. In addition, as mentioned above, its rightmost column demonstrates that the Station Areas are highly similar to the Flatlands according to the indicators shown, thereby allowing confidence in the extrapolation of results gathered from the Homeowner Survey, collected from properties randomly sampled within the Station Areas, to the Flatlands.[4]

Several features of the Flatlands are worth noting. Despite the Flatlands' moderately high density, plentiful rapid transit access, and walkable neighborhoods, almost 40% of the housing units are in one-unit freestanding structures, mostly single-family houses but also detached secondary units. Because, as of the year 2000, more than 45% of the housing stock was built before 1940, we can presume that the legacy of early 20th-century development patterns, which produced many streets within the Flatlands primarily composed of 'minimal bungalow [i.e. modest single-family house] districts' continues to

Table 1. Portrait of the Flatlands and Station Areas.

	Flatlands		Station Areas	
	Most recent estimate[a]	Trend since 2000	Most recent estimate[a]	Trend since 2000
Population and household characteristics				
Population	134,733	Up 6.3%	50,655	Up 1.3%
Population density (people/square mile)	11,668	Up 6.3%	12,432	Up 1.3%
People of color as a share of the population	53.0%	Down 2.8%	55.4%	Down 3.0%
Share of households earning under US$25,000 (2010 US$)	26.9%	Down 0.1% [b]	24.2%	Up 0.3% [b]
Share of households earning more than US$100,000 (2010 US$)	24.5%	Up 2.5% [b]	26.8%	Up 5.0% [b]
Housing stock indicators				
Housing units	60,721	Up 2.1%	23,458	Up 0.6%
Owner-occupied share of occupied housing units	38.6%	Up 2.2%	40.3%	Up 1.8%
Units in one-unit detached buildings as a share of the housing stock	39.5%	Down 0.9%	41.5%	Down 1.7%
Units in one-unit attached buildings as a share of the housing stock	4.3%	Up 0.4%	4.8%	Up 0.6%
Units in two-unit buildings as a share of the housing stock	10.9%	Up 0.8%	10.9%	Up 1.2%
Share of the housing stock built before 1940	[c]	45.5% in 2000	[c]	40.7% in 2000

[a]Notes: Population, population density, and people of color figures are from the 2000 and 2010 US Censuses. All other figures are from the American Community Survey (2006–10).
[b]Household earnings comparisons between the years 2000 and 2010 are estimated by inflating year 2000 incomes to 2010 US$ using consumer price index statistics published by the US Bureau of Labor.
[c]Housing stock age estimates (last row) from the American Community Survey are too unreliable for 2006–10, and so only Census 2000 figures are quoted.

be expressed in the building stock today (Groth 2004). And while the population of the Flatlands has increased modestly (by about 6%) over the last decade, the housing stock has grown by barely more than 2%. This indicator suggests that the Flatlands area has experienced strong market conditions, but without much housing development to accommodate the increased demand, over the past decade. In other words, at present the Flatlands are not fulfilling their infill potential.

The potential of a conventional infill strategy in the Flatlands

Before analyzing the possibilities for the addition of backyard cottages to the Flatlands, we begin by examining how much housing a conventional infill strategy, i.e. one relying on dense, multifamily housing, could possibly yield in the Flatlands. Following a method pioneered by Landis et al. (2006) for estimating infill housing potential in California, we started with 2005 parcel-level data from the Alameda and Contra Costa County property tax assessors.[5] (The procedure followed is summarized in Appendix B). Using the most generous assumptions, and assuming that *all* infill development takes the form of housing rather than commercial or institutional uses, the model indicated that 5807 of the 32,426 parcels in the Flatlands, occupying 1.5 out of 9.5 square miles of the land base (not including street rights-of-way), are ripe for rebuilding. Using density criteria that take into account both constraints (such as neighborhood context) and opportunities (such as proximity to commercial districts, rail stations, and bus lines), these infill parcels could accommodate up to 16,239 units of new housing, as compared with the 60,721 that exist today.

While over 16,000 new units of infill housing appears robust, in reality this estimate is likely much too high, as it presupposes many miniscule infill projects of two to four units, making up 30% of the total unit count, and another 9% consisting of up to one unit. By contrast, of the housing units that started construction in the cities of El Cerrito, Berkeley, and Oakland during 1996–2011 (inclusive), fewer than 3% were in two-to-four unit structures, while fully 79% were in buildings of five units or more (US Census 2012b). An additional 17% were single-family houses, which in many cases simply replaced similar structures on single-family house lots, and therefore made no net contribution to infill housing stock. (Note that very few secondary units are captured in these totals, since as previously mentioned, the vast majority that are created are unpermitted.) Restricting the model's output to parcels capable of accommodating five units or more reduces the total potential to a more realistic 'Conventional Infill Buildout Scenario' of 7882 units on 694 parcels occupying 0.5 square miles.

How fast might this development potential be realized? A rough proxy for the pace of residential building activity in buildings of five or more units in the Flatlands shows historical production levels varying wildly from a low of 18, in 1996, to a high of 440 housing starts in 2008 (in the period from 1996 to 2011 inclusive) (US Census 2012b).[6] At the average pace of 184 housing starts per year in 1996–2011, it would take almost 43 years for the 7882 infill units of the Conventional Infill Buildout Scenario to be built in the Flatlands. Even in the unlikely event that the maximum yearly pace in the 1996–2011 period were to be sustained, full buildout would still take almost 18 years.

The potential for scaling up a backyard cottage strategy

Having estimated 7882 new housing units of total possible infill from a Conventional Infill Buildout Scenario in the Flatlands, what could be achieved from an alternative strategy

focusing exclusively on the construction of secondary units? To answer this question, we analyzed the potential for the addition of one particular type of secondary unit, freestanding backyard cottages, to the Flatlands. To do so, we extended an analysis of the feasibility of building backyard cottages in five BART station areas to the Flatlands. This extrapolation required first screening Flatlands parcels for lot size, lot coverage, and backyard space (to meet open space and parking requirements) to determine the number of units that could be built both under current requirements and assuming a relaxed set of regulations. To account for the possibility that some of these parcels already contain secondary units, we then subtracted 16% of the parcels (the share of East Bay parcels with existing secondary units according to our Homeowner Survey). This assumes that secondary units are already present on these lots in the same proportion that they are present on all single-family residential parcels.

While the calculated potential production levels for backyard cottages are, in the end, only order-of-magnitude estimates, they provide a sense of the scale of infill that could be achieved from a set of carefully selected, incremental, and politically feasible changes to land-use policies within the Flatlands cities. The exact nature of these reforms varies greatly by jurisdiction, although easing off-street parking requirement is generally the most crucial. Others include changing building height limits, reducing or eliminating minimum lot size requirements, and reducing or eliminating setback standards (Chapple et al. 2011).[7]

The experience of other West Coast cities similar to the East Bay in terms of the level of contention in local homeowner politics suggests that the land-use reforms that we presuppose in our analysis, while not trivial to implement, are realistic. For instance, as mentioned above, Santa Cruz achieved a major increase – a near-tripling – in its level of production of secondary units following its revision of single-family district zoning, most notably via a relaxation in parking requirements. The much larger City of Seattle arguably cleared a higher bar, moving from a total citywide prohibition of secondary units to a loosening of restrictions in one small section of the city to a citywide zoning ordinance permitting backyard cottages in less than four years (Interview 2011b).[8]

To gauge the productivity of an infill strategy focused on backyard cottages, potential housing unit production levels are expressed in comparison with the benchmarks set by the SCS planning effort for the Bay Area in Table 2. Under current zoning, the Flatlands could accommodate approximately 3625 additional backyard cottages, and with the set of relaxed regulations that we assumed, 8677. The potential backyard cottage production levels within the Flatlands (henceforth, the Backyard Cottage Buildout Scenario) translate into substantial fractions of the housing production targets planned for the period 2010–40 in the Berkeley (60%) and Oakland (44%) portions of the Flatlands and even exceed them in El Cerrito (117%).[9] Furthermore, the total infill potential from the Backyard Cottage Buildout Scenario of 8677 units compares favorably with the potential of 7882 new housing units from the Conventional Infill Buildout Scenario.

Backyard cottages, then, could yield infill housing production levels exceeding the results of an aggressive conventional infill scenario that would take decades to realize. What is more, unlike market rate multifamily development, backyard cottage projects require comparatively small injections of capital (frequently under US$100,000, as compared with millions of dollars for even a small five-unit project), and can be easily completed within a year (Interview 2011a). By contrast, multifamily projects take several years from conception to completion. Finally, backyard cottage development offers at least the possibility of continuing amidst housing downturns, because of the very low capital

requirements and minimal construction delay risk, whereas development of multifamily developments tends to grind to a near-halt during down periods.

Two caveats are in order. First, it should be noted that secondary units tend to be smaller than other types of rental housing. Indeed, the average secondary unit in the Rental Market Analysis had 0.99 bedrooms (where studios are considered to be zero-bedroom units), as compared with 1.52 for other types of apartments. These results reinforce evidence from the Homeowner Survey that backyard cottages and other types of secondary units house predominantly childless adults. The survey results showed only 0.18 children per household in secondary units, compared with 0.37 in the households occupying the primary dwellings on the parcels they share. In addition, the average age of adults living in secondary units was fully 11 years less than the age of those residing in the main houses (38.6 versus 49.6) (Wegmann 2012). Backyard cottages and other types of secondary units are therefore not likely to be useful for housing large families with children or multigenerational households. Nevertheless, projections indicate that small households, in both absolute and relative terms, will account for the vast majority of new households in the United States in the coming decades (Klinenberg 2012). Thus, regardless of whether a Backyard Cottage or a Conventional Infill Buildout Strategy is pursued, it is probable that the increase in housing supply will be mainly driven by increasing demand for small units. To the extent that either strategy is successful, the relief of demand on the existing stock of larger, family-sized rental units – today frequently rented by groups of childless adults to the detriment of large, low-income households with children – will be a major benefit.

A second caveat concerns the possible pace of backyard cottage production. An early report suggested that jurisdictions with moderately supportive treatment of secondary units in their zoning codes tend to see the construction of one such permitted unit per 1000 single-family house parcels per year (Hare 1991). While we were unable to find systematic historic records on permits granted for backyard cottages or other types of secondary units within the Flatlands jurisdictions, our interviews with local planners suggested that very few have been permitted (perhaps three annually, on average, in recent years in Berkeley).

If the three Flatlands cities were to match the levels of production, measured in terms of the ratio between annual secondary units produced and the number of citywide detached single-family house lots, observed in Santa Cruz in the fourth year following that city's policy changes towards secondary units in 2003, the Flatlands could expect to see about 90 new units per year (personal communication, May 2011). Of these, 30 would be expected to be backyard cottages if the distribution of types of secondary units observed in the Homeowner Survey were to persist. The 90 new secondary units per year would equate to almost half of the average of 184 housing starts per year in the Flatlands over the past 15 years (as discussed above). What is more, whereas conventional infill strategies have now been employed with relatively modest results for decades, it is conceivable that the production of

Table 2. Infill potential of new backyard cottages in the Flatlands.

	El Cerrito Flatlands	Berkeley Flatlands	Oakland Flatlands	Total
Potential backyard cottages created with regulatory reforms	1681	5074	1923	8678
Housing unit growth targets (2010–40)	1440	8490	4413	14,343
Percentage of household growth accommodated by new backyard cottages	116.7%	59.8%	43.6%	60.5%

Source: For housing unit growth targets: Association of Bay Area Governments 2012.

backyard cottages and other secondary units could increase beyond the levels achieved in Santa Cruz in the Flatlands and elsewhere as acceptance and recognition of backyard cottages and other secondary unit types grows over time. In the Homeowner Survey we found that of the responding owner-occupants of single-family properties currently lacking a secondary unit on their properties, 21% were interested in installing one, 7% had previously tried to do so and failed, and 3% were actively planning to do so, for a total of 31%, or nearly one-third, expressing some past, present, or future willingness to pursue adding an additional dwelling. These results suggest that the level of interest among homeowners in installing backyard cottages and other types of secondary units is already considerable.

Secondary units' contribution to housing affordability

Can secondary units in general, and backyard cottages in particular, act as a smart growth strategy that increases housing affordability? An increase in housing affordability within a given neighborhood contributes to Talen's (2006) concept of *place diversity* in at least two ways. More affordable units increase *social equity* by giving more low-income residents access to the amenities that are typically found in higher-income areas, such as higher-performing and better-funded schools, better police protection, and so forth. In addition, introducing affordable housing to neighborhoods that are adjacent to amenities that encourage non-automobile trips, such as regional rail transit stations and walkable convenience retail, increases the number of people that can make use of such amenities without using a car. In addition, because low-income households drive less, on average, affordable housing proportionately increases the usage of such amenities. Thus, introducing affordable secondary units to suitably located residential streets also makes a contribution to *ecological sustainability.*

The following section examines the extent to which existing secondary units of all types in the Flatlands are providing housing that is affordable vis-à-vis sub-regional incomes, while the next section demonstrates that existing secondary units are providing housing that is affordable with respect to their immediate neighborhoods. Finally, we close the affordable housing discussion with an analysis of the potential for the particular subcategory of secondary units of backyard cottages to contribute to the fulfillment of regional fair share housing production targets under the Backyard Cottage Buildout Scenario discussed in the last section.

Provision of regionally affordable housing by secondary units

Data collected from the Rental Market Analysis from within the Rental Market Study Area makes it possible to compare the rents charged for secondary units with those charged for other types of rental units (what we will refer to as 'non-secondary units') within the same area. Note that we computed *adjusted rents* for the units being advertised by adjusting rents downward in cases where some or all of the public utility charges were included. Adjusted rents could then be expressed in terms of affordability[10] with reference to area median income (AMI) figures published by the US Department of Housing and Urban Development (HUD) for the Oakland–Fremont Metropolitan Statistical Area (MSA), which encompasses the entirety of the Flatlands. One major limitation of this approach is that the rent data collected for existing secondary units include units of all ages, including, presumably, some that have declined in quality. In addition, the rent data are collected for all types of secondary units, not only backyard cottages. This makes for difficulty in comparing these rents with what can be charged for a newly constructed backyard cottage.

However, it seems generally reasonable to assume that, all else being equal, backyard cottages are a rough substitute for other types of secondary units from the renter's point of view. In addition, with the passage of enough time, we would anticipate a new equilibrium in which the income profile of those living in the new backyard cottages would eventually come to more closely resemble that of those living in existing secondary units.

The average secondary unit in the sample is affordable to a household earning 62.8% of AMI, as compared with 69.3% of AMI for the average non-secondary unit.[11] Table 3 shows the distribution of affordability of sampled units with reference to the four standard categories of extremely low, very low, low, and moderate to upper income. While scarcely any rental units advertised on Craigslist within the Rental Market Study Area appear to be affordable to extremely low-income households, a considerably larger share of secondary units (30%) than non-secondary units (12%) is rented at the very low-income level. Furthermore, it is probable that the disparity in affordability between secondary units and non-secondary units is even greater than these figures suggest, since rental units in large and/or professionally managed properties are more likely to be advertised via means other than Craigslist, such as glossy rental apartment publications, billboards, magazine and newspaper advertisements, and the like.

Provision of locally affordable housing by secondary units

Another way of evaluating affordability is to compare rents against median household income at the census tract level. In so doing, we construct a metric that differs from what is typical in standard practice, which would tend to use household income for the entire Oakland–Fremont MSA, rather than a census tract-level measure of income, as the yardstick against which rents are normalized. To calculate what we refer to as a *local rent burden index* for a given rental housing unit, we compute the ratio between annual adjusted rent for the housing unit and annual median income for the households in the census tract in which the housing unit is located. For example, a housing unit renting for US$1000 per month (or US$12,000 per year), including utilities, in a census tract with a median household income of US$48,000 per year would have a local rent burden index of 25%.

Lower values of the local rent burden index for particular rental housing units indicate that these dwellings are providing rental housing opportunities that are more affordable to renters by the standards of the particular neighborhoods in which they are situated. Lower local rent burden indices are especially noteworthy within medium and high-income census tracts, wherein small housing units and rental housing in general would be expected to be more scarce than within low-income tracts.

Table 3. Observed secondary units by affordability category.

Income category	Non-secondary units (%)	Secondary units (%)
Extremely low income (less than 30% of AMI)	1	1
Very low income (30–49% of AMI)	12	30
Low income (50–80% of AMI)	67	49
Moderate to upper income (more than 80% of AMI)	21	20
Total	**100**	**100**

Note: Affordability is measured relative to the median income for the Oakland–Fremont Metropolitan Statistical Area (MSA). All observations were taken from within the Rental Market Study Area (as defined in Figure 2).

Figure 3 shows that the local rent burden index for secondary units advertised on Craigslist is markedly lower, on average, than for other types of rental units offered in the same forum. If we sort the census tracts in which the units advertised on Craigslist are located into three categories on the basis of median household income reported in the 2005–2009 American Community Survey, this relationship holds true for census tracts that are in the top and medium income terciles, as well as in the lowest income tercile. In addition, a much higher proportion of secondary units advertised on Craigslist are located in top tercile tracts (48%) than is the case for other types of rental units (11%). By contrast, only 22% of secondary units are located in lowest tercile tracts, as compared with 44% of the other rental units.[12]

This evidence supports, therefore, a view of secondary units as likelier to provide rental housing that is affordable *within its neighborhood context* than rental housing in general. Furthermore, a much greater share of secondary units are located in high-income areas of the Rental Market Study Area. Secondary units appear to be considerably likelier to bolster income diversity through addition to the stock of modestly priced rental apartments in high-opportunity neighborhoods than are other types of unsubsidized rental housing. In addition, and unlike absentee-owned rental housing, secondary units have the potential to provide an income stream to existing homeowners. Thus, in addition to facilitating the entry of non-affluent residents into otherwise unattainable neighborhoods, secondary units can further contribute to income diversity by helping existing homeowners age in place even amidst transformative life events such as job loss, retirement, and health setbacks.

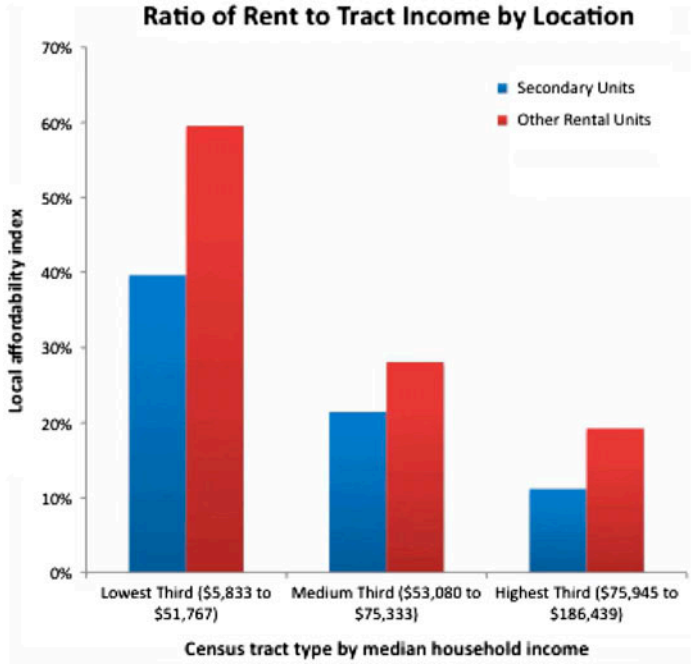

Figure 3. Average local affordability rent burden index for secondary units and other rental units advertised on Craigslist by census tract median household income category (as reported in the 2005–2009 American Community Survey).

Secondary units and regional affordable housing production targets

Under existing California state law, all MPOs are periodically given affordable housing production targets based on economic forecasts produced by the state government. MPOs, in turn, allocate metropolitan-wide housing growth projections to their member local governments under the so-called Regional Housing Needs Allocation (RHNA) process. Local jurisdictions are required to release Housing Elements as part of their mandated General Plans, which demonstrate that they have zoned sufficient amounts of land to make the addition of their housing quota possible by the end of the compliance period. While RHNA has been criticized for its uneven rate of compliance and weak enforcement mechanisms (cf. Lewis 2005), it does at least provide a widely recognized metric against which to evaluate affordable housing production.

While local Housing Elements, with some exceptions, typically do not take secondary units into account, RHNA affords us an opportunity to assess the quantity of affordable housing that they are likely providing at present. In addition, if we assume the implementation of the full Backyard Cottage Buildout Scenario, we can calculate the resulting boost to affordability in comparison with each city's RHNA targets. To compute these estimates, and mirroring the results from the Homeowner Survey, we assume that of the newly produced secondary units, 49% are rented on the open rental market (Wegmann 2012). The remaining 51% of the new units are presumed to be occupied by either all or part of the homeowner's household, or else rented to relatives, friends, or acquaintances for free or for reduced rents, or in exchange for childcare, lawn maintenance, or other in-kind labor.[13] We then assume that the income splits observed in the Rental Market Study Area apply to the new backyard cottages rented on the open market within the Flatlands.

The results of these projections are shown in Table 4, alongside our previous estimates of the number of already-existing secondary units (of all types, not just backyard cottages) in the Flatlands (Wegmann et al. 2012). The estimated quantity of existing (but overwhelmingly unpermitted) secondary units in the Flatlands is on its own enough to exceed citywide RHNA targets for units affordable to households earning 31–50% of median

Table 4. Affordable housing production targets, existing secondary units, and potential backyard cottages in the Flatlands.

Affordability categories	RHNA affordable housing targets, 2007–14	Already existing flatlands secondary units	Backyard cottage buildout scenario
Units with free, in-kind or reduced rent (rented to friends, relatives or acquaintances)	0	1326	4278
Open market, extremely low income (under 30% of AMI)	272	14	44
Open market, very low income (31–50% of AMI)	365	409	1320
Open market, low income (51–80% of AMI)	721	668	2156
Open market, moderate to upper income (more than 80% of AMI)	3162	273	880
Total	**4519**	**2689**	**8677**

Sources: For Regional Housing Needs Assessment affordable housing targets: 2007–14 housing elements for the cities of El Cerrito, Berkeley, and Oakland.

household income. The number of potential affordable units added by the Backyard Cottage Buildout Scenario exceeds the combined RHNA targets in the Flatlands by almost four- and almost threefold in the 31–50% and 51–80% of median income categories, respectively.

Expressed another way, secondary units already comprise 4.4% of the total existing housing stock in the Flatlands, and 7.9% of the existing occupied rental housing stock. The benefits to affordability and, by extension, to place vitality provided by these (mostly unpermitted) units are already operative. However, just one type of secondary unit – backyard cottages – could, with the relatively modest land-use changes we have assumed, offer the potential to provide an expansion of the current total Flatlands housing stock by up to 14% and of current Flatlands rental housing stock by up to 23%. We estimate that this expansion would equate to 3520 new units rented on the open market and affordable to households earning 80% or less of AMI.

How would this quantity of added affordable housing stock compare with what would be yielded under the Conventional Infill Buildout Scenario? Of the 7882 units produced via conventional infill, 5881 would be built in Berkeley, the only city of the three in the Flatlands that currently has an inclusionary housing ordinance.[14] Since Berkeley requires reserving 20% of all units in developments of five units and more for affordable housing, the Conventional Infill Buildout Scenario could result in the production of up to 1176 affordable units, much less than the 3519 new units yielded by the Backyard Cottage Buildout Scenario. Given the high construction costs of dense building types suitable for infill development (which, according to the infill model, would have an average density of over 26 units per acre), it is highly unlikely that many, if any, of the non-inclusionary units produced in the Conventional Infill Buildout Scenario would be affordable to households earning less than 80% of the median income.[15]

Conclusion

A strategy to scale-up the production of secondary units holds great potential for injecting a considerable amount of housing into areas, such as the Flatlands, in which single-family houses occupy the preponderance of the land area. Such a strategy would necessarily begin with a loosening of existing obstructive land-use regulations on the local level, with additional elements, such as efforts to educate the public on secondary units, guide homeowners through the permitting and construction processes, and provide low-cost financing added over time. It would require the deployment of a considerably different suite of policies from those that many US jurisdictions have used in pursuit of a conventional, smart growth-style infill strategy. As we have demonstrated throughout this paper, a backyard cottage strategy in the Flatlands could surpass conventional infill development emphasizing dense multifamily housing on at least two key dimensions, including overall levels of production and affordable housing generated.

None of the foregoing should be construed as a claim that secondary units are a perfect substitute for dense multifamily development, and that the latter should therefore be abandoned. To be sure, fulfilling certain vital policy objectives, such as the construction of large, family-sized apartments, the creation of vertically mixed-use urban environments, and the provision of on-site services for vulnerable populations such as the elderly and the formerly homeless dictates the construction of large multifamily buildings. But increasing the stock of backyard cottages and other types of secondary units would help to liberate scarce public subsidies to allow conventional infill to be targeted to where it is most needed.

Pursuing a secondary unit strategy would have an additional effect: neighborhoods dominated by single-family houses, long conceded as effectively off-limits to development in the smart growth discourse, could be brought into the discussion of regionally equitable growth scenarios. Whereas multifamily development is often seen by neighboring single-family homeowners as posing a purely negative externality, the prospect of those same homeowners adding a revenue-producing or otherwise useful additional unit to their properties could change the by-now well-entrenched political dynamics that have contributed to smart growth falling well short of the achievements the movement promised a quarter century ago. The results could lead to the furtherance of 'place vitality,' in Talen's (2006) schema of place diversity, to many streets of single-family houses currently lacking in variety of housing type, tenure, and socioeconomic composition. Much remains to be learned about backyard cottages and other forms of secondary unit housing. Since regions vary so widely, studies comparing conventional infill and secondary unit strategies outside of the Flatlands and the Bay Area would be valuable. In addition, very little is known about how homeowners finance, or fail to finance, the installation of secondary units. Preliminary research on the varying fiscal impacts of different types of housing development to cities has suggested significant benefits to local governments via increased property tax revenues (Wegmann et al. 2012); however, future studies should examine regional variation in fiscal impact.

Finally, important questions persist about the consequences of pursuing a strategy that seeks to deliver infill housing units and affordable housing by encouraging the actions of thousands of individual homeowners, as opposed to more typical approaches led by municipal governments, nonprofits, and commercial developers. For instance, careful empirical work by Rudel (1984) on Long Island raised concerns that white homeowners were discriminating against African Americans as potential tenants for their secondary units. Other questions arise, given the large and persistent racialized wealth gaps in the United States, about the differing financial capacities of homeowners to install new backyard cottages and other secondary units on their properties.

It is entirely possible that new institutional arrangements will arise to embrace the novel challenges and opportunities afforded by removing gratuitous restrictions on secondary units in the Flatlands and other similar places. For instance, typical nonprofit housing developers currently oriented to the production of subsidized multifamily rental housing, or Habitat for Humanity and similar entities focused on the production of solely owner-occupied developments could insinuate themselves into the promotion, production, management, and even ownership of secondary units. At this early stage, it is difficult to foresee what new models may emerge. Regardless, it is our contention that backyard cottages and other types of secondary units are increasingly worthy of scholars' attention as a potentially effective and equitable infill strategy in the Flatlands and beyond.

Acknowledgements

This research was supported by a Faculty Grant from the University of California Transportation Center (UCTC). The authors gratefully acknowledge the contributions of Alison Nemirow in developing and implementing the parcel analysis methodology.

Notes

1. For detailed information on the two quantitative gathering methods, see Wegmann (2012).
2. Examples of telltale phrases indicating that a given advertisement was for a secondary unit included 'cottage behind the main house,' 'flat above the garage,' and 'unit has its own

entrance, with the landlord right next door.' In general, secondary units were distinguished from units within duplexes by indications that the unit in question was considerably smaller than the main house or the main portion of the house.

3. On each day that data collection took place, all advertisements for secondary units within the Rental Market Study Area were collected. Next, all listings for apartments that were not secondary units were collected in the order shown on the appropriate Craigslist web pages until they approximately equaled the number of advertisements for secondary units that had been collected up to that point. Following the end of data gathering, once all advertisements had been analyzed and their salient characteristics entered into a database, some of the listings were discarded because they lacked critical information such as the number of bedrooms or bathrooms. These procedures resulted in the totals of 174 and 164 advertisements for secondary and non-secondary unit apartments, respectively.
4. The Flatlands are extrapolated from the Station Areas as the sections within the cities of El Cerrito, Berkeley, and Oakland that are flat-lying and relatively similar in terms of zoning, parcelization patterns, and demographics to the areas of those cities that lie within the Station Areas. Insufficient data were obtained from the other jurisdictions making up small sections of the Station Areas – Richmond, Albany, and unincorporated Kensington – for these results to be plausibly generalizable, and therefore they were left out of the definition of the Flatlands. For more in-depth discussion, see Chapple et al. (2011).
5. While 2005 data are somewhat out of date, there has been relatively little residential construction in the East Bay since that time due to the regional and global economic recession. For instance, an average of only 264 residential units were started within the cities of El Cerrito, Berkeley, and Oakland per year from the years 2005 to 2011, inclusive, equating to a rate of increase of barely 0.1% of the housing stock per year, even when ignoring conversion, demolition, and abandonment of existing units (US Census 2012b).
6. Because it is difficult to obtain housing starts data at the sub-city level, the proxy measure quoted here is computed as Oakland's citywide housing starts of buildings of five or more units, with the 11.3% factor applied to account for North Oakland's share of citywide housing units as of the 2010 Census, plus citywide totals of the same category of developments for Berkeley and El Cerrito.
7. To our knowledge, no comprehensive review of all 110 jurisdictions in the nine-county Bay Area with respect to permissiveness towards secondary units in zoning codes has been undertaken. Our analysis showed Berkeley generally to be the most permissive of the three Flatlands cities, and El Cerrito to be the most restrictive, with Oakland somewhere in between (Chapple et al. 2011). Even El Cerrito, however, appears to be more permissive than many of the other jurisdictions in the Bay Area, such as the majority of the small incorporated cities in Santa Clara County ('Silicon Valley'), the highly affluent and jobs-rich southern portion of the Bay Area.
8. Bay Area cities, including all three Flatlands jurisdictions, commonly predicate occupancy of a secondary unit on owner-occupation of the property. In other words, a secondary unit typically cannot be occupied unless the property's owner resides either there or in the primary dwelling. We have not factored the rate of owner-occupancy amongst the single-family housing stock in the Flatlands into the analysis. The main reason for this omission is the supposition that with increasing acceptance of backyard cottages and other secondary units, there is a high likelihood of the eventual removal of owner-occupancy requirements. This is due to homeowners gaining greater familiarity with secondary units and eventually coming to see them as valuable income-producing assets rather than as threats to neighborhood quality of life. This dynamic appears to be underway in Santa Cruz and Seattle, two jurisdictions that are much further along in efforts to increase the acceptance of secondary units than the Flatlands jurisdictions, although the owner-occupancy requirement reforms have not yet taken place at the time of writing (Interviews 2011a, 2011b).
9. Since RHNA targets are published at the citywide scale, we assigned North Oakland a share of 11.3% of the city's targets, corresponding to the share of the city's housing units represented by the Oakland section of the Flatlands. The Berkeley and El Cerrito RHNA targets shown are citywide.
10. Here we follow the US Department of Housing and Urban Development (HUD) definition of 'affordability,' in which a dwelling unit is deemed to be affordable for a household if monthly rent plus utility costs do not exceed 30% of the household's monthly income before taxes, and which is normalized by household size and the number of bedrooms.

11. We do not adjust rents to take account of parking provision, even though free off-street parking is a valuable amenity, to match US affordability definition conventions.
12. These results, of course, are only pertinent to the subset of apartments that are advertised on Craigslist. It is entirely possible that there exists a separate category of secondary units that are located in lower-income areas but which do not appear on Craigslist because they are advertised by word of mouth or other geographically limited means. The ability of a prospective tenant to rent such a unit, however, would likely be dependent on his/her having pre-existing ties to particular social networks or locations. The results summarized here suggest that among *widely publicized* apartments secondary units are more likely than other types of rental apartments to be located in higher-income neighborhoods.
13. While rental units provided at reduced rates or rent-free to friends, relatives or family members provide an undeniable housing affordability benefit to those persons, because such units are not available on the open market they would not be counted against RHNA-style affordable housing quotas. We follow this convention here.
14. While inclusionary housing ordinances have been actively considered in El Cerrito and Oakland, they have not been implemented to date.
15. Between 2001 and 2011 inclusive, 23 subsidized new construction multifamily rental projects in Oakland and Berkeley received Affordable Housing Program (AHP) monies from the Federal Home Loan Bank of San Francisco. (No rental developments in El Cerrito with AHP funding were completed during this period.) These yielded a total of 1677 units, with an average project capital cost of about US$25.5 million and just under US$351,000 per unit in 2012 inflation-adjusted dollars. No project cost less than US$199,000 per unit to develop. While these figures pertain only to subsidized multifamily rental housing, total development costs would be expected to be similar for market rate projects, given the use of the same building types, similar land costs, and a similar regulatory environment, or perhaps even higher, given investor expectations for a return on equity. (For details regarding the data set from which these figures are drawn, please contact the authors.)
16. The Sampling Design Tool was created by the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science. The tool can be downloaded at: http://ccma.nos.noaa.gov/products/biogeography/sampling/.
17. This far exceeds the sample size needed to achieve a 90% confidence interval and 10% margin of error (standard assumptions in the field of planning), using even the most conservative assumption of $p = 0.5$.
18. For garages, the number of parking spaces (one or two cars) was based on observed width. Some garages that appear from the street to accommodate only one car may in fact be deep enough to accommodate two cars.

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Appendix A: Parcel analysis methodology

To screen single-family house parcels for their ability to accommodate a new backyard cottage, we analyzed them in ArcGIS for conformance with basic zoning requirements for secondary units, including zoning district and land use, lot size, lot coverage, and floor area ratio, assuming a detached secondary unit located in the backyard, with a 300 square-foot footprint and an exterior

measuring 17 by 17 feet. Next, we used a Sampling Design Tool in ArcGIS[16] to randomly sample several hundred parcels[17] in each city from the universe of parcels that met lot size, lot coverage, and/or floor area ratio requirements, and exported the parcel boundary shapefiles into Google Earth Pro. For each of the sample parcels, we used Google Earth to measure the depth and width of the parcel as well as the front- and backyards, and noted driveway configurations and existing detached backyard structures. After compiling these measurements, we estimated buildable backyard area by subtracting from the total backyard area the space required for setbacks and building separation in each city.

Last, we conducted fieldwork to understand parking configurations in each city, after using the Sampling Design Tool to select a random sample of about 70 parcels that, according to the ArcGIS screening and Google Earth measurements, could accommodate a secondary dwelling unit within the buildable area of the backyard. We visited each of the randomly selected parcels in person, and estimated the number of existing covered parking spaces (i.e. garages and carports) on each lot,[18] the number of cars that could fit in the driveway or other existing paved area, and the configuration of existing covered and uncovered parking spaces (in tandem or side by side). Based on these observations, we estimated the share of the sampled parcels that could accommodate the parking required for a secondary unit in each city, and extrapolated to the Station Areas as a whole.

For each city, we also studied how changing key zoning requirements would affect the number of lots that could accommodate detached secondary units. To study the effect of eliminating the lot size minimum, therefore, we selected a new sample of 70 parcels that were smaller than the required lot size minimum; screened for lot coverage; measured lot dimensions in Google Earth; and calculated buildable area. From our original Google Earth measurements, we already had the dimensions of a random sample of the parcels that met lot coverage requirements. Using these measurements, we recalculated the buildable width, depth, and area using setbacks reduced to 4 feet. Finally, based on the parking configurations observed in the parking surveys, we estimated the percentage of parcels that could meet parking requirements for a secondary unit if those requirements were relaxed to allow tandem parking; if non-conformance with the parking requirement for the primary unit persisted; or if parking waivers were provided for the secondary unit.

Appendix B: Infill analysis methodology

We used the following procedure for determining the infill potential, in terms of housing units produced, of the Flatlands. This method generally follows the methodology described by Landis et al. (2006).

First, using property tax assessor data (from Alameda County for the Berkeley and Oakland portions of the Flatlands, and from Contra Costa County for the El Cerrito portion) from 2005, vacant lots were identified as those with buildings and other improvements valued at a total of US$5000 or less. Non-vacant parcels available for 'refill' (i.e. for the demolition of existing structures and their replacement with housing) were identified as those with a ratio of structure plus improvement value-to-land value (the 'I/L ratio') of 0.5 or less for single-family residential properties, and 1.0 or less for all other types of properties, including commercial, industrial, and multifamily. Of the identified vacant and refill parcels, properties were eliminated from the pool of parcels eligible to receive infill housing development if they met one or more of several additional criteria: (1) containing a single-family house whose structure was valued in the 40th percentile or above of single-family houses in either the El Cerrito Flatlands or in the Berkeley/Oakland Flatlands, depending on its location; (2) being used as public open space or as a public school; or (3) being used as a cemetery. In addition, multiple instances of condominium units, which repeatedly listed the number of units for the entire complex of which they formed part, were eliminated so as not to count the same units multiple times.

Once the roster of parcels eligible for infill housing development was identified in the manner listed above, adjacent parcels were consolidated into larger, combined properties. Adjacent parcels were identified as those exhibiting consecutive street numbers (defined as those within two or four of each other on either the odd- or the even-numbered side of the street).

The last step was to determine the densities of infill development to apply to each of the infill-eligible parcels. To do this, infill parcels were classified by neighborhood type (such as 'Downtown/Intense Mixed-Use Neighborhood,' 'Low Density Residential,' and so forth) as described in Landis et al. (2006, Table 3). Next, each parcel was assigned a density (expressed in housing units per area)

equal to that prevailing in the census block in which it was located (as of the 2010 US Census), which was then multiplied by a factor that varied by neighborhood type classification, also in accordance with Landis et al. (2006, Table 3). Finally, densities lying above or below a range of densities, specified in relation to the neighborhood type, also detailed in Landis et al. (2006, Table 3), were either increased up to the minimum or decreased down to the maximum, as appropriate. Finally, the parcel's land area was multiplied by the density of housing development calculated for that parcel to yield a number of housing units. The housing units resulting from all infill-eligible parcels were, as the last step, summed together to yield the estimate of the infill potential of the Flatlands.