

Community Impacts of Higher Density Development

# Multifamily Housing Impact Literature Review

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October 2018



## Document Overview

As part of the Community Impacts of Higher Density Development study, DVRPC has conducted a review of literature related to the potential impacts of higher density development. This document presents highlights from that review and is designed to provide municipal and county planning officials with information that may be useful as they review individual development proposals and consider broader land use and zoning regulations.

This document is organized according to three topics: **Economic Impacts**, **Community Impacts**, and **Travel Impacts**. Within each topic, the key findings from individual studies are presented. Although many of these studies and documents focus on communities outside of our region, they may provide insights that into planning and development issues in Greater Philadelphia.

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## Economic Impacts

### Infrastructure Costs (Water, Sewer, Roadways)

**Study Name:** Building Better Budgets: A National Examination of the Fiscal Benefit of Smart Growth Development

- ✚ **Authors & Date of Creation:** Smart Growth America, 2013
- ✚ **Purpose of Study:** Smart Growth America (SGA) is a research organization devoted to promoting **Smart Growth development**, which encourages mixed uses of land and buildings, compact development patterns, access to multiple forms of transportation, and the diverse housing mixture needed to allow people from various walks of life to live in one community.<sup>1</sup> SGA reviewed the findings of various regional fiscal impact analyses of smart growth development patterns. In doing so, they created a national assessment of the potential financial benefits that smart growth development can bring to communities throughout the US.
- ✚ **Key Findings:**
  - The study found that decisions about development patterns and location have **implications for one-third of a typical municipality's budget.**
  - Smart growth development costs **38 to 50 percent less in up-front infrastructure construction** (new roads, sewers, water lines, etc.) than conventional suburban development (areas primarily designed for driving, with separate land uses for residences, retail, and so on.)
  - This study determined that smart growth approaches to development would help many municipalities improve their financial bottom line. This improvement could come through savings on upfront infrastructure, **reductions in the cost of ongoing services** like fire, police and ambulance, or through **generation of greater tax revenue.**
- ✚ **Addresses Concerns About:**
  - How does the cost of providing hard infrastructure (water, sewer, roadways) vary between multifamily and single-family development?
  - How does the cost of providing police and emergency services vary between single-family and multifamily development?

### Cost of Locally Provided Services (Police, Fire, Schools)

**Study Name:** Abington School District Enrollment Projections

- ✚ **Authors & Date of Creation:** Montgomery County Planning Commission, 2016
- ✚ **Purpose of Study:** At the request of the Abington School District, MCPC reviewed their enrollment statistics, housing construction trends, birth rates, and other demographic data to determine future enrollment patterns for the district. This study used a cohort progression model to make projections about grade level attendance for the next 10 years.

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<sup>1</sup> <https://smartgrowthamerica.org/our-vision/what-is-smart-growth/>

 **Key Findings:**


- The Abington School District's enrolled population of students will likely grow by 5 percent (but possibly up to 8 percent) in the next 10 years.
- Some of this growth will be driven by new residential construction and an increase in the popularity of apartment housing to families. However, the growth will also be a result of an expected increase in birth activity caused by continued increases in the population of adults entering the most popular child-bearing years.
- Within the Abington School District, a newly constructed **single-family detached home is over 15 times more likely to contain a school age child** than multifamily units.
- Over the last six years, construction activity across all unit types had resulted in an estimated **7 new school age children per year**. Almost all new units constructed were infill single family detached.

 **Addresses Concerns About:**

- What is the impact of multifamily development on local school districts? Do apartments typically generate more or less school children than other forms of development?

**Study Name:** Building Better Budgets: A National Examination of the Fiscal Benefit of Smart Growth Development

 **Authors & Date of Creation:** Smart Growth America, 2013

 **Purpose of Study:** Smart Growth America (SGA) is a research organization devoted to promoting **Smart Growth development**, which encourages mixed uses of land and buildings, compact development patterns, access to multiple forms of transportation, and the diverse housing mixture needed to allow people from various walks of life to live in one community.<sup>2</sup> SGA reviewed the findings of various regional fiscal impact analyses of smart growth development patterns. In doing this, they created a national assessment of the potential financial benefits that smart growth development can bring to communities throughout the US.

 **Key Findings:**

- Again, this study found that decisions about development patterns and location have **implications for one-third of a typical municipality's budget**.
- This study found that smart growth development **saves municipalities an average of 10 percent on police, ambulance and fire service costs**.
- They found even higher savings for less urban municipalities, with smart growth development **saving as much as 70 to 80 percent in rural areas**.

 **Addresses Concerns About:**

- How does the cost of providing police and emergency services vary between single-family and multifamily development?

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<sup>2</sup> <https://smartgrowthamerica.org/our-vision/what-is-smart-growth/>

## Potential Impacts of Higher-Density Development on the Property Values of Nearby Single-Family Homes

**Study Name:** Targeted smart growth planning initiatives in the suburbs: Effects on home values

- ✚ **Authors & Date of Creation:** Kyungsoon Wang and Dan Immergluck (Georgia Institute of Technology), 2014
- ✚ **Purpose of Study:** This study measured the impacts of a pair of smart growth planning and development efforts on home values in the suburban context. Using a multivariate housing price model, the authors studied the impacts of these developments on nearby home prices. Both smart growth developments were in the Atlanta metro area, and focused on creating suburban town and/or activity centers.
- ✚ **Case Study Background:**
  - The smaller scale town center was a mixed-use development including a city hall, parks and open space, a pedestrian tunnel, a new library, a new police station, an extension of sewer services, and the redevelopment of a playground structure with a climbing wall, bridges, slides, and swings. While the majority of homes in the smaller-scale town center were single-family detached homes, there were several newly constructed attached townhomes and residential lofts above retail.
  - The larger scale activity center contained primarily nonresidential land uses, such as retail commercial centers, business and industrial parks, and public buildings. This area was the largest employment center in the suburbs of the Atlanta metro region, and was continuing to develop as a transit center and and center for new office, hotel, residential and retail space.
- ✚ **Key Findings:**
  - Both the smaller scale town center and larger scale activity center **developments positively affected housing prices within a mile of the centers.**
  - These developments had different effects on more distant areas.
  - In larger-scale smart growth developments, **even home prices in areas further than one mile rose or remained constant**, suggesting a net-positive impact in these areas.
- ✚ **Addresses Concerns About:**
  - Does the presence of multifamily housing impact the price of nearby single-family homes?

**Study Name:** Smart Growth and the Challenge of NIMBY: Multifamily Dwellings and their Association with Single-Family House Selling Prices in Tallahassee, Florida, USA

- ✚ **Authors & Date of Creation:** Huston Gibson and Matthew Becker (Kansas State University and Sentinel Real Estate Corporation), 2013
- ✚ **Purpose of Study:** This study sought to investigate many single-family homeowners' fears of the financial impacts of multifamily housing. Gibson and Becker used a multi-variate regression analysis (hedonic price model) to show multifamily housing's impact on single-family home prices in Tallahassee-Leon County, FL.

 **Key Findings:**

- The study found that single-family houses within 300 feet (or closer) of multifamily housing experienced **no negative impact in property values**.
- In many cases, the authors observe that single-family homes near multifamily housing **often witnessed an increase in property values** compared to single-family homes not adjacent to high-density development.
- These findings held true **regardless of the form of multifamily housing**. For example, neither “non-intrusive” townhomes nor “disruptive” apartment buildings lowered the property values of their neighboring single-family homes.


 **Possible Limitations to Research:**


- Gibson and Becker did not delineate between the values of multifamily housing, and their position in the hierarchy of the neighborhood housing stock.
- Thus, they suggested that some improvements in single-family property values were due to their location in “transition zone” neighborhoods: ones with increased higher-density development alongside general increases in all development, area desirability, and land values.

 **Addresses Concerns About:**

- Does the presence of multifamily housing impact the price of nearby single-family homes?

**Study Name:** Examining the Impact of Mixed Use/Mixed Income Housing Developments in the Richmond Region

 **Authors & Date of Creation:** Lisa A. Sturtevant & John McClain (George Mason University Center for Regional Analysis), 2010

 **Purpose of Study:** “The Partnership for Housing Affordability contracted with the George Mason University Center for Regional Analysis (CRA) to analyze the impacts of 11 mixed income and mixed use housing developments in the Richmond area. For this report, CRA analyzed the impacts on home prices, property assessments, and crime levels around 11 mixed income/mixed use sites in four Richmond area jurisdictions.” For comparison methods, they analyzed the impacts of mixed housing as the rates of change in neighborhood compared to rates of change in the cities/counties as a whole. The 11 developments studied are all of a higher-density, making them useful for our research.


 **Key Findings:**


- Throughout the Richmond area, **single-family home prices** and assessments were **not adversely impacted by the presence of mixed-use and mixed-income developments**, with several areas of study showing increases in value after mixed-use construction.
- For more than half of the developments studied, **single-family home prices near mixed-use and mixed-income developments appreciated** at a greater rate than in other areas of the county and/or city, suggesting a potential benefit to this form of development.

 **Addresses Concerns About:**

- Does the presence of multifamily housing impact the price of nearby single-family homes?

**Study Name:** Effects of Mixed-Income, Multifamily Rental Housing Developments on Single-Family Housing Values

 **Authors & Date of Creation:** Henry O. Pollakowski, David Ritchay, and Zoe Weinrobe (MIT Center for Real Estate), 2005

 **Purpose of Study:** This study was funded by the Housing Affordability Initiative at the MIT Center for Real Estate. Pollakowski et al. used hedonic regression analysis to examine the impact over time of introducing a large-scale, mixed-income, multifamily rental development into a neighborhood of single-family houses.

 **Key Findings:**

- This study concluded that the **introduction of large-scale, high-density** mixed-income rental developments in single-family neighborhoods **does not affect the value of surrounding homes.**
- For extra certainty, they chose to study the most disruptive examples of multifamily housing: large-scale, mixed-income, and rental apartments. **Even while using extreme cases** of higher-density development, they still found a lack of any negative impacts on property values.


 **Addresses Concerns About:**

- Does the presence of multifamily housing impact the price of nearby single-family homes?

## Tax Revenue

**Study Name:** Building Better Budgets: A National Examination of the Fiscal Benefit of Smart Growth Development

 **Authors & Date of Creation:** Smart Growth America, 2013

 **Purpose of Study:** Smart Growth America (SGA) is a research organization devoted to promoting **Smart Growth development**, which encourages mixed uses of land and buildings, compact development patterns, access to multiple forms of transportation, and the diverse housing mixture needed to allow people from various walks of life to live in one community.<sup>3</sup> SGA reviewed the findings of various regional fiscal impact analyses of smart growth development patterns. In doing so, they created a national assessment of the potential financial benefits that smart growth development can bring to communities throughout the US.

 **Key Findings:**

- Smart growth developments were found to generate **10 times more tax revenue per acre** than conventional suburban development.

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<sup>3</sup> <https://smarthgrowthamerica.org/our-vision/what-is-smart-growth/>




- This revenue primarily came from property taxes and sales taxes, and in some cases, licensing fees or other small sources.
- The study concluded that increasing the per-acre tax yield would **reduce pressure on municipalities to increase taxes** for its residents.

 **Addresses Concerns About:**

- How does the tax revenue generated from multifamily development compare to other forms of development? How does mixed-use development factor into this analysis?

**Study Name:** The Multifamily Myth: Exploring the Fiscal Impacts of Apartments in the Suburbs

 **Authors & Date of Creation:** Dorothy Ives Dewey, 2007

 **Purpose of Study:** to examine the fiscal impacts of suburban apartments on tax burdens. Dewey developed a statistical model that would determine the tax burdens of development in Chester and Bucks counties, and displayed the model using an Ordinary least squares (OLS) multiple regression.

 **Key Findings:**

- Empirical results provide evidence that **apartment uses in a community can have a positive fiscal impact** on a suburban municipality.
- Dewey found that **when the value of apartments increased, the tax burden in the municipality's households decreased.**


 **Addresses Concerns About:**


- How does the tax revenue generated from multifamily development compare to other forms of development? How does mixed-use development factor into this analysis?

## Community Impacts

### Public Safety/Crime

**Study Name:** Examining the Impact of Mixed Use/Mixed Income Housing Developments in the Richmond Region

 **Authors & Date of Creation:** Lisa A. Sturtevant & John McClain (George Mason University Center for Regional Analysis), 2010

 **Purpose of Study:** “The Partnership for Housing Affordability contracted with the George Mason University Center for Regional Analysis (CRA) to analyze the impacts of 11 mixed income and mixed use housing developments in the Richmond area. For this report, CRA analyzed the impacts on home prices, property assessments, and crime levels around 11 mixed income/mixed use sites in four Richmond area jurisdictions.” For comparison methods, they analyzed the impacts of mixed housing as the rates of change in neighborhood compared to rates of change in the cities/counties as a whole. The 11 developments studied are all of a higher-density, making them useful for our research.

 **Key Findings:**


- Crime rates were **lower in neighborhoods with mixed-use and mixed-income developments** than those without them.
- In Richmond, **crime rates decreased at a higher rate** in neighborhoods with mixed-use and mixed-income development than in the rest of the city.


 **Addresses Concerns About:**

- Will multifamily housing bring crime to our neighborhood?

## Influence on Demographic Character

**Study Name:** Who Lives in New Jersey Housing? : Updated New Jersey Demographic Multipliers: The Profile of Occupants of Residential Development in New Jersey

 **Authors & Date of Creation:** Alexandru Voicu & David Listokin (Center for Urban Policy Research at Rutgers University), September 2018

 **Purpose of Study:** To improve the knowledge on residential patterns in New Jersey, Voicu and Listokin produced demographic information on household size and pupil generation. Their research was particularly focused on becoming both *current* (uses the latest released American Community Survey data from the U.S. Census Bureau) and *New-Jersey specific* (contains demographic data unique to their state alone).

 **Key Findings:**

- Many of the general findings were in line with previous research showing that **multifamily housing is responsible for less people and school-aged children per unit.**
- Lower valued housing units (below the median value for the state) were found to produce more residents and school aged children per unit than high and median-valued homes.
- Both New Jersey and Pennsylvania have **lower projected growth rates in school age children than other states in the Northeast** and other regions in the U.S.
- With the exception of Mercer County, **New Jersey counties in the Delaware Valley Region are expected to have lower population and school age growth** than the state as a whole, and many other NJ counties.

 **Addresses Concerns About:**

- Will higher-density development and multifamily housing bring residents with different values and priorities into our community?

**Study Name:** Housing Choices in Aging Households: The Influence of Life Cycle, Demographics, and Family

✚ **Authors & Date of Creation:** Gary Painter & KwanOk Lee (USC Lusk Center for Real Estate), Spring 2010

✚ **Purpose of Study:** Painter and Lee wanted to study the growing population of prospective renters who are senior citizens, and detail some of their generation's changing housing choices. Due to the Baby Boomers' growing age and impact on the housing market as they grow older, they decided to examine in-depth survey and Census data on their housing tenure transitions past the age of 50. Their changing choices for housing often include higher-density development and multifamily housing, making the study worth consideration.

✚ **Key Findings:**

- Nearly **25 percent of seniors will experience at least one housing transition** after the age of 50.
- Common reasons for Baby Boomers' changes in living situations included: loss of a spouse/divorce, change in health status, and desire to move to a new area (such as one near their children).
- The study found that **lower health statuses and being a single head of household were important predictors** of housing tenure transitions.
- While living closer to their children decreases seniors' likelihood of switching from home owning to renting, **households with wealthier children are more likely to downsize.**

✚ **Addresses Concerns About:**

- Will higher-density development and multifamily housing bring residents with different values and priorities into our community?

**Study Name:** Overcoming Opposition to Multifamily Rental Housing

✚ **Authors & Date of Creation:** Mark Obrinsky and Debra Stein (Joint Center for Housing Studies at Harvard University), March 2007

✚ **Purpose of Study:** This report was prepared for Revisiting Rental Housing: A National Policy Summit. Obrinsky and Stein used national growth predictions to dispel some of the commonly held misconceptions about the community impacts of multifamily rental housing.

✚ **Key Findings:**

- **Every 100 single-family newly constructed houses will produce 64 children, while every 100 newly constructed apartment units will produce 29.**
- **Apartment dwellers will contribute a higher percentage of tax revenue** than single family houses, due to the commercial real estate tax placed on their homes.
- **Apartment residents were almost twice as likely to socialize with their neighbors** as owners of single-family houses, and just as likely to be involved in structured social groups

✚ **Addresses Concerns About:**

- Will higher-density development and multifamily housing bring residents with different values and priorities into our community?

## Travel Impacts

Due to the complex nature of individual travel decisions, researchers commonly cite the challenge of isolating the variables that contribute to these decisions from one another. Scholars have noted the futility of trying to measure the unique travel effects of any one aspect of the built environment.<sup>4</sup>

For this reason, the existing research on travel impacts is grouped by thematic questions that represent common concerns about higher density development. Readers should understand that the cited studies researched the travel impacts of high-density development alongside other factors, such as surrounding land use.

## Traffic and Congestion

### **How does the travel behavior of multifamily residents compare to single-family residents? Does multifamily development cause more congestion than single-family homes?**

- ✚ The most common form of measuring travel behavior is by using the vehicle trip rates found in the Institute of Transportation Engineers (ITE) Trip Generation Manual.
- ✚ ITE trip generation data can suggest the travel behavior of residents, and travel behavior can indicate the likelihood of congestion in various areas
  - For example, developments with high trip generation rates would also be likely to experience more congestion.
- ✚ Many scholars have found significant problems with the trip generation estimates found in the ITE Manual, some of which will be explained below.<sup>5,6,7</sup>
- ✚ Scholars measuring travel behavior using ITE trip data found that a single-family detached house generates 42 percent more weekday trips than an apartment unit.<sup>8</sup>
- ✚ This suggests that even with overestimation of multifamily trip rates, apartments still generate less congestive travel behavior per unit than single-family homes.

### **Are trip generation estimates for multifamily units accurate? If not, what factors contribute to the difference?**

- ✚ ITE trip generation data consistently overestimates trip rates in urban spaces, areas near transit, and walkable locations, as well as in higher-density developments.
- ✚ One study of trip generation at smart growth developments in California found that ITE trip estimates were 2.3 times higher than actual vehicle trips in the morning and 2.4 times higher than those in the afternoon.<sup>9</sup>

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<sup>4</sup> Cervero, Robert, and Kara Kockelman. "Travel demand and the 3Ds: density, diversity, and design." *Transportation Research Part D: Transport and Environment* 2, no. 3 (1997): 199-219.

<sup>5</sup> Cervero, Robert, and G. B. Arrington. "Effects of TOD on housing, parking and travel." *Transit Cooperative Research Program Report* 128 (2008).

<sup>6</sup> Cervero, Robert, and G. B. Arrington. "Vehicle trip reduction impacts of transit-oriented housing." *Journal of Public Transportation* 11, no. 3 (2008): 1.

<sup>7</sup> Clifton, Kelly J., Kristina M. Currans, and Christopher D. Muhs. "Adjusting ITE's Trip Generation Handbook for urban context." *Journal of Transport and Land Use* 8, no. 1 (2015): 5-29.

<sup>8</sup> Obrinsky, Mark, and Debra Stein. "Overcoming opposition to multifamily rental housing." *National Multi Housing Council (NMHC) White Paper* (2007).

- ✚ These findings (and others like them) are greatly relevant for multifamily units, which are often clustered in urban areas near transit and part of higher-density, “smart growth” developments.<sup>10,11, 12</sup>

## Parking Demand & Supply

### Do multifamily residents own vehicles at the same rate as single-family residents?

- ✚ A sizeable range of literature finds that **single-family residents own more vehicles per housing unit than multifamily residents**, and generate more automobile trips per household.<sup>13,14</sup>
- ✚ However, it is difficult to discern if the difference in vehicle ownership is a result of the majority of multifamily housing being located in urban areas with generally low rates of vehicle ownership.

### How does the supply of parking required for multifamily housing correspond to the demand? How does this demand vary by context and proximity to transit services?

- ✚ The majority of the literature on parking supply and demand is focused on Transit-Oriented Developments (TODs). Due to the high residential density needed to support transit stations, and the common use of multifamily housing in higher-density developments, it is safe to assume that research on TOD parking supply and demand is relevant for our study.
- ✚ Studies found several instances where the **over-supply of parking in TODs created cases of induced demand**, where residents who might not otherwise use a vehicle for travel brought automobiles to their developments, at least partially due to the abundant supply of parking at these sites.<sup>15,16</sup>
- ✚ Others found that **peak parking demand at TODs was less than half of the estimated parking demand** for the development.<sup>17</sup>
- ✚ These findings suggest a **vast over-supply of parking at many multifamily housing developments**, especially when they are close to transit services. Thus, issues of excessive parking at multifamily housing are likely issues of design and zoning, and not issues of residents’ vehicular usage.

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<sup>9</sup> Schneider, Robert J., Kevan Shafizadeh, Benjamin R. Sperry, and Susan L. Handy. "Methodology to gather multimodal trip generation data in smart-growth areas." *Transportation Research Record* 2354, no. 1 (2013): 68-85.

<sup>10</sup> Certero, Robert, and G. B. Arrington. "Effects of TOD on housing, parking and travel." *Transit Cooperative Research Program Report* 128 (2008).

<sup>11</sup> Certero, Robert, and G. B. Arrington. "Vehicle trip reduction impacts of transit-oriented housing." *Journal of Public Transportation* 11, no. 3 (2008): 1.

<sup>12</sup> Clifton, Kelly J., Kristina M. Currans, and Christopher D. Muhs. "Adjusting ITE's Trip Generation Handbook for urban context." *Journal of Transport and Land Use* 8, no. 1 (2015): 5-29.

<sup>13</sup> Obrinsky, M., & Stein, D. (2007). Overcoming opposition to multifamily rental housing. *National Multi Housing Council (NMHC) White Paper*.

<sup>14</sup> Guo, Zhan. "Does residential parking supply affect household car ownership? The case of New York City." *Journal of Transport Geography* 26 (2013): 18-28.

<sup>15</sup> Certero, Robert, and G. B. Arrington. "Effects of TOD on housing, parking and travel." *Transit Cooperative Research Program Report* 128 (2008).

<sup>16</sup> Guo, Zhan. "Does residential parking supply affect household car ownership? The case of New York City." *Journal of Transport Geography* 26 (2013): 18-28.

<sup>17</sup> Ewing, Reid, Guang Tian, Torrey Lyons, and Kathryn Terzano. "Trip and parking generation at transit-oriented developments: Five US case studies." *Landscape and Urban Planning* 160 (2017): 69-78.

## Traffic Safety

### Does the presence of multifamily development have an impact on local traffic safety conditions? Vehicle crash rates? Pedestrian and bicycle crash rates?

- ✚ The pool of literature addressing these topics is still growing, with much need for further research. Existing studies primarily focus on the attributes of areas with low traffic safety, examining such characteristics as their walkability and surrounding land use.
- ✚ By understanding the general density and mixed-use nature of areas with higher-density developments, we can use these studies to suggest the traffic safety impacts of multifamily development.
- ✚ Studies assessing the **most dangerous areas for pedestrians and cyclists** found the highest crash rates at intersections without pedestrian safety controls such as crosswalks and pedestrian traffic signals, and in **areas where detached homes connected to major roads**.<sup>18</sup>
- ✚ Other studies focused on the connection between vehicle crash rates and urban design. They found that **areas with urban forms less compatible with multifamily development** (such as automobile-oriented retail uses, strip commercial uses, and big box stores) **were more likely to be associated with crash increases**.<sup>19</sup>
- ✚ While these findings are not plentiful or generalizable enough to suggest that multifamily development improve local traffic safety conditions, they definitely do not suggest that they make their neighborhoods more dangerous.

## Transit, Biking, & Walking

### Are multifamily residents more or less likely than single-family residents to travel by transit? Bicycle? On foot?

- ✚ While the direct impact of multifamily residences on transit, biking, and walking choices is unclear, there is considerable research on the effects of Transit-Oriented Development on these resident choices.
- ✚ In the Delaware Valley Region, many higher-density developments are also transit-oriented, suggesting that these findings are helpful for the following questions.
- ✚ Scholars at UC Berkeley found that residents of **TOD sites were 2–5 times more likely to commute using transit** than others in their region.<sup>20</sup>
- ✚ Case studies of **TODs in San Francisco** found that residents were considerably more likely to use modes of travel besides their own automobiles. When calculating the average mode shares for the TODs, **automobile trips accounted for less than half of all trips** counted.<sup>21</sup>
- ✚ While the likelihood of multifamily residents to bike or walk for travel is unclear, studies have shown that **nearly 25 percent of Americans believe they should be able to walk or bike to**

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<sup>18</sup> Hu, Yujie, Yu Zhang, and Kyle S. Shelton. "Where are the dangerous intersections for pedestrians and cyclists: A colocation-based approach." *Transportation Research Part C: Emerging Technologies* 95 (2018): 431-441.

<sup>19</sup> Dumbaugh, Eric, Robert Rae, and Douglas Wunneberger. "Using GIS to develop a performance-based framework for evaluating urban design and crash incidence." *Urban Design International* 16, no. 1 (2011): 63-71.

<sup>20</sup> Cervero, Robert, and G. B. Arrington. "Effects of TOD on housing, parking and travel." *Transit Cooperative Research Program Report* 128 (2008).

<sup>21</sup> Ewing, Reid, Guang Tian, Torrey Lyons, and Kathryn Terzano. "Trip and parking generation at transit-oriented developments: Five US case studies." *Landscape and Urban Planning* 160 (2017): 69-78.

**work**, even though less than 5 percent currently do so. This suggests that many potential multifamily residents would be likely to bike or walk for travel if the design of their developments and surrounding neighborhoods allowed them to do so.<sup>22</sup>

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<sup>22</sup> Nelson, Arthur C., Gail Meakins, Deanne Weber, Shyam Kannan, and Reid Ewing. "The tragedy of the unmet demand for walking and biking." *The Urban Lawyer* (2013): 615-630.



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