More Housing, Fewer Cars:
Reducing Commute-Related Emissions on the South Coast

Project Members
Jenny Bankie

Kaitlin Carney

Michelle Graff

Amy Stuyvesant

Advisor
Dr. Mark Buntaine

Client
Mr. John Campanella

March 2016

A group project submitted in partial satisfaction of the requirements for the degree of Environmental Science and Management.

BRENSCHOOL
UC SANTA BARBARA

✔YARDI

As authors of this Group Project, we are proud to archive this report on the Bren School's website such that the results of our research are available for all to read. Our signatures on the document signify our joint responsibility to fulfill the archiving standards set by the Bren School of Environmental Science & Management.

_____

Jenny Bankie

_____

Kaitlin Carney

_____

Michelle Graff

_____

Amy Stuyvesant

The mission of the Bren School of Environmental Science & Management is to produce professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a year-long activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Final Report is authored by MESM students and has been reviewed and approved by:

_____

Mark Buntaine, Ph.D.

ACRONYMS & ABBREVIATIONS

AB   Assembly Bill

AUD   Average Unit-Size Density Incentive Program

ARB   Air Resources Board

BAU   Business as Usual

CO$_2$e   Carbon Dioxide-equivalent

GHG   Greenhouse Gas

RTP   Regional Transportation Plan

SCS   Sustainable Communities Strategy

SB   Senate Bill

SBCAG   Santa Barbara County Association of Governments

SOV   Single Occupancy Vehicle

TDM   Transportation Demand Management

VMT   Vehicle Miles Traveled

Table of Contents

Figures

Tables

1. EXECUTIVE SUMMARY

Transportation is one of the greatest sources of greenhouse gas emissions in both California and nation-wide. State goals to reduce emissions have focused on transportation, but leave much of the actual work up to local jurisdictions.

An increase in population growth, geographic constraints, and high housing prices have led to an extreme jobs-housing imbalance in the South Coast of Santa Barbara County. The lack of affordable housing in the City of Santa Barbara has forced employees to reside out of the downtown core and in neighboring bedroom communities, where they must contend with long work commutes. In response, the City of Santa Barbara has made efforts to increase workforce housing, thereby reducing the transportation burden on employees and also decreasing the harmful emissions associated with single-occupancy vehicle (SOV) travel. Their "Average Unit-Size Density Incentive Program" (AUD) encourages affordable, high-density housing projects located near transit and workplaces by providing development incentives.

But there are still questions about the effectiveness of this policy and the state of transportation usage in the South Coast. What is the potential of high-density infill development to reduce work commutes and their associated emissions? How does this compare to incentives for increased alternative transportation usage? While policies designate the downtown core of Santa Barbara as a priority for high-density developments, the City needs a more thorough understanding of behavior in this area. They also need a better understanding of why South Coast residents choose to drive an SOV and what incentives or disincentives can promote a mode shift. With this information, City officials can make well-informed and effective policy decisions.

This report involves the South Coast of Santa Barbara County, the intersection of housing and transportation, and the influence of housing on commute-related emissions. Surveys were sent out to residents in the cities of Goleta, Santa Barbara, and Carpinteria. The 121 completed surveys indicate what current commute behavior looks like in the South Coast. The results also describe what factors influence a resident's transportation mode choice. Finally, the survey explores which incentives or fees might lead a person to switch transportation modes.

For this selected sample, high-density housing residents throughout the South Coast commuted significantly fewer miles each day compared to residents of single-family homes. Within the AUD zone, residents did not commute less in terms of mileage, however they did have lower emissions due to a higher usage of alternative transportation. Currently, incentives are not significant factors influencing respondents' commute transportation mode choice. However when paired with a parking fee, respondents were more likely to choose modes other than an SOV.

Since residents of the AUD zone commute in less greenhouse gas-intensive modes, the City should continue with the AUD program. With careful and continued monitoring of AUD development residents, the City can ensure that the program is successful in promoting alternative modes of transportation and reduces dependency on SOV. Additionally, while these results did not conclude incentives alone were enough to cause a mode shift, an incentive program paired with a parking fee may be highly effective. Therefore the City should work with employers to encourage alternative transportation usage and also discourage the use of SOVs.

2. SIGNIFICANCE

Santa Barbara is one of the most idyllic regions in California. It has become a vacation destination for thousands of tourists each year, attracting visitors from near and far. Aside from its famous beauty, the South Coast (Santa Barbara, its neighboring cities of Goleta and Carpinteria, and the areas of the unincorporated County in-between) is infamous for its high cost of living. Home prices are well above the national average and the city has a rental vacancy rate of less than 0.5%. Many of the South Coast's employees cannot afford homes in the area, forcing them to live outside of the city in which they work. This puts pressure on the workforce, which must now contend with long, congested commutes each day.

Work commutes in single occupancy vehicles have many negative economic, environmental, and cultural impacts. City officials fear that employees will tire of the long commute and eventually leave their jobs on the South Coast, finding work closer to home. This could entice employers to vacate the region, reducing the City's revenue. In addition, long work commutes emit large amounts of greenhouse gases, contributing to climate change and decreased air quality. Culturally, people that spend the majority of their free time alone in a car are hindered in engaging with their families or communities.

The City of Santa Barbara wants to reduce the jobs-housing imbalance. Its proposed solution is infill development, housing units built on vacant or underdeveloped land in urban areas (California Office of Planning and Research (OPR), n.d.)

Through a survey of South Coast residents, this group project aims to characterize current behavior and attitudes regarding transportation choices. First, the project will assess current commute behavior throughout the study area. Additional analysis will fill a knowledge gap of why South Coast residents choose certain modes of transportation and if any combination of programs will result in a movement of individuals out of SOVs and into alternative modes. Understanding these attitudes will help City planners decide where to best spend their efforts, whether it be continuing infill development, implementing employer incentive programs, increasing access to public transit or bike routes, increasing the cost of parking, or a combination of all as a coordinated effort.

3. OBJECTIVES

Based on the existing knowledge gaps regarding commute-related behavior in the South Coast, regional planning interest in improving the jobs-housing imbalance, and complying with statewide sustainable development objectives along the South Coast, this project has three primary objectives:

1) Establish a baseline for commute behavior, examining differences among:
    a. Apartment and single family home residents in Goleta, Carpinteria, and Santa Barbara as a whole
    b. Residents of the Santa Barbara AUD zone and surrounding one-mile buffer.

2) Examine what demographic and behavioral factors affect people's decisions to drive a single occupancy vehicle to work compared to alternative modes (carpool, bus, bicycle, walk).

3) Analyze the influence of employer incentives and increasing the cost of parking on promoting a shift away from the use single occupancy vehicles and into alternative modes of transportation among commuters (particularly carpooling, busing, or biking).

4. BACKGROUND

4.1 The Jobs-Housing Imbalance in Santa Barbara

The City of Santa Barbara has experienced a shift toward single family homes outside of the city center since the 1960s due to a large increase in commercial and residential development. Fragmenting the city in this way decreases residential density and compartmentalizes land use, typically increasing overall and per capita levels of driving in the region (Herold, Goldstein, & Clarke, 2003)*. More recently in Santa Barbara County, the high cost of housing has forced employees to make tradeoffs between their home and workplace. Today, Santa Barbara County ranks in the bottom 5% of metropolitan areas in the country in terms of housing affordability (NAHB, 2015). The spatial mismatch between affordable housing and workplaces forces South Coast employees to seek housing in distant "bedroom communities," creating a jobs-housing imbalance. For the last several years, new development has been concentrated in the North County, thereby perpetuating this imbalance.

4.2 Transportation's Contribution to GHG Emissions

Studies have long shown that motor vehicles are one of the greatest sources of air pollution and a large contributor to annual greenhouse gas (GHG) emissions. In the City of Santa Barbara, on-road vehicle emissions account for the highest per capita and overall source of GHG emissions, contributing just over 57% of the City's total reported emissions (City of Santa Barbara, 2012). Commute trips alone represent approximately 20% of on-road emissions and 11% of total City emissions.

Transportation similarly comprises a substantial source of emissions at the state and national level. In 2013, transportation was the biggest source of GHG emissions for California at 37% of statewide emissions, and the second greatest contributor behind the electricity industry of total US emissions at 27% (ARB, 2015; EPA, 2015). Emissions related to transportation have been increasing over time largely due to an increase in overall levels of driving, measured in vehicle miles traveled (VMT). The EPA attributes much of this increase in VMT to population growth, economic growth, and urban sprawl (EPA, 2015).

4.3 State Efforts to Reduce GHG Emissions

California has established the strictest GHG emissions standard in the nation. In 2005, Governor Schwarzenegger issued Executive Order S-3-05, mandating that California reduce its GHG emissions. The EO establishes reduction targets for three time periods: 1) by 2010, a reduction to 2000 levels, 2) by 2020, a reduction to 1990 levels, and 3) by 2050, a reduction to 80% below 1990 levels. The California Global Warming Solutions Act of 2006 (AB 32) quickly followed this EO, making California the first state to officially take action to reduce GHG emissions. AB 32 requires the same reduction as the 2020 goal of EO S-3-05. The California Air Resources Board (ARB) is tasked with implementing the law and must develop a Scoping Plan, updated every five years, to achieve the law's goals. As an interim target to EO S-3-05, Governor Brown issued Executive Order B-30-15 in April 2015, which requires a 40% reduction below 1990 levels by 2030 (for further information on EO B-30-15, see Appendix A1).

In 2008, California passed the Sustainable Communities and Climate Protection Act of 2008, Senate Bill (SB) 375, to aid efforts of reaching the goals set out by AB 32. Under SB 375, the California Air Resources Board (ARB) sets goals of GHG reductions from passenger vehicles for each region. Santa Barbara County has been assigned a target of zero net growth in vehicular GHG emissions.

Additionally, SB 375 requires that all regional Metropolitan Planning Organizations establish a Sustainable Communities Strategy that integrates housing, transportation, and land-use to achieve a required reduction in passenger vehicle GHG emissions. The Santa Barbara County Association of Governments (SBCAG), the regional planning agency consisting of Santa Barbara County and its eight incorporated cities (Buellton, Carpinteria, Goleta, Guadalupe, Lompoc, Santa Barbara, Santa Maria, and Solvang), passed its own SCS in August 2013 (SBCAG, 2013). For additional, relevant state bills, see Appendix A2-A4.

4.4 Santa Barbara County's Regional Transportation Plan

SBCAG's 2040 Regional Transportation Plan & Sustainable Community Strategy (RTP-SCS) (2013) considers several management options for reducing transportation GHG emissions and contains a Sustainable Communities Strategy in line with the SB 375 requirements of meeting housing demands for the entire regional population through 2022.

   4.4.1 BAU scenario vs. preferred scenario. The 2040 RTP-SCS's business as usual (BAU) regional growth scenario is one that follows existing General Plan land use allowances and planned transportation projects from prior Regional Transportation Plans. Population and employment are forecast to increase by 23% (96,100 people) and 29% (56,000 jobs), respectively, from 2010 to 2040. Under BAU, most of the County's projected population growth occurs in the North County, and per capita VMT and transportation GHG emission increase.

The preferred scenario, meanwhile, sees more of the projected population growth occurring in the South Coast and addresses the region's jobs-housing imbalance through increased job growth in the North County and housing development in the South Coast. The South Coast, however, has little room for sprawl, bounded by the Pacific Ocean to the South and the Santa

Ynez Mountains to the North, This preferred scenario thus focuses on higher-density infill and transit-oriented development and land use. Commercial and housing development will be concentrated in urban areas, providing adequate affordable and workforce housing near transit. Long-distance commuting will be further decreased through a combination of land use zoning, employer-sponsored housing, economic development, parking pricing, commercial growth management, and average unit size ordinances.

4.4.2 Alternative transportation goals. Plans laid out in the RTP-SCS to decrease transportation-related GHG emissions focus primarily on alternative transportation. The preferred scenario increases the alternative transportation mode share to 6.6% for all intercounty trips and 5% for all commute trips. Though still a small percentage, this is a 7% relative increase over the percentage for all trips taken via alternative transportation in 2010 (6.2%) and an 11% relative increase over work trips taken with alternative transportation in 2010 (4.6%). Simultaneously, the percentage of personal and work trips taken via single occupancy vehicles is projected to decline.

These measures in combination with other transportation initiatives are expected to result in a decline in countywide per capita daily VMT of 16% in 2040 and a decrease in per capita GHG emissions by 17% in 2035. Both decreases are compared to projected levels under the BAU scenario, and the per capita GHG projection for 2040 is not presented in the RTP-SCS. Compared to 2005 levels, this represents a 3% decrease in per capita VMT and a 15% decrease in per capita GHG emissions. At a projected 2040 county population of 519,965 people, this results in just over 730 thousand kg of CO_2 emissions avoided per year, which is equivalent to taking approximately 140 cars off the road. This will also result in improved air quality by decreasing emissions of other air pollutants. By reducing overall vehicular emissions, the preferred scenario thereby performs better than the state-mandated target of zero net growth set under SB 375. As SBCAG and its associated governments work to achieve the reductions projected under the preferred scenario, it will be imperative that they continue to encourage a mode shift among commuters, while also considering novel solutions to reduce transportation per capita emissions.

4.4.3 Jobs-housing imbalance. The RTP-SCS also includes several provisions for equitable housing development to accommodate population growth and protect open space. As mentioned previously, a large jobs-housing imbalance exists along the South Coast and is a central concern for future urban planning. A ratio of jobs to households of 1.5 to 1 or lower is considered ideal. The ratio observed in 2010, however, was 1.59:1 for the entire South Coast, 1.28:1 for the City of Carpinteria, and an alarming 1.80:1 and 1.94:1 for the Cities of Santa Barbara and Goleta, respectively. In the preferred scenario through 2040, the ratios reach ideal or better levels for all regions, despite a slight increase for Carpinteria. Goleta and the City of Santa Barbara's jobs-housing imbalances are remedied through a substantial increase in housing with only a minor increase in jobs.

4.4.4 Infill development plans. In the preferred scenario, thirty percent of new housing is planned for infill development, compared to 13% for BAU. Housing density will increase countywide from 1.76 units/acre in 2010 to 2.08 in 2040 for the preferred scenario, compared to a baseline 2040 unit density of 1.99 units/acre. In tandem with increasing infill development, the

RTP-SCS ensures that development will only occur within currently developed urban zones such that all present open space will remain intact through 2040. This is a decided contrast from the BAU scenario, under which development would be in accordance with existing general plans and thereby out of compliance with SB 375 provisions for sustainable regional development. The effects of infill development on transportation emissions, however, has yet to be quantified.

4.5 City of Santa Barbara's Average Unit-Size Density Incentive Program

Following precedents for infill development set by the State and SBCAG, the City of Santa Barbara passed the Average Unit-Size Density (AUD) Incentive Program ordinance in 2013. The AUD program is a means of implementing the City's 2011 General Plan, which aims to address the jobs-housing imbalance and promote additional housing development, particularly those that are multi-family and located near the center of employment downtown. Under the program, density restrictions are loosened and development requirements are modified in order to encourage smaller, more affordable residential units. Developers can put more units on a single parcel of land and are only required to provide one parking space per unit, thereby decreasing the cost to build an AUD project and incentivizing developers (Santa Barbara, CA, Municipal Code Title 28, Ch 28.20). In accordance with existing zoning, the City has identified "Medium-High Density Residential" and "High Density Residential" zones that are eligible for an increased housing density (City of Santa Barbara, 2014). Additionally, certain areas are designated as "Priority Housing" and are allowed an even higher unit density given that the housing is either rental, employer sponsored, or limited equity cooperative housing. The program will be in trial for either eight years or until 250 units have been built in High Density or Priority Housing Overlay zones, after which it will be extended, modified, or revoked.

In addition to providing local housing, the AUD program encourages developments near transit and within walking distance to local services. The City is hopeful that these characteristics, coupled with AUD developments' reduced parking availability and employees' relocation closer to work, will encourage residents of AUD developments to travel by modes other than a car and thereby reduce local VMT-related GHG emissions.

4.6 Behavioral Influences on VMT

Though the AUD program is attempting to alter human behavior related to commute choices through land use, literature suggests that simply moving a person closer to his or her destination will not necessarily encourage the individual to cease traveling by car (Ewing & Cervero, 2001). Ewing and Cervero (2001) found travel demand to be unaffected by built environment shifts (i.e. sprawl to high density), suggesting human behavior impacts the amount of time in a car and further serves as an influential factor beyond solely relocating closer to work. Overwhelmingly, studies are pushing for the wider incorporation of behavioral science into environmental protection strategies, arguing that these considerations will allow for an expansion of intervention targets as well as a focus on more long-term solutions (Lehman & Geller, 2005). As the City and County work to reduce VMT and encourage a mode shift to alternative transportation through land use management and urban design, it is imperative that they understand what characterizes current residents' mode choices and consider what practices may alter that specific behavior.
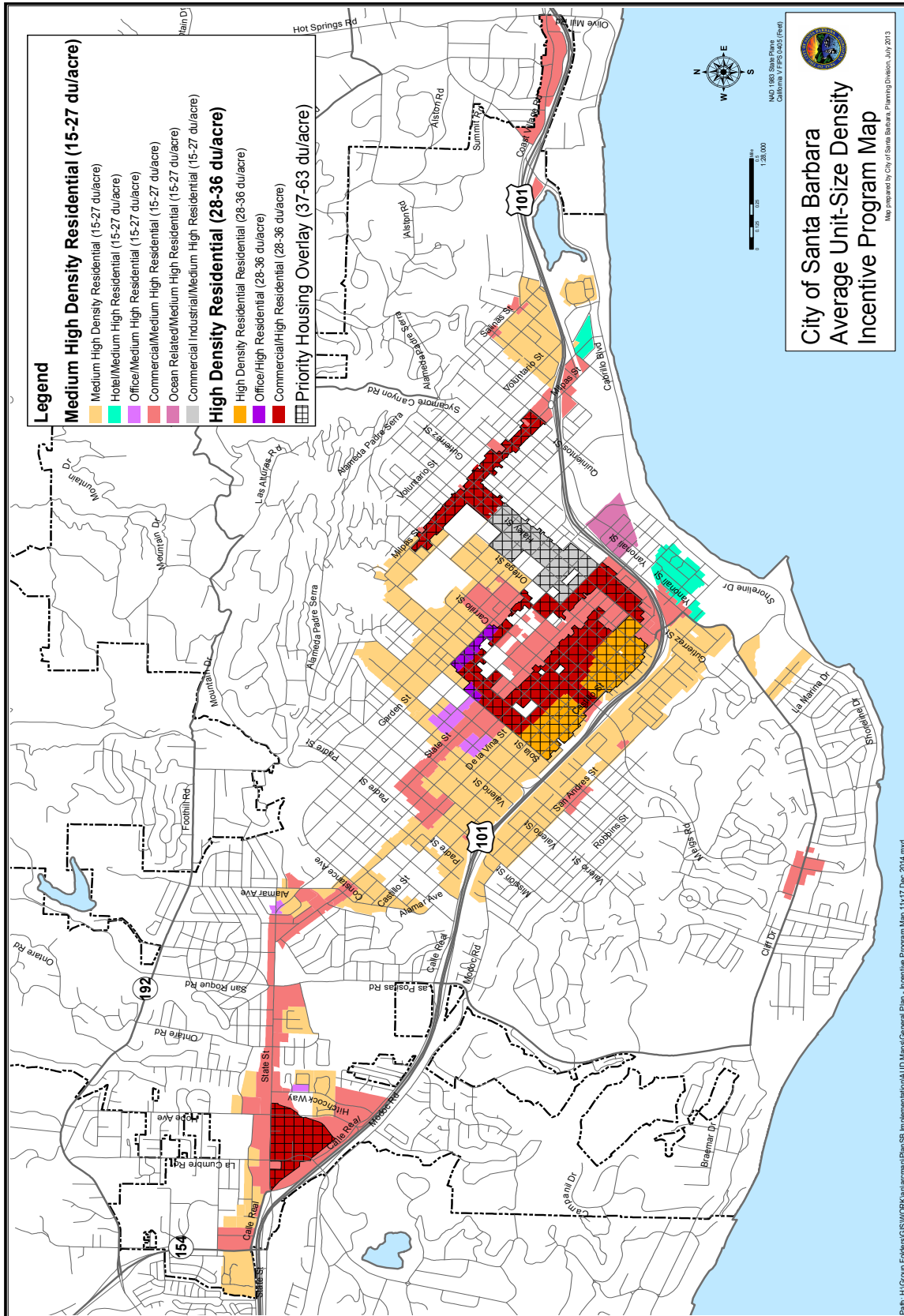
Figure 1. AUD Program Map. The City of Santa Barbara's AUD Program Map, showing existing zoning and their allowed unit density under the AUD program.

4.6.1 Initial studies linking behavior with environmental attitudes. Studies relating behavior to environmental attitudes were first conducted regarding global attitudes about climate change (Lehman & Geller, 2005; Semenza et al., 2008; van der Linden, 2014). Researchers modeled what factors lead to these varying attitudes and attempted to quantify one's willingness to shift his or her choices. Demographic information, such as age and income, described attitudes toward being concerned with climate change while a desire for a governmental support role that assuages economic, structural, and social stress associated with change acted as barriers to action (Semenza et al., 2008; van der Linden, 2014). Transportation-related behavior guiding an individual's decision on their primary mode choice follows similar patterns (Handy, Cao, & Mokhtarian, 2005; Nobis, 2007). No matter what policy or program is put in place, there needs to be cooperation from the public, necessitating the move towards understanding why people choose to engage in certain environmental behaviors and how receptive they are to altering those choices. Cities all over the world are looking at how to incentivize alternative transportation or discourage single occupancy vehicle (SOV) usage, and at the crux of these conversations lies a need of understanding the intricacies of human nature.

4.6.2 Transportation demand management programs. In the United States, metropolitan areas such as Portland, Seattle, San Diego, and San Francisco (including surrounding cities) are looking into these travel-behavior conundrums by heavily supporting various programs aimed at shifting mode choice, generally referred to as either Mobility Management or Transportation Demand Management (TDM). A main objective of these programs is to shift SOV trips either to alternative modes of transportation or out of peak hours, a task being accomplished through combinations of private-public partnerships and/or employers (SDOT, 2008).

Seattle's TDM program provides a good model for future cities to follow in enacting their own TDM programs. The program splits methods into a few categories of best practices that help organize how cities can cope with this difficult task. Land use management and urban design, the framework of Santa Barbara's AUD program, is one such category. Seattle's counterpart to the AUD program, *Vision 2040*, is planning for 1.7 million additional residences and 1.2 million additional jobs by strategically placing mixed use facilities in concentrated areas near businesses and public transit (Watterson, 1993). However, due to the inelasticity of travel demand to shifts in the built environment, a movement towards this urban design framework may not be enough to enact meaningful change (Boarnet & Crane, 2001; Hong, Shen, & Zhang, 2013; Lehman & Geller, 2005; Melia, Parkhurst, & Barton, 2011). As such, this is not the only strategy Seattle is acting upon. Access to public transit and promoting the use of transit services and carpooling (a second method of TDM best practices) is often tightly nested with discussion of land use management. This dynamic, also addressed by SBCAG's RTP-SCS, hopes to ensure a cohesion between concentrating people and businesses by providing ease of movement between locations without need of an SOV. This can allow an individual's shift out of an SOV to be relatively burden-free.

4.7 The High Cost of Cheap Driving

A substantial percentage of Santa Barbara County employees drive alone to work. According to SBCAG's 2014 State of the Commute Report, 67% of employees in 2010 commuted to work in

an SOV as their primary mode, and only 26% commuted via carpool, bus, or bicycle (with carpool being the largest form of alternate transportation at 15%).

Aside from the convenience of driving alone, it is likely that this mode of transportation is further encouraged by employees' access to free parking. Eighty-eight percent of employees reported that they received free parking at their workplace (SBCAG, 2007). Back-of-the-envelope calculations using an average round-trip commute distance of 28 miles (SBCAG, 2007), an average 2013 passenger vehicle fuel economy of 27.6 gallons/mile (EPA, 2014), an average statewide regular-grade fuel price as of 9 November 2015 of $2.84/gallon (California Energy Commission (CEC), n.d.), and an average of 22 workdays per month show the fuel-cost of driving is nearly the same as that of a monthly bus pass with the Santa Barbara Metropolitan Transit District (MTD). An MTD monthly bus pass costs $63, while monthly fuel costs average $52. This roundtrip work commute distance is further supported by a 2015 survey administered by the Coastal Housing Coalition, which found that 79% of employees had roundtrip commute distances of less than 30 miles, and 42% commute less than 10 miles roundtrip. At this lower bound, driving becomes more cost-effective than busing, costing approximately $23 per month. While the cost of fuel is not the only cost of driving, it is the primary variable cost that allows for comparison across transportation modes.

Due to the similar variable costs of driving and busing, there is little incentive to switch to alternative modes of transportation when gasoline prices are low. Because local governments have little to no control over gasoline prices, they will need to reevaluate how they promote alternative modes of transportation, while simultaneously discouraging SOVs.

Free or low cost parking has been associated with high levels of SOV commuting in other cities nationwide, including the City of Portland, which is usually thought of as one of the success stories in altering commuter behavior. Even though Portland places high emphasis on a bike- and walk-friendly culture and incentivizes alternative transportation, the city also offers places to park all day for only $10 and thus has failed to encourage meaningful decreases in SOV transit over time (Metro, 2005; Portland Bureau of Transportation, 2015). However, Portland is still making strides toward a city with vastly reduced SOVs on the road. A study on what makes people more or less likely to bike in Portland did show street connectivity and availability of bike lanes to be significant predictors, suggesting this information is needed in the effort to shift mode choice in conjunction with outside incentives and more costly parking (Dill & Voros, 2007). Putting efforts towards only one of these best practices may be insufficient for the desired effect.

4.8 Supply and Demand Dynamics of Parking

Parking management is seen as a huge mover in TDM best practices (SDOT, 2008). This method examines how supply and demand can ultimately decide travel behavior, where it is hypothesized that if parking supply (number of spots as well as cost of those spots) remains the same, demand will not shift (Jakobsson, Fujii, & Gärling, 2000; Shoup, 1997). Considering the relationship of supply and demand in regards to price and quantity, if the given state of equilibrium is shifted so that supply (in this case, the amount of parking) decreases, then the price for parking will increase. If this exceeds a person's willingness to pay, the demand for parking will consequently lower, pushing people out of SOVs and into other modes.

The AUD program is working to decrease parking supply at residences, but this decrease in supply will need to be matched by the City in some way (i.e., at work) in order to be most effective in curbing SOV commuting. Further, decreasing the supply of parking in the City could be effective in discouraging residents of AUD developments to own cars, thereby addressing the concern of locals that the AUD program will simply lead to more on-street parking.

Altering parking supply has been shown to be an effective strategy for decreasing driving in case studies in Los Angeles, CA and Eugene, OR. Lowering available spaces in all city parking garages, setting parking spot maximums for new developments, and rising prices of existing spots were shown to lower SOV work commutes in Los Angeles, CA by 14% and decrease parking demand in Eugene, OR by 35% (City of Pasadena, 2006; Metro, 2005). While these tactics did not fix all of the travel issues in either of these cities, they show promise as a piece to a very interconnected plan in successfully changing behavior. This behavior change results in a substantial portion of passenger vehicles being removed from the road, thereby decreasing per capita VMT.

4.9 Employer Incentives as a Tactic to Decrease SOV Commuting

Employer incentive programs have also found success in encouraging alternative transportation usage, especially in dense metropolitan regions, and many cities have begun looking into these programs as another category of best practices (Herzog, Bricka, Audette, & Rockwell, 2006). In this category, financial incentives generally show the highest rate of success (SDOT, 2008). Employers may offer a portion of the employee's paycheck pre-tax, pay for transit services for employees, unbundle the cost of parking so that employees realize the "true cost of parking," and/or charge carpoolers and vanpoolers less than SOVs for parking. Essentially the financial incentives are split into two ideas: 1) cause employees to realize how expensive parking is and 2) make non-SOV options more affordable relative to SOV. Employers may also provide facilities that promote non-SOV modes of transportation to work, such as bike showers or lockers, vanpool services, a guaranteed ride home, or preferred parking for carpoolers. In this way, employers attempt to put the ease and convenience of SOV and non-SOV travel on the same level. As peak commute times are an issue as well, some employers are offering flexible work hours in an attempt to spread out congestion on the road. This method does not necessarily remove personal cars from the road, it merely spreads the burden, which may be appropriate if the primary goal regards health concerns of smog. Of course at the root of all of these measures is increasing awareness to employees as to what alternative modes exist and what environmental effects are associated with SOV (MTS, Navy Region Southwest, & SANDAG, 2010; ODOE, 2015; SDOT, 2008; SFCTA, 2015).

Locally, 35% of Santa Barbara County employers offered incentives for alternative transportation usage as of 2007 (SBCAG, 2007). One of these programs, broadly referred to as Santa Barbara County TDM, is run by the county and rewards full-time government employees who commute by public transportation at least 80% of the time with an accrual of 0.62 hours of vacation per pay period (Dobberteen & Turnbull, n.d.). In addition, the City promotes biking to work through a partnership with Bikestation (available in other cities in California as well as Washington, DC), which provides third-party bike storage in two parking lots downtown to

accommodate for employers that may not be able to provide these services. These stations also provide repair services as well as exclusive use of the showers and easy access to public transportation. Despite all of these efforts, South Coast employees still largely choose to drive alone as their primary mode of transportation (SBCAG, 2007). There is an array of effort towards mitigating this problem in the South Coast, and identifying the missing behavioral links is crucial for any future planning or policy recommendations.

There is not a clear reason why some of these tactics work some of the time and not others, highlighting the importance in distinguishing which goals – reduce air pollution, diminish GHG emissions, protect human health, decrease traffic congestion, or a combination – an area desires to reach before the best strategy can be determined. As the City and County of Santa Barbara respond to a statewide push to decrease per capita VMT, it will be important to understand current commute choices in the South Coast to determine what action could have the strongest impact.

5. METHODOLOGY

A survey was distributed to South Coast residents in order to gather information on commute behaviors in the region and better understand which efforts may be most effective in reducing local VMT and associated GHG emissions.

5.1 Survey Design

The survey was split into four sections: 1) present commute behavior 2) perceptions of alternative transportation and currently offered employer incentives, 3) previous commute behavior (pre-move to the South Coast), and 4) a choice experiment examining effects of employer incentives on encouraging a mode shift among employees. The first three sections involved all respondents, while the last section only involved respondents who answered "Car - Individual" for their current primary commute mode choice (Appendix B).

  5.1.1 Introductory commute questions. This portion referred specifically to the first objective, establishing a baseline of commute characteristics in the South Coast, and captured the respondents' work zip code, commute days per week, commute distance, primary mode choice, type of car driven for commute if applicable, number of individuals in a carpool if applicable (excluding children), and bus route if applicable. The same questions were repeated for a respondent's previous commute for the last place he/she lived.

  5.1.2 Commute details and employer incentives. The second portion explored respondents' perceptions of availability and ease of use for all mode options as well as currently offered employer incentives at respondents' workplaces in order to examine why a person chooses to drive alone to work. We captured walking distance to bus stop on each end of the commute, perceived predictability of bus arrival at stop, perceived cleanliness of the bus, number of transfers needed on bus commute, whether employees live near coworkers, and perceived bike-riding ability. We further captured what incentives their employers may offer and

if employees are aware of these offers, specifically asking if employers offer the following incentives: a free or reduced-price bus pass, a shower, bicycle storage, preferred parking for carpoolers, a recognition program for alternative transportation users (and if so, for which modes of transportation), and a guaranteed ride home if necessary for employees using alternative transportation.

5.1.3 Discrete choice experiment on mode choice with various fees and randomized employer incentives. To tease out what combination of parking fees and randomized incentives could be the most effective at reducing the number of SOVs on the road, our survey also included a discrete choice experiment. Respondents who chose "Car - Individual" as their current primary mode choice were sent to the third section of the survey. In the experiment, respondents were presented with two options: drive alone or use an alternate mode (bus, bicycle, carpool) with a randomized incentive (Table 1). Each respondent was asked the questions three times for each mode, where the first question had no parking fee attached, the second question had a $10 daily parking fee, and the last question had a $15 daily parking fee; the incentive was randomized for each question, so respondents were not necessarily shown the same incentive at each level of parking fee. Parking fees are based off of the cost to park all day in downtown Santa Barbara and the cost of a lost ticket (thereby representing the theoretical maximum price of parking), respectively.

5.2 Survey Sample Selection and Distribution

As we were interested in the commute choices of the South Coast, we downloaded Santa Barbara County addresses from the county's tax assessment parcels (Clerk-Recorder-Assessor Map Division, 2008). Only addresses within the cities of Goleta, Santa Barbara, and Carpinteria were included. We were specifically interested in examining commute differences among residents of detached single family homes and apartments, as these represent the two extremes of housing unit density and are the most common types of housing in both Goleta and Santa Barbara (Coastal Housing Coalition & California Economic Forecast, 2012). As such, we only selected addresses that were designated as either one of the above two housing types or a mobile home, which we included as part of our single family home sample. Apartment addresses did not include unit numbers, resulting in one entry per apartment building despite there being multiple units at that location. To compensate, we looked up the number of units for a random sample of 60 addresses from Santa Barbara, Goleta, and Carpinteria on USPS's address lookup website. From this search, we determined the median number of units in apartment buildings in each city, and manually replicated each apartment address to reflect this median number. Santa Barbara apartments had a median of 8 units, and Goleta and Carpinteria apartments had a median of 10 units.

We oversampled apartments with 5 or more units in the City of Santa Barbara compared to other residences in order to increase the number of responses from residents in apartments in the AUD zone (Table 2).

Table 1. Incentive choices offered for each alternative mode of transportation. For each mode one random choice was displayed against drive alone, drive alone and pay $10 for parking, and drive alone and pay $15 for parking.

Bicycle	Bus	Carpool
Have a shower at workplace	Have an employer-guaranteed ride	Have an employer-guaranteed ride home
Have safe bicycle storage at workplace	Have a free, reduced price, or pre-tax bus pass offered by employer	Have a preferred parking space at work
Have a storage locker at workplace	Have a shuttle from major bus stops offered by employer	Have a tool that shows which coworkers live nearby
Have employer-organized bike conveys to work	Receive monthly compensation for unused parking spot	Have my employer offer a flexible work schedule
Have city-organized morning, pre-work bike events	Have my employer offer a portion of paycheck pre-tax	Receive monthly compensation for unused parking space
Have complete, safe bike paths for commute	Have my employer offer a flexible work schedule	Have my employer offer a portion of paycheck pre-tax
Have my employer offer a portion of paycheck pre-tax		Have a reduced-price carpool parking permit
Receive monthly compensation for unused parking space		

Table 2. Probability of address being chosen based on city and housing type. Note Goleta apartment addresses omit Isla Vista as college students are not the intended demographic. Montecito and Summerland addresses were also omitted due to primarily outlying income brackets. While the calculated probability does account for median units and thus is a unit-level sampling, the probabilities are not directly comparable. The total number of apartments are an approximation while total single family homes and mobile homes are exact counts.

City	Housing Type	Total	Sampled	Probability
All	Single Family	37,114	1,000	0.027
Santa Barbara	Apartments	4,816	1,000	0.21
Goleta & Carpinteria	Apartments	1,530	500	0.33

Once addresses were chosen, each apartment listing was found via USPS's website for assigning the proper unit structure to determine if the apartment units are designated with numbers or letters. A random number or letter generator then chose the actual unit to receive the survey. Those not found were assumed to be numbers. Those chosen received a mailed letter detailing the project and a link to the survey hosted on Qualtrics. This letter also provided a unique code for each respondent used to gather information on their parcel ID, housing type, and zip code from the downloaded address data. A follow-up postcard requesting participation from non-respondents was sent approximately one month after the initial distribution.

5.2.4. Weighting for unit nonresponse bias. We received 121 complete survey responses, representing a 4.8% response rate (Appendix C). We ran a chi squared test of association examining whether gender proportions broken down by age groupings were significantly associated between the weighted survey sample and actual population. We received significant results, leading us to implement a poststratification method. We collected demographic data from 2010 Census Bureau data for Santa Barbara, Goleta, and Carpinteria and calculated the percent of each gender in each age bracket. These proportions were also calculated for the survey population (Appendix XXXX). The applied weight was then calculated:

$$Sample\ Weight\ = \frac{\%Breakdown\ of\ Population}{\%\ Breakdown\ of\ Sample}.$$

This weighting was applied in all regressions (Table 3). The age group 26 – 35 is over-representative of the population and tends to be in apartments in Santa Barbara, so down weighting this group both aides gender and age strata to resemble the population as well as accounts for the oversampling of apartments in Santa Barbara.

Table 3. Post stratification weights based on age and gender of population and sample. Values represent result from dividing population percentages by sample percentages.

Age Bracket	18-25	26-35	36-45	46-55	56+
Men	5.10	1.30	2.77	1.69	2.45
Women	1.81	0.829	2.20	16.8	2.21

5.3 Greenhouse Gas Emissions Calculations

GHG emissions were used as a metric to compare the environmental impact of respondents' commutes. Per capita direct (tailpipe) one-way commute emissions were calculated for each respondent's primary mode of transportation:

$$Per\ Capita\ Emissions\ = \frac{Transportation\ Mode\ Tailpipe\ Emissions}{\#\ of\ Commuters\ Per\ Mode},$$ reported in kg CO_2/person/trip.

5.3.1 Tailpipe emissions. Respondents who primarily commute via SOV or carpool provided the make, model, and year of the car driven. We collected GHG tailpipe emissions levels for individual respondents' cars from the EPA's 1984-Present Fuel Economy database. Within each model year, there are multiple subsets of these models (including options for upgraded engines, 2WD vs 4WD, etc.), leading to different emissions levels. We assumed the minimum level of emissions provided for each car in order to provide a conservative estimate of overall commute-related emissions in the South Coast. Electric cars were assigned an emissions level of zero, as they emit no tailpipe GHGs while being driven. Additionally, some respondents had provided car models that do not actually exist or were not produced in the given year (for example, 2008 Dodge Journey), so we made best guesses of the intended model based on internet searches of existing car models.

Bus tailpipe emissions were calculated using an average fuel economy of 3.26 mpg, based on data provided the US Department of Energy's Office of Energy Efficiency and Renewable Energy, and the EPA's emission factor for motor gasoline of 8.78 kg CO_2/gallon (Federal Highway Administration, 2015). Motorized scooters were assigned a fuel economy of 80 mpg, based on Consumer Report's reported fuel economy range of 60 - 100 mpg. This value was converted to tailpipe emissions using the same EPA emissions factor as used for buses.

Respondents who selected walking, bicycling, or work from home received GHG emissions of zero, as their primary mode does not emit any direct GHGs.

Average Amtrak train emissions, provided in lbs CO_2/passenger-mile, was collected from a 2008 Union of Concerned Scientists report on green travel. For a complete list of respondents' vehicle emissions, see Appendix D.

5.3.2 Commuters per mode. Respondents who carpooled provided the number of commuters per trip.

MTD's Fiscal Year 2014-2015 bus ridership (passengers per revenue hour) was collected from MTD's 2015 Ridership Report. We assumed that each bus route takes approximately one hour to complete and thus that this value accurately represents the average number of commuters per one-way bus trip.

All other modes of transportation have one person per commute trip; train emissions are already given per passenger-mile so did not need to be converted to per capita emissions.

5.4 Establish a Baseline for the AUD Zone and Current South Coast Apartments.

While the AUD program is primarily focused on density of housing, it is also concerned with the location of that housing. We therefore used two comparison groups for examining commute mileage, mode share, and GHG emissions in order to establish a baseline against which to measure future conditions of commute behavior in the South Coast. The first looked at apartment-dwelling residents in the AUD zone versus all housing types in a one-mile buffer around the AUD zone in order to create a clean comparison for the AUD zone. We aimed to

establish if there are inherent characteristics regarding apartments in this zone already supporting lower VMT and GHG emissions with a mode share in favor of alternative transportation. The second comparison group looked at apartments and single family homes within Goleta, Santa Barbara, and Carpinteria to explore the impacts of high-density housing, a characteristic emphasized by the AUD program. With this group, we examined if residing in an apartment rather than a single family home leads residents to produce lower VMT and GHG emissions with a mode share in favor of alternative transportation.

To contextualize each comparison group, we performed several regressions. The first binary logistic regression used housing type as the outcome variable with age, income, and gender as predictor variables. The second binary logistic regression used whether a respondent lives in the AUD zone or the buffer zone as the indicator variable and the respondent's age, income, and gender as the predictor variables. Commute distance and GHG emissions were used as individual outcome variables in two separate linear regressions, again with age, income, and gender as predictor variables. While we are still interested in comparing mileage, GHG emissions, and mode in these specific comparison groups, it was important to also understand what, if any, demographic factors predict the likelihood of falling into one category over the other.

Commute distance was captured in the survey, and GHG emissions were calculated through the methods described in Section 5.3. In all comparison groups only active commuters (a total of 113 respondents) were considered as they are the employees who must actively make a decision on which transportation mode to choose. Respondents with a commute distance of zero were therefore removed (this includes a combination of respondents who work from home, those who are retired, and a few who listed a mode but recorded their commute distance as zero). The same sample population is used for all three metrics within each comparison group.

5.4.1 High-density housing versus single family homes. Given that the AUD program supports high density housing, we chose to explore this aspect by subsetting our respondents into those living in high density apartments and those living in single family homes based on their information from the County Tax Assessor data. Once the two groups were established, we performed separate one-sided Mann-Whitney U tests to analyze if the mileage and commute per capita emissions in apartments were lower than those of residents in single family homes.

Mode share was used as a means to explore if certain groups already favor alternative transportation that work to lower their GHG emissions as compared to their counterparts. Each transportation choice was split into binary categories (i.e. respondents who chose an SOV and respondents who did not) for each mode (car - individual, car - carpool, bicycling, busing, and walking), where success is defined as choosing a specified mode and failure defined as not choosing that mode. Using a test of hypothesized proportions based on the matrix of number of successes in apartments and single family homes with associated total numbers, we tested for a difference of proportions between apartments and single family residences. This test was also complemented with a chi-squared test for associations to determine if there is an association between housing type and primary mode choice (where each mode choice is expressed as count values).

5.4.2. The AUD zone versus a one-mile buffer. Using ESRI ArcGIS, we isolated responses from apartment residences currently inside the AUD zone and those from the residences (both apartment and single-family homes) within a one-mile buffer of this zone (**Figure 2**). A one-mile zone allows for a clean comparison isolating the effects of the AUD zone without confounding factors from geographical changes in the area. Once comparison groups were established we ran separate one-sided Mann-Whitney U analyses to test if commute mileage and commute per capita emissions were lower for residents inside the AUD zone versus residents within the one-mile buffer.

Similar to the methods in Section 5.4.1, primary mode choices were split into binary data for each mode. Proportions of modes between categories was analyzed by the same methods in Section 5.4.1.
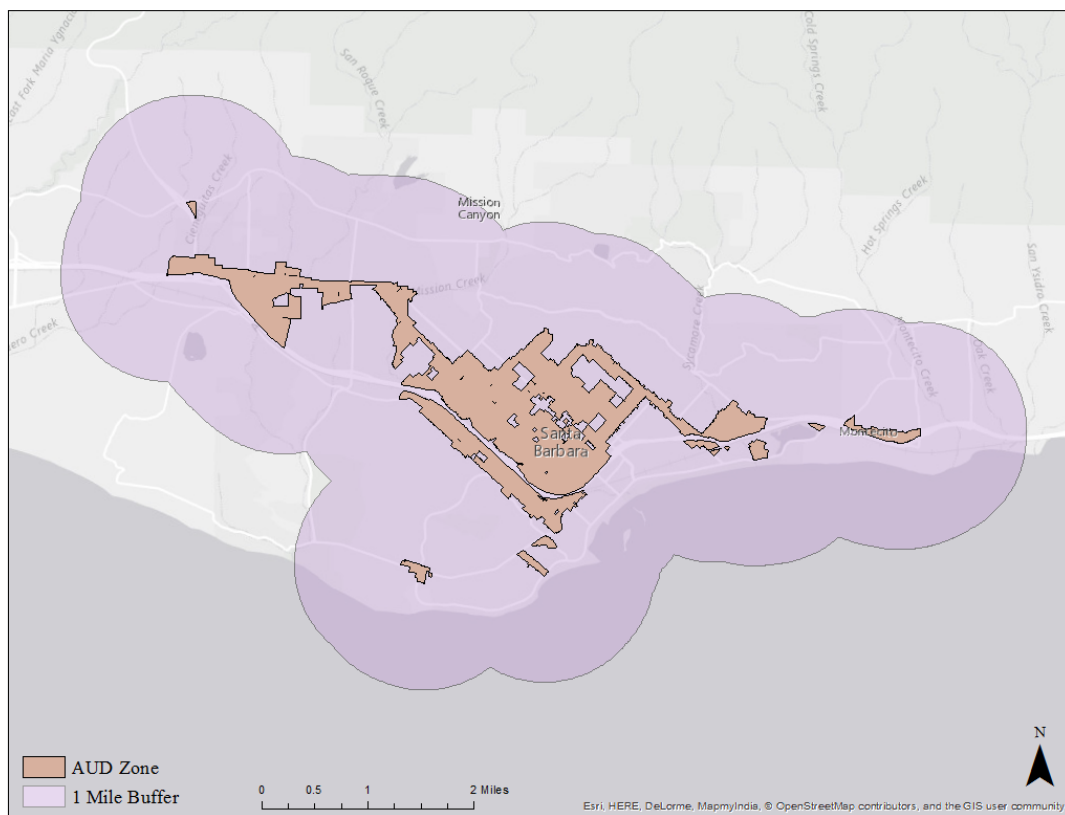
Figure 2. AUD zone (brown) and one-mile buffer selection (lilac) for survey respondents.

5.5 Characterizing Likelihood of Choosing an SOV as Primary Mode

As part of the effort to establish a baseline that could be used to measure projects implemented in the AUD pilot program, we explored the reasons why respondents chose to drive an SOV over other methods as a whole. Responses were split into a binary format for those who drive an SOV (yes) and those who chose any other mode (no). A binary logistic regression was performed using RStudio to determine significant predictors for a person's likelihood of choosing the specified mode of transportation. All data, except housing type, was collected from the

second portion of the survey (perceptions of alternatives and use of incentives by employers). Using the Multivariate Imputation by Chained Equations package in R, missing values were imputed via a default predictive modeling method using other user input for prediction. Each value went through five iterations with five simulations each. Data were then pooled for the regression.

More specifically, the regression tested the effects of the following variables on a person's likelihood of choosing to commute via an SOV:
- knowledge of the number of bus transfers required for the bus route to a respondent's work
- being offered any incentives from one's employer for commuting via alternative transportation
- perception of predictability of bus arrivals
- the number of days a respondent runs regular errands a respondent runs before or after work
- complete bike paths along a respondent's route to work
- if respondents live near co workers
- demographic factors (age, gender, income)
- type of residence

All incentive variables were grouped into one category, and certain perception variables were removed due to collinearity.

5.5.1 A deeper exploration into the effect of commute distance on mode choice. As the effects of the AUD program on residents' commute distances is of particular interest to local planners, additional tests were performed to assess the robustness of the regression model. A power analysis was performed to establish the minimum detectable effect (MDE) of the commute distance predictor variable. One thousand random t-distributions were generated based off the mean, standard error, and degrees of freedom in the model from Section 4.5. The MDE was chosen as the mean value required to reach an 80% success rate for t-distributions greater than zero.

We carried out two tests to further examine how (and if) a respondent's mode choice is associated with commute distance. We used a Kruskall-Wallis test to explore if median commute distance significantly varied by mode (cars - individual, cars - carpool, bicycling, busing, and walking). The category 'Other' was excluded as it primarily contained those who work from home.

As a main goal of the AUD program is to move residences closer to work and thereby hopefully encourage these residents to switch out of an SOV, we ran a binary logistic regression to test the effect of moving closer to work on the likelihood of switching mode choice from "Car - Individual" to any other mode. Respondents were categorized into two groups, those who moved closer to work and those who moved further or remained equidistant, based on their input mileage for current and previous daily commute. This is not specific to the AUD zone or residence type and is intended to isolate potential effects of moving closer to work anywhere

inside the South Coast. In doing so, we establish a baseline for the South Coast in general to later compare those who moved specifically into the AUD zone.

5.5.2 Further exploring perceptions of the bus system. Our survey asks respondents about their perceptions of the bus and these values are used in the regression in section 5.5. To determine if these perceptions are close to reality or if some sort of information campaign may be beneficial, we used Google Maps to calculate the walking time to the closest bus stop that a respondent could use to get to work. Since our survey did not ask for a resident's exact place of work, we strategically chose points within each zip code (Appendix E). These work destinations were placed in or near the center of a zip code and in commercial or industrial zones. While these locations may not reflect the exact workplace of every respondent, they should provide an accurate representation of bus commutes on a whole. Similarly, for those who currently drive a car to work we calculated how long their commute would be if they instead took a bus. For both metrics, we tested for correlation and fit a linear model to determine how a person's perception compares to reality as well as if there are respondents living in areas where the bus is not feasible to take as it would add a great deal of time to their commute.

5.6 Effect of Incentives and Price of Parking on Mode Choice

Individuals that chose "Car – Individual" as their current primary mode of transportation were additionally asked to complete a discrete choice experiment, described in Section 5.1.3.

To test the effect of the employer and city-wide incentives chosen as well as the effect of the parking fee, we generated a binary logistic regression model in RStudio. The respondents' choice was the outcome variable, and the parking fees and incentive were the independent variables. Interactions between parking fee and incentive were tested for each regression. Due to the fact these respondents already made an active choice between an SOV and an alternative mode without a fee or incentive, there is no true control incentive. As such, the reference level was set at the least effective incentive. A variable's effectiveness is thus interpreted with regards to this baseline incentive. Standard errors are clustered by respondent to avoid over emphasizing the effect of one single respondent's preferences.

6. RESULTS

6.1 Commute Behavior by Housing Type

Commute behavior differs between apartment residents and single family home residents in both their commute mileage and mode share and subsequently their associated GHG emissions. Apartment residents commute a median of 8 miles to work, while single family home residents commute a median of 12 miles, and both show substantial positive skewness, corroborated by a Shapiro-Wilk test (Apartments: $Z = 3.81$, $p < 0.001$; Single Family Homes: $Z = 6.13$, $p < 0.001$; Figure 3). Commute distances are significantly different among the two housing groups ($Z = -1.98$, $p = 0.024$).

Although SOVs are the most popular mode choice for both apartment and single family home residents (48% and 68%, respectively), there is a significant difference in the overall mode share for the two resident groups ($\chi^2 = 11.55$, $p = 0.041$; Figure 4). A further exploration into the differences between specific modes reveals that there is a significant difference between apartment and single family home residents commuting via SOV ($p = 0.038$) and walking ($p = 0.033$). There is no significant difference among the proportions of commuters using the bus ($p = 0.218$), a bicycle ($p = 0.822$), or carpool ($p = 0.289$).
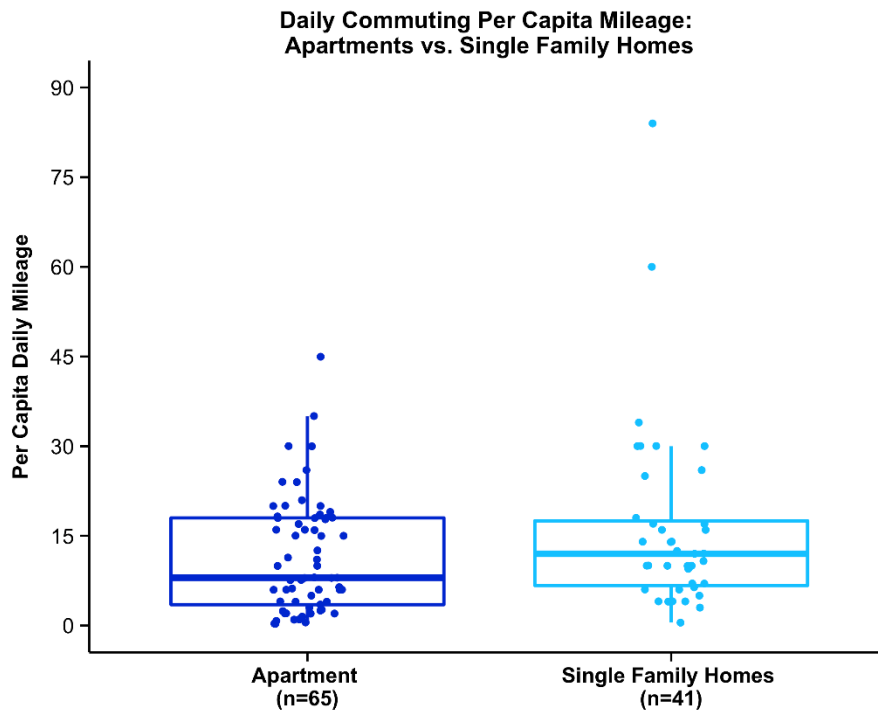
Figure 3. Daily Commuter Mileage by Housing Type. Daily per capita commute mileage for residents of apartments (n = 65) and single family homes (n = 41). Each point represents an individual survey response. Note that figure excludes an outlier of a single family home resident's 190 mile commute.

Transportation Mode Choice by Housing Type

Legend: SOV, Carpool, Bus, Bicycle, Walk, Other
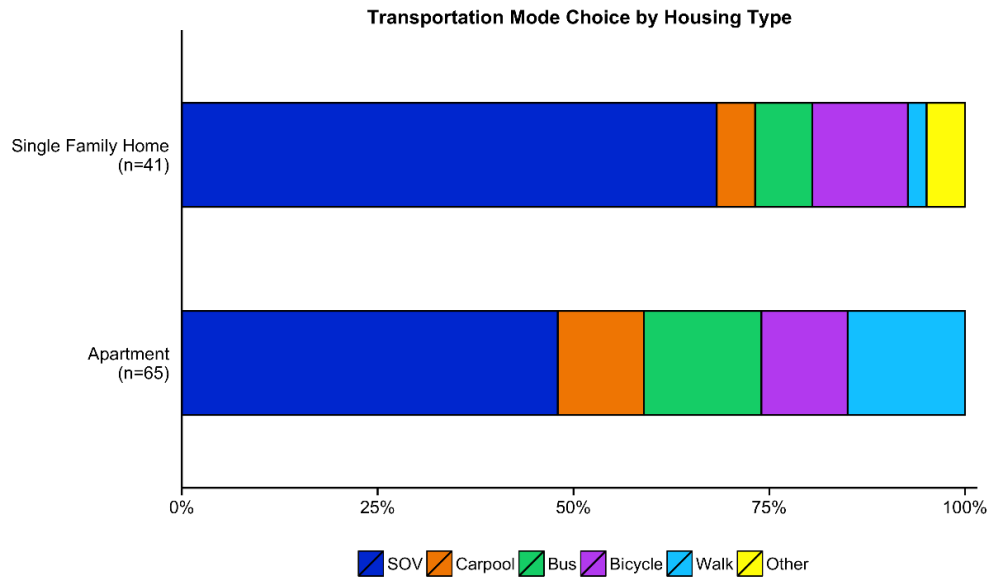
Figure 4. Differences in Commuters' Mode Share by Housing Type. A test of proportions for commuters indicates that single occupancy vehicles (individuals in cars) and walking are significantly different ($p = 0.038$ and $p = 0.033$, respectively) for respondents in apartments (n = 65) and single family homes (n = 41).

Daily Commuting Per Capita GHG Emissions: Apartments vs. Single Family Homes
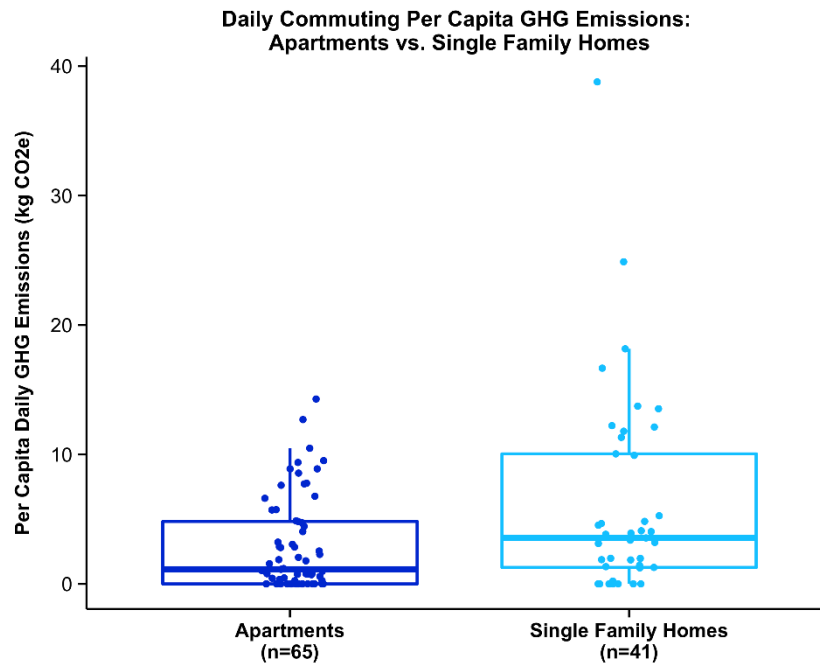
Figure 5. Daily Commuter GHG Emissions by Housing Type. Daily per capita commute emissions for residents of apartments (n = 65) and single family homes (n = 41). Each point represents an individual survey response.

Per capita commute GHG emissions are similarly positively skewed and range from 0 kg CO_2e for both housing groups to 14.3 kg CO_2e for apartments and 38.8 kg CO_2e for single family homes, with median values at 1.12 kg CO_2e and 3.55 kg CO_2e, respectively. Distributions are significantly different between housing groups (Z = -2.29, p = 0.024; Figure 5).

We contextualized demographic differences in the housing types through a binary logistic regression, which showed that both the oldest age demographic (56+ years) and highest income bracket ($100,000+) are significantly less likely to live in apartments than in single family homes (p < 0.001 for both variables; Table 4). However, age and income do not significantly affect a resident's commute distance or GHG emissions (Table 5 and Table 6, respectively). Groups were further split into six discrete strata: below median income, above median income, below median age, above median age, below median age income, and above median age and income in order to isolate what demographic and housing type patterns predict an individual's commute distance (Appendix F) and GHG emissions (Appendix G). Living in an apartment does significantly predict commute distance and GHG emissions for those below the median age and income level (p < 0.05 for all).

Table 4. Binary logistic regression examining the effects of demographic factors (age, gender, and income) on housing type (apartments versus single family homes). Positive coefficients indicate an increased probability of living in an apartment, whereas negative coefficients indicate a decreased likelihood.

log(Probability of Living in an Apartment)				
Factor	**Coefficient**	**SE**	**p**	**Odds Ratio**
Intercept	3.848	1.325	0.005	46.919
Gender[1]	-0.262	0.642	0.684	0.770
Age (18-25)[2]	-0.754	1.253	0.549	0.471
Age (36-45)[2]	-2.754	1.304	0.037	0.064
Age (46-55)[2]	-2.391	1.356	0.081	0.092
Age (56+)[2]	-4.027	1.254	0.002	0.018
Income ($60,000-$99,000)[3]	-1.061	0.694	0.130	0.346
Income ($100,000+)[3]	-2.599	0.811	0.002	0.074

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference age group = 26 - 35
[3]Reference income group = <$60,000

Table 5. Demographic Characteristics and Commute Distance. Linear logistic regression results examining the effect of age, gender and income on commute distance (R^2 = 0.068). Coefficient indicates a one mile change in commute distance.

Commute Distance			
Factor	**Coefficient**	*SE*	*p*
Intercept	17.627	9.012	0.053
Gender[1]	3.697	4.460	0.409
Age (18-25)[2]	4.940	6.563	0.453
Age (36-45)[2]	7.852	9.123	0.392
Age (46-55)[2]	11.980	9.281	0.200
Age (56+)[2]	0.373	8.295	0.964
Income ($60,000-$99,000)[3]	-4.389	5.118	0.393
Income ($100,000+)[3]	-0.735	6.672	0.912

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference age group = 26 - 35
[3]Reference income group = <$60,000

Table 6. Demographic Characteristics and GHG Emissions. Linear regression results examining the effect of age, gender, and income on GHG emissions (R^2 = 0.129). Coefficient indicates a one unit increase in GHG emissions (measured in kg CO_2e).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*
Intercept	1.681	1.788	0.350
Gender[1]	2.172	0.875	0.015
Age (18-25)[2]	2.360	1.366	0.088
Age (36-45)[2]	2.886	1.849	0.122
Age (46-55)[2]	1.974	1.847	0.288
Age (56+)[2]	2.802	1.602	0.084
Income ($60,000-$99,000)[3]	-2.537	1.313	0.057
Income ($100,000+)[3]	-0.490	1.023	0.633

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference age group = 26 - 35
[3]Reference income group = <$60,000

6.2 Commute Behavior in the AUD Zone Versus a One-Mile Buffer

Commute mileage for respondents in both the AUD zone (n = 37) and surrounding one-mile buffer (n = 21) are positively skewed, and a Shapiro-Wilk test confirms their non-normality (AUD: Z = 2.37, p = 0.009; Buffer: Z = 5.2, p < 0.001; Figure 6). Despite the significant skew, both zones have a similar median commute distance among respondents (AUD median = 15 miles, Buffer median = 12.6 miles), and a one-sided Mann-Whitney U test revealed that there was no significant difference between the commute mileage for the two respondent groups (Z = -0.74, p = 0.23).

SOVs are the most popular commute mode of transportation among both AUD zone and buffer zone residents, at a 54% mode share for AUD residents and 57% for buffer zone residents (Figure 7). There is no significant difference among the overall mode share between the two groups (χ^2 = 5.67, p = 0.309).
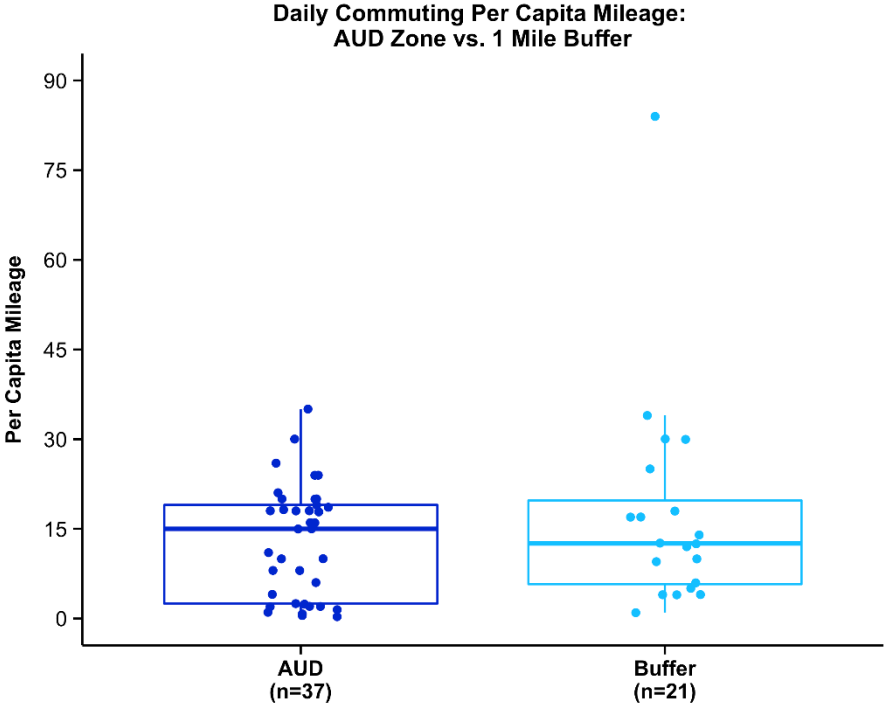
Figure 6. Differences in Commuter Mileage by Housing Zone. Commute mileage for respondents in both the AUD zone and a one-mile buffer. Each point represents an individual survey response. Note that one outlying point at 190 miles for a buffer zone respondent is not shown.

Transportation Mode Choice - AUD Zone vs. 1-Mile Buffer

Legend: SOV | Carpool | Bus | Bicycle | Walk | Other
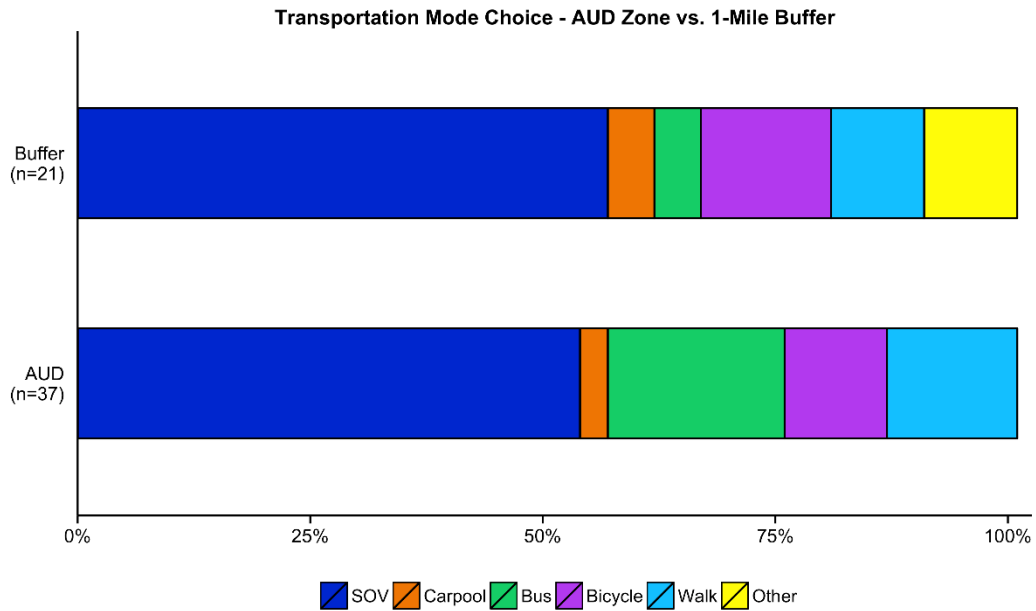
Figure 7. Differences in Commuters' Mode Choice by Housing Zone. Primary commute mode choice for both AUD zone and buffer zone respondents. "Other" includes respondents who commute by train or motorized scooter.

Daily Commuting Per Capita GHG Emissions: AUD Zone vs. 1 Mile Buffer
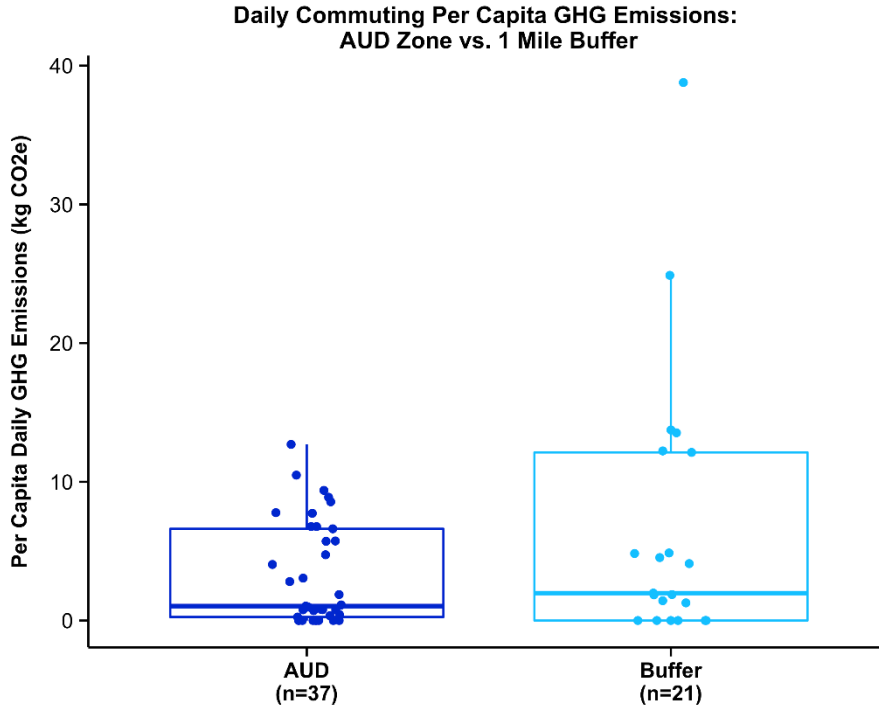
Figure 8. Differences in Commuter GHG Emissions by Housing Zone. Commuter GHG emissions for respondents in the AUD zone and a one-mile buffer. Each point represents an individual survey response.

Given the skewness of the mileage data, related GHG emissions were similarly positively skewed (Shapiro-Wilk test for AUD zone: $Z = 4.19$, $p < 0.001$; for buffer zone: $Z = 4.43$, $p < 0.001$; Figure 8). As expected due to insignificant findings for both mileage and mode share among AUD and buffer zone residents, there exists no significant difference between the commute-related GHG emissions of the two resident groups (AUD median = 1.04 kg CO_2e, Buffer median = 1.98 kg CO_2e, $Z = -0.93$, $p = 0.18$).

Considering that the AUD zone subset only includes apartment residences, we see similar results in how demographic factors affect a respondent's decision to live in the AUD zone versus the surrounding buffer area (Table 7). The oldest age demographic is less likely to live in the AUD zone than its youngest counterpart (18-25) ($p = 0.001$), while respondents in the middle income bracket ($60K-$90K) are three times more likely than the highest income bracket to live in the zone ($p = 0.012$).

Table 7. Binary logistic regression examining the effects of demographic factors (age, gender, and income) on residence location (AUD zone versus a one-mile buffer). Positive coefficients indicate an increased probability of living in the AUD zone, whereas negative coefficients indicate a decreased likelihood.

log(Probability of Living in AUD Zone)				
Factor	Coefficient	SE	p	Odds Ratio
Intercept	-0.470	0.500	0.348	0.625
Gender[1]	0.739	0.423	0.081	2.09
Age (26-35)[2]	1.15	0.748	0.126	3.15
Age (36-45)[2]	-0.100	0.614	0.871	0.905
Age (46-55)[2]	0.315	0.634	0.619	1.37
Age (56+)[2]	-1.90	0.584	0.001	0.149
Income (Under $60,000)[3]	0.932	0.500	0.062	2.54
Income ($60,000-$99,000)[3]	1.39	0.554	0.012	4.03

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference age group = 18-25
[3]Reference income bracket = $100,000+

6.3 Factors Affecting Commute Mode Choice

A combination of logistic regressions examined the impact of demographics, commute characteristics, commute distance, and employer-offered incentives on promoting a shift from single occupancy vehicles to alternative modes of transportation (particularly carpooling, busing, and biking).

Just over 70% of respondents are currently offered some form of incentive for using alternative transportation (Figure 9). The most prevalent incentive was safe bicycle storage, with 50% of respondents indicating that their employer offers this perk, while a guaranteed ride home was the most uncommon incentive at 6%. Further, there was generally a high level of awareness regarding employer incentives; for all incentives, less than 26% of respondents reported "Don't Know" when asked if their employers offered the specific incentive.
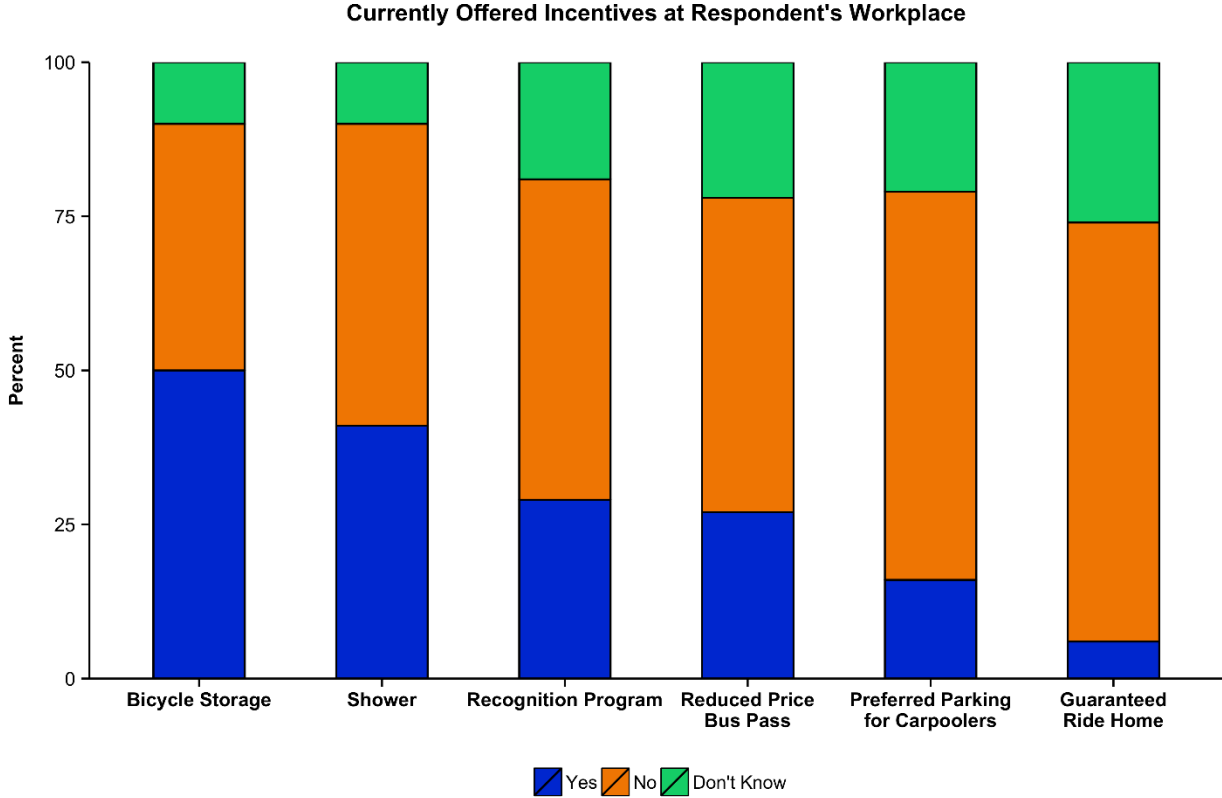
Figure 9. Currently Offered Employer Incentives at Respondents' Workplaces. Percentage of respondents indicating they receive (blue), do not receive (green), or do not know if they are offered (orange) specific employer incentives for utilizing alternative transportation.

A binary logistic regression (
Equation 1) indicates that the number of commute days per week (p = 0.001), a "not very" predictable bus (p = 0.049), an unknown number of bus transfers (p = 0.036), and being female (p = 0.006) significantly increase likelihood of choosing an SOV as the primary commute method (
Using the regression model to gather probabilities, a 26-35 year-old woman making $60,000 - $99,000, commuting 5 days at a distance of 12 miles, perceiving the bus as unpredictable and not knowing the amount of bus stops on the commute, completing 2 errands, receiving an incentive, and living in an apartment has a probability of 0.967 of choosing an SOV (Equation 1). Comparatively, a man with the same characteristics has a probability of 0.939.

A Kruskal-Wallis test was performed to compare whether median commute distance significantly varies by mode choices of cars-individual, cars-carpool, bicycle, bus and walking. Median distance differed significantly (X^2 = 30.718, df = 4, p < 0.001). Post-hoc tests revealed a significant difference between commute distance for respondents who walk compared to all other modes except bicycle (Figure 10).

Commute Distance by Transportation Mode Choice

Figure 10. Daily Commute Distance by Mode Choice. Variations in respondent's commute distance for each primary mode of transportation (SOV (blue), carpool (orange), bus (green), bicycle (purple), and walk (light blue)). *Note*: Like letters indicate results that are not significantly different.

Table 8). Notably, both commute distance (p = 0.287) and currently being offered an employer incentive (p = 0.397) are not significant predictors for primary commute method.
Equation 1:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 * Commute\ Days + \beta_2 * Commute\ Distance + \beta_3 * Predictability(DK)$$

$$+ \beta_4 * Predictability(Not\ Very) + \beta_5 * Predictabiity(Very) + \beta_6 * Transfers(1-2)$$

$$+ \beta_7 * Transfers(DK) + \beta_8 * Bike\ Path(DK) + \beta_8 * Bike\ Paths(Yes)$$

$$+ \beta_9 * Errands + \beta_{10} * Gender + \beta_{11} * Age(26-35) + \beta_{12} * Age(36-45)$$

$$+ \beta_{13} * Age(46-55) + \beta_{14} * Age(55+) + \beta_{15} * Incentive$$

$$+ \beta_{16} * Income(\$60-99) + \beta_{17} * Income(\$100+) + \beta_{18} * Housing\ Type$$

Using the regression model to gather probabilities, a 26-35 year-old woman making $60,000 - $99,000, commuting 5 days at a distance of 12 miles, perceiving the bus as unpredictable and not knowing the amount of bus stops on the commute, completing 2 errands, receiving an

incentive, and living in an apartment has a probability of 0.967 of choosing an SOV (Equation 1). Comparatively, a man with the same characteristics has a probability of 0.939.

A Kruskal-Wallis test was performed to compare whether median commute distance significantly varies by mode choices of cars-individual, cars-carpool, bicycle, bus and walking. Median distance differed significantly ($X^2 = 30.718$, df = 4, $p < 0.001$). Post-hoc tests revealed a significant difference between commute distance for respondents who walk compared to all other modes except bicycle (Figure 10).

Figure 10. Daily Commute Distance by Mode Choice. Variations in respondent's commute distance for each primary mode of transportation (SOV (blue), carpool (orange), bus (green), bicycle (purple), and walk (light blue)). *Note*: Like letters indicate results that are not significantly different.

Table 8. Commute days, commute distance, predictability of the bus, number of bus transfers on commute route, presence of continuous bike paths, number of errands run before or after work, gender, age, income, whether employers offer an incentive for alternative transportation users, and housing type were used in a binary logistic regression predicting respondents primary mode choice (SOV or non-SOV). Positive coefficients indicate respondents are more likely to drive an SOV.

log(Probability of Commuting via SOV)				
Factor	**Coefficient**	*SE*	*p*	**Odds Ratio**
Intercept	-4.36	1.63	0.009	0.0130
Commute Days	0.810	0.234	0.001	2.25
Commute Distance	0.0120	0.011	0.287	1.012

Predictability (Don't Know)[1]	-0.282	0.776	0.718	0.754
Predictability (Not Very)[1]	2.44	1.22	0.049	11.4
Predictability (Very)[1]	0.006	0.677	0.992	1.01
Transfers (1-2)[2]	0.046	0.682	0.947	1.05
Transfers (Don't Know)[2]	1.439	0.676	0.036	4.22
Bike Paths (Don't Know)[3]	1.071	1.03	0.304	2.92
Bike Paths (Yes)[3]	-1.03	0.699	0.145	0.358
Errands	0.292	0.205	0.162	1.34
Gender[4]	1.62	0.571	0.006	5.04
Age (26-35)[5]	-0.428	0.805	0.597	0.652
Age (36-45)[5]	-0.093	1.12	0.934	0.912
Age (46-55)[5]	-0.368	1.19	0.757	0.692
Age (56+)[5]	-0.502	1.09	0.646	0.605
Incentive (Yes)	-0.521	0.612	0.397	0.594
Income ($60,000- $99,000)[6]	0.518	0.635	0.417	1.68
Income ($100,000+)[6]	-0.241	0.821	0.770	-1.87
Housing Type (Apartment)[7]	-1.033	0.721	0.155	0.356

[1]Reference predictability = Somewhat predictable; [2]Reference transfers = 0 transfers;
[3]Reference bike paths = No complete bike paths; [4]Gender codes: 0 = Man, 1 = Woman;
[5]Reference age group = 18-25; [6]Reference income bracket = <$60,000;
[7]Housing codes: 0 = Single Family Home, 1 = Apartment

Further exploring the commute distance variable, a binary logistic regression (Equation 2) indicates moving closer to work does not significantly affect likelihood of switching from an SOV to alternative transportation as the primary commute method (p = 0.510; Table 9).

Equation 2:

$$\ln\left(\frac{p}{1-p}\right) = -0.54 + 0.15 * Distance$$

Table 9. Binary logistic regression results for mode choice (SOV or non-SOV) with moving closer or further to work as the predictor variable. A positive coefficient indicates respondent is more likely to switch to an alternative mode of transportation.

log(Probability of Commuting via Alternative Transportation

Factor	Coefficient	SE	p	Odds Ratio
Intercept	-0.537	0.171	0.002	0.585
Distance (Closer)	0.148	0.224	0.510	1.160

Using the methods described in Section 5.5.1, a power analysis indicates the minimal detectable effect for commute distance is 0.810. Since the commute distance coefficient is 0.012, the conclusion that commute distance does not have an effect on transportation mode choice is uncertain; it may be a reflection of a low response rate.

6.4. Further Analysis of Bus System

Our analysis examining a respondent's actual walk time to the nearest bus stop for the route that would take him or her to work compared to the respondent's perception of this walk time indicate that respondents are generally poorly informed about how close the nearest bus stop is (Figure 11; Figure 12). This is particularly noticeable among respondents who think the bus stop is a greater than 15 minute walk, as these respondents tended to overestimate their walk by 10 – 20 minutes. Respondents with a less than 10 minute walk were relatively accurate (±5 min) in their predictions of walk time.

Traveling from a respondent's home to a specified central point in his or her workplace zip code (Appendix E) via a Santa Barbara Metropolitan Transit District bus takes three times as long as that same trip in a car (Figure 13). The bus trip adds a median of 20 minutes to the travel time of the car trip, and nearly one-third of respondents would see an additional 30+ minutes added to their trip time.

Perceived vs. Actual Time for Walk to Bus Stop (min)
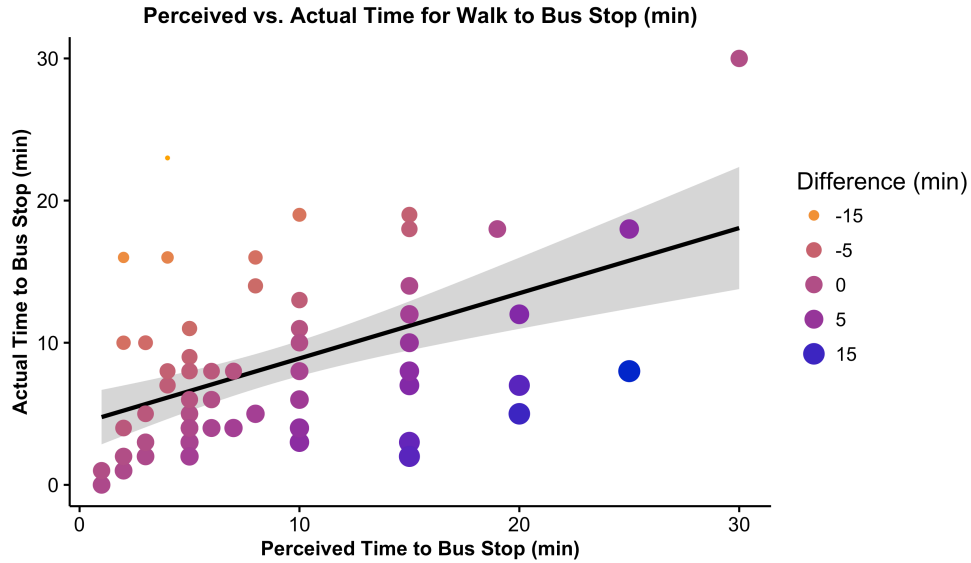
Figure 11. Perceived vs. Actual Time for Walk to Bus Stop (min). The difference in time (min) between a respondent's perception of how far the nearest bus stop (for the route that would be taken to work) is from his or her home in comparison to the actual walking time (n = 71). Only respondents who do not commute via bus are shown. Larger, purple to blue circles represent higher inaccuracy between a resident's perception and the actual walking distance, while smaller, orange to light pink circles represent an underestimate of the distance. The black line represents the actual walk time compared to a respondent's perception based on the linear regression model y = 4.31 + 0.459x (R^2 = 0.235, p < 0.001), and the light grey shading represents 95% confidence.

Walk Time to Bus Stop for Respondents Unaware of Walk Time (min)

Figure 12. Actual Walk Time to Bus Stop for Respondent's Unaware of Walk Time. The walking time (min) to the nearest bus stop (for a route that would be taken to work) for respondents who indicated that they did not know how far the nearest bus stop was to their homes (n = 14).
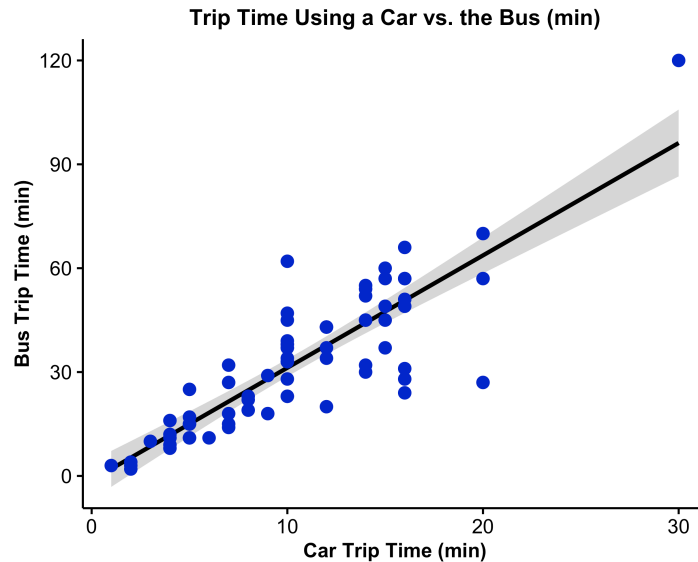
Figure 13. Trip Time Using a Car vs. the Bus (min). A respondent's calculated commute time (min) to a given central point in their workplace zip code using the bus versus a car (n = 71). Black line represents predicted bus time given car time using the linear regression y = -1.21 + 3.26x (R^2 = 0.723, *p* < 0.001), and grey shading represents 95% confidence.

6.5 Influence of Employer Incentives and Parking Fees on Mode Choice

A binary logistic regression for each alternative mode (bicycling, busing, and carpooling) examined the impact of parking fees, incentives, and an interaction between parking fees and incentives on promoting a shift from single occupancy vehicles to the specified alternative mode of transportation. For each regression, the reference incentive is that which was the least effective in encouraging a shift to an alternative mode of transportation.

6.5.1 Effects of incentives and fees on increasing usage of all alternate modes of transportation. Some residents are more likely to switch from an SOV to a bicycle, bus or carpool with an incentive, with nearly 30% willing to switch to carpooling and nearly 20% willing to switch to busing (Figure 14). An incentive coupled with a $10 parking fee or an incentive coupled with a $15 parking fee further increases willingness to switch mode choice away from an SOV. With a $10 fee and incentive, nearly 60% indicate a willingness to switch to carpooling, and over 40% are willing to switch to a bicycle or bus (Figure 14). With a $15 fee, willingness to switch to using a bicycle or bus increase to nearly 50%.

**Percent Respondents Choosing
Alternative Transportation + Incentive**
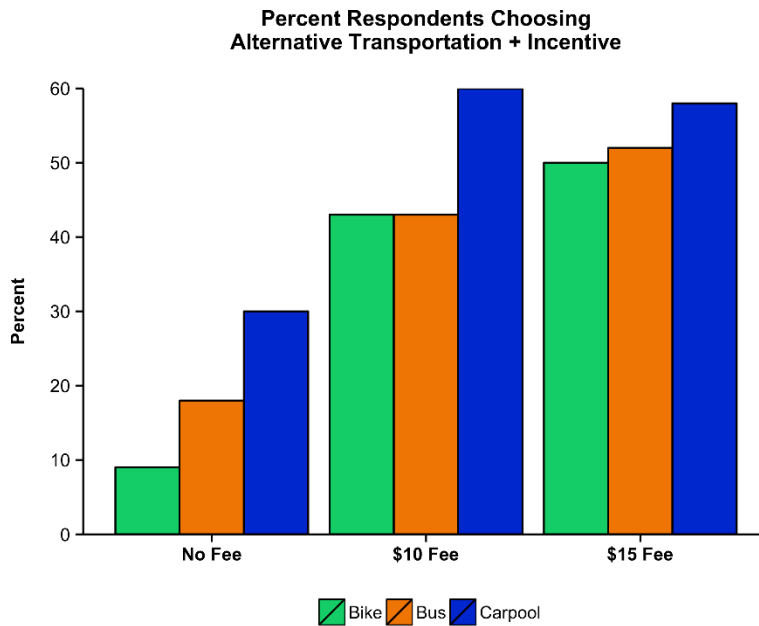
Figure 14. Percent Respondents Choosing Alternative Transportation + Incentive. The percentage of respondents who chose (in the discrete choice experiment) to commute via alternative transportation when offered a random incentive for doing so. Percent responses are shown for three different parking fee levels ($0 daily, $10 daily, and $15 daily), and three modes of alternative transportation (bicycling (green), busing (orange), and carpooling (blue)).

6.5.2 Effects of incentives and fees on increasing bicycling. A binary logistic regression examining the effects of a $10 or $15 parking fee and one of eight bicycling incentives indicates that both parking fees are significant ($p < 0.001$). For the incentives, none came out as significant relative to the baseline incentive of city-organized pre-work bike events (Table 10). An employee only offered monthly compensation (the most effective incentive although not significant) with a $10 daily parking fee has a predicted probability of 0.66 of choosing a bicycle over an SOV. Increasing the fee to $15 decreases this probability to 0.50.

6.5.3 Effects of incentives and fees on increasing carpooling. A binary logistic regression examining the effects of a $10 or $15 parking fee and one of seven carpooling incentives indicates that both parking fees are significant ($p < 0.001$; Table 11). Additionally, receiving monthly compensation for an unused parking space ($p = 0.020$) significantly switched a respondent's commute mode choice from an SOV to carpooling relative to being offered a guaranteed ride home from work. Using the regression estimation, a person facing a $10 daily parking fee and receiving monthly compensation from their employer has a predicted probability of 0.34 of choosing an SOV. This drops to 0.26 once the parking fee increases to $15 per day.

6.5.4 Effects of incentives and fees on increasing busing. A binary logistic regression examining effects of a $10 or $15 parking fee indicates a parking fee is significant ($p < 0.001$) in reducing the amount of respondents that chose to drive an SOV, as is a flexible work schedule ($p = 0.045$) in regards to a guaranteed ride home from work (Table 12). A person that faces a $10 parking fee and is offered a flexible schedule then has a predicted probability of 0.53 of choosing an SOV, which drops down to 0.40 once the fee increases to $15.

Table 10. Results of a binary logistic regression for commute choice (SOV or bicycle) with a parking fee ($10 or $15) and eight employer incentives as predictor variables. Negative coefficients indicate respondent is less likely to choose an SOV. Fee is a continuous variable. For a detailed list of incentives offered, see Table 1.

log(Probability of Choosing SOV)				
Attribute	**Coefficient**	*SE*	*p*	**Odds Ratio**
Intercept	3.62	2.37	0.124	37.4
Fee	-0.130	0.0852	<0.001	0.878
Shower	-1.78	1.17	0.301	0.169
Bicycle Storage	-2.03	1.33	0.157	0.131
Locker	-0.99	0.65	0.387	0.373
Bike Convoys	-2.14	1.40	0.190	0.117
Complete Bike Paths	-1.50	0.98	0.224	0.223
Portion Paycheck Pre-tax	-1.59	1.04	0.264	0.203
Compensation	-1.66	1.09	0.171	0.189

Reference Incentive: City-organized pre-work bike events

Table 11. Results for a binary logistic regression where mode choice (SOV or carpool) is regressed against seven employer incentives. Negative coefficients refer to respondent being less likely to choose an SOV. Fee is a continuous variable. For a detailed list of incentives offered, see Table 1.

log(Probability of Choosing SOV)				
Attribute	**Coefficient**	*SE*	*p*	**Odds Ratio**
Intercept	1.78	1.16	0.010	5.91
Fee	-0.085	0.0557	<0.001	0.919
Guaranteed Ride Home	-0.896	0.587	0.194	0.408
Tool	-0.545	0.357	0.460	0.580
Flexible Schedule	-1.26	0.828	0.075	0.283
Compensation	-1.57	1.03	0.020	0.207
Portion Paycheck Pre-Tax	-1.20	0.789	0.107	0.300
Reduced-Price Parking	-1.21	0.790	0.185	0.300

Reference Incentive: Preferred parking space for carpoolers

Table 12. Binary logistic regression results for mode choice (SOV or bus) with parking fees ($10 or $15), six employer incentives, and an interaction between the parking fees and incentives as predictor variables. Negative coefficients indicate a respondent is less likely to choose an SOV. For a detailed list of incentives offered, see Table 1.

log(Probability of Choosing SOV)				
Attribute	**Coefficient**	*SE*	*p*	**Odds Ratio**
Intercept	2.35	1.54	0.006	10.4
Fee	-0.101	0.0665	0.003	0.904
Guaranteed Ride Home	-0.950	0.623	0.155	0.387
Reduced-Price Bus Pass	-0.660	0.432	0.403	0.517
Shuttle	-0.527	0.345	0.528	0.591
Portion Paycheck Pre-Tax	-0.801	0.525	0.190	0.449
Flexible Schedule	-1.22	0.799	0.045	0.295

Reference Incentive: Monthly compensation for unused parking spot

7. DISCUSSION

Exploring the question of why people choose a certain mode of transportation begs the question of whether people are simply making transportation choices or if they are making other decisions that subsequently force them into certain modes of transportation.

7.1 Commute Greenhouse Gas Emissions Are Correlated With Housing Type

The significant difference in commute-related greenhouse gas emissions for apartment versus single family home residents (Figure 5) may be due to several factors, including household composition and demographics, community factors, and the need for joint decisions among married couples.

Though residents of apartments are more likely to be younger and of lower income than their single family home counterparts, these demographic factors do not significantly affect a person's decision to commute via an SOV (
Using the regression model to gather probabilities, a 26-35 year-old woman making $60,000 - $99,000, commuting 5 days at a distance of 12 miles, perceiving the bus as unpredictable and not knowing the amount of bus stops on the commute, completing 2 errands, receiving an incentive, and living in an apartment has a probability of 0.967 of choosing an SOV (Equation 1). Comparatively, a man with the same characteristics has a probability of 0.939.

A Kruskal-Wallis test was performed to compare whether median commute distance significantly varies by mode choices of cars-individual, cars-carpool, bicycle, bus and walking. Median distance differed significantly (X^2 = 30.718, df = 4, p < 0.001). Post-hoc tests revealed a significant difference between commute distance for respondents who walk compared to all other modes except bicycle (Figure 10).

Figure 10. Daily Commute Distance by Mode Choice. Variations in respondent's commute distance for each primary mode of transportation (SOV (blue), carpool (orange), bus (green), bicycle (purple), and walk (light blue)). *Note*: Like letters indicate results that are not significantly different.

Table 8), and thus it seems unlikely that these factors are causing the observed difference. We speculate that this difference may instead be due to household size, a variable we did not capture in our survey. An analysis of the 2007 American Household Survey shows that married couples, particularly those with children, are much more likely to move into a detached single family home than one-person or single parent households: 73% of married couples with children moved into detached single family homes in 2007 versus 27.5% of one-person households (Emrath & Siniavskaia, 2009). Married couples with children may favor single family homes because of a desire for a larger living space and/or bundled community factors. Their primary decision may thus be housing type and neighborhood, which subsequently could limit their transportation options for commuting.

Community factors such as community design, layout, and local amenities likely contribute to observed differences in preferred commute mode and greenhouse gas emissions by housing type. Single family home communities often have circuitous residential streets and are peripheral to major streets, while apartment complexes are more compact and are usually located on or near main thoroughfares and commercial zones. As bus stops are usually located near major streets, single family residents are more likely to have longer walking distances to

the nearest bus than do apartment residents. These long walks to bus stops create yet one more barrier to people's use of public transportation. Additionally, single family home communities are often separate and distant from commercial zones, such that residents' bus riding, biking, and walking times needed for household errands may be longer than that of their apartment counterparts – often to the point of being infeasible. Together, community design and layout often increases the time and inconvenience of taking alternative transportation for the majority of single family home residents who do not live next to a major street compared to apartment residents.

Further, married couples must make joint decisions regarding housing location that can impact one or both person's commute. Unless the couple works in a similar location, it is unlikely that the couple's home will be located close to both persons' places of employment, thereby generally increasing the distance that one person must travel to work. In addition, having children generally increases the need for a car, particularly if the parent is responsible for transporting the child to and from school and to other activities. This increased commute mileage coupled with higher levels of SOV mode share together work to increase the median commute-related GHG emissions of single family home residents relative to apartment residents.

Recognizing single family home residents' multiple reasons for living in their communities is an important first steps for policymakers working to address the differences in residents' commute modes and greenhouse gas emissions between housing types. Appropriate alternative transportation options can then be catered to those communities.

One way in which policymakers could work to increase alternative transportation usage in single family home communities would be to increase the bus stop locations and routes serving these communities. They could also advocate for small commercial zones in proximity to residential communities, which could facilitate the use of walking or bicycling to run household errands. For many single family home residents, particularly couples with children who have multiple errands or stops on their daily commute, driving alone may remain the only feasible commute option. To decrease greenhouse gas emissions among this population, increasing incentives and awareness of electric and alternative fuel vehicles may be the best option. The State of California already has an electric vehicle adoption target of 1.5 million by 2025, which regional planning agencies must incorporate in decision-making, and new battery technology is quickly decreasing the cost of electric vehicles (California Office of Governor Edmund G. Brown Jr., 2012). Greater awareness on a local basis and financial incentives could help reduce commute-related emissions while meeting the lifestyle needs of single family home residents.

7.2 Differences in Commute-Related GHGs in the AUD Zone

Honing in on the AUD apartments compared to homes in a one-mile buffer does not elucidate any significant differences in either mileage or mode share between the zones (Figure 6; Figure 7). Subsequently, though AUD zone residents' median per capita commute greenhouse gas emissions are slightly lower than that of the buffer zone residents at 1.04 kg CO_2e and 1.98 kg CO_2e, respectively, there is no significant difference among the groups (Figure 8). However, it is important to remember that the infill developments slated to be built through the AUD program

do not yet exist. Our results are aimed at establishing baseline behavior in these groups, and therefore our result does not conclude that the AUD program will not be important in decreasing commute-related emissions in the South Coast. Instead, our findings suggest that building high-density residences is likely to be an important tactic in decreasing overall per capita commute emissions while simultaneously increasing housing. Further, they point to the need for future studies in-kind to our own upon construction of the AUD infill developments.

7.3 Women Are Much More Likely to Drive than Men

Our finding that women are substantially more likely than men to commute in a single occupancy vehicle (
Using the regression model to gather probabilities, a 26-35 year-old woman making $60,000 - $99,000, commuting 5 days at a distance of 12 miles, perceiving the bus as unpredictable and not knowing the amount of bus stops on the commute, completing 2 errands, receiving an incentive, and living in an apartment has a probability of 0.967 of choosing an SOV (Equation 1). Comparatively, a man with the same characteristics has a probability of 0.939.

A Kruskal-Wallis test was performed to compare whether median commute distance significantly varies by mode choices of cars-individual, cars-carpool, bicycle, bus and walking. Median distance differed significantly (X^2 = 30.718, df = 4, $p < 0.001$). Post-hoc tests revealed a significant difference between commute distance for respondents who walk compared to all other modes except bicycle (Figure 10).

Figure 10. Daily Commute Distance by Mode Choice. Variations in respondent's commute distance for each primary mode of transportation (SOV (blue), carpool (orange), bus (green), bicycle (purple), and walk (light blue)). *Note*: Like letters indicate results that are not significantly different.

Table 8) is not anomalous within the national context of commute patterns. Women's propensity toward individual driving can be explained through a combination of "push" and "pull" factors that work together to make commuting via an SOV the (seemingly) most appropriate choice.

Among its peer nations, the United States has both some of the lowest biking and walking mode shares and some of the most dangerous biking and walking conditions (Pucher & Dijkstra, 2003). Locally, Santa Barbara County had the third most bicycle collisions out of all California counties in 2013, while the City of Santa Barbara ranked second among 103 similarly-sized California cities for bicycle collisions and third for pedestrian collisions (California Office of Traffic Safety (OTS), 2013). Garrard, Rose, & Lo (2008) found that countries with low bicycle mode shares also tend to see big gender differences for bicycle transit, which is consistent with our findings (of the 12 respondents indicating bicycle as their primary mode of transportation, only one identifies as a woman). Traffic safety concerns have been implicated as an important factor, with observed differences in the gender breakdown among cyclists likely due to widely documented differences in risk aversion between genders, in which women are much more risk averse than men in most behavioral choices (Byrnes, Miller, & Schaffer, 1999; Eckel & Grossman, 2008; Garrard et al., 2008). Due to this heightened level of risk aversion, women are much less likely to commute via bicycle or walking, as both modes are inherently more risky than other modes of transportation on both a per-mile and per-trip basis (Garrard et al., 2008; Pucher & Dijkstra, 2003).

It is not simply risk aversion, however, that encourage women to choose to commute via SOV. Concerns about personal safety as well as the needed convenience of a car due to the typical nature of women's trips together contribute to women's increased levels of SOV commuting. In comparison to men, women are much more likely to engage in higher levels of home- and children-oriented travel and "trip chaining," in which multiple, short trip segments are carried out as the commuter moves from one anchor activity to the next anchor activity (i.e., home to work or work to home) (Crane, 2007; Dickinson, Kingham, Copsey, & Hougie, 2003; Primerano, Taylor, Pitaksringkarn, & Tisato, 2007; Root & Schintler, 1999). Women's trips thus tend to be multipurpose and often somewhat time-constrained, so the fixed schedule and route of public transit makes it an "infeasible or highly inconvenient," option (Root & Schintler, 1999). If these trips also involve transporting or picking up children or household items, biking and walking also quickly become impractical. We see examples of concern for safety, children-oriented travel, and "trip chaining" among our survey respondents, who responded to our survey with comments such as "I do not feel safe waiting for the bus in the dark," "It would be difficult to do anything other than drive my own car to work, because of my kids," and "I'm able to run errands on my own that if I carpooled would be impossible." While one male respondent indicated that he needed to drive individually in order to transport his children, most men left comments regarding the lack of structural incentives (shower and storage) at their workplace that would facilitate biking.
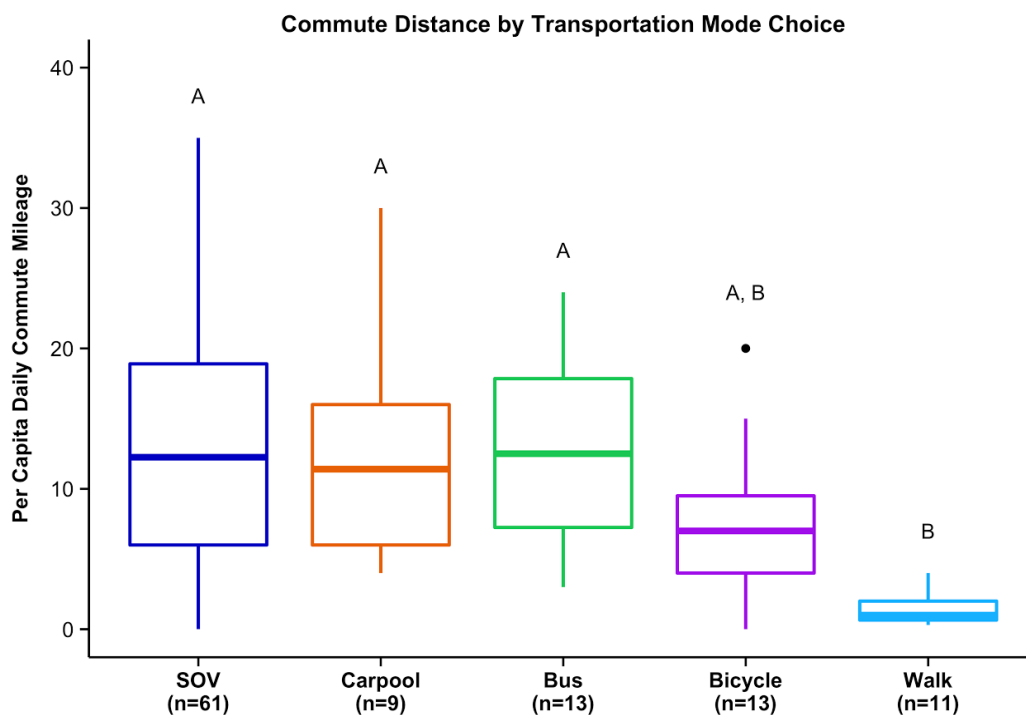
7.4 Awareness and Perception of Commute Factors Affect Commute Choice

In addition to gender being an important predictor of the likelihood to drive an SOV, we further find the following factors to be the significant predictors of commute preference for an SOV: the

number of commute days per week, a perception that the bus is "not very" predictable, and a lack of awareness regarding the number of bus transfers needed for the commute to work (Using the regression model to gather probabilities, a 26-35 year-old woman making $60,000 - $99,000, commuting 5 days at a distance of 12 miles, perceiving the bus as unpredictable and not knowing the amount of bus stops on the commute, completing 2 errands, receiving an incentive, and living in an apartment has a probability of 0.967 of choosing an SOV (Equation 1). Comparatively, a man with the same characteristics has a probability of 0.939.

A Kruskal-Wallis test was performed to compare whether median commute distance significantly varies by mode choices of cars-individual, cars-carpool, bicycle, bus and walking. Median distance differed significantly (X^2 = 30.718, df = 4, p < 0.001). Post-hoc tests revealed a significant difference between commute distance for respondents who walk compared to all other modes except bicycle (Figure 10).

Figure 10. Daily Commute Distance by Mode Choice. Variations in respondent's commute distance for each primary mode of transportation (SOV (blue), carpool (orange), bus (green), bicycle (purple), and walk (light blue)). *Note*: Like letters indicate results that are not significantly different.

Table 8). Together, this suggests that general awareness and perception of commute characteristics play an important role in preference towards commuting in an SOV.

We hypothesize that complete and safe bike paths do not significantly affect a person's commute mode choice because other behavioral factors are likely to more heavily influence a person's decision to bike. Commuters who have several errands to run before or after work, a need to transport supplies, or a need or preference to arrive in professional attire may be disinclined to consider biking regardless of the condition of bike paths along a commute route. Perceived biking ability, comfort in traffic, and a person's age and health may also play a role.

Bus predictability and bus transfers also affect commute choice. Those who think bus predictability is "not very" high are ten times more likely to drive an SOV, suggesting that most respondents can tolerate a certain level of unpredictability before becoming significantly disinclined to use a bus. Those who do not have an opinion on bus predictability are likely indifferent because they have not considered busing as an alternative to driving an SOV. An unknown number of necessary bus transfers along a commute also significantly inclines commuters towards choosing an SOV. This may be because those respondents have not considered busing as an option, are unfamiliar with the bus system, may have preexisting preferences towards characteristics of driving alone, or have lifestyles for which driving an SOV is the most feasible option.

Divergence between perceptions of time required to use the bus system in the South Coast and actual bus system ease of use suggest that an information campaign may increase public transportation ridership (Figure 11). The greatest differences between perceived and actual walking time are seen among those respondents who perceive they have particularly long (>10 minute) walks to the nearest bus stop. Those who perceive they have a relatively short walk are more accurate and often underestimate the amount of time it takes to walk to the nearest stop. Additionally, the actual walking times of those who indicate they do not know the time to the nearest bus stop range from 2 to 22 minutes; whether they actually reside near or far from a bus stop, some residents do not know enough about local transit system availability. These perceptions and indicated lack of knowledge suggest that greater awareness of the availability of bus stops near residents is necessary. This could best be accomplished through an information campaign and/or clearer signage of bus stop locations. This will be particularly important for those who think the walking distance is far or are unsure of the distance.

Our findings that the time to commute to most work destinations by bus is an average of three times greater that time to travel by SOV (Figure 13) suggests that awareness campaigns of bus system availability alone are inadequate. In addition, most routes in the transit system would need to be faster to encourage bus ridership. This might be accomplished through express routes with fewer stops and along more direct routes or through a greater variety of routes. These improvements may simultaneously increase bus predictability and decrease the need for transfers, two other factors that affect mode choice. The Santa Barbara Metropolitan Transportation District (MTD) regularly considers the utilization of its service routes and periodically makes adjustments accordingly (Santa Barbara MTD, 2016). Given a constrained operating budget, it can best serve residents' needs by focusing on areas with higher housing density and more commercial activity. Results of travel time by bus versus SOV indicate that MTD could continue to study – and perhaps experiment with – more effective and usable commute routes.

7.5 Commute Distance Alone May Not be Enough for Mode Shift

While other studies have shown commute distance to be a significant predictor of mode choice, our regression model produced an insignificant finding (Buehler, 2011; Frank, Bradley, Kavage, Chapman, & Lawton, 2007; Limtanakool, Dijst, & Schwanen, 2006). In an effort to examine if

commute distance and mode choice are consistently unrelated, we ran two additional tests and computed the minimum detectable effect (MDE) given our sample size.

One of the tests, a binary logistic regression model, specifically explored if moving closer to work made a respondent more likely to switch out of an SOV and into any other alternate mode (excluding working from home) (Table 9). We did not find significant results, corroborating the previous null result for commute distance. It is, however, important to note our survey sample only included those living within the South Coast, where the average commute distance is 12 miles (SBCAG, 2007). We did not capture individuals commuting long distances specifically to work within the South Coast and therefore did not capture the tail. This may be irrelevant, as the intent is to encourage individuals to get out of their SOV and into an alternate mode by moving closer to work and near transit, and we measured those who are living relatively near their place of work. While just moving closer to work may not inherently promote a mode shift, it is likely still an important component, as providing an environment in which it is easier to shift out of an SOV is still a common tactic in making a person's mode shift somewhat burden free.

Examining the median commute distance between modes via the Kruskal-Wallis test fell in line with the two previous models. While commute distance did significantly vary between modes, post-hoc testing revealed only the walking commute distance differed from busing, carpooling, and driving individually (Figure 8). Though SOV commuters have the highest maximum commute distance of any mode, there are still SOV commuters driving a few miles, further emphasizing that commute distance alone is not enough to shift a person's mode choice. In regards to the other modes, respondents that choose to walk to work do have a lower median commute mileage than those traveling via vehicular modes as walking is generally a vastly slower option. Bicycling is not significantly different from walking but is also not significantly different than the other modes, meaning it is right on the cusp of being an alternate mode where shortening commute distance may encourage its usage. Because of this, it is reasonable that moving residents much closer to work via the AUD zone may help push residents into walking or bicycling over driving an SOV. However, it is apparent something additional will be needed to effectively see this change.

Due to our low response rate and the importance of the commute distance variable we felt it necessary to explore the option that our model could not detect the effect. A general test of randomized t-distributions considering our results did expose that the MDE for commute distance is larger than our finding. While we recognize the value in obtaining a larger sample size in order to test for significance, the consistency of other tests with this null result suggests it is possible we would not observe a significant effect even with more responses.

With these results we have established a commute behavior baseline for Carpinteria, Goleta, and Santa Barbara as a whole. It will be important to measure the mode choices of individuals moving into the AUD pilot units to see how their behavior compares to the surrounding areas. Furthermore, these results do not mean commute distance is completely irrelevant and a program like the AUD will not be effective. Rather, it suggests altering commute distance while maintaining the status quo for other factors is likely not enough to see large-scale mode shifts.

7.6 Incentives are Not Enough, but Parking Fees Work

Our analysis of incentives was two-fold. First, we found that incentives are not currently a significant factor in a respondent's decision to commute by SOV or an alternative mode (Using the regression model to gather probabilities, a 26-35 year-old woman making $60,000 - $99,000, commuting 5 days at a distance of 12 miles, perceiving the bus as unpredictable and not knowing the amount of bus stops on the commute, completing 2 errands, receiving an incentive, and living in an apartment has a probability of 0.967 of choosing an SOV (Equation 1). Comparatively, a man with the same characteristics has a probability of 0.939.

A Kruskal-Wallis test was performed to compare whether median commute distance significantly varies by mode choices of cars-individual, cars-carpool, bicycle, bus and walking. Median distance differed significantly (X^2 = 30.718, df = 4, p < 0.001). Post-hoc tests revealed a significant difference between commute distance for respondents who walk compared to all other modes except bicycle (Figure 10).

Figure 10. Daily Commute Distance by Mode Choice. Variations in respondent's commute distance for each primary mode of transportation (SOV (blue), carpool (orange), bus (green), bicycle (purple), and walk (light blue)). *Note*: Like letters indicate results that are not significantly different.

Table 8). For residents who are currently offered some form of incentive for commuting by a non-SOV mode, the reward is not enough to shift them out of an SOV. This was true for all types of incentives, whether they are structural, monetary, or programs.

However, in the choice experiment portion of this analysis incentives did entice respondents to switch out of their SOVs when combined with a parking fee. While parking fees are currently uncommon in the South Coast, they were included in this study because literature suggests

parking fees tend to be the most successful in reducing SOV usage (City of Pasadena, 2006; Jakobsson et al., 2000; Metro, 2005; Shoup, 1997). Studies show that 95% of employees park at their workplaces for free. This is not because the parking is actually free but because employers subsidize this parking. In this study, parking fees were combined with an incentive to push commuters from both directions, with both an incentive to use an alternative mode and a disincentive to use an SOV. This method is also more favorable politically since a parking fee is expected to be unpopular with commuters. The results show that a parking fee of either $10 or $15 is effective at reducing SOV usage no matter which incentive it is paired with. But once again, those same incentives are not effective when paired with no parking fee (Table 10; Table 11; Table 12). These conclusions align with previous research that found a 2% decrease in VMT with a parking fee of $3 and a 12% decrease when employees were offered a parking cash-out under California's AB 2109 (ARB, 2009; Spears, Boarnet, & Handy, 2014)

7.7 Limitations

While we made every effort to create a project as thorough and comprehensive as possible, there exist some limitations to the research presented here due to constrained time and resources.

First, this project uses work-home commutes to make inferences about transportation patterns and thereby ignores other trips. This method is consistent with literature in the field and is arguably acceptable due to the fact that 34% of vehicle miles traveled is due to work-home commutes, and studies have found that improving the jobs-housing balance reduces travel more (Cervero & Duncan, 2006; US DOT, 2011).

In addition, this project was limited in terms of the population that was sampled. Only residents of apartment complexes of 5 or more units, single-family homes, and mobile homes were selected for the survey. This is due to both availability of addresses and relevance to the project's goals. In addition, residents of Summerland, Montecito, and Isla Vista were not included in the sample although they are part of the South Coast. Thus, if we wanted to make inferences about the commute patterns of the entire South Coast, the study would need to be expanded to include these excluded residents. However, for the purposes of this project, residents of these areas were considered to be different from the typical AUD development resident and the average work commuter. The unincorporated areas of Montecito and Summerland are made up of residents of high incomes and mostly single-family homes. It is not likely that these residents would move into an AUD unit, and it is unlikely that they would commute by a mode other than SOV due to geographic limitations. Residents of Isla Vista are unique in many ways. They are almost all students of the University of California, Santa Barbara, making their commute patterns different from a typical employee. Their time in the South Coast is limited to the duration of their education. In addition, biking and walking are used almost exclusively to travel from home to school, and this pattern would have given a misrepresentation of overall trends of commuting in the South Coast.

8. SUMMARY & RECOMMENDATIONS

The results of our survey combined with our review of existing literature and successful transportation management programs suggest that the City of Santa Barbara has an opportunity to successfully reduce GHG emissions from employee commuting. In the following sections, we provide a summary of and insights gleaned from our results and provide a series of next steps for the City as it works to reduce SOV dependency and commute-related GHG emissions.

8.1 The Importance of the High-Density Housing

Overall, our project outlines the distinct value of high-density residences in decreasing commute-related emissions. Actively commuting apartment residents emit fewer per capita GHGs for each one-way commute (1.12 kg CO_2e) than single family home residents (3.55 kg CO_2e). This is due to both a lower median commute mileage and a smaller SOV mode share for apartment residents. Aside from knowing that younger ages and lower incomes tend to live in apartments, we do not fully understand the characteristics of apartment residents that lead them to have lower commute-related GHG emissions. However, we argue that this precise characterization is of lesser value than the important result of lower emissions itself when considered in the context of macroscale goals. At the City level, the discussion is focused on the demographics that can and will live in Santa Barbara and how the City can be made accessible to varying incomes and age brackets. However, the City itself cannot directly work to target specific demographics, but it does have authority to encourage the development of apartments, which can indirectly work to bring in desired demographics to the region. The AUD program is working to increase the number of apartments in the City, and it is likely that these developments will attract a similar demographic to current apartment residents. Our study provides evidence that if the City of Santa Barbara can become accessible and a more feasible place for people of lower incomes to live in, then the region should expect to see a decrease in both the number of SOV commuters and residents' commute-related GHG emissions.

Though we do not see significant differences among AUD residents in comparison to the one-mile buffer zone or to apartment residents in general, we believe this statistical insignificance is due to the small sample size of our AUD zone resident data. Together, these findings, coupled with the positive housing benefits of infill development, lead us to recommend that the City of Santa Barbara move forward with the AUD program. The AUD program represents a prime example of how environmental goals can be advanced through and harmonized with other social and urban planning policies.

8.2 Monitoring the Impacts of the AUD Program

While we recognize the unique value that the AUD program can potentially provide to the City, future study is necessary to ensure that the environmental benefits are actually achieved. The results of our study lead us to believe that the AUD program will have a positive environmental effect, however the true outcomes can only be seen once units are built and residents inhabit them. Therefore, we recommend that the City conduct post-construction surveys to accurately

measure the impact of the AUD program in comparison to both housing in the one-mile buffer zone around the AUD zone and South Coast apartments in general. We recommend that this survey occur approximately one year after residents move into the AUD units, so residents have time to adjust to the new lifestyle and implement any potential changes to their transportation mode. Then, the City should survey AUD residents to determine the number of cars per household, per capita commute mileage and the associated GHG emissions, and residents' usage and perceptions of alternative transportation. Depending on the outcomes of this survey, the City can proceed in one of two ways. If there is no positive effect on transportation (i.e.: residents own several cars per household, GHG emissions are greater than or not significantly different from the baseline/buffer zone, SOVs remain the primary mode) then the City should evaluate and proceed with the AUD program solely as a housing affordability program and not as an environmental/climate action program. However, if the City sees a positive effect on transportation (i.e.: residents own one or fewer cars per household, GHG emissions are less than the baseline/buffer, SOV are not the primary mode) then the City should adopt the AUD program and implement it as part of its Climate Action Plan.

8.3 Improving Usage of Alternative Transportation

Despite Santa Barbara's temperate climate and the region's efforts to increase usage of alternative transportation, SOVs remain the predominant mode of transportation among all residents. Just over 52% of respondents commute via SOV versus 8% by carpool, 11.5% by bus, 11% by bicycle, and 10% by foot; the remaining 8% commutes by some other mode of transportation (such as motorized scooter or train) or works from home. Local residents' fears that planned AUD developments with limited parking will usurp currently available on-street parking are thus well-founded. The City will need to focus its efforts on allowing people to live in the region without a car in order for new parking allowances to be effective in reducing SOV dependency in the South Coast.

We further find that commute distance is not a significant predictor of a person's likelihood to use alternative transportation. Instead, people's perception of alternative transportation and demographic factors, particularly gender, are much more important predictors of a person's decision. In addition to improving access to transit, the City must also focus efforts on improving general public awareness and understanding of alternative transportation options, especially for the bus system.

Policymakers and regional planners may consider implementing information campaigns and bus system improvements. Though there are many misperceptions surrounding the proximity of local bus stops, our findings also suggest that many bus routes are simply too inconvenient to be used. These information campaigns and system improvements may be particularly important in single family home communities that are typically not designed for public transportation usage. In addition, policymakers could consider incentives and improved ease of use of electric vehicles, which have zero tailpipe emissions and would thereby help the City reduce its transportation-related GHG emissions. Further, this may be easier to implement, as these policies and incentives would allow residents to continue using an SOV and thereby avoid any behavior changes.

Lastly, outside literature also suggests the importance of considering the gender balance, particularly with regards to childcare duties, when developing new policies and programs focused on increasing alternative transportation usage. For example, transportation planners may want to consider the location of daycares and schools when developing commercial districts, recognizing that many parents do not feel safe allowing their children to commute to school alone or in small groups. Parents who chaperone or transport their children themselves likely find alternative transportation methods to be either inconvenient or impossible. Locating daycares near commercial centers or incentivizing employers to offer daycare, either alone or paired with other businesses, could make public transportation more feasible for parents by potentially removing an additional, out-of-the-way stop. Daycare siting represents merely one of many possible programs that could work to address the gender imbalance of SOV commuters and points to the overall need for future City transportation planning to bring in factors that are outside of their typical realm of concern.

8.4 The Cost of Parking

Coupling a daily parking fee with financial or structural incentives to use alternative transportation significantly affected people's decision to continue commuting to work via an SOV. Though this is only hypothetical and does not reflect actual decisions made, the choice experiment nonetheless indicates that parking fees cause employees to reconsider their commute mode. As such, the City should consider partnering with local employers in order to unbundle the cost of parking for employees (i.e. charging employees to park at or near work), while also helping the employers offer financial incentives for employees commuting by alternative transportation. We believe that coupling a financial disincentive for driving an SOV (i.e. a parking fee) with a financial or structural incentive for using alternative transportation is likely to be more locally palatable and politically feasible than simply requiring that employees pay for parking. Alternatively, the City could consider raising the cost of parking permits. This would raise operational expenditures for employers that provide parking to employees and thus could be effective in nudging employers toward charging employees for parking, even if a nominal fee.

9. CONCLUSION

This research represents a novel attempt to understand current commute patterns in the South Coast, evaluate the impact of high density and infill development on commute behavior, and explore the potential for increased usage of alternative modes of transportation.
The results of this project will allow the City of Santa Barbara to continue with the AUD program with a more thorough understanding of transportation behavior. In addition, this baseline information will provide a comparison for later studies that evaluate the impact of individual AUD developments.

In addition, this project's value extends beyond the City of Santa Barbara. There is a strong connection between jurisdictions in the South Coast, and this project will benefit each of these member agencies. Other Santa Barbara County jurisdictions are creating similar programs for

workforce housing, including the City of Santa Maria. These programs all share a parallel goal of improving the lives of those that live and work in the Santa Barbara region.

As one of the largest sources of greenhouse gas emissions, the impacts of transportation go well beyond Santa Barbara. Transportation has a significant effect on air quality and the climate. In addition, transportation issues are only expected to worsen as population grows. Creating programs now is an important first step in reducing these negative environmental and health impacts. Altering human behavior, whether through exposing the real cost of SOV commuting or increasing the appeal and ease of alternative modes of transportation, is a challenge local governments face today. With innovative solutions and a thorough understanding of their constituents' behaviors and preferences, these agencies have the tools they need. The key is to maintain a big-picture view, consider a suite of solutions, and work closely with constituents to enact change.

REFERENCES

ARB. (2009). California's Parking Cash-Out Program: An Informational Guide for Employers. Retrieved February 13, 2016, from http://www.arb.ca.gov/planning/tsaq/cashout/cashout_guide_0809.pdf

ARB. (2015). California's Greenhouse Gas Emission Inventory. Retrieved November 14, 2015, from http://www.arb.ca.gov/cc/inventory/data/data.htm

Boarnet, M. G., & Crane, R. (2001). Travel by Design: The Influence of Urban Form on Travel. Retrieved from http://trid.trb.org/view.aspx?id=681317

Buehler, R. (2011). Determinants of transport mode choice: a comparison of Germany and the USA. *Journal of Transport Geography*, *19*(4), 644–657. http://doi.org/10.1016/j.jtrangeo.2010.07.005

Byrnes, J. P., Miller, D. C., & Schaffer, W. D. (1999). Gender differences in risk taking: A meta-analysis. - ProQuest. Retrieved February 13, 2016, from http://search.proquest.com.proxy.library.ucsb.edu:2048/docview/614369773/fulltextPDF/B1E96ADD5DF4435FPQ/1?accountid=14522

California Energy Commission (CEC). (n.d.). California Gasoline Statistics & Data. Retrieved November 14, 2015, from http://energyalmanac.ca.gov/gasoline/

California Office of Governor Edmund G. Brown Jr. (2012). Governor Brown Announces $120 Million Settlement to Fund Electric Car Charging Stations Across California. Retrieved March 8, 2016, from https://www.gov.ca.gov/news.php?id=17463

California Office of Planning and Research (OPR). (n.d.). Infill Development. Retrieved November 17, 2015, from http://www.opr.ca.gov/s_infilldevelopment.php

California Office of Traffic Safety (OTS). (2013). 2013 OTS Rankings. Retrieved February 28, 2016, from http://www.ots.ca.gov/Media_and_Research/Rankings/default.asp

Cervero, R., & Duncan, M. (2006). 'Which Reduces Vehicle Travel More: Jobs-Housing Balance or Retail-Housing Mixing? *Journal of the American Planning Association*, *72*(4), 475–490. http://doi.org/10.1080/01944360608976767

City of Pasadena. (2006). *Traffic Reduction Strategies Studies - Draft Report*. Pasadena. Retrieved from http://ww2.cityofpasadena.net/councilagendas/2007 agendas/Feb_26_07/Pasadena Traffic Reduction Strategies 11-20-06 DRAFT.pdf

City of Santa Barbara. (2012). *Chapter 2 (Reducing Carbon Emissions That Contribute to Climate Change)*.

City of Santa Barbara. Municipal Code Title 28 (2014).

Clerk-Recorder-Assessor Map Division. (2008). County of Santa Barbara - SBCSDE.SDE.Zoning.

Coastal Housing Coalition, & California Economic Forecast. (2012). *Santa Barbara's Changing Demographics and Housing Trends California*.

Crane, R. (2007). Is There a Quiet Revolution in Women's Travel? Revisiting the Gender Gap in Commuting. *Journal of the American Planning Association*, *73*(3), 298–316. http://doi.org/10.1080/01944360708977979

Dickinson, J. E., Kingham, S., Copsey, S., & Hougie, D. J. P. (2003). Employer travel plans, cycling and gender: will travel plan measures improve the outlook for cycling to work in the UK? *Transportation Research Part D: Transport and Environment*, *8*(1), 53–67. http://doi.org/10.1016/S1361-9209(02)00018-4

Dill, J., & Voros, K. (2007). Factors Affecting Bicycling Demand: Initial Survey Findings from the Portland, Oregon, Region. *Transportation Research Record: Journal of the Transportation Research Board*, *2031*, 9–17. http://doi.org/10.3141/2031-02

Dobberteen, M., & Turnbull, S. (n.d.). Transportation Demand Management (TDM) Benefit. Retrieved November 8, 2015, from http://cosb.countyofsb.org/hr/pdf/benefits/TDMprogram.pdf

Eckel, C. C., & Grossman, P. J. (2008). Chapter 113 Men, Women and Risk Aversion: Experimental Evidence. *Handbook of Experimental Economics Results*, *1*, 1061–1073. http://doi.org/10.1016/S1574-0722(07)00113-8

Emrath, P., & Siniavskaia, N. (2009). Household Type, Housing Choice, and Commuting Behavior.

Retrieved February 13, 2016, from https://www.nahb.org/en/research/housing-economics/special-studies/household-type-housing-choice-and-commuting-behavior-2009.aspx

EPA. (2014). *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2014* (Vol. EPA-420-S-).

EPA. (2015). *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Retrieved from http://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Main-Text.pdf

Ewing, R., & Cervero, R. (2001). Travel and the built environment: a synthesis. *Transportation Research Record: Journal of the Transportation Research Board*, *1780*, 87–114.

Federal Highway Administration. (2015). Average Fuel Economy of Major Vehicle Categories Motorcycle.

Frank, L., Bradley, M., Kavage, S., Chapman, J., & Lawton, T. K. (2007). Urban form, travel time, and cost relationships with tour complexity and mode choice. *Transportation*, *35*(1), 37–54. http://doi.org/10.1007/s11116-007-9136-6

Garrard, J., Rose, G., & Lo, S. K. (2008). Promoting transportation cycling for women: the role of bicycle infrastructure. *Preventive Medicine*, *46*(1), 55–9. http://doi.org/10.1016/j.ypmed.2007.07.010

Handy, S., Cao, X., & Mokhtarian, P. (2005). Correlation or causality between the built environment and travel behavior? Evidence from Northern California. *Transportation Research Part D: Transport and Environment*, *10*(6), 427–444. http://doi.org/10.1016/j.trd.2005.05.002

Herold, M., Goldstein, N. C., & Clarke, K. C. (2003). The spatiotemporal form of urban growth: measurement, analysis and modeling. *Remote Sensing of Environment*, *86*(3), 286–302. http://doi.org/10.1016/S0034-4257(03)00075-0

Herzog, E., Bricka, S., Audette, L., & Rockwell, J. (2006). Do Employee Commuter Benefits Reduce Vehicle Emissions and Fuel Consumption?: Results of Fall 2004 Survey of Best Workplaces for Commuters. *Transportation Research Record: Journal of the Transportation Research Board*, *1956*, 34–41. http://doi.org/10.3141/1956-05

Hong, J., Shen, Q., & Zhang, L. (2013). How do built-environment factors affect travel behavior? A spatial analysis at different geographic scales. *Transportation*, *41*(3), 419–440. http://doi.org/10.1007/s11116-013-9462-9

Jakobsson, C., Fujii, S., & Gärling, T. (2000). Determinants of private car users' acceptance of road pricing. *Transport Policy*, *7*(2), 153–158. http://doi.org/10.1016/S0967-070X(00)00005-6

Lehman, P. K., & Geller, E. S. (2005). Behavior Analysis and Environmental Protection: Accomplishments and Potential for More. *Behavior and Social Issues*, *13*(1), 13. http://doi.org/10.5210/bsi.v13i1.33

Limtanakool, N., Dijst, M., & Schwanen, T. (2006). The influence of socioeconomic characteristics, land use and travel time considerations on mode choice for medium- and longer-distance trips. *Journal of Transport Geography*, *14*(5), 327–341. http://doi.org/10.1016/j.jtrangeo.2005.06.004

Melia, S., Parkhurst, G., & Barton, H. (2011). The paradox of intensification. *Transport Policy*, *18*(1), 46–52. http://doi.org/10.1016/j.tranpol.2010.05.007

Metro. (2005). *Evaluation of Potential Measures for Achieving Modal Targets*. Retrieved from http://www.oregonmetro.gov/sites/default/files/finalreport_modaltargets.pdf

MTS, Navy Region Southwest, & SANDAG. (2010). *Navy Metro Transportation Demand Management Initiative*. San Diego.

NAHB. (2015). NAHB/Wells Fargo Housing Opportunity Index (HOI). Retrieved February 1, 2016, from http://www.nationalhousingendowment.org/reference_list.aspx?sectionID=135

Nobis, C. (2007). Multimodality: Facets and Causes of Sustainable Mobility Behavior. *Transportation Research Record: Journal of the Transportation Research Board*, *2010*, 35–44. http://doi.org/10.3141/2010-05

ODOE. (2015). Transportation. Retrieved November 8, 2015, from http://www.oregon.gov/energy/trans/pages/transhm.aspx

Portland Bureau of Transportation. (2015). Parking Meter Rates. Retrieved November 17, 2015, from https://www.portlandoregon.gov/transportation/article/320238

Primerano, F., Taylor, M. A. P., Pitaksringkarn, L., & Tisato, P. (2007). Defining and understanding trip chaining behaviour. *Transportation*, *35*(1), 55–72. http://doi.org/10.1007/s11116-007-9134-8

Pucher, J., & Dijkstra, L. (2003). Promoting Safe Walking and Cycling to Improve Public Health: Lessons From The Netherlands and Germany. *American Journal of Public Health*, *93*(9), 1509–1516. http://doi.org/10.2105/AJPH.93.9.1509

Root, A., & Schintler, L. (1999). Women, motorization and the environment. *Transportation Research Part D: Transport and Environment*, *4*(5), 353–355. http://doi.org/10.1016/S1361-9209(99)00012-7

Santa Barbara MTD. (2016). MTD Reports and Publications. Retrieved March 11, 2016, from http://sbmtd.gov/about/publications.html

SBCAG. (2007). *2007 Commute Profile*. Santa Barbara, San Luis Obispo, and Ventura Counties. Retrieved from http://www.sbcag.org/uploads/2/4/5/4/24540302/2007_commuter_profile_report.pdf

SBCAG. (2013). *2040 Regional Transportation Plan and Sustainable Communities Strategy*.

SDOT. (2008). Best Practices in Transportation Demand Management. Retrieved November 8, 2015, from http://www.seattle.gov/transportation/docs/ump/07 SEATTLE Best Practices in Transportation Demand Management.pdf

Semenza, J. C., Hall, D. E., Wilson, D. J., Bontempo, B. D., Sailor, D. J., & George, L. A. (2008). Public perception of climate change voluntary mitigation and barriers to behavior change. *American Journal of Preventive Medicine*, *35*(5), 479–87. http://doi.org/10.1016/j.amepre.2008.08.020

SFCTA. (2015). Transportation Demand Management Partnership Project | San Francisco County Transportation Authority. Retrieved November 17, 2015, from http://www.sfcta.org/transportation-planning-and-studies/current-research-and-other-projectsstudies/transportation-demand-management-partnership-project

Shoup, D. C. (1997). The High Cost of Free Parking. *Journal of Planning Education and Research*, *17*(1), 3–20. http://doi.org/10.1177/0739456X9701700102

Spears, S., Boarnet, M. G., & Handy, S. (2014). California's Parking Cash-Out Program: An Informational Guide for Employers. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/pricing/parking_pricing_brief.pdf

US DOT. (2011). Table 5-3: Highway Vehicle-Miles Traveled (VMT): 2005, 2010 | Bureau of Transportation Statistics. Retrieved November 13, 2015, from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/state_transportation_statistics/state_transportation_statistics_2011/html/table_05_03.html

van der Linden, S. (2014). The Social-Psychological Determinants of Climate Change Mitigation Intentions and Behaviours: A Domain-Context-Behaviour (DCB) Model. *SSRN Electronic Journal*. http://doi.org/10.2139/ssrn.2469464

Watterson, W. T. (1993). Linked simulation of land use and transportation systems: Developments and experience in the Puget sound region. *Transportation Research Part A: Policy and Practice*, *27*(3), 193–206. http://doi.org/10.1016/0965-8564(93)90059-T

APPENDIX

Appendix A. Additional Relevant State Bills & Executive Orders

A1. Executive Order B-30-15 (2015). In addition to GHG reduction goals, EO B-30-15 requires that the Governor's Office of Planning and Research assist state agencies in considering climate change impacts in future planning. The EO further directs the California Natural Resources Agency to update the state's climate adaptation strategy, Safeguarding California, every three years. Various state sectors, including transportation, must identify vulnerabilities to climate change and create an implementation plan that outlines action steps. Considering climate change in future projects is likely to impact the way in which transportation and urban development plans are prioritized, with particular consideration for VMT and preferred mode of transportation which influence on-road GHG emissions.

A2. Strategic Growth Council Plan (SB 732), 2008. Complementing SB 375, SB 732 creates a Strategic Growth Council (SGC) committee. The committee is composed of a variety of agencies with the common goal of fostering sustainable communities by taking into account economics, social equity, and the environment. The committee is responsible for distributing California Proposition 84 funds for planning grants and incentives to encourage regional and local water conservation, reduced automobile use and fuel consumption, greater infill and compact development, protection of natural resources and agricultural lands, and increased adaptability to climate change. All projects are required to complement state planning priorities and reduce GHGs consistent with AB 32. The SGC is encouraging infill development as a means to accomplish goals of all member agencies.

A3. Low Carbon Transit Operation Program (SB 862), 2014. Passed in June 2014, SB 862 closely complements SB 732 by establishing funding mechanisms for land use and transportation plans. The bill creates a Low Carbon Transit Operations Program to provide financial assistance for transit agencies. It aims at reducing GHG emissions while improving mobility and serving disadvantaged communities. At least 50% of funds must be demonstrated to aid these communities. SB 862 requires the Department of Transportation, in coordination with the ARB, to develop transit-agency guidelines to demonstrate and report that expenditures meet specified criteria. It allocates 5% of the annual proceeds of the Greenhouse Gas Reduction Fund (GGRF), funds generated from the statewide carbon cap-and-trade market, for the program.

SB 862 also required that the Strategic Growth Council "develop and administer the Affordable Housing and Sustainable Communities [AHSC] Program" and set aside 20% of annual proceeds of the GGRF to the SGC for this program. The AHSC Program focuses on the intersection of land use, housing, transportation, and land preservation. As such, the program supports infill development as a way to decrease GHG emissions. In efforts to benefit disadvantaged communities and reduce GHG emissions, primarily through decreased VMT, the program funds two types of projects: transit-oriented development projects (TOD) and integrated connectivity projects (ICP). TOD includes projects located in areas with affordable housing developments within a half-mile of high quality transit and which demonstrate a VMT reduction through a shift in transportation choice or a decrease in VMT. ICP includes projects with a transit stop and which

demonstrate a VMT reduction through a shift in transportation choice or a decrease in VMT; ICP does not need to incorporate affordable housing developments. The AHSC program offers funding for these infill development and related transportation projects, funding projects like the City of Santa Barbara AUD Program.

A4. CEQA Reform to Accommodate Transit-Oriented Infill Development (SB 743), 2013. In 2013 California passed SB 743, revising the California Environmental Quality Act (CEQA) guidelines under which transportation analyses are conducted. Originally, CEQA offered both passenger vehicle miles traveled (VMT) and Automobile Trips Generated (ATG) as acceptable metrics for determining GHG impacts of transportation and urban development projects. ATG counts the number of motor vehicle trips related to the project and only considers the loss of service from increased traffic congestion. A VMT metric, on the other hand, accounts for the change in the number of miles traveled by motor vehicles due to a proposed project. This metric better captures the full extent of these vehicle trips and thus the project itself, deeming the ATG metric inferior.

This CEQA reform highlights the importance of multi-modal urban transit and roadway alterations for impactful GHG reductions. As new residential projects are proposed, SB 743 will be particularly applicable in deciding how and where development happens. While this study does not directly model how VMT will be affected by the implementation of the AUD program, it explores human behavior that may impact VMT. Part of this study also establishes a baseline of commuting characteristics within and around the AUD zone for further study on AUD developments' impacts on VMT.

In more direct relation to the actual AUD program, SB 743 promotes infill development as a means of reducing VMT-related GHG emissions. The bill creates a new CEQA exemption category for certain projects that are consistent with a Specific Plan (i.e. if the project is a residential, employment center, or mixed use project; is located within a transit priority area; is consistent with a specific plan for which an environmental impact report (EIR) was certified; and is consistent with an adopted SCS). The need to evaluate aesthetic and parking impacts of a project has also been eliminated, benefitting transit-oriented infill development proposals. Both of these exemptions decrease the CEQA barriers in approving infill development projects, making the AUD program a more feasible project in the City of Santa Barbara.

Appendix B. Survey

Dear Valued Resident at:

<address>
<address>

Graduate students from the Bren School of Environmental Science & Management at UC Santa Barbara are conducting a survey of Santa Barbara County. We need your help to better understand how residents choose their mode of transportation.

We would appreciate 5-10 minutes of your time to complete the questionnaire. All responses are confidential and anonymous; you must be at least 18 years of age to complete the survey; all working adults are welcome to complete the survey, your unique ID is valid for several responses.

The survey is available online at:
<link to Qualtrics site> and enter your unique ID: <###>.

If you prefer to respond by paper survey, email us at
SBDevelopment@lists.bren.ucsb.edu and we can mail you a paper version.

We would appreciate your response by November 30th.

As a reward for your time and efforts, the research team is offering a prize raffle. If you choose to include your email address in the survey, you will be **entered into a drawing to win one of five Amazon gift cards** - one valued at $50 and 4 valued at $10. Email addresses will be used solely to contact the raffle winner and for no other purpose. Your privacy is a high priority for us.

Thank you for taking the time to complete this survey. We appreciate your participation and responses.

Sincerely,
Jenny Bankie, Kaitlin Carney, Michelle Graff & Amy Stuyvesant
Bren School of Environmental Science & Management
University of California, Santa Barbara

Comments or questions? Please contact us at: SBDevelopment@lists.bren.ucsb.edu

By completing this survey, I agree that I have read the terms of consent outlined on the previous page and I agree to participate in this survey voluntarily.

What is the zip code of your current workplace?   _____
How many days per week do you commute to work?   _____

What is your average daily commute distance to work, ***round trip***, in miles?
(Include regular stops along the way, such as taking your children to school/daycare.)
_____

Is your answer for commute distance a calculation (such as from Google Maps) or an approximation?
   □ Calculation   □ Approximation

Which method do you use most frequently to commute to work? *(Check the option that matches your most frequent method. If you drive by yourself or with children, check Car- Individual. If you drive with other working adults, check Car- Carpool.)*
□ Car – Individual   □ Bicycle   □ Bus
□ Car – Carpool   □ Walk   □ Other _____

What is the make (ex: Toyota), model (ex: Camry), and year of the vehicle you use most frequently to commute?
Make _____   Model _____   Year _____

How many people are usually in the car, including yourself?   _____

Which bus route do you normally take to commute to work? _____ □ I do not take the bus

How long does it take to walk from your house to the closest bus stop you would take to work? _____ minutes

How long does it take to walk from the closest bus stop to your work?   _____ minutes

How predictable do you feel the bus is?
□ Very predictable   □ Somewhat predictable   □ Not very predictable   □ I Don't know

How many transfers do you need to make when riding the bus from your house to work?
   _____ transfers   □ I Don't know

Does your employer offer a reduced price bus pass or other form of bus fare compensation?
   □ Yes   □ No   □ I Don't know

How clean do you feel the bus is?
   □ Very clean   □ Somewhat clean   □ Not very clean   □ I Don't know

Does your workplace have a shower for employee use?
   □ Yes   □ No   □ I Don't know

Does your workplace have a bike storage/locker for employee use?
　　□ Yes　　　　　□ No　　　　　□ I Don't know

How confident are you in your bike riding skills and abilities?
　　□ Very confident　□ Fairly confident　　□ Not very confident　□ Not at all confident

Does your bike route to work consist entirely of bike paths, designated bike lanes on the road, or a combination of the two? *If there are portions of your ride in which bike lanes do not exist and you must share the lane with cars, please check "no".*
　　□ Yes　　　　　□ No　　　　　□ I Don't know

Do you live near fellow co-workers?
　　□ Yes　　　　　□ No　　　　　□ I Don't know

Does your employer offer preferred carpool parking spaces?
　　□ Yes　　　　　□ No　　　　　□ I Don't know

Does your employer have a recognition program for those who use alternative transportation? (*choose all that apply*)
　　□ Yes, for bikers　　□ Yes, for carpoolers　　□ Yes, for bus riders　　□ No　　□ I Don't know
　　What kind? _____

On average, how many days per week do you run errands on your way to or from work? _____

Does your employer offer a guaranteed ride home for non-car drivers in the event that you have to work late, there is bad weather, you get sick, etc.?
　　□ Yes　　　　　□ No　　　　　□ I Don't know

Now we would like to ask you about your previous residence. Please consider the last place that you lived prior to your current residence.

What is the zip code of your previous residence? _____

While you lived in that residence, what was the zip code of your workplace? _____

What was your average commute distance to work, ***round trip***, while living in your *previous* residence, in miles? *(Include stops along the way, such as taking children to school/daycare.)* _____

Is your answer for commute distance a calculation (such as from Google Maps) or an approximation?
　　□ Calculation　　　　　□ Approximation

Which method did you use most frequently to commute to work from your *previous* residence? (Check the option that matches your most frequent method. If you drive with children, check Car-Individual. If you drive with other working adults, check Car- Carpool.)

□ Car – Individual   □ Bicycle   □ Bus

□ Car – Carpool   □ Walk   □ Other _____

If you drove alone from your *previous* residence, what is the make, model, and year of the car you used most frequently to commute?

Make _____   Model _____   Year _____

If you took the bus from your previous residence, which bus route did you normally take? ____

If you carpooled from your *previous* residence, with how many people did you usually carpool, including yourself?

_____

If you carpooled from your *previous* residence, what is the make, model, and year of the car you used most frequently to commute?

Make _____   Model _____   Year _____

Commuters who choose "drive alone" as their primary mode of transportation are directed to the following section of the survey. All other respondents are sent to the starred section below.

For each scenario, choose the commute that best suits your lifestyle.

Scenario 1:

□ Drive my car to work alone   □ <Ride the bus with an incentive>

Scenario 2:

□ Drive my car to work alone and pay a $10 daily parking fee   □ <Ride the bus with an incentive>

Scenario 3:

□ Drive my car to work alone and pay a $15 daily parking fee   □ <Carpool with an incentive>

Scenario 4:

□ Drive my car to work alone   □ <Carpool with an incentive>

Scenario 5:

□ Drive my car to work alone and pay a $10 daily parking fee   □ <Bike to work with an incentive>

Scenario 6:

□ Drive my car to work alone and pay a $15 daily parking fee   □ <Bike to work with an incentive>

****

What was your most recently reported household annual income, based on your tax return filing status?

□ Under $30,000   □ $30,000 - $59,999   □ $60,000 - $99,999   □ $100,000 - $149,999
□ $150,000- $199,999 □ $200,000 - $249,999   □ $250,000+   □ Prefer not to answer

What gender do you most identify with?
□ Man   □ Woman   □ Other   □ Prefer not to answer

What is your age?
□ 18 - 25   □ 26-35   □ 36-45   □ 46 – 55   □ 55+   □ Prefer not to answer

Thank you for taking the time to participate in this survey!

Is there anything else you would like to tell us regarding your work commute?
_____

To learn more about our project, visit our website at:
http://sbdevelopment.wix.com/sbdevelopment

Optional: Provide your email address here for prize raffle purposes only. (Remember, your email will only be used to contact you if you win a prize. Your email will be stored in a secure location until the raffle, and will be erased immediately following.)
_____
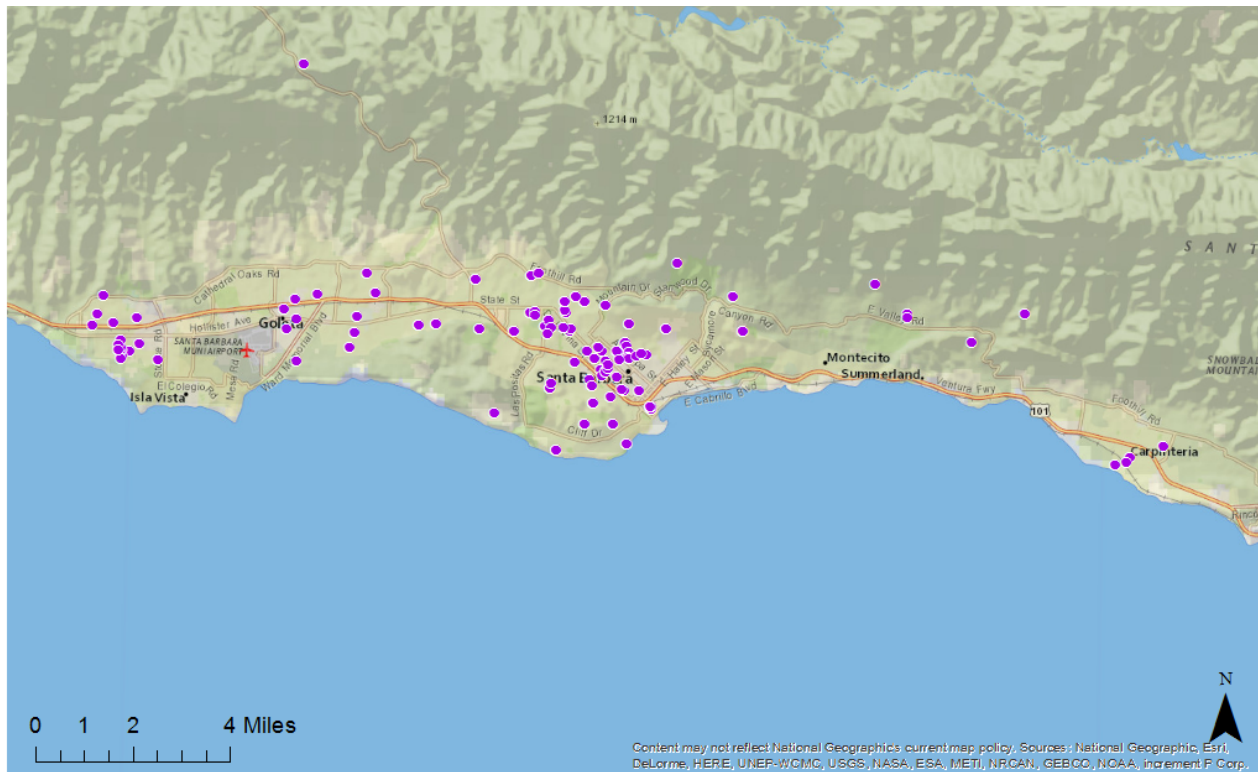
Figure A1. Surveys received. Distribution of 121 survey responses, where each purple dot represents a response from a unique household. Note that some households had multiple responses, as each adult resident was invited to complete the survey.

Appendix D. Vehicle Emissions Data

**Table A1.** Tailpipe vehicle emissions for respondent's primary mode of transportation. Table only includes respondent's who commute via motorized vehicle. Note that duplicate vehicles have been removed, and each line does not represent one respondent.

Current Vehicle	Tailpipe Emissions (g CO_2)	Current Vehicle	Tailpipe Emissions (g CO_2)
Scooter	110	2007 Toyota Camry	355
2013 Toyota Prius	179	2015 Buick Verano	355
2005 Toyota Prius	193	2011 Nissan Rogue	355
2007 Toyota Prius	193	2012 Volkswagen Beetle	355
Train	204	2006 Mazda 6	370
2013 Lexus CT 200H	211	2002 Toyota Camry	370
1995 Honda Civic	234	2010 Honda CR-V EX	370
2014 Scion IQ	238	2013 Ford Mustang	383
2015 Mazda 3	260	2002 Ford Ranger	386
2014 Honda Civic	268	2004 Kia Optima	386
2001 Toyota Echo	278	2007 Volvo V50	386
2004 Volkswagen New Beetle	283	2009 Honda CR-V	386
2011 Toyota Corolla	287	1994 Toyota Camry	386
2006 Toyota Corolla	287	2015 Ford Explorer	392
2010 Toyota Corolla	296	2012 BMW Hybrid	393
1999 Toyota Corolla	296	2015 Toyota Highlander	398
1998 Toyota Corolla	296	2012 Audi Q5	404
2012 Toyota Corolla	296	2004 Honda Crv	404
2010 Toyota Corolla	296	2009 BMW 328i	404
2014 Volkswagen Jetta	297	2007 BMW 328Ci	404
2010 Volkswagen Jetta	299	2008 Dodge Journey	423
2010 Mazda 3	317	2005 Lexus ES 330	423
2007 Nissan Sentra	317	2003 Acura 3.2Tl	423
2009 Hyundai Elantra	317	2001 Nissan Xterra	468
2015 BMW 328i	324	2001 Dodge Grand Caravan	468
2016 Audi A3	328	2013 Nissan Xterra	489
2011 Honda Accord	329	1995 Mercedes-Benz E420	494
2003 Ford Focus	329	2006 Toyota 4Runner	494
2013 Volkswagen GTI	331	2002 Ford Explorer	523
2015 Volvo XC60	333	1999 GMC Sierra	523
2015 Audi Q5	333	2001 Mercedes-Benz Ml430	555
2010 Toyota Camry	342	1985 Toyota Land Cruiser 4WD	808
2007 Honda Accord	342	Bus	2693
2009 Toyota Camry	355		

Appendix E. Workplace Destinations for Bus Perceptions Test
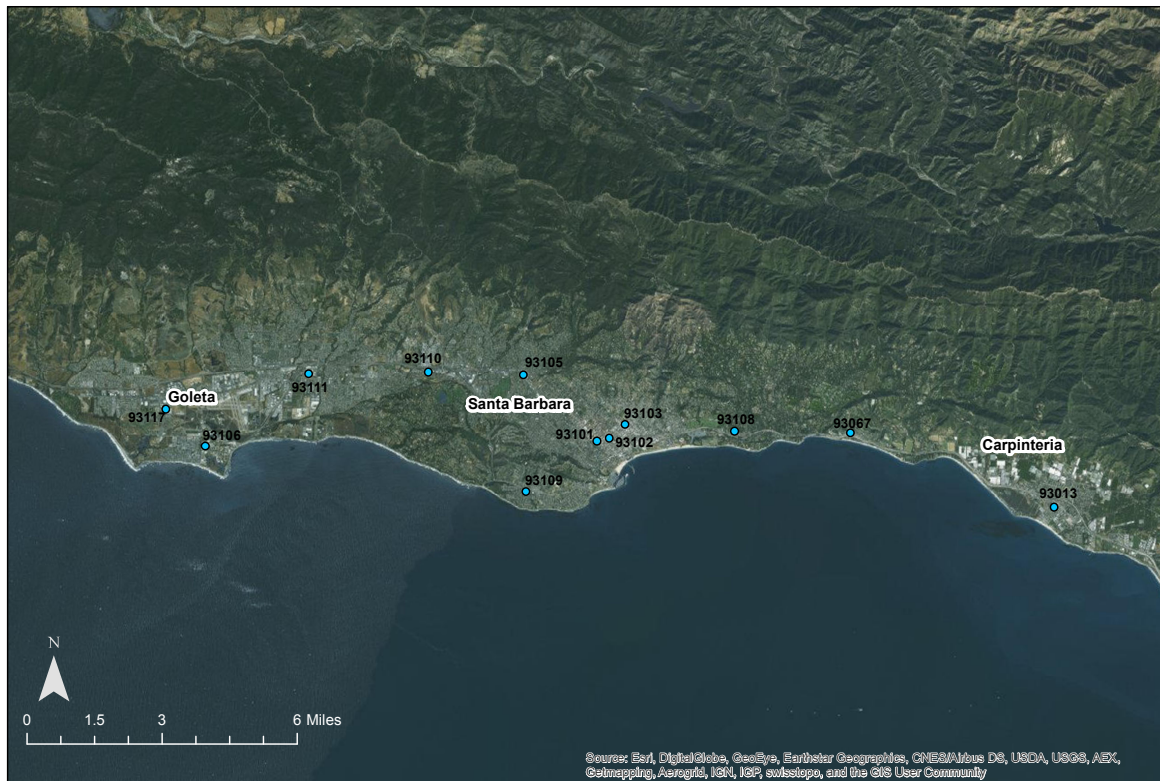
Figure A2. Workplace Zip Code Destinations. Centroid points (blue) chosen for each zip code to calculate home-work bus walking distance and travel time to work in both a car and a bus.

Appendix F. Linear Regression Results for Commute Distance

Table A2. Below Median Income. Linear regression results for commute distance regressed against gender, age, and housing type (R^2 = 0.113). Respondents in this subset (n = 45) include those below the median income in Santa Barbara County (Under $60,000).

Commute Distance			
Factor	**Coefficient**	*SE*	*p*
Intercept	23.378	6.028	< 0.001
Gender[1]	-2.280	3.534	0.523
Age (18-25)[2]	1.234	3.740	0.743
Age (36-45)[2]	-12.030	6.991	0.093
Age (46-55)[2]	2.915	8.103	0.721
Age (56+)[2]	6.996	4.841	0.157
Housing Type (Apartment)	-11.292	5.111	0.033

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference age group = 18-25

Table A3. Mid-High Income. Linear regression results for commute distance regressed against gender, age, and housing type (R^2 = 0.012). Respondents in this subset (n = 62) include those above the median income in Santa Barbara County ($60,000-$99,000 and $100,000+).

Commute Distance			
Factor	**Coefficient**	*SE*	*p*
Intercept	13.899	16.760	0.411
Gender[1]	5.271	7.587	0.490
Age (18-25)[2]	5.665	13.857	0.684
Age (36-45)[2]	12.636	16.199	0.439
Age (46-55)[2]	14.371	16.732	0.394
Age (56+)[2]	-2.043	16.645	0.903
Housing Type (Apartment)	-12.935	9.827	0.194

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference age group = 18-25

Table A4. Below Median Age. Linear regression results for commute distance regressed against gender, Income, and housing type (R^2 = -0.081). Respondents in this subset (n = 56) include those below the median age (18-25, 26-35).

Commute Distance			
Factor	**Coefficient**	*SE*	*p*
Intercept	27.451	6.042	<0.001
Gender[1]	-1.381	3.064	0.654
Income ($60,000-$99,000)[2]	-3.885	3.311	0.246
Income ($100,000+)[2]	-3.214	6.275	0.611
Housing Type (Apartment)	-15.429	5.875	0.011

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference income bracket = $100,000+

Table A5. Above Median Age. Linear regression results for commute distance regressed against gender, Income, and housing type (R^2 = -0.030). Respondents in this subset (n = 51) include those above the median age (36-45, 46-55, 55+).

Commute Distance			
Factor	**Coefficient**	*SE*	*p*
Intercept	17.892	13.274	0.185
Gender[1]	4.876	8.483	0.568
Income ($60,000-$99,000)[2]	-3.271	12.533	0.795
Income ($100,000+)[2]	5.270	12.848	0.684
Housing Type (Apartment)	-6.240	10.324	0.549

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference income bracket = $100,000+

Table A6. Low Income and Below Median Age. Linear regression results for commute distance regressed against gender and housing type (R^2 = 0.081). Respondents in this subset (n = 40) include those below the median income in Santa Barbara County (Under $60,000) and below the median age (18-25, 26-35).

Commute Distance

Factor	Coefficient	SE	p
Intercept	28.783	6.483	<0.001
Gender[1]	-4.485	3.803	0.246
Housing Type (Apartment)	-13.687	6.223	0.034

[1]Gender Codes: 0 = Man, 1 = Woman

Table A7. Mid-High Income and Above Median Age. Linear regression results for commute distance regressed against gender and housing type (R^2 = -0.020). Respondents in this subset (n = 42) include those above the median income in Santa Barbara County ($60,000-$99,000 and $100,000+) and above the median age (36-45, 46-55, 55+).

Commute Distance			
Factor	**Coefficient**	*SE*	*p*
Intercept	10.122	2.157	< 0.001
Gender[1]	2.554	3.157	0.424
Housing Type (Apartment)	-1.330	3.946	0.738

[1]Gender Codes: 0 = Man, 1 = Woman

Appendix G. Linear Regression Results for GHG Emissions

Table A8. Below Median Income. Linear regression results for commute distance regressed against gender, age, and housing type (R^2 = 0.608). Respondents in this subset (n = 40) include those below the median income in Santa Barbara County (Under $60,000).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*
Intercept	4.259	1.584	0.011
Gender[1]	2.347	1.067	0.035
Age (18-25)[2]	-1.819	1.783	0.315
Age (36-45)[2]	0.762	2.076	0.716
Age (46-55)[2]	5.888	1.254	0.000
Age (56+)[2]	1.523	0.969	0.126

| Housing Type (Apartment) | -4.460 | 1.283 | 0.002 |

[1] Gender Codes: 0 = Man, 1 = Woman
[2] Reference age group = 18-25

Table A9. Mid-High Income. Linear regression results for commute distance regressed against gender, age, and housing type (R^2 = -0.039). Respondents in this subset (n = 58) include those above the median income in Santa Barbara County ($60,000-$99,000 and $100,000+).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*
Intercept	1.007	2.468	0.685
Gender[1]	1.326	1.101	0.234
Age (18-25)[2]	2.332	2.615	0.377
Age (36-45)[2]	2.333	2.594	0.373
Age (46-55)[2]	0.821	2.244	0.716
Age (56+)[2]	1.630	2.513	0.519
Housing Type (Apartment)	-0.672	1.574	0.671

[1] Gender Codes: 0 = Man, 1 = Woman
[2] Reference age group = 18-25

Table A10. Below Median Age. Linear regression results for commute distance regressed against gender, Income, and housing type (R^2 = 0.136). Respondents in this subset (n = 44) include those below the median age (18-25, 26-35).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*
Intercept	5.401	1.725	0.003
Gender[1]	1.221	0.953	0.208
Income ($60,000-$99,000)[2]	0.084	1.020	0.935
Income ($100,000+)[2]	1.034	2.115	0.628
Housing Type (Apartment)	-4.274	1.658	0.014

[1] Gender Codes: 0 = Man, 1 = Woman

Table A11. Above Median Age. Linear regression results for commute distance regressed against gender, Income, and housing type (R^2 = 0.098). Respondents in this subset (n = 52) include those above the median age (36-45, 46-55, 55+).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*
Intercept	5.870	1.814	0.002
Gender[1]	2.029	1.178	0.091
Income ($60,000-$99,000)[2]	-2.299	1.679	0.177
Income ($100,000+)[2]	-4.282	1.909	0.030
Housing Type (Apartment)	-2.416	1.351	0.080

[1]Gender Codes: 0 = Man, 1 = Woman
[2]Reference income bracket = $100,000+

Table A12. Low Income and Below Median Age. Linear regression results for commute distance regressed against gender and housing type (R^2 = 0.156). Respondents in this subset (n = 40) include those below the median income in Santa Barbara County (Under $60,000) and below the median age (18-25, 26-35).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*
Intercept	5.563	1.734	0.003
Gender[1]	1.225	1.017	0.236
Housing Type (Apartment)	-4.188	1.665	0.016

[1]Gender Codes: 0 = Man, 1 = Woman

Table A13. Mid-High Income and Above Median Age. Linear regression results for commute distance regressed against gender and housing type (R^2 = -0.014). Respondents in this subset (n = 42) include those above the median income in Santa Barbara County ($60,000-$99,000 and $100,000+) and above the median age (36-45, 46-55, 55+).

GHG Emissions			
Factor	**Coefficient**	*SE*	*p*

Intercept	2.748	0.926	0.005
Gender[1]	1.325	1.321	0.322
Housing Type (Apartment)	-1.288	1.454	0.381

[1]Gender Codes: 0 = Man, 1 = Woman