

# DEVELOPING SUSTAINABLE ADU GUIDELINES FOR SAN JOSÉ, CA

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# APPROVAL

Submitted in partial fulfillment for the  
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# ABSTRACT

Many US cities are experiencing exceptionally high housing costs and housing shortages, this is especially true in California, where housing costs greatly exceed those of the rest of the nation. State law-makers and municipalities are looking for ways to quickly improve the housing crisis. A promising strategy for affordable housing can be found in low-density single family neighborhoods; Accessory Dwelling Units (ADUs) offer the opportunity to increase housing options, without greatly affecting city character and existing infrastructure.

This project explores the potential of ADUs as a strategy for sustainable growth in municipal density at multiple scales. Currently ADUs are seen as sustainable options simply because of their smaller footprint, but little research has been done to further develop responsible ecologically and socially driven housing opportunities. This project addresses the need for density while striving for comfortable spaces that meet the needs of residents as well as addressing the city's goals for sustainability. This project identifies barriers that prevent widespread implementation of ADUs in San Jose, California through analysis of case studies of municipal policy and surveys. Site scale designs and performance analysis demonstrate that sustainable ADU design can be added to residential lots while improving environmental performance through on-site stormwater treatment, energy savings, and a balance between privacy and communal space. Policy recommendations further explore options to address these concerns and mitigate potential negative impacts. This project shows that sustainable ADU models can address many concerns about densification and identifies challenges and benefits for homeowners.



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# 1

## INTRODUCTION

### ***1.1 Background***

From San Diego, CA to Seattle, WA, the west coast housing crisis is a prominent and devastating concern for many families. In California, the shortage of affordable housing, displacement and gentrification are clearly evident, as housing costs exceed those of the rest of the nation. (California Department of Housing and Community Development, 2016; Kushel, 2018). Consequences of the housing shortage in California include crowding, longer commutes which equals more Vehicle Miles Traveled (VMT), and higher overall housing costs for both homeowners and renters (Legislative Analyst's Office, 2015). This makes coming to or staying in California particularly difficult for young professionals and retirees on fixed incomes.

As policy catches up with the demand for housing, state law-makers in California and other west coast states are looking for ways to improve the housing crisis quickly, and a promising opportunity can be found in low-density single family neighborhoods. Accessory Dwelling Units (ADUs) offer the opportunity to increase housing stock in cities, without greatly affecting the character and major infrastructure in already developed areas.

Accessory Dwellings Units (ADUs) are additional (smaller) separate living units on existing single-family lots. ADUs can take many forms, such as a basement apartment, an apartment over a garage or a backyard cottage [usually between 400-900sqft], and can provide affordable, flexible, and energy efficient living. They can either be attached to the primary home on the lot or be a separate building. The most common reasons for adding an ADU are gaining income via

rent and adding additional space to house a family member (City of Eugene, 2018). Accessory Dwelling Units are required to include a bedroom or sleeping area, a bathroom and a kitchen; they often provide housing at a more affordable rate than standard apartments of a similar size. **Figure 1** shows an example of a detached ADU.

Accessory Dwelling Units (ADUs) have the potential to bridge the gap between denser, multi-family housing types and single family residences and offset the housing crisis on the west coast. Public investment is focused on the larger scale housing opportunities that take time to implement; ADUs may be a faster route to additional housing as they are smaller and don't have to go through as rigorous a process for development. Additional benefits of constructing ADUs, are the environmental benefits that a smaller housing footprint can provide and the option to live near existing amenities without added urban sprawl. Programs for developing Accessory Dwelling Units are becoming more prominent across the west coast and are considered to be a critical form of infill development (California Department of Housing and Community Development, 2016).

A memorandum at the state level from December, 2016, published by the California Department of Housing and Community Development asks: "Should [local] ordinance[s] encourage the development of ADUs?" The answer was a resounding "yes" with new changes to ADU Requirements State-wide to reduce barriers and streamline approval and potential capacity of ADUs consistent with "Government Code Section 65852.150:

(a) The Legislature finds and declares all of the following:

1. Accessory dwelling units are a valuable form of housing in California.
2. Accessory dwelling units provide housing for family members, students, the elderly, in-home health care providers, the disabled, and others, at below market prices within existing neighborhoods.
3. Homeowners who create accessory dwelling units benefit from added income, and an increased sense of security.
4. Allowing accessory dwelling units in single-family or multifamily residential zones provides additional rental housing stock in California.
5. California faces a severe housing crisis.
6. The state is falling far short of meeting current and future

Figure 1: Example of a detached ADU  
Designed by Connect Homes



housing demand with serious consequences for the state's economy, our ability to build green infill consistent with state greenhouse gas reduction goals, and the well-being of our citizens, particularly lower and middle-income earners.

7. Accessory dwelling units offer lower cost housing to meet the needs of existing and future residents within existing neighborhoods, while respecting architectural character.

8. Accessory dwelling units are, therefore, an essential component of California's housing supply.

(b) It is the intent of the Legislature that an accessory dwelling unit ordinance adopted by a local agency has the effect of providing for the creation of accessory dwelling units and that provisions in this ordinance relating to matters including unit size, parking, fees, and other requirements, are not so arbitrary, excessive, or burdensome so as to unreasonably restrict the ability of homeowners to create accessory dwelling units in zones in which they are authorized by local ordinance”

Point six in particular speaks to the heart of this project, asking for environmental solutions to help solve the housing crisis. In 2017, S.B. 1069 and AB 2299 provoked changes that aim to reduce barriers in California including a new law that prohibits municipalities from barring ADUs in single family residential zones at the local level; if a local ordinance was not adopted before January 1st, 2017 then State standards are automatically in effect.

## ***1.2 Why San José?***

In San José, California ([Figure 2](#)), these small houses may be an answer to the housing crisis that is felt strongly; here, urban sprawl rules as the dominant typology (Hurley, 2017). San José is located in the Bay Area, about 50 miles south of San Francisco (City of San José, CA<sub>4</sub>, 2018). It has a Mediterranean climate with hot, dry summers and mild, rainy winters with about 300 days of sun per year. Before the 1960's, San José was a relatively small city that consisted of farms and orchards, taking advantage of the fertile valley soil and great weather. The urban center was surrounded by close knit walkable neighborhoods

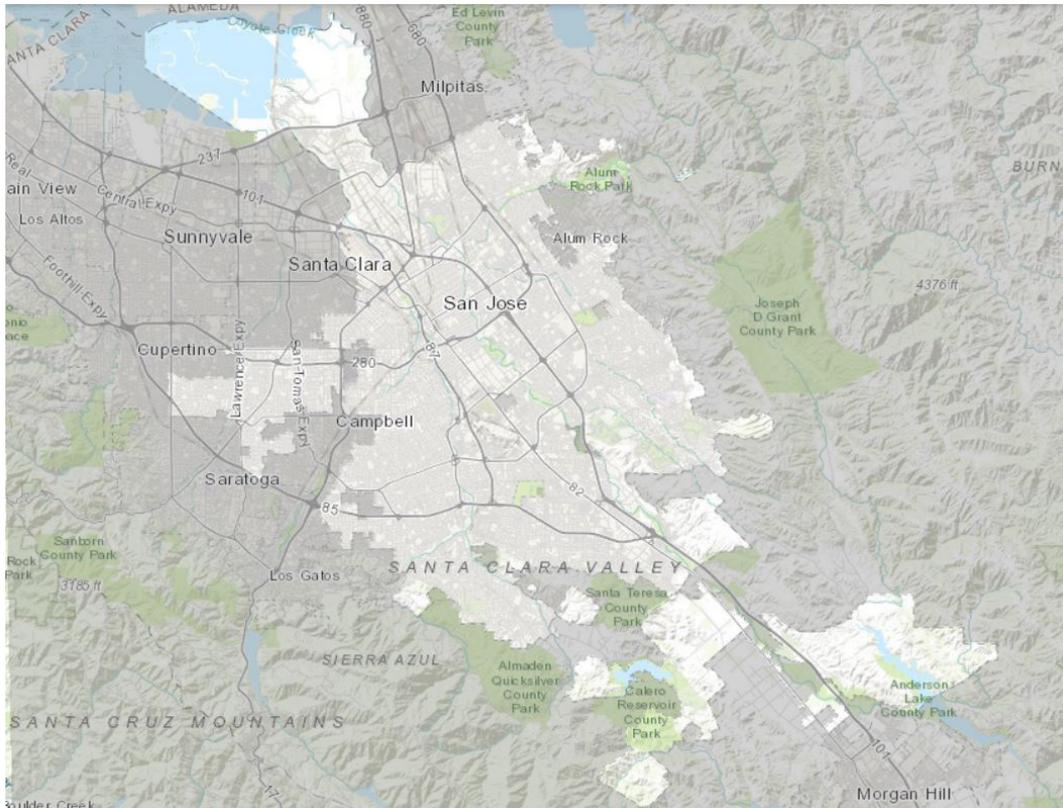


Figure 2: San José City Boundary

accessible to downtown.

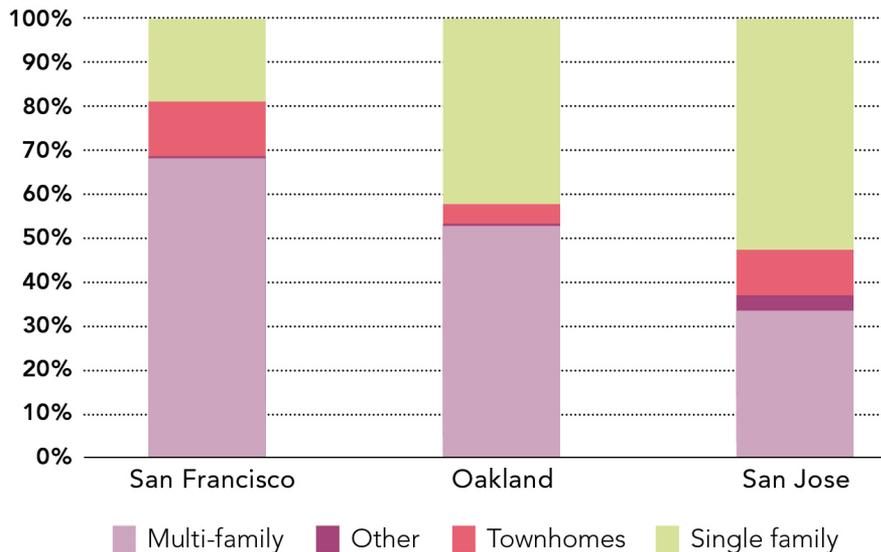
By the 1960' and 1970's San José became one of the fastest developing cities in the country (City of San José, CA<sub>3</sub>, 2018), changing directions from agricultural industry to a technology driven economy. An external report by San Francisco Bay Area Planning and Urban Research Association (SPUR), written in 2017 states that: “Since 2010, every county in the Bay Area has added substantially more jobs than housing. While existing residents have taken some of the new jobs, the region still hasn't built enough housing for new workers in an already limited housing market” (Figure 3). Although San José has plans to add more density; residential neighborhoods that make up a bulk of the city will remain broadly unchanged (City of San José, CA<sub>3</sub>, 2018). This is important when thinking about potential solutions for the housing shortage because according to the SPUR Report, “San José has the greatest share of single-family homes compared to other big cities in the Bay Area” (Figure 4).

Recent projections expect continued growth for the city but constraints of land availability, the need for public services and fiscal and environmental



“Change in total jobs and total housing units by county between 2010 and 2015.”

Figure 3: SPUR Report Jobs vs Housing Chart



“Percentage of 2015 housing stock by type of housing. San Jose’s share of single-family homes is larger than San Francisco’s or Oakland’s. In absolute terms, San Jose has over 30,000 more single-family homes than the two other cities combined.”

Figure 4: SPUR Report Housing Types Chart

factors put strain on the system (City of San José, CA<sub>3</sub>, 2018). The city currently has a population of around 1 million people and is known as the heart of the Silicon Valley and a hub for technological advancement; it is also one of the most expensive places to live in the country (Kiersz, 2018). **Figure 5** shows a view of San José from City Hall.

Low density residential zoning currently makes up about 48% of all land use zoning in San José (determined from San José GIS Data). Unless changes occur to alter current land use planning strategies, that is not likely to change in the next few years (**Figure 6**). ADUs can fulfill a need by providing infill in these low density areas; the role that ADUs play in the context of the city scale is



Figure 5: View of San José from City Hall

demonstrated in **Figure 7**. The City’s General Plan states that “A Major Strategy of the Envision General Plan is to focus new growth capacity in specifically identified “Growth Areas,” while the majority of the City is not planned for additional growth or intensification. This approach reflects the built-out nature of San José, the limited availability of additional “infill” sites for development compatible with established neighborhood character, and the emphasis in the Plan Vision to reduce environmental impacts while fostering transit use and walkability” (City of San José, CA<sub>3</sub>, 2018). Although viewed as a positive tool to densify, only 500 Accessory Dwelling Units would be constructed between 2017 and 2022 according to a 2017 memorandum for the Affordable Housing Investment Plan (Morales-Ferrand, 2017). ADUs are a relatively new type of formalized development. The slow rate of implementing these units can be



Figure 6: San José Low Density Residential Zones

attributed to the high cost of permitting, which can cost a staggering \$20,000 per unit, in addition to the high up front cost of construction (Kendall and Murphy, 2018; Nava, 2019). The City of San José and Santa Clara County are both working to reduce barriers for ADU construction but have not reached any final solutions to help homeowners easily develop these units to the extent needed based on current housing demand.

A concern that is not considered is if these units do become widespread across San José or even more broadly across the west coast, what is the potential impact of that added density? ADUs are associated with low density, this means that ideal ADU development areas tend to have less impervious surfaces and are able to infiltrate larger volumes of stormwater runoff than areas that are more densely populated. ADUs may be less environmentally significant than large multi-story apartments, but still have the potential to impact the existing processes and infrastructure. Currently ADUs are not considered to have a substantial environmental impact; in fact they are touted as an environmentally conscious housing option due to their small footprint and low energy consumption compared to full sized units (Brown, 2014; Morales, 2018). There has been little research done on environmental impacts of ADU development at the citywide scale. Potential negative impacts of added development can profoundly impact our environment. Added ADUs have the potential to increase peak energy demand and intensify stormwater runoff, these problems become more extreme as the impacts of climate change become more intense. The increased built areas (rooftops, added parking, driveways etc.) and conversion of green space to impervious surfaces exacerbate urban island heat effects and increase energy needs. In addition, more extreme temperatures and intense storms expected with climate change are likely to inundate existing stormwater infrastructure. The added load of wide-spread ADUs without the implementation of sustainable measures, may add to the strain on the existing systems if current regulations do not change. These added strains on the urban environment may seem small when considering a single unit, but imagine the effects multiplied by minimum of 500 units expected by 2022.

San José and many other cities across the west coast are still trying to find ways to streamline the development process for ADUs. A key question that this study seeks to answer is:

***How can sustainable, adaptive policy reduce financial barriers for ADU construction and address environmental concerns that may follow wide-spread implementation of these units in San José?***

This project uses case studies to evaluate how other municipalities have addressed ADU barriers and development. It also looks at potential negative effects that these additional units may have on the city as a whole when widely implemented. Generating sustainable design tools and developing policy recommendations for San José targets potential solutions to streamline ADU development and preemptively reduce negative environmental impact at the site and city scale.

This project evaluates regulations and barriers on Accessory Dwelling Units and aims to generate solutions for sustainable, affordable growth. Newer state laws effective January 1st, 2017, help to address the high costs associated with ADU development that dissuaded many homeowners from building an ADU, like the added cost of utility fees (Hughey, 2018; Pender, 2016). Even though some barriers have been reduced, another question to consider is: do people know that ADUs are an option in San José or should education be a priority for the city moving forward with their ADU program?

The agenda to mitigate negative impacts of these developments while striving for sustainable housing options aligns with the city's general plan: Envision San José 2040 and the Climate Smart San José initiative specifically the "protection of neighborhood character, reduction of automobile dependency and the City's aim to reduce vehicle miles travelled (VMT) per capita, and the creation of new, vibrant, urban districts" (City of San José, CA<sub>1,3</sub>, 2018). The top priority from the city is to mitigate stormwater runoff, utilize clean renewable energy and reduce of peak energy consumption. (City of San José, CA<sub>1,5</sub>, 2018). Recent updates of San José's ADU requirements (July, 2018) show the desire to push for more implementation of Accessory Dwelling Units as a lower cost, flexible housing option that is more financially attainable for older residents on fixed incomes and young professionals.

### ***1.3 Project Scope***

There is a lot of complexity to adding housing to our cities. Public investment tends to lend itself to higher density forms (more housing units per acre), however, we need a variety of solutions (the full range of housing types) to combat the problem. The growing need for new housing options in San José in the midst of sustainable initiatives such as the State's NetZero action plan

# Where Do ADUs Fit?

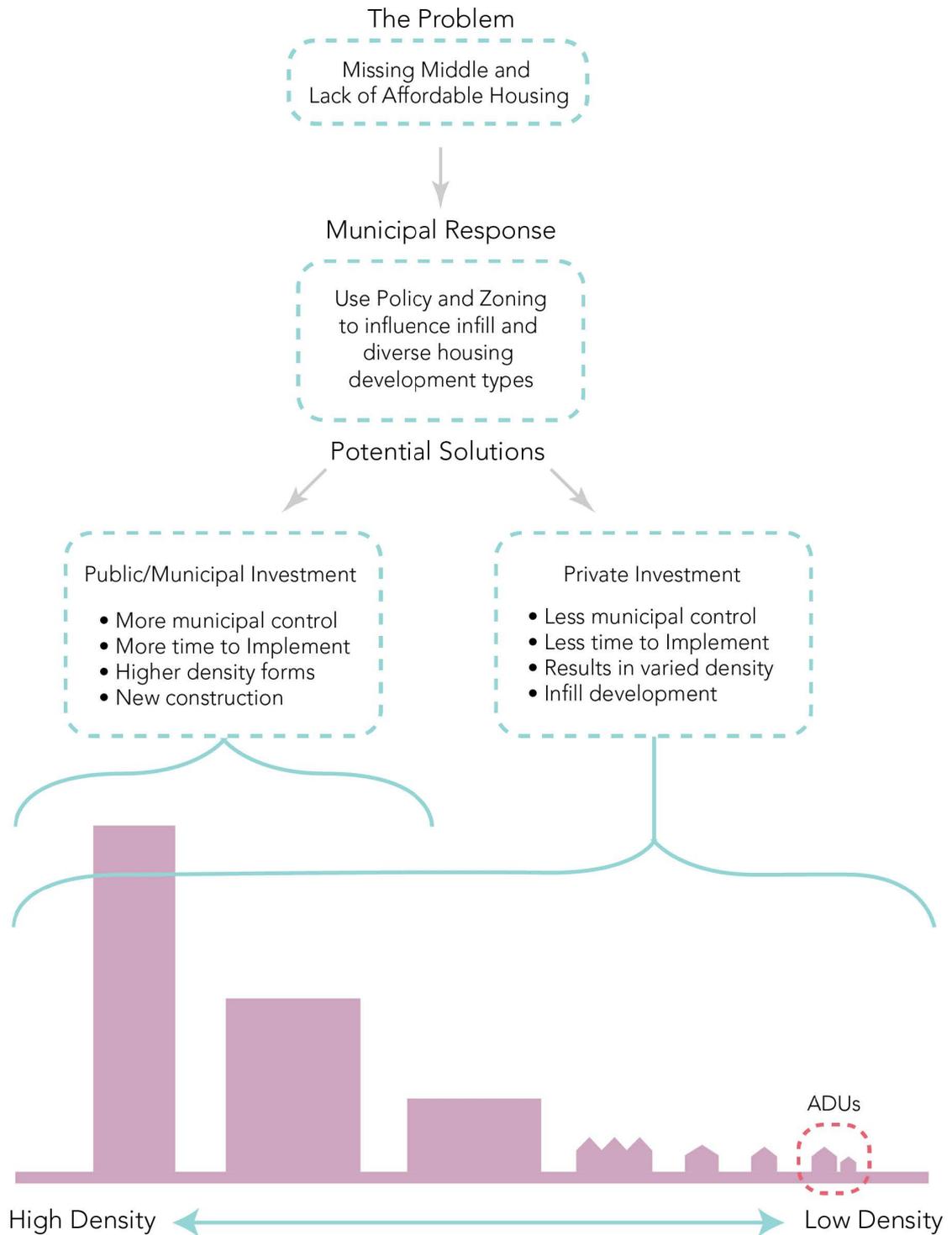


Figure 7: This diagram shows the role of ADUs in the greater context of densification

and long term climate action goals intensifies the potential of ADUs to rapidly change the fabric of low density urban neighborhoods. If Accessory Dwelling Units become common in areas that are currently low density, what are the larger ramifications that can be expected?

This project seeks to understand the on-the-ground impacts of adding an ADU to a typical lot in San José. I then compare the same lot containing a sustainably built design. This project intends to develop strategies that make sustainable ADUs more financially accessible to homeowners. Current barriers prevent the widespread potential proposed by the state, however if barriers are reduced and wide-spread ADU development does occur, would changing the current requirements reduce negative environmental impacts? By multiplying the effects across a percentage of single-family lots that meet current code requirements we can infer the impacts of a sustainable ADU development pattern at the city scale.

Case studies are used to understand what other cities are doing to reduce barriers and make Accessory Dwelling Units more sustainable and resilient to climate change. A goal of this study is to understand key benefits and concerns surrounding ADUs from a municipal standpoint by surveying municipal departments to determine the main barriers for ADU development and sustainable design implementation. Concerns and priorities of residents will also be taken into consideration through surveys; this information will be helpful to further refine policy recommendations specific to San José. By assessing both the individual taxlot parcel and city-wide scales, with a focus on the added energy demand and stormwater implications, a design “toolkit” that provides sustainable intervention options to mitigate impacts of highest concern. This project questions the potential city-wide impacts of ADU implementation and if those impacts can be mitigated through design and policy changes. A question that arises when looking at ADUs as an infill strategy: is the added amount of density worth it for the City to incentivize?

Looking at the issue of ADUs broadly, a major constraint residents face when developing an ADU is Proposition 13. Passed by voters in June 1978, Prop 13 is an amendment to the California Constitution that was originally put into place to keep property taxes affordable for homeowners. It establishes the concept of “base year value for property tax assessments, and limitations on the tax rate and assessment increase for real property” (County of Santa Clara, 2016). The reassessment of property value that occurs after the development of Accessory Dwelling Units may affect taxes for those homeowners who have resided in their homes for longer periods under proposition 13.

“Proposition 13 provides three very important functions in property tax assessments in California. Under Prop 13, all real property has established base year values, a restricted rate of increase on assessments of no greater than 2% each year, and a limit on property taxes to 1% of the assessed value (plus additional voter-approved taxes). Once Proposition 13 passed, property assessments for the 1978-79 fiscal year were required to be “rolled back” to 1975-76 values, establishing the first base year values in California. Properties that have not sold or undergone new construction since February 1975 are said to have a 1975 base year value.

When a change in ownership occurs, whether full or partial, real property is re-assessed at its current market value as of the date of transfer. This establishes a new base year value for both the property’s land and improvements.

When new construction occurs, it is re-assessed at current market value as of the date of completion. This establishes a new base year value for the property’s newly constructed improvements only.” (County of Santa Clara, 2016).

Because of the extremely high market value of real estate in the bay area, many long-time residents simply cannot afford the increase in taxes that construction of an ADU will bring, especially if the unit is intended for a friend or family member who may not be renting the unit at market rate. Long-time property owners who have not made significant changes to their property since the initial purchase may be heavily burdened with the subsequent impacts of development. The very measure aiming to maintain affordable housing is in itself a barrier but will not be addressed further in this study.

Another constraint to keep in mind is that these units are built on private property and will not be implemented unless there is interest from the homeowner. Because these units are privately funded it takes pressure off of the City to provide relatively quick-to-construct housing options. For this reason, considering greater incentives for residents to build ADUs may further grow this synergic relationship for housing development.



# 2

## FOUNDATIONAL RESEARCH

### ***2.1 Methods Overview***

The research for this study utilized both qualitative and quantitative methods to analyze and evaluate the final guidelines. There are very few peer reviewed journal entries on Accessory Dwelling Units as they are a relatively new formal housing type. The following methods and steps were used to develop sustainable ADU design for San José. To answer my research question I needed to understand the two forces that impact ADU development: Cities and residents. Methods are broken down in to clear groups in [figure 8](#).

- Case studies were used for researching existing ADU policies from different municipalities for ADU development.
- A pilot study in Eugene, OR, was conducted to test my research design and approach.
- Surveys directed to municipal planners and the public were performed to identify the qualities for a final projective site design that demonstrate new potential code requirements and sustainable technologies.
- Spatial analysis using ArcMap was performed to identify eligible taxlot parcels in low density single-family zones in San José and to develop site typologies that are most suitable for ADUs.

- Two site design proposals were made and their environmental performances (e.g. on-site stormwater treatment and energy savings) were assessed.
- Based on the precedents and my site design proposal, I made policy recommendations for ADU development in San José.

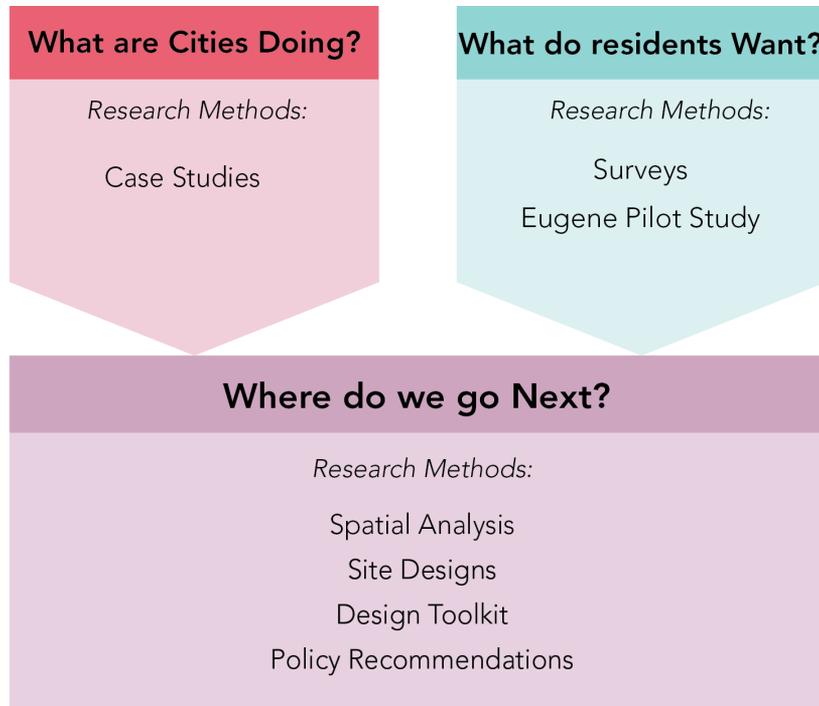
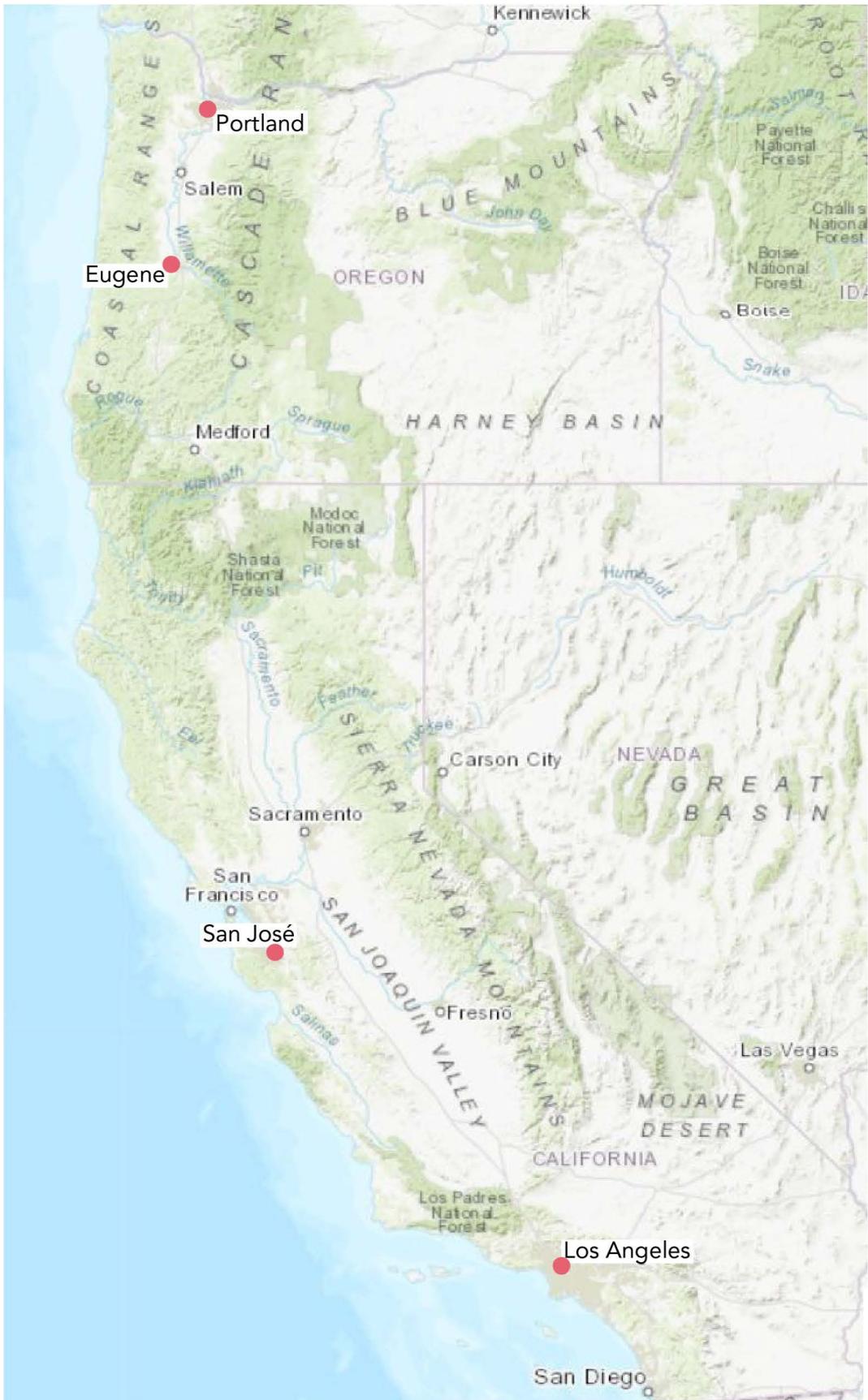


Figure 8: Methods Diagram

## 2.2 Case Studies

The intention of each case study is to gain a clear view of what other cities are doing with their ADU programs and what areas are successful. Understanding the current strategies of reducing barriers will aid in determining best practices for San José. Los Angeles, CA, Portland, OR, and Eugene, OR (Figure 9) were selected based on municipal survey responses sent to multiple cities across the west coast, current policy and location. Table 1 shows a comparison of the ADU policies in these 4 cities.

Figure 9: West Coast Context Map



## ***Los Angeles, CA***

Los Angeles (LA) is the largest city in California and is iconic for its idyllic weather, thriving entertainment industry, beaches and cultural diversity. Los Angeles has a population of about 4 million people and is situated between the Pacific Ocean and the San Gabriel Valley foothills. The state laws that require the allowance of ADUs on single family lots offers options to the large city in desperate need of housing (Chiland, 2018). A municipal employee confirms the importance of ADUs stating that “the City of LA has done a lot of work to reduce regulatory barriers and help Angelenos understand how to build ADUs. ADUs are one important part of the housing solution by increasing supply in constrained housing markets.” Although Los Angeles is not currently a leader in ADU policy, it is important to recognize that San José and LA are reacting to the same political climate. As housing needs grow in these large cities, new methods are needed to accommodate growing urban populations. One incentive that stands out in Los Angeles is their “LA County ADU Pilot Program” approved in 2017. The goal is “to create an ADU pilot program that:

- Streamlines the permitting process
- Provides technical assistance to homeowners
- Provides financial incentives for preserving and constructing Accessory Dwelling Units in exchange for housing homeless families/individuals

This program will provide three homeowners in unincorporated LA County with a forgivable loan of \$75,000 to construct an ADU that will house people transitioning out of homelessness, for a minimum of ten years. [Their] role has been to develop and manage the homeowner selection process and guide homeowners through[] the process of financing, designing, permitting, and constructing an ADU on their property (LA Mas, 2019).” This may or may not be the solution for San José but shows the creativity possible to lessen or alleviate the financial strain of ADU construction for many homeowners.

## ***Portland, OR***

The nations Accessory Dwelling Unit leader (Brown, 2014), Portland, Oregon is a helpful case study to observe because the program is already well defined by the city and utilized by residents. The city has about 650,000 residents

and is located along the Interstate 5 corridor and the confluence of the Willamette and Columbia Rivers just south of the Washington State boarder. The city is known for its eclectic charm, its many options for outdoor recreation and rainy winters.

Portland, Oregon has a thriving ADU community and is actively looking for new ways to streamline the development process. In Portland, the size of the second unit is not dictated by the lot size but by the size of the existing unit; because Portland had smaller blocks and lots, this requirement makes a big difference in the accessibility of construction for many homeowners. The city has also waived Standard Development Charges (SDC), which can also provide substantial cost savings. Accessory Dwelling Units are widely touted as a sustainable development option based on the smaller footprint of the units. However little research has been done with respect to sustainable practices to ADU development and the potential outcomes in cost and ecological function. Even in Portland it is currently up to the individual home owners to incorporate environmentally conscious systems such as passive heating and cooling, solar panels and green roofs. Portland does provide opportunities for homeowners interested in ADU construction to learn about energy efficient construction options according to a city employee.

An extensive study is currently being conducted in Portland looking at similar issues to this study (The Institute for Sustainable Solutions, 2019); overlaps in the two studies include emphasis on affordable housing options, ADUs as drivers of equity in housing and increasing financing options for homeowners, streamlining the processes for designing, financing and permitting Accessory Dwelling Units. The Institute for Sustainable Solutions conducted a survey of ADU owners and renters of ADUs in Portland to better understand the process of designing, financing and constructing the units as well as the long terms uses, and published a report of their findings in June 2018. The study suggests that although the city has incentivized ADUs since 2010 and the number of permits issued has greatly improved, many of the approved permits did not result in completed projects. This suggests that even without the high cost of permits and fees, there are still many hurdles to cross before ADUs become wide-spread (The Institute for Sustainable Solutions, 2018).

Looking closer at the requirements that Portland uses to regulate development, the lack of parking requirements is noteworthy. The City of Portland is currently looking to reduce vehicular travel and strongly encourages walking, cycling and use of the extensive public transportation systems (Portland Bureau of Transportation, 2015). The lack of additional parking during ADU construction is one way to promote lower Vehicle Miles Traveled (VMT), as ADUs have the potential for low impact urban infill in areas that are already served by existing

infrastructure. This is an important factor to consider as added off-street parking on an already small urban lot adds a large amount of impermeable surface and at a broader scale may exacerbate traffic and street side parking that is already a nightmare in San José.

## ***Eugene, OR***

Eugene is the third largest city in Oregon, with a population of about 160,000, just smaller than the state capital, Salem. The city is situated at the southern end of the Willamette Valley along the Interstate 5 corridor and the Willamette River. Eugene has a similar climate to San José with long dry, summers and wet winters. The city is home to the University of Oregon and is known for outdoor recreation opportunities. Eugene’s environmentally minded values come through in the city’s’ planning goals. Like all cities in Oregon, Eugene has an Urban Growth Boundary (UGB) – A boundary dictating urban areas and the land-use within it. In 2017, Eugene adopted a new comprehensive plan to address land-use development and planning objectives that articulate the cities goals and policies (City of Eugene2, 2017).

“The Envision Eugene Comprehensive Plan translates the values of [the] community into land use policy. Some of those values come from [the] local community, articulated through the Envision Eugene pillars.

- Provide ample economic opportunities for all community members
- Provide housing affordable to all income levels
- Plan for climate change and energy resiliency
- Promote compact urban development and efficient transportation options
- Protect, repair and enhance neighborhood livability
- Protect, restore and enhance natural resources
- Provide for adaptable, flexible and collaborative implementation (City of Eugene2, 2017).”

Outside of the comprehensive plan Eugene shows an interest in closing the gap in housing supply and demand, specifically what the city refers to as “The Missing Middle”. The Missing Middle refers to duplexes, triplexes, cottages, row houses, and other smaller multi-unit attached and detached housing types that

were historically common planning typologies (Figure 10).

“Today, cultural and demographic changes have created interest in using Missing Middle housing to:

- Respond to the demand for walkable urban living
- Create more options for smaller dwellings
- Increase ownership options
- Respond to shifting demographics

Nationally and locally the population is getting older, households are smaller, and family types are more diverse than in previous decades. Housing is also becoming less affordable to people of middle income. Thus, the existing single-family housing stock should evolve to meet the changing needs [of the community]” (City of Eugene<sup>3</sup>, 2017). Accessory Dwelling Units can potentially fill some of these gaps for the city.

Eugene has a fairly young Accessory Dwelling Unit program; only 2 total permitted units have been developed since the inauguration of the new program was pushed through by Oregon Senate Bill 1051 in 2017 (Eugene Municipal Survey Response, 2019). Prior to that Eugene maintained a strict ADU policy and very few units were permitted (Strategic Economics, 2019). Although the city is still slowly easing into ADUs, the program is starting to take shape with goals such as: providing affordable housing, increasing urban density while maintaining Eugene’s Urban Growth Boundary (UGB), and diversifying housing types including intergenerational housing options. Maintaining urban tree canopy and pervious surfaces for stormwater runoff are important to the City of Eugene and as new ADU requirements are implemented in the city, they must be considered. Recognizing Eugene’s goals for added density while maintaining its natural resources, observing the city as it develops its ADU program to suit these goals may be a helpful tool for updating San Jose’s program sustainably.



Figure 10: Missing Middle Housing Diagram

## ***2.3 Eugene Pilot Study***

In fall 2018, Danielle Valdez, Martha Wassweiler (OU Students), and I ran a small pilot study in Eugene to gain a deeper understanding of the benefits, concerns and impacts of ADU development in cities. The study was in connection with the Urban Sustainability course over fall term with Yekang Ko and Scott Altenhoff as project supervisors. The pilot study focused on three Eugene neighborhoods and helped to identify some potential barriers early on in the research. Our goals for the Pilot Study were to 1) explore different ADU types, 2) to define possible sustainable approaches that can be applied to Accessory Dwelling Units in Eugene and 3) research various Eugene neighborhood typologies and determine which ADU types would suit the character of our chosen neighborhoods. A key to the third goal was to utilize the flexibility of ADUs to fit the needs of individual neighborhoods and address benefits and concerns.

### ***Benefits and Concerns***

Early in the research we were able to pinpoint generalized benefits and concerns regarding ADU development for individual homeowners through website review; these were not directly connected to Eugene but were common themes from homeowners in cities where ADU development is introduced. Probable benefits for homeowners included: potential for passive income, increased property value, increased housing density while maintaining neighborhood character, cheaper/flexible housing options for homeowners and renters. Similar lists are commonly cited on municipal and ADU information websites (Eugene CAN, 2019; Brown, 2014; City of San José<sub>7,8</sub>, 2019) with varying levels of research included to back up claims. Accessory Dwelling Units can be a contentious topic in some neighborhoods and pushback is not unheard of. Common concerns for homeowners include reduced privacy, increased traffic and parking issues, “undesirable” tenants, added noise and a negative change in the neighborhood quality. Traditionally, single-family neighborhoods are known to be resistant to added density; but in recent years policy makers are turning to these low density areas for new zoning and urban development projects as housing needs increase (Schneider, 2018; Kirk, 2018).

Although low density single-family development may not fit with the

# ADU CODE COMPARISON MATRIX

<b>Code:</b>	<b><i>San José</i></b>	<b><i>Los Angeles</i></b>	<b><i>Portland</i></b>	<b><i>Eugene</i></b>
Minimum Lot Size or EU Requirements	3,000 sqft	N/A	Existing Unit must be greater than 1,400 sqft	6,100 sqft Flag lots must be greater than 12,500 sqft
Maximum ADU Size (or range)	600-900 sqft dependent on lot Size	1200 sqft dependent on ADU type or 50% of existing living space (whichever is less)	<75% of Existing Unit living area or 800 (sf)	800 sqft, unless occupying the full story of a multistory structure.
Zoning Requirements	R-1, R-2 ,PD ,R-M Zoning Districts	Single Family Residential Zone	Residential, Commercial, and in the Central Employment (EX) zone	AG, R-1, R-2, R-3, R-4 and S-E
Setbacks form Side or Rear Property Line	1 story: 0 feet Conversions: 5 feet	5 feet from property line, 10 feet from Existing Unit	40 feet from a front lot line or behind the rear wall of Existing Unit	5' setback, 6' gap between structures
Lot Coverage Allowance	No more than 40% of rear yard	N/A	No more than 15% of total site area	10% Total lot or 800 sqft
Number of bedrooms	Under 800 sqft: Studio or 1 bed, 800 sqft or more: 2 bedrooms	N/A	N/A	2 maximum
Design Standards	Visual Compatibility with Existing Unit	N/A	Visual Compatibility with Existing Unit	The primary entrance to an ADU shall be defined by a roofed porch.
Parking Requirements	ADU requires 1 Parking Space - Unless property qualifies for exemption	One spot needed if Existing Unit location does not fit defined criteria (i.e. if site is within .5m of public transit)	No additional Parking is required	One off street parking space must be provided
Yard Paving	No more than 50% paved (permeable or impermeable)	N/A	N/A	A 3 foot hard surface walkway is required from the street or alley to the primary entrance of the ADU
Maximum Height	single story: 18 feet, 2 story: 22 feet	N/A	N/A	15 feet if located within 20 ft. of a property line
Owner Occupancy & Short Term Rental	N/A	N/A	Short term allowed, Accessory Short Term Rentals (ASTR) may not waive Service Development Charges (SDC)	Owner must occupy either the ADU or primary dwelling

modern notions of sustainable development (Campbell, 1996; Condon, 2010), it is important to acknowledge the qualities, amenities and lifestyles that many people find desirable when choosing to live in a low density neighborhood. These qualities vary in each city and neighborhood but may include safety, minimal noise, less traffic, privacy and the freedom of controlling one's own space. ADUs offer the option of easing-in to denser development typologies with the added benefit of each homeowner having control of the tenants with whom they share their property.

Looking at Portland as a case study we were able to determine that generally, loss of parking, undesirable tenants, added noise and negative change in neighborhood quality were not supported by literature (Brown, 2014). The issue of parking is especially notable in debates surrounding Accessory Dwelling Units, however research shows that “whether ADUs are a good or bad policy for community development, there is absolutely no evidence they cause parking problems. Because ADUs are extremely rare (Portland, the nation's ADU “leader,” has them on less than 1% of eligible lots), and because ADU households have fewer cars than other households, ADUs should have virtually no effect on parking conditions on a citywide basis” (Brown, 2014). The concern of privacy was found to be situation dependent, the homeowner has control over the property and tenants to nurture a comfortable environment.

Appraising the challenges faced by homeowners looking to develop ADUs in Eugene. The cost of development is only one of many barriers. As seen in the Eugene municipal ADU requirements in **Table 1** the lot size is a potential obstacle for homeowners; at 6,000 square feet, Eugene lot requirements are the most restrictive of all of the case studies. This not only makes development challenging for residents whose property may not meet the requirements but reduces the overall potential impact that ADUs can make in the housing market. Current parking requirements and owner occupancy rules also impact the feasibility of development for many residents.

## ***Sustainability Factors***

Adding sustainable technologies and environmentally conscious development practices, as the potential to improve the already sustainable model of Accessory Dwelling Units. Many of these technologies have a higher

upfront cost but have the potential to pay for themselves over time through energy savings, and other resources conservation. We briefly looked into a small number of options for Eugene including physical products such as solar panels, permeable pavers and greywater recycling systems and options like deciduous tree shading and southern exposure. The City of Eugene showed particular interest in potential impacts of placing ADUs on taxlots due to the potential for existing tree loss. This concern led us to investigate the many ADU types that may have less impact (Figure 11).

## ADU TYPES

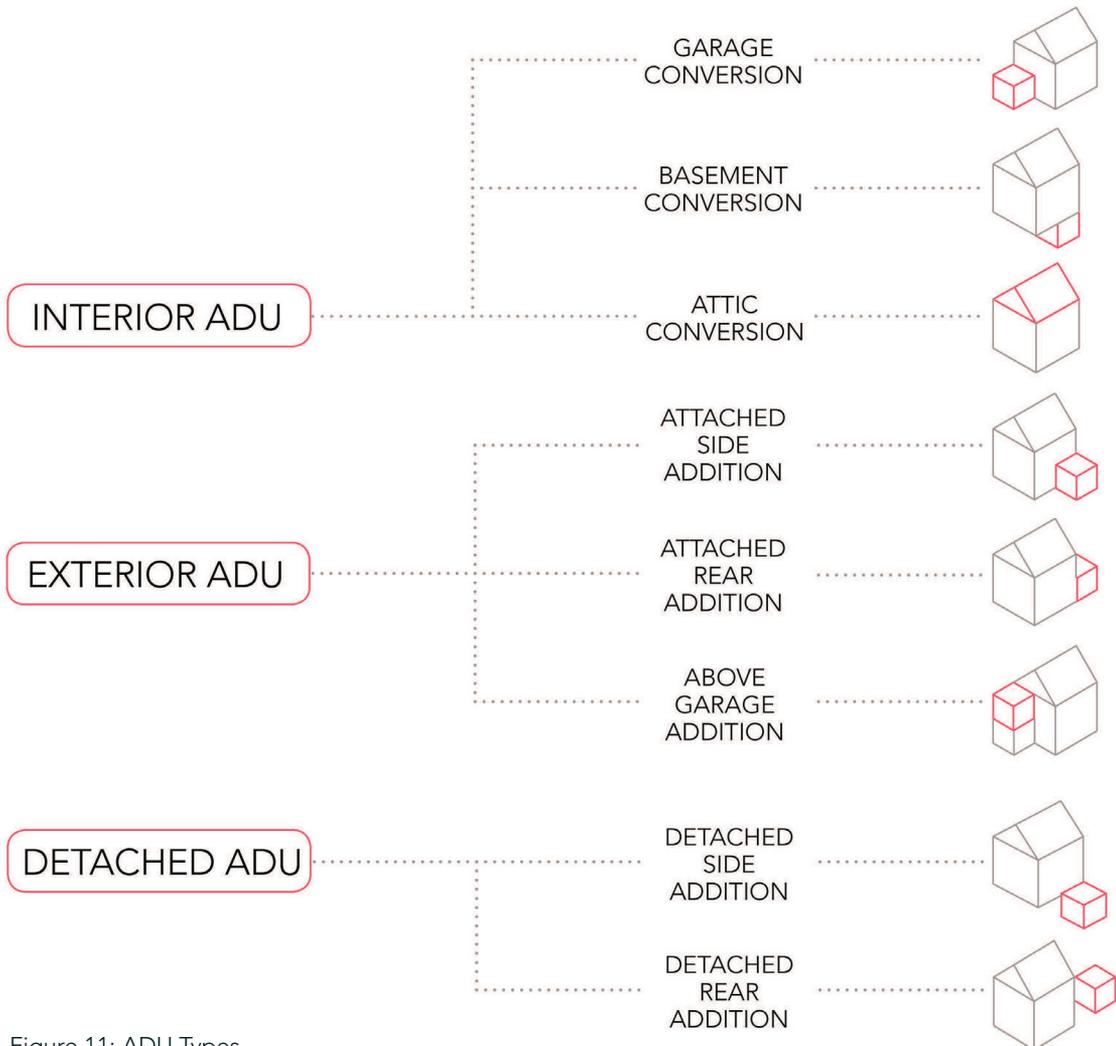


Figure 11: ADU Types

## Choosing Neighborhoods

We used the 2011 census data to select three neighborhoods in Eugene (Figure 12) close to the university and downtown. We looked for a diverse range of ages and occupancy types and determined that the Whiteaker neighborhood, Amazon neighborhood and Friendly neighborhood gave us a wide range of diversity while remaining close to downtown and the University of Oregon campus and accessible to public transit. Increasing density near transit stations is important because it allows incoming residents to use a more gas efficient modes of transportation (Condon, 2010). Each neighborhood is home to a range of ages and housing types, these differences show the versatility of ADU's and their ability to be customized to unique environments.

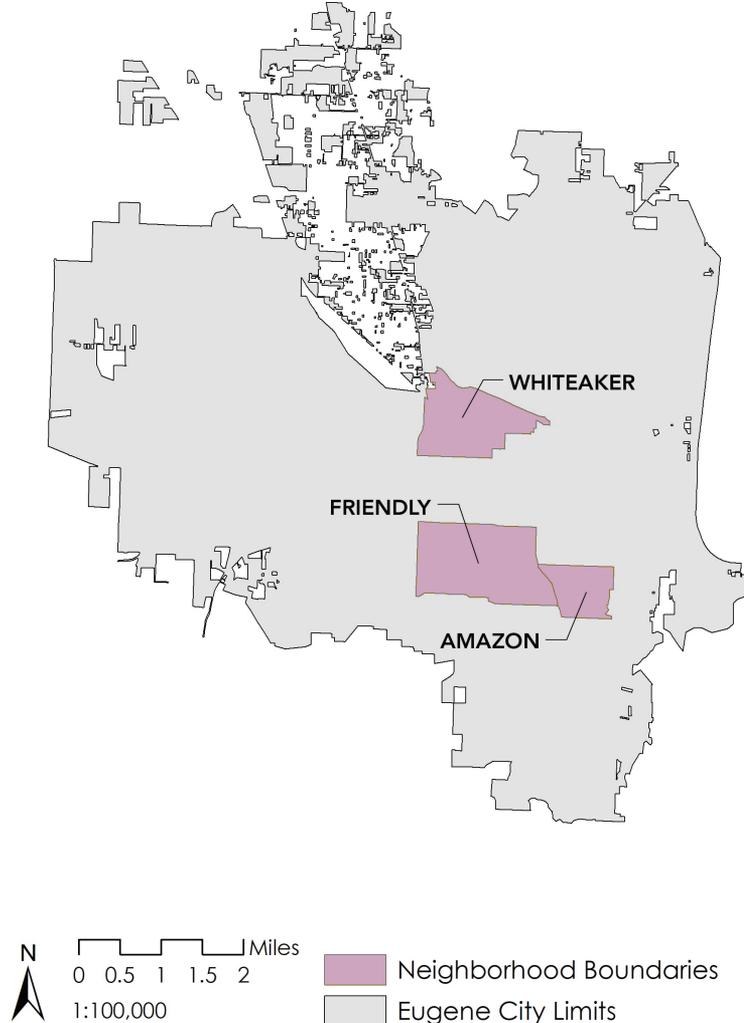


Figure 12: Eugene Neighborhood Choices

#### Amazon:

Amazon neighborhood has a high concentration of student aged residents and the neighborhood is equally split between renters and owner occupied households. ADU's in this neighborhood would be able to provide student housing that blended in with the rest of the neighborhood and provided added income to residents. With more than half of the neighborhood low-density residential we recommended the interior ADU Type for the Amazon Neighborhood.

#### Whiteaker:

ADU's in the Whiteaker neighborhood can help densify housing without building large apartment complexes, allowing the Whiteaker to maintain its artistic and diverse character. The Whiteaker neighborhood has a broader range of ages than the other two choices and is over 80% renter occupied. There is a mixed range of residential development densities which we felt lends itself to potential exterior ADU development types.

#### Friendly:

ADU's in the Friendly neighborhood provide a flexible housing option for families. An ADU can easily transition from being a secondary income, to providing extra space for a family, and finally allowing elderly relatives to live nearby. Because a vast majority of the neighborhood is low-density residential, we recommended the detached ADU type.

Through spatial analysis in ArcMap we were able to determine the approximate number of lots that meet current city requirements. We determined suitable lots based on current ADU codes in Eugene using GIS. First we selected R1 and R2 zoned lots in our chosen neighborhoods, we then selected lots that fit the size criteria of 6,000sf or more (up to 50,000sf). 2,960 lots within the three neighborhoods were suitable for ADU development seen in [Figure 13](#).

To understand mass transit possibilities, we extracted ADU suitable lots that are within a quarter mile radius of LTD stops; the majority of lots were within walking distance from transit and we concluded that the city may waive off street parking requirements in these areas to reduce impermeable surfaces without upsetting current parking ratios. Two-thousand nine-hundred and thirty (2,930) total lots were found to be within the quarter mile radius.

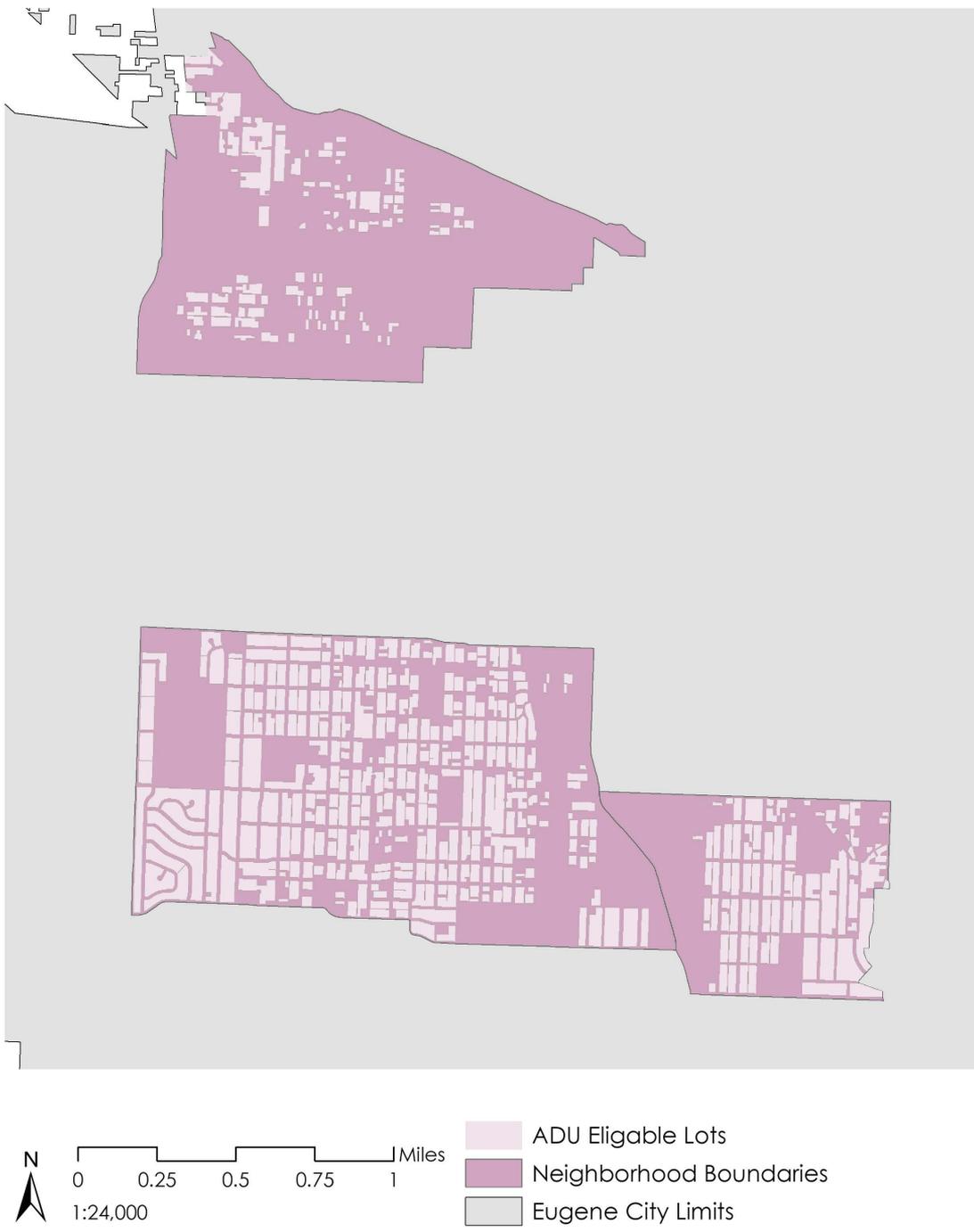


Figure 13: Eugene Potential ADU Lots

## ***Eugene Survey***

After examining the analysis process with GIS and census data we hoped to understand the neighborhood characteristics at a finer grain through a survey process. We developed a survey to be sent out to our chosen neighborhoods, we then contacted the neighborhood associations to see if they would be open to distributing the surveys through their social media outlets to reach a wide audience. Information gathered from the surveys could be used to further identify typologies and customize ADU types and sustainable technologies to the individual communities; however we received a great deal of pushback from the neighborhood associations as we drew to the end of our study.

Community involvement is difficult and takes time to develop trusting relationships with communities. Bridging the gap between fact and fiction when it comes to Accessory Dwelling Unit development takes time and following the lead of cities like Portland may help change perceptions. Transparency on both sides can help reduce communication barriers and establish trusting relationships within the community of interest. There was also a strong emphasis on the need to involve the neighborhood association earlier in the process and get their approval on questions to be sent out. Unfortunately the study period was short, from late September to early December but we believe that with more time some of the concerns could be resolved. Because of these setbacks we were unable to resolve some of the finer grain needs of Eugene's ADU program but we learned a great deal about the contention that can surround ADUs.

## ***Conclusions and Recommendations for Eugene***

Accessory Dwelling Units (ADUs) offer flexibility and increase housing options in low density residential neighborhoods and provide many benefits to the surrounding communities in which they are built. We know that the smaller footprint of these units offer environmentally conscious solutions to growing housing demand, these units are a potentially long term housing option for Eugene. We have learned throughout the course of this study the strong opinions surrounding Accessory Dwelling Units and the challenges faced when pushing for densification in Eugene.

Specific recommendations for the city of Eugene based on our research would be to remove owner occupancy, off street parking requirements and reduce the minimum lot size for ADU development. We believe that this would reduce barriers to homeowners looking to build ADUs on their properties.

Another important takeaway from this project was regarding interactions with homeowners and neighborhood associations; being clear about project parameters and scope as well as providing ample outreach opportunities to work through community needs. Offering tours of ADU properties as we saw in the Portland case study may be a powerful outreach tool to help communities understand true impacts of ADUs. Many of these recommendations are echoed in Strategic Economics report “Eugene Housing Tools & Strategies Evaluation” prepared for the city in January, 2019. (Strategic Economics, 2019)

## ***2.4 San José Surveys***

### ***Survey Overview***

To better understand the specific needs of San José residents, a survey was developed to determine the broad outlook on Accessory Dwelling Units. Two surveys were developed to distribute for this project.

The first survey - referred to as the Municipal Survey - consisted of 9 open-ended questions that asked respondents (municipal employees) to think about ADU development in their city. The survey collected broad information from multiple municipalities in relevant city departments to determine the challenges, benefits and possible environmental concerns that come with widespread ADU Development. The municipal survey was distributed through email and limited to members of relevant departments such as Housing, Planning, and Public Works. These questions helped unpack the needs of the different cities across the west coast, and was helpful for comparing the regulations and requirements of the respective city and help to clarify their priorities for ADUs. Because of the varying answers, all relevant municipal responses were incorporated in the case study portion of this project.

The second survey - referred to as the General Public Survey - was developed for the general public in San José and was meant to determine the publics’ knowledge and opinions on ADUs and the potential barriers keeping homeowners from constructing them. The general public survey consisted of 11 multiple choice, ranked order and open ended questions and was distributed as a digital link through neighborhood associations and social media such as Nextdoor and Facebook. During the early pilot study in Eugene it became clear that outreach is where Eugene needed to start to generate a successful ADU program. There are multiple factors that a homeowner must take into consideration before deciding to develop an ADU on their property. With current

regulations it can be inconvenient at best and frustrating at worst to wade through the process from start to finish. Those who may be in need of additional income or living space for family are often the ones who are least likely to have the capital to incur the cost of permitting and constructing and ADU. The results of the survey help to define overall challenges and needs relating to ADUs in San José and will guide the development of the final “toolkit” that is applied to the final designs.

## Survey Results

**Municipal Survey:** The municipal survey received 6 responses: Two from The City of San José, Two from Eugene, and one each from Portland and Los Angeles.

**General Public Survey:** The general public survey received 176 responses from residents in San José. Surveys were conducted throughout the month of January (2019), the seasonality and timing of the survey may have affected the results. See [Appendix A](#) for full results.

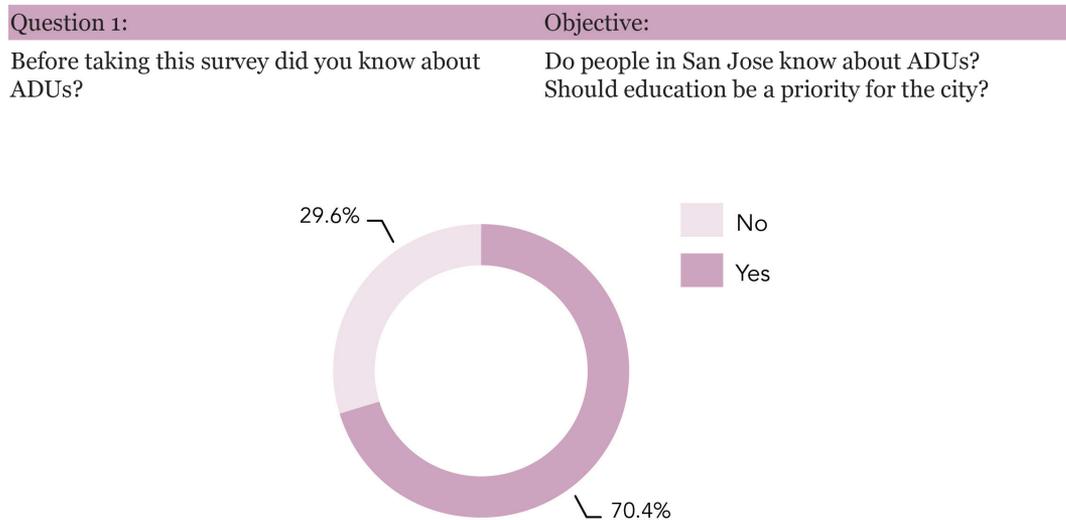


Figure 14: General Public Survey Question 1 Visualization

In question 1 (Figure 14) the response tells us that the city of San José does not need to focus a huge effort on education when it comes to ADUs, more resources should go to reducing barriers.

<b>Question 2:</b>	<b>Objective:</b>
Have you ever considered building an ADU?	Are people in San Jose interested in owning or living in an ADU?

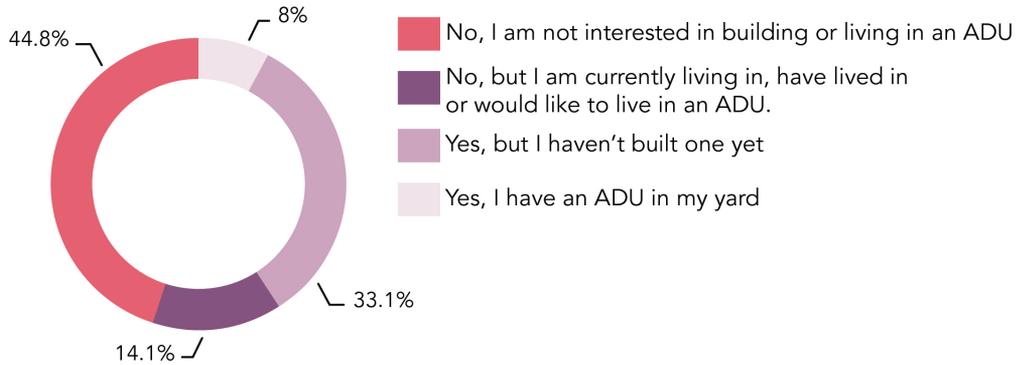


Figure 15: General Public Survey Question 2 Visualization

Responses for question 2 (Figure 15) show that more than 50% of San José respondents are interested in the idea of ADUs. It should be noted that respondents who selected “No, I am not interested in building or living in an ADU” were sent directly to question 10.

**Question 3:** **Objective:**

If you have or are seriously considering an ADU, what is your main motivation? (Ranked)

What is the biggest motivation to have an ADU in San Jose? Understanding the motivation could also help the city understand need for future housing development types.

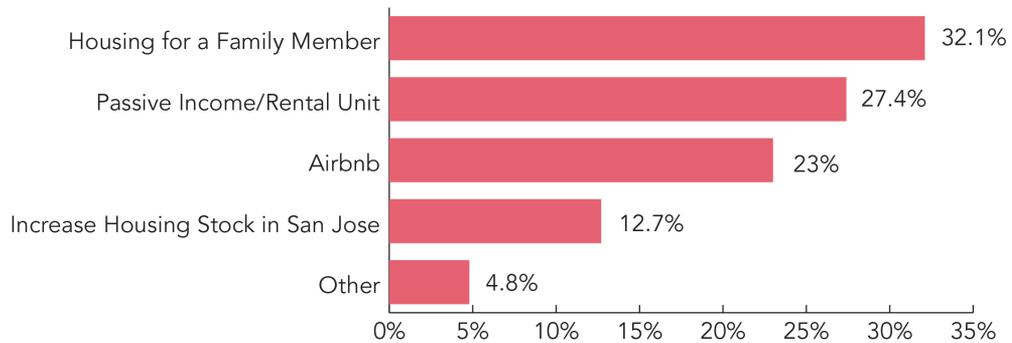


Figure 16: General Public Survey Question 3 Visualization

Responses for question 3 (Figure 16) reveal that housing a family member and using the ADU as a rental space both indicate longer term housing arrangements; more than 50% of respondents desired to have long term renters in an ADU. Airbnb is considered a short term rental and is often prohibited in municipalities ADU policies because it reduces the number of permanent housing options. The need or desire to house a family member illustrates the importance of ADUs as a resource for intergenerational families.

Question 4:	Objective:
If ADUs become prominent in your neighborhood, what would be your main concern(s)? (Ranked)	What concerns do residents have at the neighborhood extent if ADUs become widespread in San Jose?

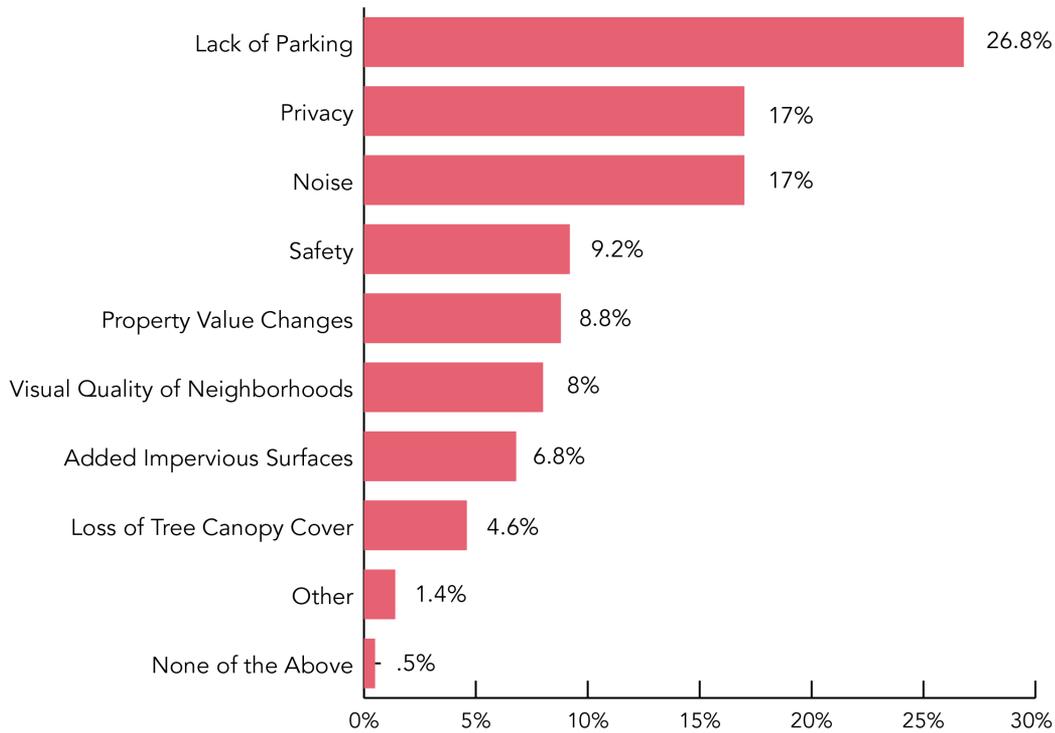


Figure 17: General Public Survey Question 4 Visualization

Question 4 in Figure 17 shows that the top concern for respondents was lack of parking, with privacy and noise as the main secondary concerns. Based on the open-ended question at the end of the survey, these conditions may already exist in the study area.

**Question 5:**

If you were to build an ADU, how would your tenants pay the utility bills?

**Objective:**

Reducing energy consumption is a main driver for this project, it is important to understand if greater energy demand and the cost of that energy is a concern for the homeowner. Consideration for how the utility will be divided indicates that it may be a financial concern.

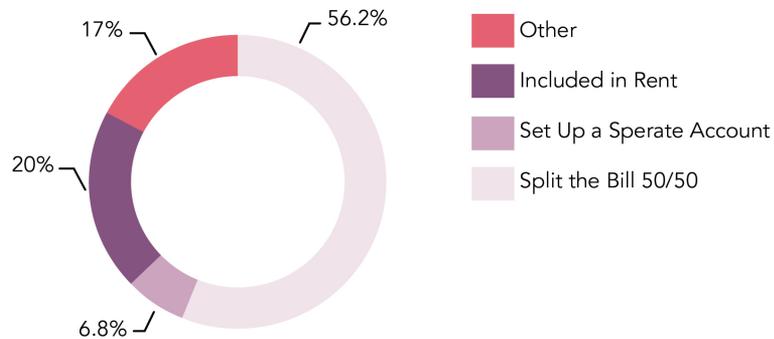


Figure 18: General Public Survey Question 5 Visualization

Over 50% of respondents would opt to split the utility bills 50/50 according to responses in question 5 (Figure 18). The option to include utilities in the rent was not one of the multiple choice options but was seen repeatedly in the “Other” category and consisted of 20% of the responses. Both top answers indicate that owners prefer to take a less formal approach to property management.

**Question 6:**

If you were to build an ADU, which sustainable improvements would you be interested in implementing? Consider that many of these options may add to the initial cost of construction. (Ranked)

**Objective:**

The ranking of these intervention types define what the general public deems most important in their outdoor space and responses will factor heavily in determining policy recommendations and site design interventions.

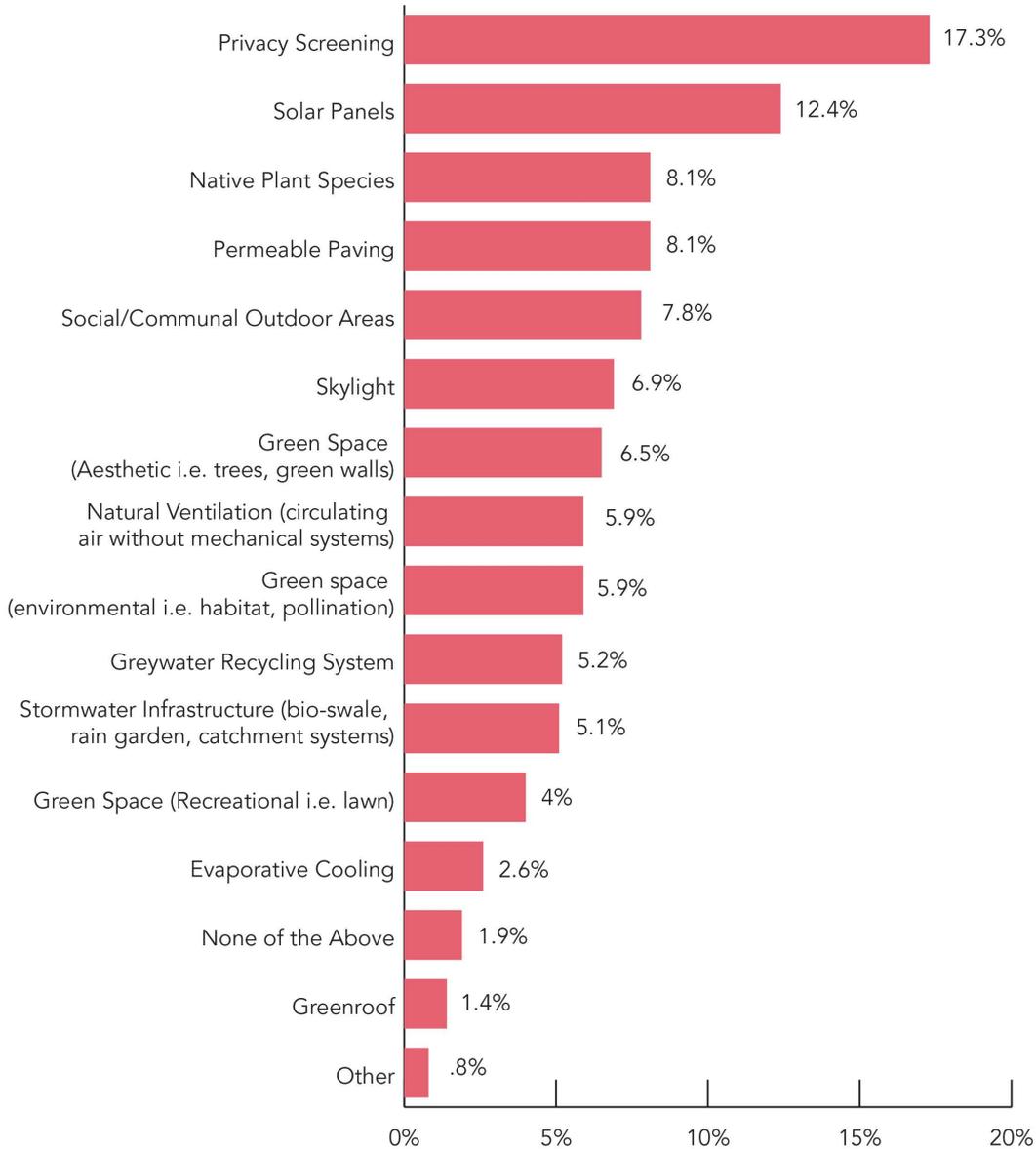


Figure 19: General Public Survey Question 6 Visualization

Comparing results from the municipal survey to question 6 (Figure 19) suggest that the city of San José is fairly well informed about and attentive to the needs of homeowners; energy and stormwater were highest on the priority list for the city as a whole. Unsurprisingly, homeowners put more weight on outdoor experiences and interventions that may be considered mainstream. Higher priorities for solar panels and skylights suggest an interest in reducing energy consumption; it is not clear from the results if this is solely to reduce costs or a desire to implement sustainable infrastructure.

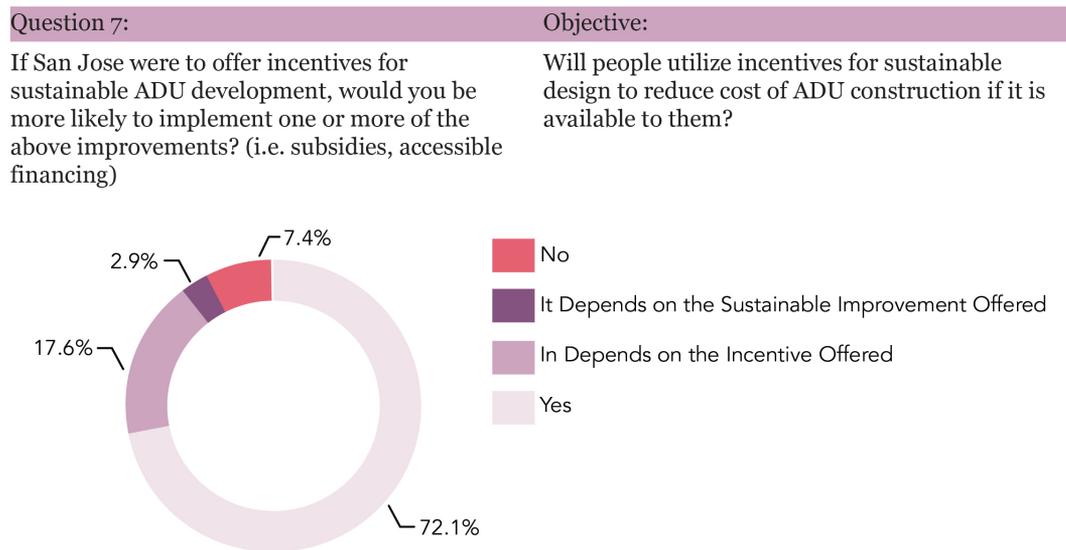


Figure 20: General Public Survey Question 7 Visualization

Based on question 7 responses from residents, the cost of sustainable interventions (or perceived cost) rather than interest is keeping San José homeowners from implementing these technologies (Figure 20). With financial assistance or incentives, over 90% of residents would be interested in implementing sustainable interventions. Providing education about the programs that are already currently available in San José may make an impact meeting the city’s climate action goals.

<b>Question 8:</b>	<b>Objective:</b>
Low energy heating and cooling techniques include passive solar heating (the capture of sunlight to heat a space), movable insulation and shading on windows, evaporative cooling. Would you consider incorporating these techniques in your ADU or would you like to see these incorporated in your neighborhood, assuming design guidelines were provided by the City?	How willing are people in San Jose to try passive or low impact heating and cooling techniques instead of or in tandem with traditional mechanical means?

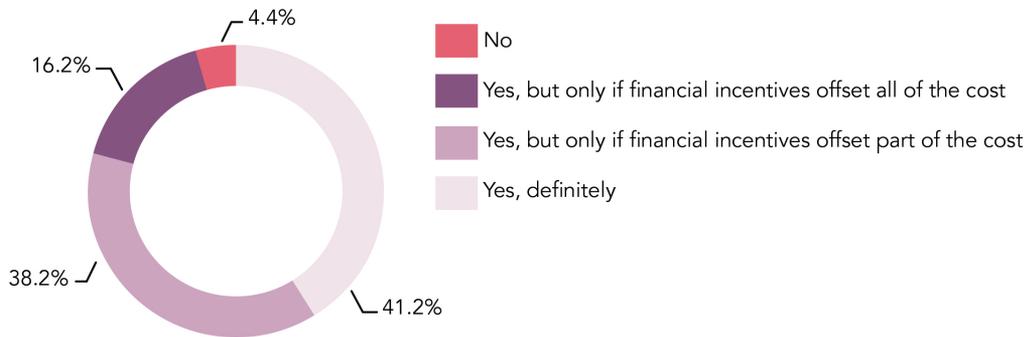


Figure 21: General Public Survey Question 8 Visualization

Low energy heating and cooling techniques received an overwhelmingly positive response from residents in question 8 (Figure 21) with over 90% indicating that they would be interested in these interventions.

<b>Question 9:</b>	<b>Objective:</b>
How many hours do you spend outdoors on your property? (front or back yard)	Understanding the amount of time spent in the yard can help me when designing the shared outdoor space.

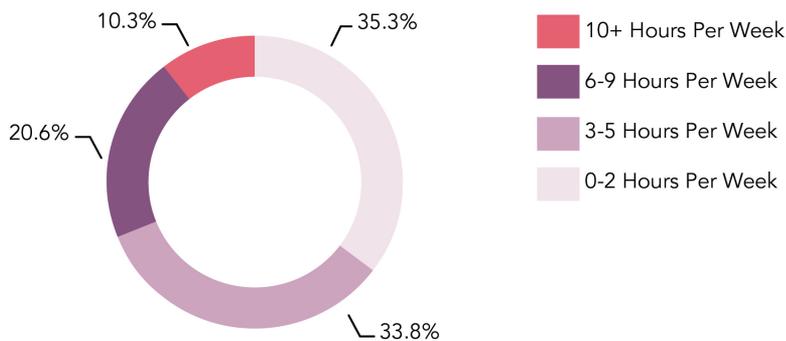


Figure 22: General Public Survey Question 9 Visualization

Hours outdoors range quite a bit, with more than 60% spending 5 hours or less in their yards (Figure 22). A takeaway from this question is that homeowners may be less inclined to build an ADU if they spend more time in their yard due to the nature of sharing space. If space rather than privacy is the objection of ADUs for these residents, smaller units (less square footage) may be better suited to maintain yard space.

Question 10:	Objective:
I am developing sustainable ADU design guidelines that can be useful for homeowners as well as the city. Are there specific activities or improvements that would positively change the amount of time spent in your yard? Please suggest any idea for the product that would be most helpful for you.	What would be the most helpful outcome from this project from a homeowner standpoint? This open ended question allows the homeowner to broadly talk about their needs and concerns.

Figure 23: General Public Survey Question and Objective

Below is a sample of responses to question 10 (Figure 23). The full list of responses can be found in Appendix A. Homeowners made many suggestions for yard amenities; common themes included sustainable or drought tolerant planting, shaded areas and trees, outdoor recreation such as pools, decks and outdoor kitchens.

“Drought friendly vegetation, more dog parks”

“Easily maintained green space”

“As long as it helps our environment and prolongs longevity for our resources, I say why not :)”

Question 11:

In which San Jose zip code do you reside?

Objective:

Zip code helps us to understand sample distribution across San Jose.

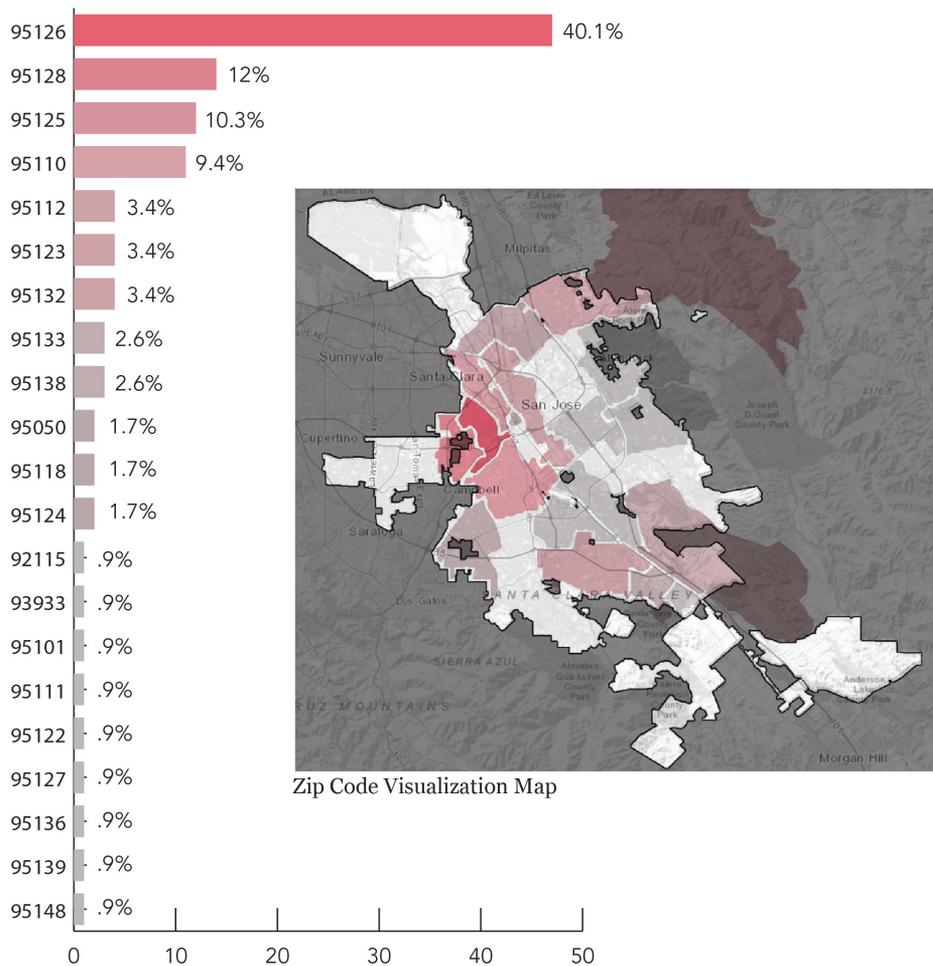


Figure 24: General Public Survey Question 11 Visualization

Responses were largely generated from west San Jose, radiating out from the downtown area (Figure 24).





# 3

## DESIGN DEVELOPMENT

### ***3.1 ADU Potential Lot Selection***

This project used ArcMap to determine potential taxlot parcels suitable for Accessory Dwellings in San José. Criteria were based on the city's current requirements for zoning and lot size, a similar method was used in the 2017 Study at Portland State University (Gleim, 2017; The Institute for Sustainable Solutions, 2019). San José code requirements specify that ADUs must be built on lots larger than 3,000sqft and must only be built on lots containing an existing single family unit. Land use zoning for these lots must be either R-1, R-2, PD (Planned Development), or R-M Zoning Districts (San José, CA Code of Ordinances, 2019).

Data were collected from the City of San José; GIS files included layers for Zoning, Parcels and Building Footprints (City of San José, 2019). Using the Zoning layer, I selected low density residential zoning district using the "COLORCODE" field with a value of '1'; this action selected all areas zoned for housing under 8 units per acre (City of San José, 2019). Next I overlaid the Parcel data, removing lots less than the minimum size requirement of 3,000sqft and lots greater than 135,000sqft; maximum cutoff number was determined by finding histogram outliers to remove larger properties allowed in the zoning ordinance such as parks and schools. Next I removed lots without an existing unit greater than 700sqft (eliminating structures such as detached garages) to meet ADU code requirement and further hone in on suitable sites. The resulting parcels give a coarse representation of available lots for ADU development. At this scale it was not possible to move into a finer grain of detail with the available data and without extensive ground truthing; however the results indicate that

approximately 150,000 lots in San José have the potential to add an Accessory Dwelling Unit (Figure 25). The results also helped to determine the average size of suitable residential lots: 7,576sqft; this information will be used to determine an average lot typology that will carry through to the design phase. See Figure 26 for a visualization of the Typical Lot selection process.

### **3.2 Design Overview**

To demonstrate the potential of the sustainable design elements in conjunction with ADU development, typical lots were defined using the average square footage of residential lots and homes in San José and aerial imagery. After defining two common/typical lot types that were within 1000sqft of the average lot size, I used these typical lots to represent common site conditions found in San José. Review of imagery as well as personal experience in the area were important to defining current conditions and land cover of the site for the “No ADU” lots and the “code ADU” lots. These “Typical Lots” are represented in Figure 27 and land cover in Figure 28.

Lot A: Lot A is a long, thin lot, (50’x155’), this lot typology generally has smaller homes and is usually found in older San José neighborhoods. Lot Size: 7,750sqft. House Size: ~1,400sqft.

Lot B: Lot B is a more standard rectangular lot (60’x110’); this typology usually contains larger homes that sit near the center of the property. Lot Size: 6,600sqft. House Size: ~2,000sqft.

As previously mentioned, the above sites (referred to as the “No ADU” option/version A and B respectively) will be compared to the same sites with business as usual ADU development or “Code ADU” that utilized San José’s minimum code requirements for ADU Development, and the designed version, referred to as “Sustainable ADU” options.

The graphs in figures 29 and 30 represent the land cover on the site and were determined by observation of aerial imagery. I looked at properties that fit these typologies and tried to find commonalities in land cover. Understanding typical land cover trends on both lot typologies and inferring what that land cover percentage would look like with a 600sqft code minimum ADU, I was able to define a “Sustainable Option” to compare it with. While the “Code ADU” assumes that no landscape changes are being made besides the added ADU, with an assumption of 1/3 tree canopy loss, the “Sustainable Option” would include landscape improvements in addition to the ADU. The sustainable design has

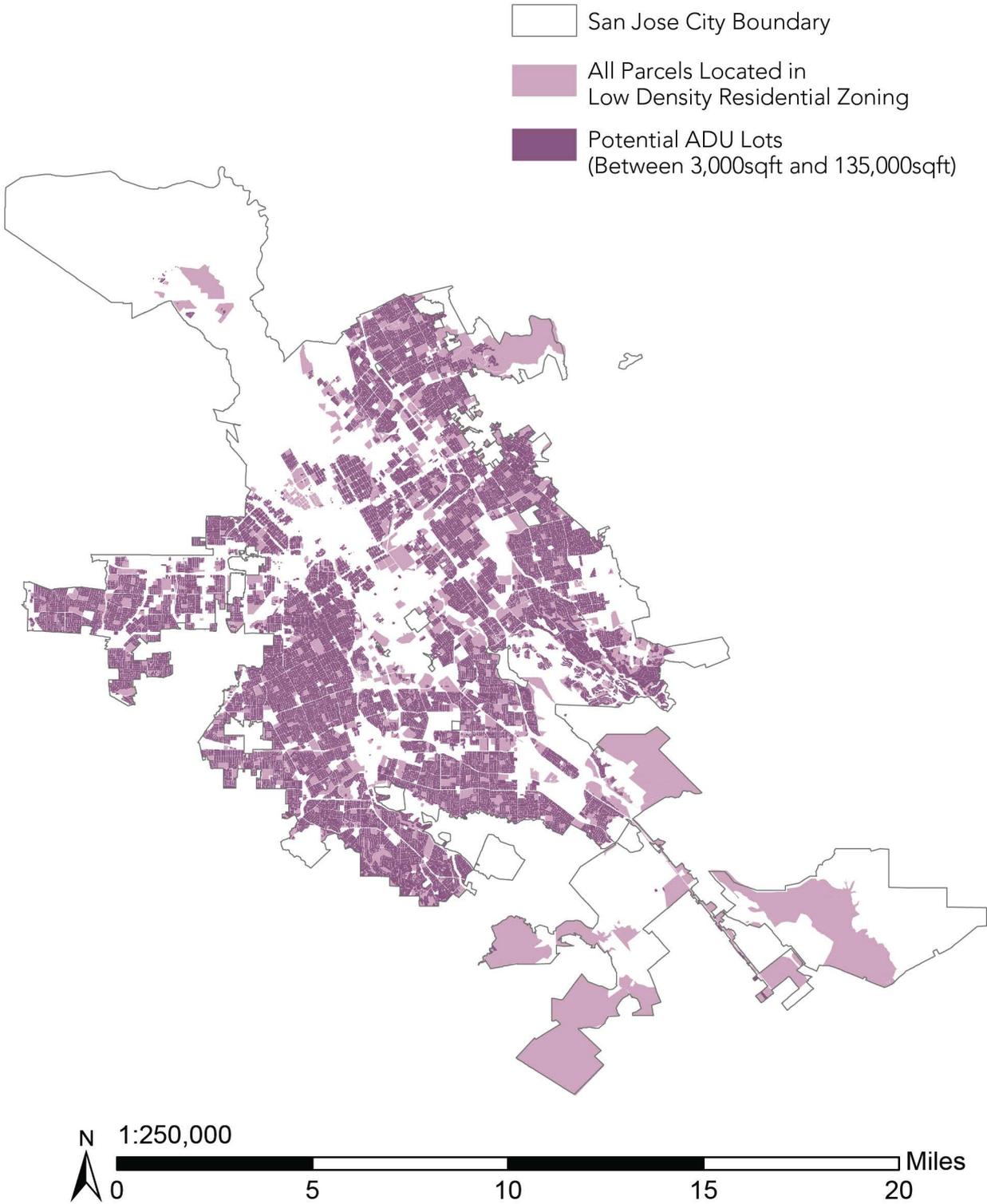
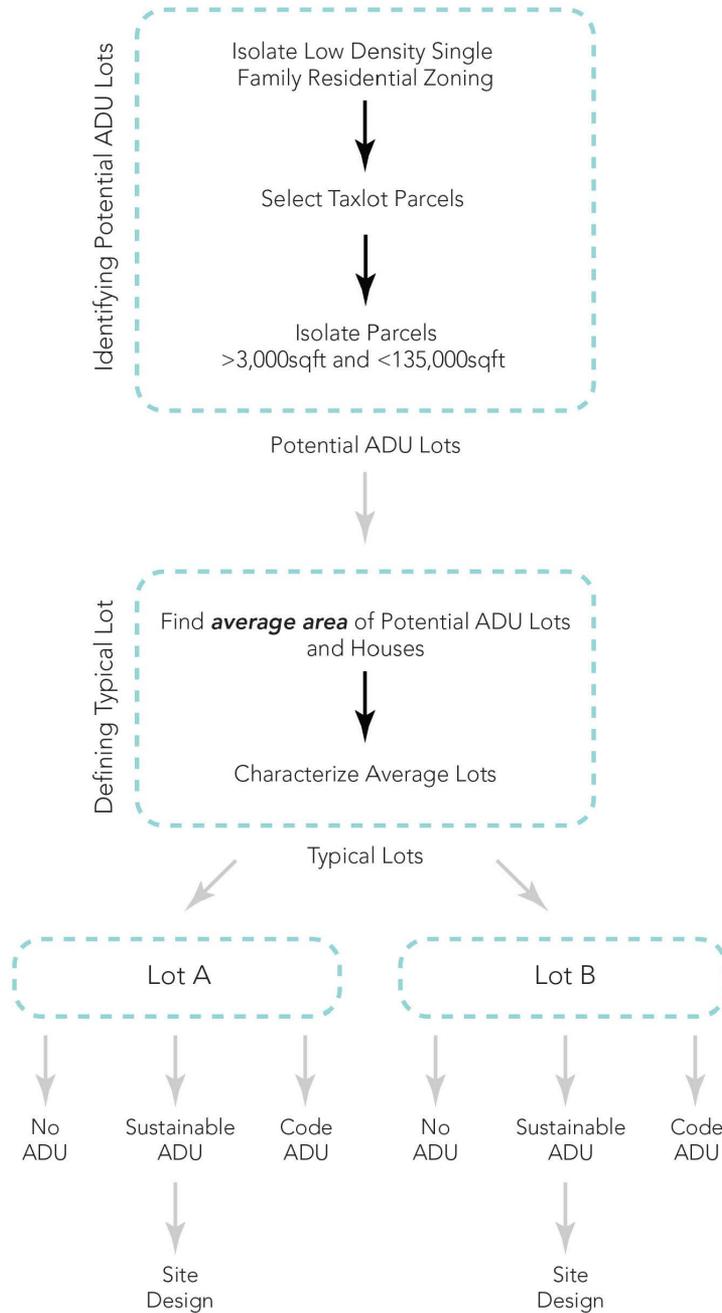


Figure 25: Potential ADU Sites – 81% of the parcels in low density residential zoning (by count not area sum) meet current requirements for ADUs - Approximately 150,000 lots.

more diversity of land cover types compared to the “Code ADU” option.

### Defining Typical Lot Typology



### **3.3 Design Elements**

I developed a set of design elements that I call the “Design Toolkit”; these elements are based on responses from both the municipal survey and the general public survey. The Design Toolkit consists of landscape elements that help to facilitate comfortable and sustainable outdoor spaces for residents with minimal maintenance as well as offset the added impermeable surfaces that are necessary when densifying.

The Design Toolkit is intended to demonstrate sustainable design elements, giving a brief overview of the strengths and weaknesses as well as the general cost and functionality of each element. The Design Toolkit should not be considered a comprehensive list of sustainable options for landscape design, but as a quick guide for thoughtful landscape intervention. This short list was curated from interest shown by the general public in San José and takes into consideration ease of maintenance, cost and benefits. See the [Appendix B](#) for more detailed descriptions of the design elements.

#### Toolkit Design Elements:

- Skylight
- Solar Panels
- Rain Garden
- Permeable Pavers
- Native Vegetation
- Turf/Lawn
- Evergreen Tree Cover
- Deciduous Tree Cover
- Hardscape

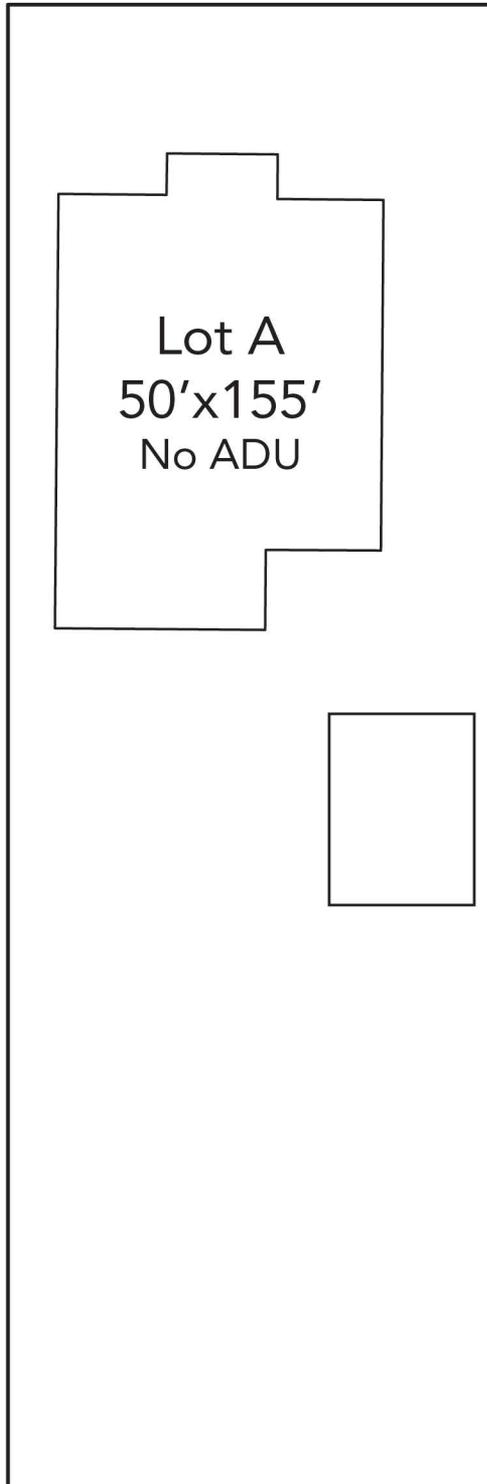
Using the “average” typologies and Design Toolkit elements, site scale designs demonstrate a few potential sustainable layouts for ADUs that address the survey results. The goal is to show the functionality of these elements when implemented together. **Figures 35-38** show how the design elements listed above are implemented in the two designs. These designs are meant to show the function and applicability of the sustainable elements to lots commonly found in San José.

Figure 26: Typical Lot Generation Diagram  
demonstrates the steps taken in sections 3.1 and 3.2

# TYPICAL LOTS

(NO ADU)

Street Edge

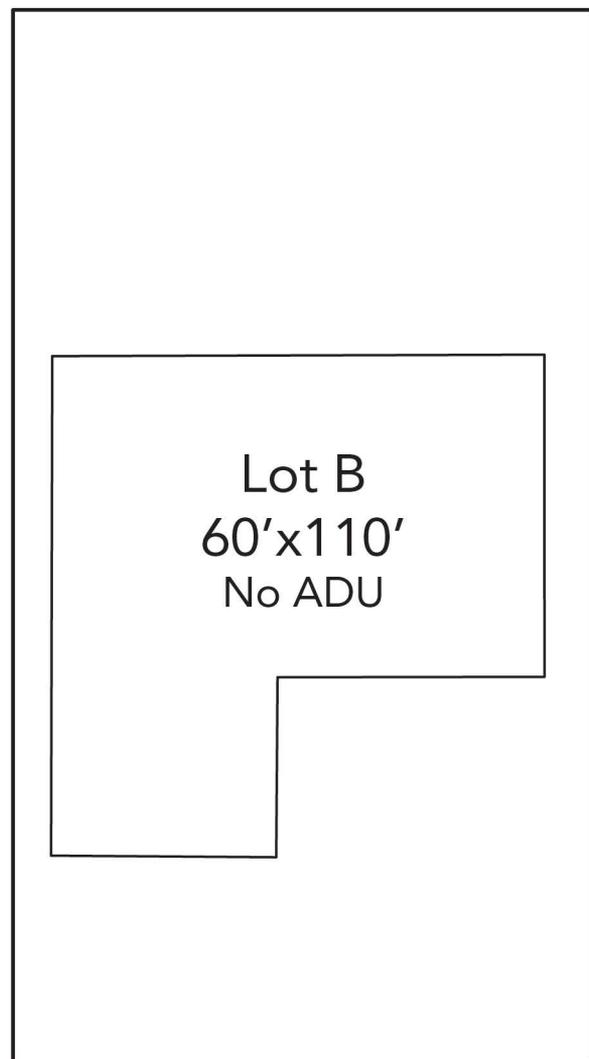


## Lot A Typology:

Lot: 7,750sqft House: ~1,400sqft

## Lot B Typology:

Lot: 6,600sqft House: ~2,000sqft

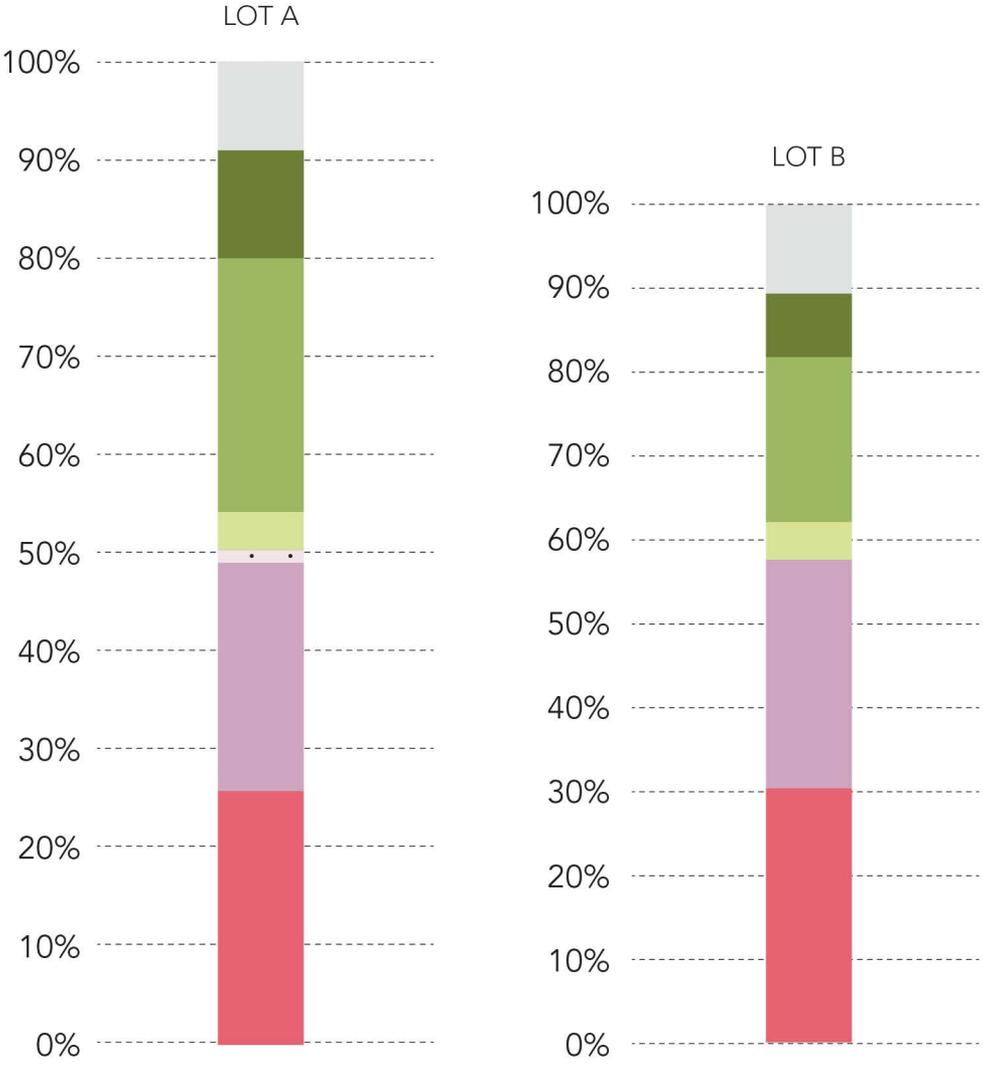


20 SCALE

Figure 27: Typical Lot Typologies

20 SCALE Street Edge

# TYPICAL LOTS (NO ADU)



Land Cover Comparison (by area)

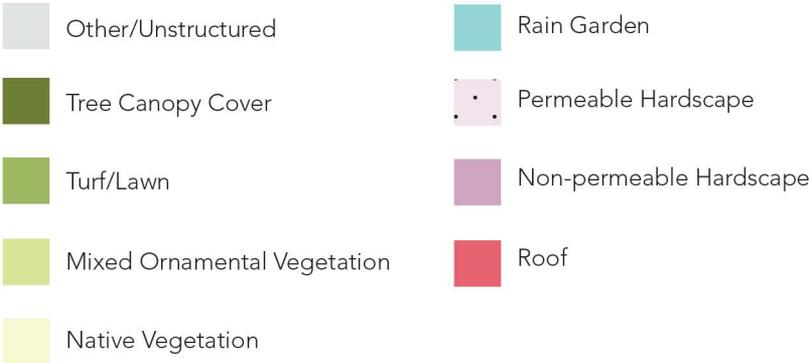
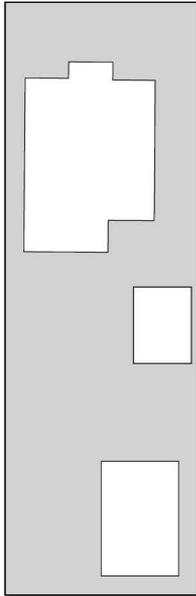
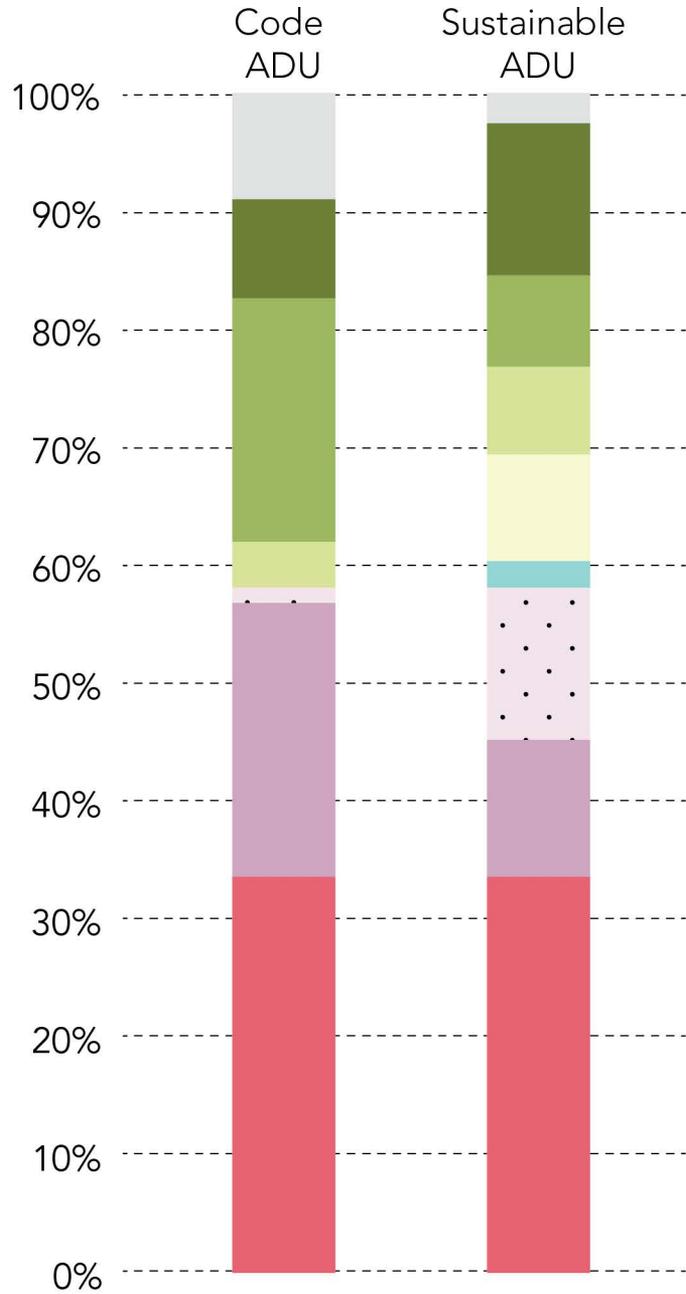


Figure 28: Typical Lot Land Cover based on aerial imagery

# LOT A



- Other/Unstructured
- Tree Canopy Cover
- Turf/Lawn
- Mixed Ornamental Vegetation
- Native Vegetation
- Rain Garden
- Permeable Hardscape
- Non-permeable Hardscape
- Roof



Land Cover Comparison (by area)

# LOT B



Land Cover Comparison (by area)

Figure 30: Lot B Site Design - Land Cover Comparison

# LOT A

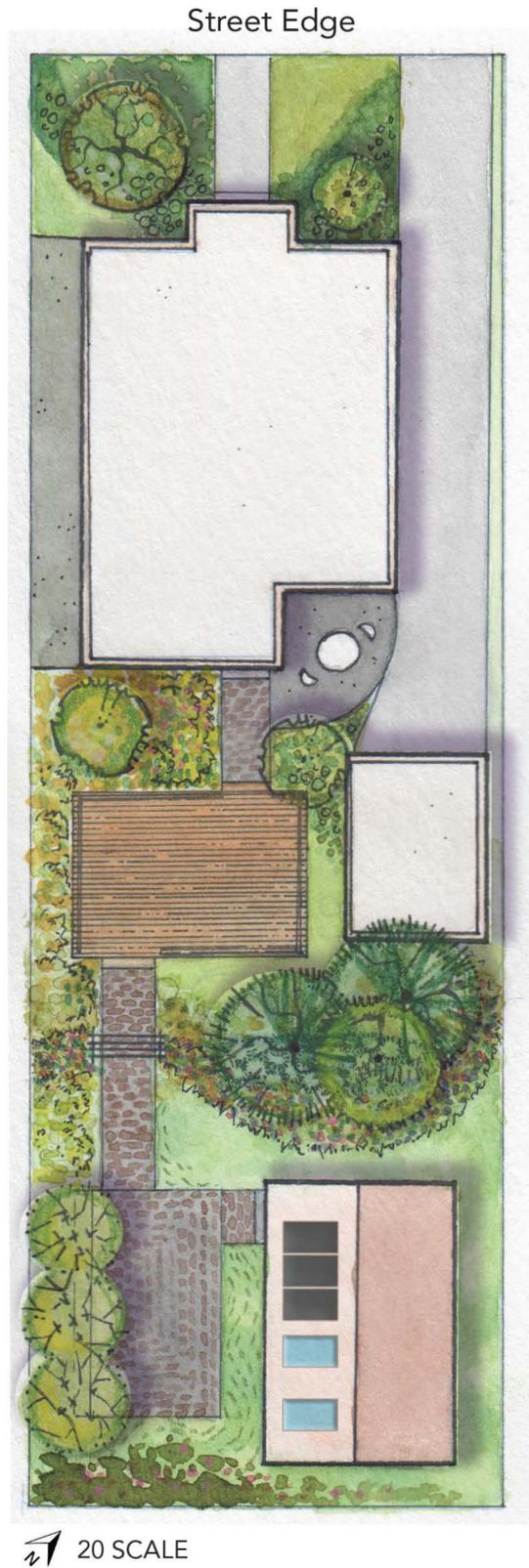
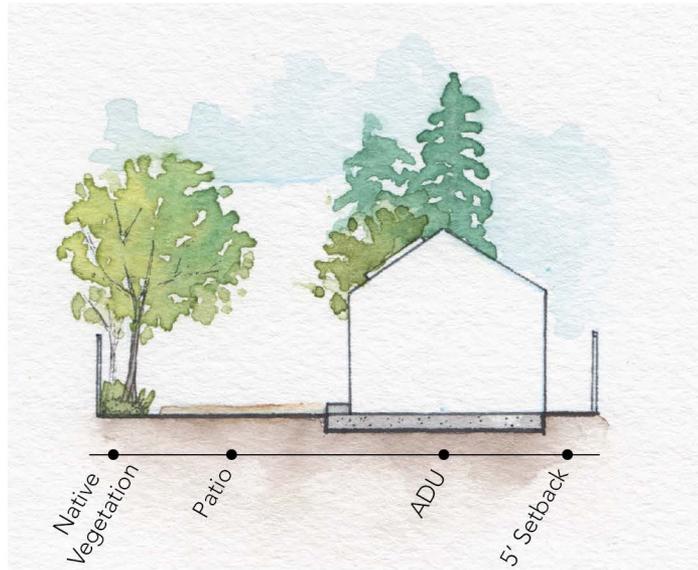
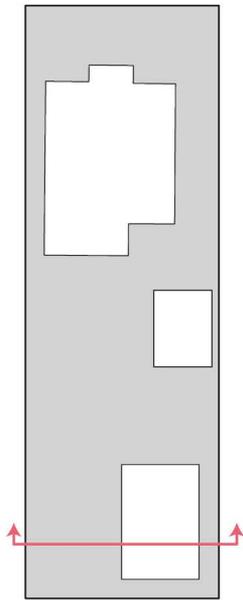
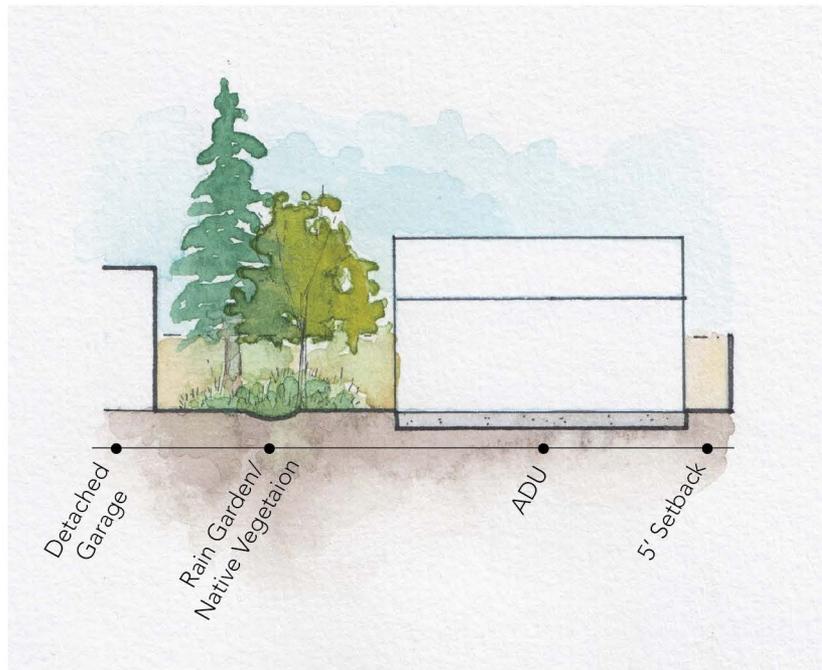
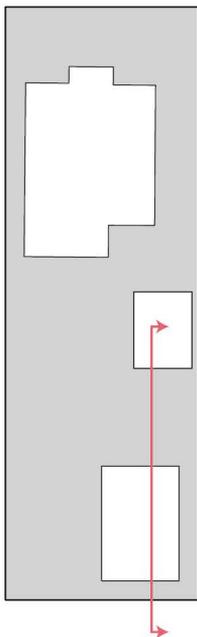


Figure 31: Lot A Site Design - Plan

# LOT A



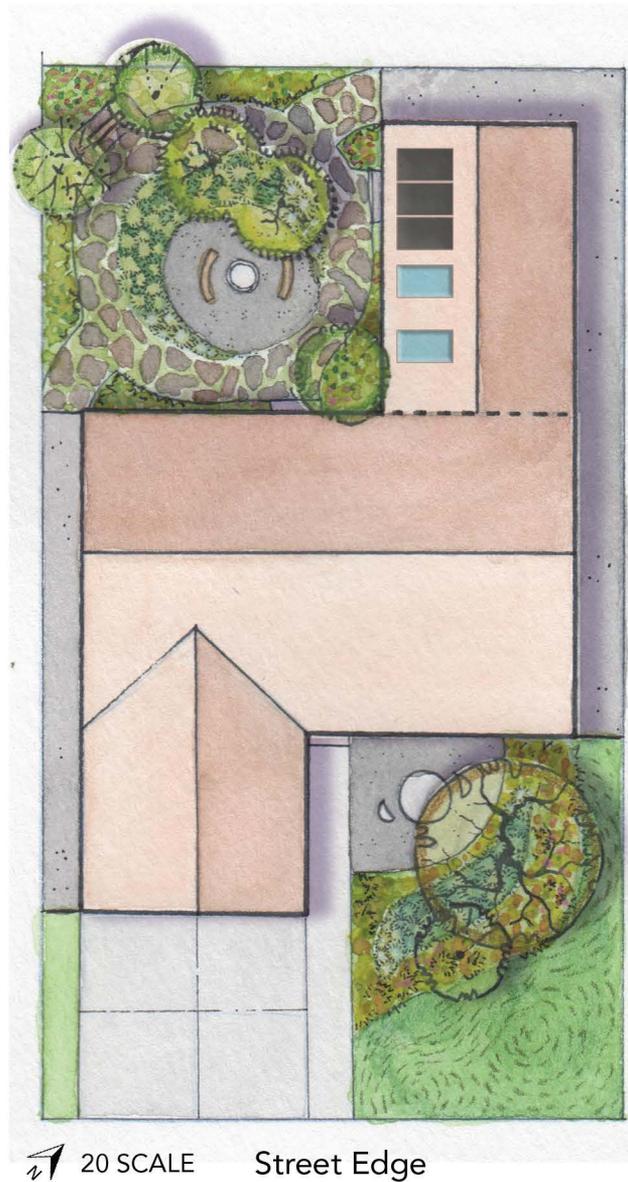
Backyard - Looking Northwest



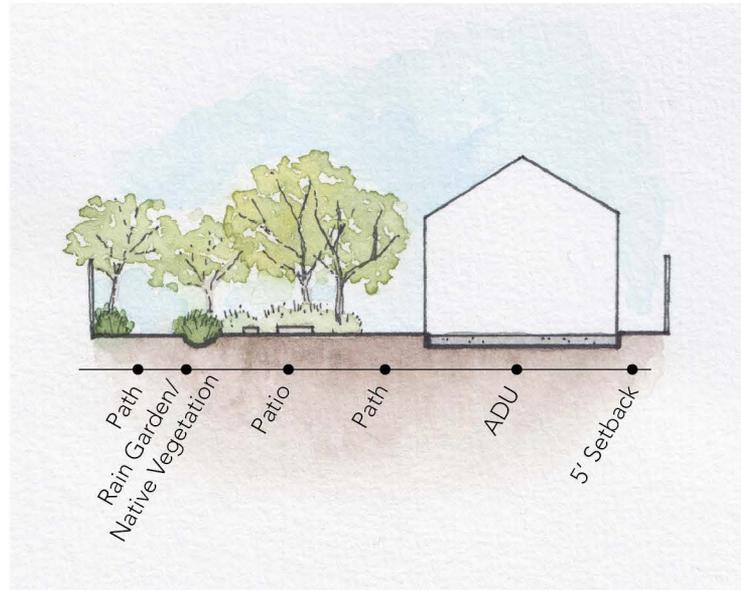
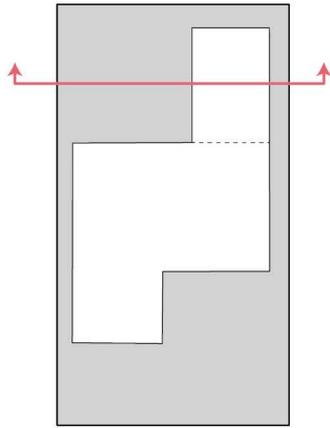
Backyard - Looking Northeast

Figure 32: Lot A Site Design - Sections

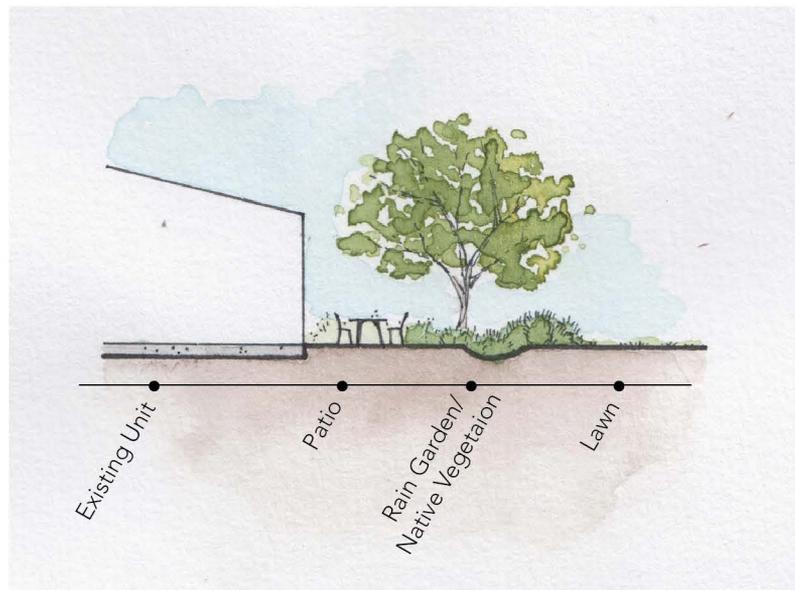
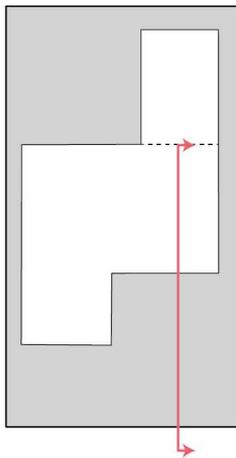
# LOT B



# LOT B



Backyard - Looking Northwest



Front Yard - Looking Northeast

Figure 34: Lot B Site Design - Sections

# LOT A

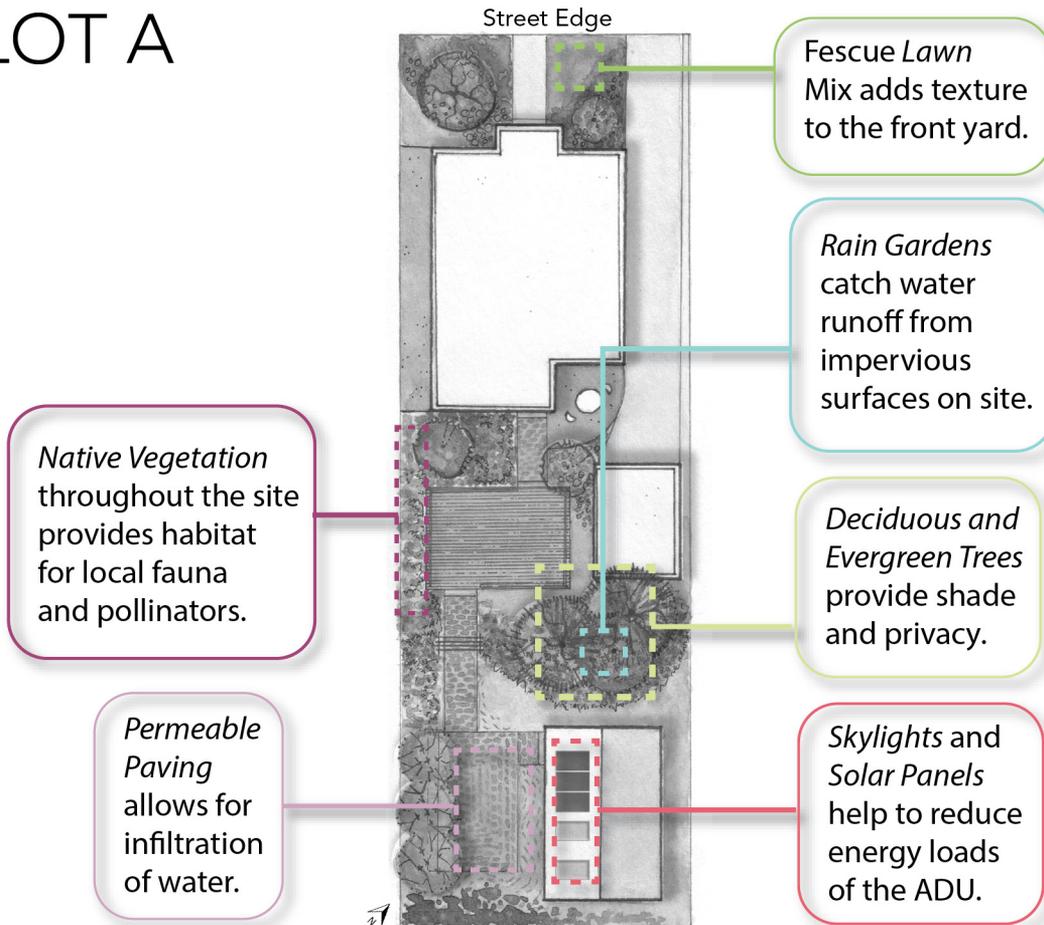


Figure 35: Lot A Site Design - Design Toolkit Elements



Figure 36: Lot A Site Design - Perspective showing Design Toolkit Elements

# LOT B

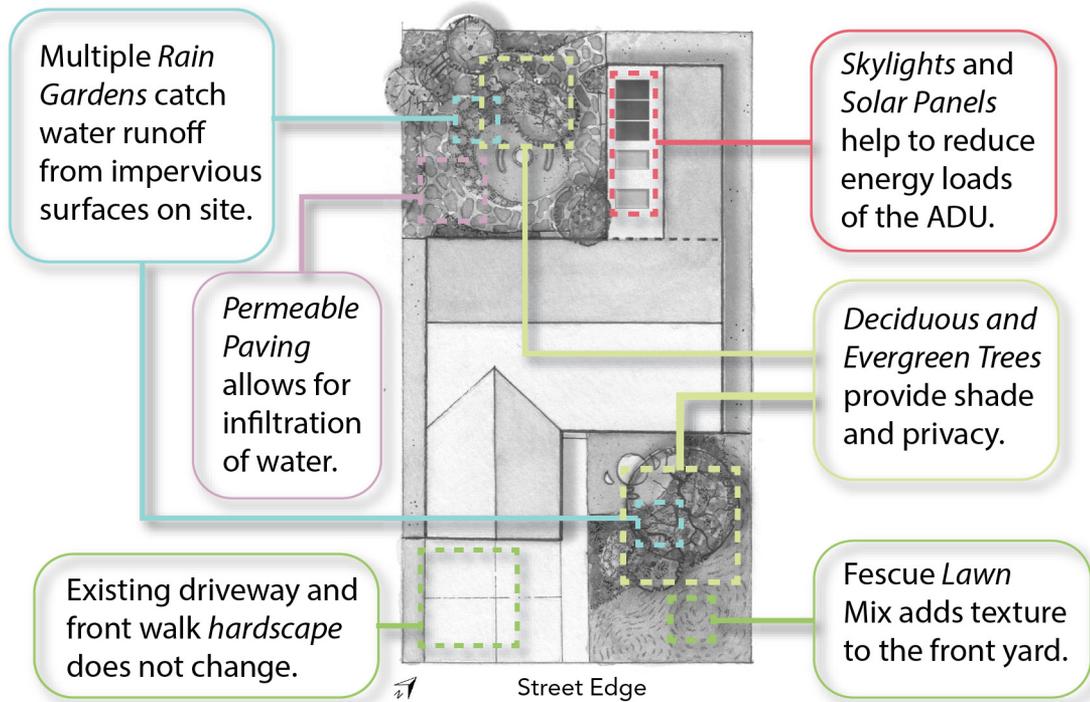


Figure 37: Lot B Site Design - Design Toolkit Elements

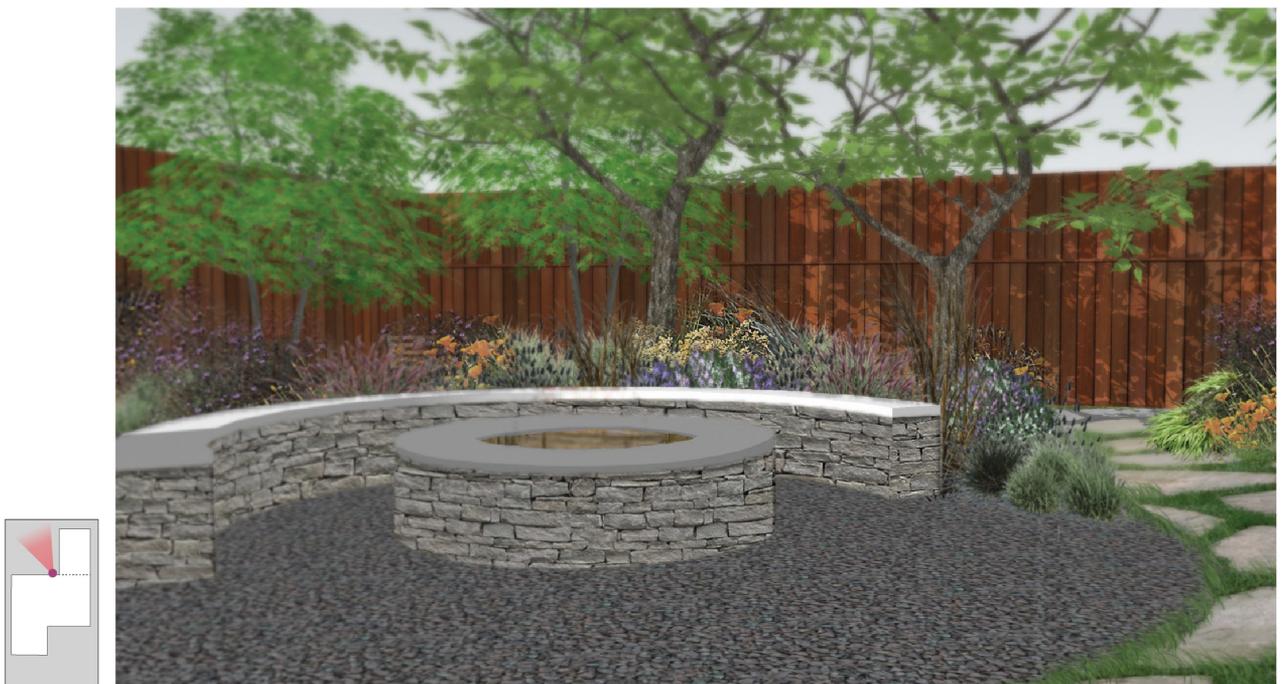


Figure 38: Lot B Site Design - Perspective showing Design Toolkit Elements



# 4

## DESIGN PERFORMANCE ANALYSIS

### ***4.1 The Design***

Using the Design Toolkit and the Typical Lot Typologies and survey results, I demonstrate the performance possibilities of a site with an Accessory Dwelling Unit. I look at multiple factors to judge the sustainability and performance of the design, including stormwater, tree canopy cover, and functionality of the outdoor spaces as well as the energy performance of the ADU itself. It is important to note that these designs are meant to demonstrate the potential for denser, more sustainable residential neighborhoods but are not by any means the only configuration for high performance landscape design. Both designs incorporate a 600 square foot Accessory Dwelling Unit addition to the site; Lot A demonstrates the detached typology and Lot B the attached option. Designs are demonstrated in **Figures 29-38**. The designs show one option for the design elements in the tool kit to work together to improve landscape function and diversity while adding density.

### ***4.2 Landscape Design Performance***

In **Figures 29-38** we can see how the sustainable design option (Sustainable ADU) compares with the same lots with an added ADU that is built to current code requirements (Code ADU). All 4 designs show the added 600 square

foot unit as well as the existing residence to show the relationship between the structures. Note the added diversity of the sustainable ADU option's land cover.

Design Assumptions:

- Lots A and B would see 1/3 tree canopy cover loss from “No ADU” option to “code ADU” based on aerial imagery and potential ADU locations.
- Minimal to zero landscape intervention/change will occur from “No ADU” option to “code ADU” scenarios outside of the added structure.
- All lot options will maintain front walk and driveway impervious hardscape.
- For city scale inferences, only 55.2% of the possible lots will build ADUs based on the survey results in question 2. (Percentage of respondents who looked favorably on ADUs)

### ***4.3 Stormwater Catchment Performance***

The site designs address potential stormwater issues through the use of multiple rain gardens. Sizing information was found in the Santa Clara County Rain Garden Fact Sheet (SCVURPPP, 2012). First, I measured the amount of impervious surfaces on the two sites – 3,500sqft on lot A and 3,250 on lot B – and utilized the given in the sizing variable of 4% of the contributing area (impermeable surfaces) (Figure 39). This .04 sizing factor seems to originate in the Santa Clara County Stormwater Guidance manual (Santa Clara County, 2015): it breaks down the 4% sizing as: 0.2 in/hr (intensity) ÷ 5 in/hr (infiltration of 85th percentile hourly rainfall). Both lot A and B see a 20% reduction of impervious surfaces even with the add 600sqft from the ADU roof surface. Both of the sustainable designs are also able to slow and clean all of the runoff from the impervious surface of the ADU as well as from the existing unit and driveway; this means that the example designs are able to collect 100% of the runoff from impervious surfaces of the two sites (Figure 40). This runoff would not be treated otherwise in ADU developments built strictly to current code. The designed rain gardens have the ability to infiltrate based on the code requirement keeping them 10' from structures. Further volumetric information cannot be gathered on these

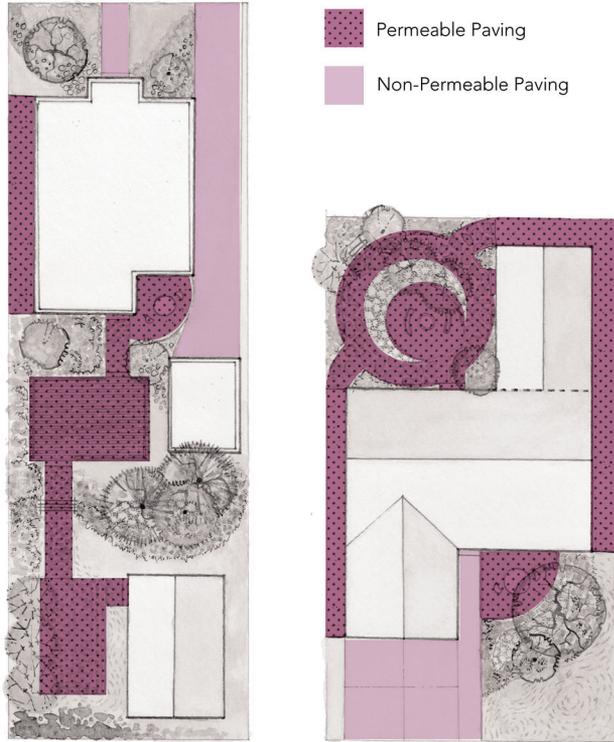


Figure 39: Paving graphic shows the location of permeable and impermeable hardscape in the designs; this project assumes that homeowners will not change driveway and front walkway from impermeable to permeable.

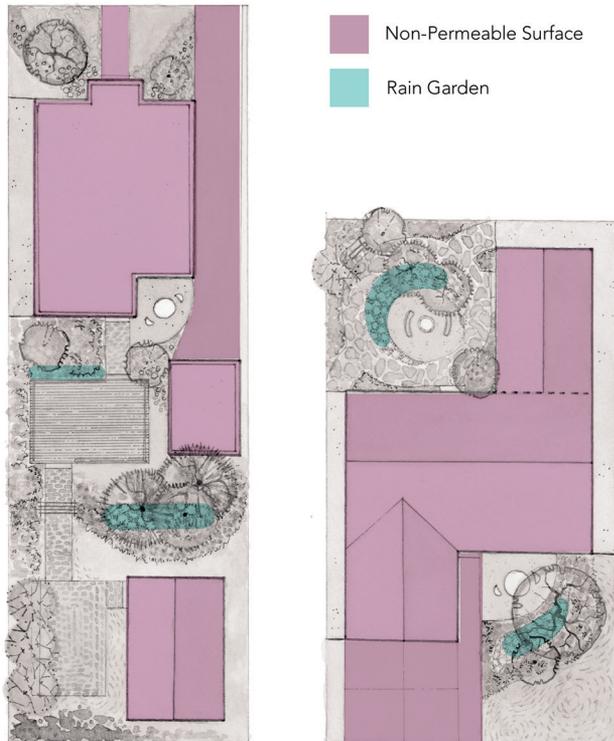


Figure 40: Rain gardens are able to collect 100% of the contributing impermeable area on the site.

sites, as they do not represent any specific soil types and therefore do not have soil infiltration variables to contribute as average typologies.

Given what we know about the sustainable design performance, and the information on potential for stormwater runoff, we can infer that if these designs were implemented at the city scale, 38% of single family residential stormwater can be slowed and cleaned before entering traditional storm systems or infiltrating the soil. This percentage comes from the percentage potential ADU lots compared to total low density residential lots (81%) times the percentage of people interested in ADU development (55.2%) times the 85th percentile design storm. (.81 \* .552 \* .85)

#### ***4.4 Tree Canopy, Vegetation and Human Comfort***

The benefits of trees in our urban environment are many and well known; besides their beauty, trees and other vegetation provide clean air, shade, windbreaks, and even have the potential to save energy to nearby structures (Ko, 2018). Although a goal of this project was to maintain tree canopy on ADU sites, it was also important to consider the strategic placement of new trees in the designs. This is significant when working in conjunction with passive and low energy strategies such as skylights and solar. With thoughtful placement of trees and lower level vegetation these designs aim to create functional spaces that receive sun and shade for resident comfort while actually increasing the tree canopy cover (Figure 41). Deciduous trees on the west side of the ADUs block strong afternoon sun but allow solar rays to reach the skylights and solar panels on the roof. Evergreen trees and various heights of vegetation allow for privacy for both the existing unit and the ADU and are placed to allow sun to reach social/communal gathering areas.

The successes of the social aspects in the designs are subjective. Both designs utilize pockets or rooms to define social and private spaces; this is again where strategic planting of trees and vegetation help to not only create comfortable microclimates but give structure to the landscape (Figure 42).



Figure 41: Lot A sees a 53.8% increase in tree canopy cover compared to the "code ADU" option. Lot B sees a 150% increase in tree canopy cover compared to the "code ADU" option.



Figure 42: Diagram shows that social and private areas can be integrated into the site design.

## 4.5 Energy Saving Performance

*Work done in conjunction with Alexandra Rempel and Yumna Imtiaz.*

Because of San José's mild climate, it is a great candidate to utilize passive solar heating and cooling techniques. Smaller units like ADUs have the potential to be equally as inefficient as their full sized counterparts if energy is not utilized efficiently. We looked at options for passive and low energy solutions to reduce peak energy demand, using California's Net Zero Energy Goal – a new requirement starting in 2020 – as a standard for new developments including ADUs.

The important factors we found that positively impact the energy efficiency of the solar and skylight features of the design include:

- **30 degree roof tilt** for optimal solar collection for both panels and skylights
- **Skylight area** of 36sqft for our 600 square foot ADU
- Use of **movable insulation** that helps to passively cool down the unit (like a honeycomb collapsible blind) that shade all day in the summer and are removed at night to allow for natural cooling (important for the skylights). Scheduled opening and closing of ventilation and insulation help to regulate temperatures in the ADU. Schedules are improved by removing ventilation in the cold months and on more vigorously, during the proper hours, in the warm months.

Even with basic code-level construction the passive measures now give us heating loads of 56% of the baseline (or typical heating), and cooling loads 34% of the baseline (using typical cooling methods) as seen in [Figure 43](#). At the city scale this would reduce 25% of the base heating loads and 15% of the cooling loads for all low density residential areas in San José. This percentage comes from the percentage potential ADU lots compared to total low density residential lots (81%) times the percentage of people interested in ADU development (55.2%) times the percentage of energy load savings. ( $.81 * .552 * .56$ ) and ( $.81 * .552 * .34$ )

## HEATING AND COOLING LOADS COMPARISON BETWEEN PASSIVE DESIGN VS BASELINE

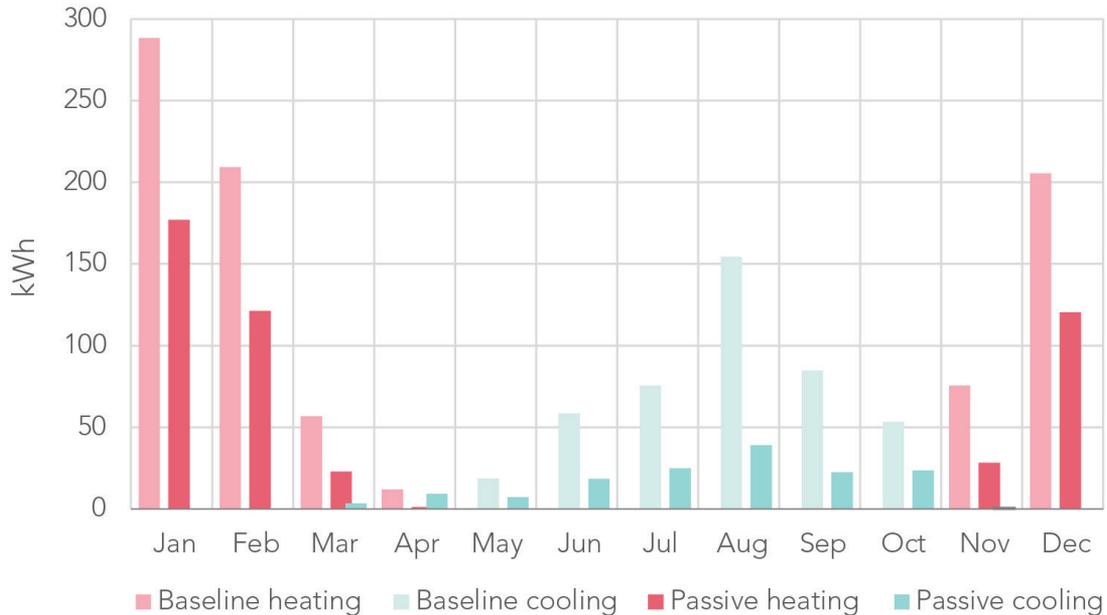


Figure 43: Passive design versus Baseline energy consumption

### ***4.6 Synthesis of Design Performance***

The design examples show that it is possible to mitigate many negative environmental impacts of the added housing unit while also fulfilling the needs of the residents defined in the survey. With thoughtful implementation of the Design Toolkit elements, it is possible for residents to maintain sustainable, livable communities while allowing for densification. All tested areas in the sustainable design (stormwater, tree canopy and energy performance), outperformed the code ADU.

- Stormwater runoff can be 100% mitigated on both sites.
- Lot A sees a 53.8% increase in tree canopy cover and Lot B sees a 150% increase in tree canopy cover compared to the “code ADU” option.
- The ADUs now give us heating loads of 56% of the baseline, and cooling loads 34% of the baseline.



# 5

## POLICY RECOMMENDATIONS & DISCUSSION

### ***5.1 Policy Recommendations***

The design examples show the potential of Accessory Dwelling Units in low-density residential areas as a strategy for infill in our cities. The ADU approach allows for density as well as high functioning social and ecological spaces with few additional costs compared to current ADU development practices. If the city chooses to further develop a sustainable Accessory Dwelling Unit program, these units offer the potential to close the housing gap quickly while the city continues with their longer term housing programs. Some recommendations to reduce barriers:

1. Waive System Development Charges (SDCs) and Parking Requirements. The city of Portland has been successful in generating more permitted ADUs since these requirements were waived and I believe that San José can see similar success using this method.

2. Consider incentivizing sustainable choices during development. Design elements could be packaged as tiered incentive options, tiers would need to take into consideration the difficulty and cost of implementation to the homeowner as well as the benefit to the city overall. For Example:

Tier 1 (Homeowner Receives 5% of total ADU development costs from the city [or flat rate]): Skylight\*, solar panels\*, Rain Garden (collects runoff from 50% impermeable area), Native Vegetation (20%), Maintain Tree Canopy Cover area\*\*

Tier 2 (10% of total ADU development costs from the city [or flat rate]):  
Skylight\*, solar panels\*, Rain Garden (75% impermeable area), Native Vegetation (50%), Maintain Tree Canopy Cover area\*\*, Permeable Paving option (50%)

Tier 3 (15% of total ADU development costs from the city [or flat rate]):  
Skylight\*, solar panels\*, Rain Garden (100% impermeable area), Native Vegetation (50%), Drought Tolerant Vegetation (60% of total vegetation including lawn and native), Maintain Tree Canopy Cover area\*\* (or add where possible), Permeable Paving option (50%)

\* Skylight and Solar options must suit specific sizing need of the ADU

\*\* Maintained Tree Canopy (Area) may include removal and replacement of tree canopy cover

City must undergo a thorough cost/benefit analysis to find appropriate incentive options.

3. Consider developing sustainable intervention education workshops to help reduce maintenance costs and provide training for upkeep of sustainable interventions. Workshops may be sponsored by local energy companies or product manufacturers, non-profits, and the city as a way to train and educate residents to maintain sustainable elements as part of an incentive program.

4. Develop pre-approved sustainable ADU templates. Template options will reduce cost for homeowners who cannot afford to hire a designer and may also fast track the design/build phase.

## ***5.2 Discussion and Conclusion***

This project looked at strategies to reduce barriers of Accessory Dwelling Unit implementation in San José. Using a range of methods to define city and residents' concerns for ADU development, I generated designs that help to promote a more sustainable urban fabric and address issues of concern at the site and city scale.

***Was this project able to implement the desired design traits from the survey into the site design?***

This project addressed many needs of San José residents and meets the needs identified at the city scale. Based on survey results, the top desired elements for integration into the designs were: privacy screening, solar panels, native plants, permeable paving, social communal space, skylights. These elements were able to integrate into the two site designs and were found to perform better than a business as usual code ADU. The desire to save energy costs, mitigate for stormwater runoff and balance social/private space was achieved and can be repeated across scales.

Examining the top concerns for home owners: parking, privacy and noise, privacy was the main element possible to integrate mitigation at the site scale. The designs in this study do not address the top concern of homeowners: Parking. Cities like Portland have been successful in adding more ADUs by removing the parking requirements for ADU development but have the public transit to maintain a larger population of riders. Because parking was by far the largest concern for residents, the city may need to reassess the need for greater investment in accessible modes of transport outside of vehicular travel. To increase density in the city in any way, through ADUs or any other more traditional methods, the city needs to adapt its current vehicle centric infrastructure. San José's Urban Village initiative is a good first step in the direction of more diverse communities, connecting these villages through public transit and allowing for more opportunities in single family neighborhoods that are less likely to rapidly develop without private investment. Sustainable ADU models can address many concerns experienced by residents but surveys show that there may already be an underlying problem regarding parking and vehicle ownership that should put greater emphasis on the need for transit in low-density areas. Densifying without addressing this issue may lead toward resistance to the much needed growth. By allowing for flexibility in private residential neighborhoods – transportation options, housing density variations, land-use and zoning – communities can become more adaptable and resilient and maintain (or gain) their own micro-cultural ambiance.

***Did the interventions have positive or negative effects?***

The design analysis points to positive results across the tested areas. This project shows that there could be a 5%-10% increase of impermeable surfaces from the “no ADU” scenario to the “Code ADU” option and a 0%-5% increase or even a small decrease with the sustainable ADU option even taking

into consideration the added roof area on the site. The site design also shows a positive outcome with added tree canopy cover, reduced stormwater runoff and a reduction in traditional energy consumption. At the city scale, following through with sustainable design has the potential to reduce 25% of the base heating and 15% of the cooling energy loads, increase tree canopy cover by more than 50% and clean 38% of stormwater runoff in all low density residential areas in San José.

***Are sustainable dwellings more costly than standard code dwellings?***

The upfront cost of sustainable elements may slightly raise the initial cost of construction, however many of the sustainable design elements add little cost upfront or pay for themselves over time in energy savings. Skylights and solar panels are commonly incorporated into new residential structures and with the optimal aspect and tilt of the roof integrated in the design/development stages, as well as proper scheduling of movable insulation and natural ventilation, the savings will be greater for little to no added cost.

Strategic placement of vegetation offers many benefits; but takes time to reach mature size and top performance potential. Landscapes are often over planted initially to make an instant statement, however costs can be reduced if homeowners are willing to wait out a minimally planted yard as the plants grow into a space.

Cost comparison of permeable and non-permeable pavers show little to no cost difference but installation fees many vary. Overall (solar and skylights excluded), the cost difference between a sustainable and code ADU is negligible; the added cost would come from the addition of landscape interventions that this project is assuming would not occur in a business and usual code Project.

***Do policy recommendations allow for more affordable development of ADUs and is the added amount of density worth it for the City to incentivize?***

San José residents face many obstacles if they wish to build an Accessory Dwelling Unit; because these units are privately funded by the homeowner for a high upfront cost the main way to make these units more accessible is to reduce that upfront cost. The question: Is it worth it for the city to cover a percentage of the cost and waive or reduce fees for ADU development? Why should the city care to reduce the financial burdens for ADUs? This project offers a strategy to

add housing density in areas where it is difficult to make sweeping changes from a planning standpoint. Low density takes up a large amount of many US cities and finding ways to mitigate for wear on existing infrastructure as populations grow may help cities like San José move closer to goals laid out in their general plan. This project offers San José residents the ability to reduce the upfront costs associated with ADU design and construction, potential to obtain a passive income in a city with a high cost of living and suggests design interventions that reduce environmental impacts. The city of San José will need to run a thorough cost/benefit analysis to determine the appropriate incentive or rebate percentage that could be offered when sustainable options are implemented. The outcome of the study indicates that the potential for ADUs as a tool for infill in low density residential areas could have a substantial impact on housing availability.

ADUs are a way to add infill development to low density areas and help provide missing middle housing. Making a conscious effort to implement sustainable elements to new large scale developments has become intrinsic to modern urban growth; however current regulations do not encourage existing single-family residential areas to contribute to vital added density or resilience in our cities. This project shows that with small changes to our residential areas, it is possible to mitigate for added density in these zones as well as create balanced spaces for human comfort (Figure 44). Diversity breeds resilience and by incentivizing the simple yet diverse elements proposed in this project, the City of San José can embrace a more sustainable future.

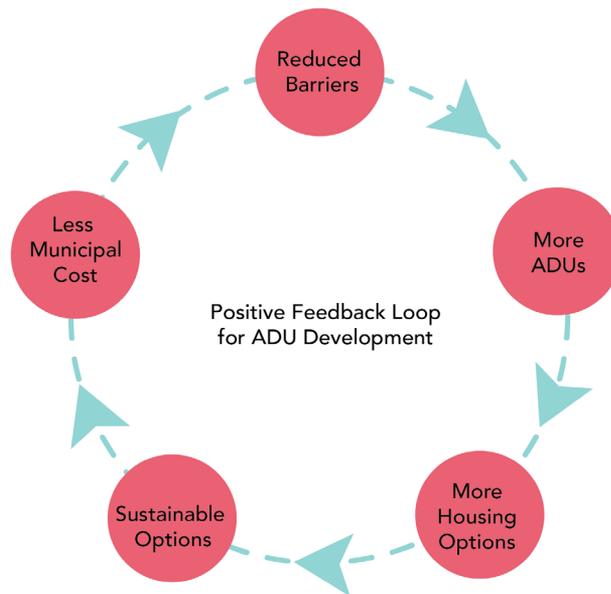


Figure 44: Positive Feedback Loop for ADU Development



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[missingmiddlehousing.com](http://missingmiddlehousing.com)

San José City Boundary:

City of San José: [csj.maps.arcgis.com](http://csj.maps.arcgis.com)

View of San José from City Hall:

Image Courtesy of James Stagi

West Coast Context Map Altered from:

City of San José: [csj.maps.arcgis.com](http://csj.maps.arcgis.com)



# APPENDIX A

## ***Survey Results***

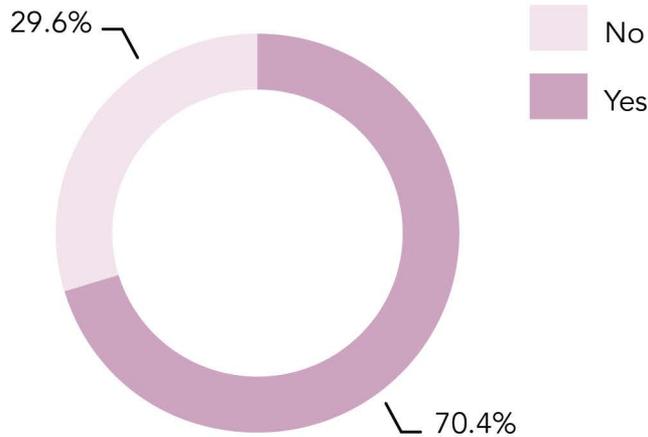
The following pages contain the full results from the San Jose general public Survey, distributed in January 2019.

**Question 1:**

Before taking this survey did you know about ADUs?

**Objective:**

Do people in San Jose know about ADUs? Should education be a priority for the city?

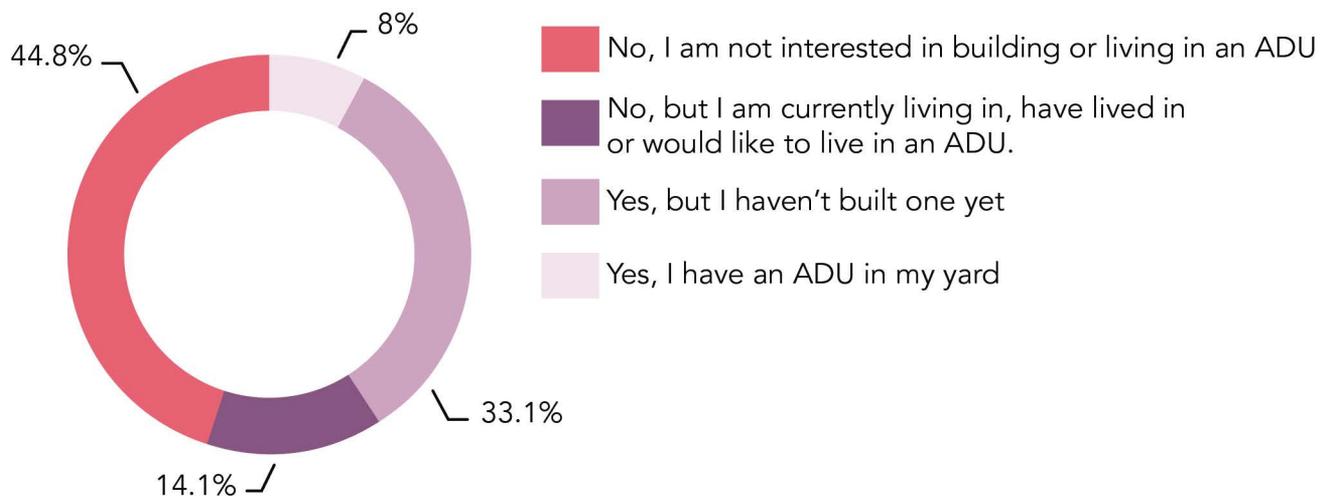


**Question 2:**

Have you ever considered building an ADU?

**Objective:**

Are people in San Jose interested in owning or living in an ADU?

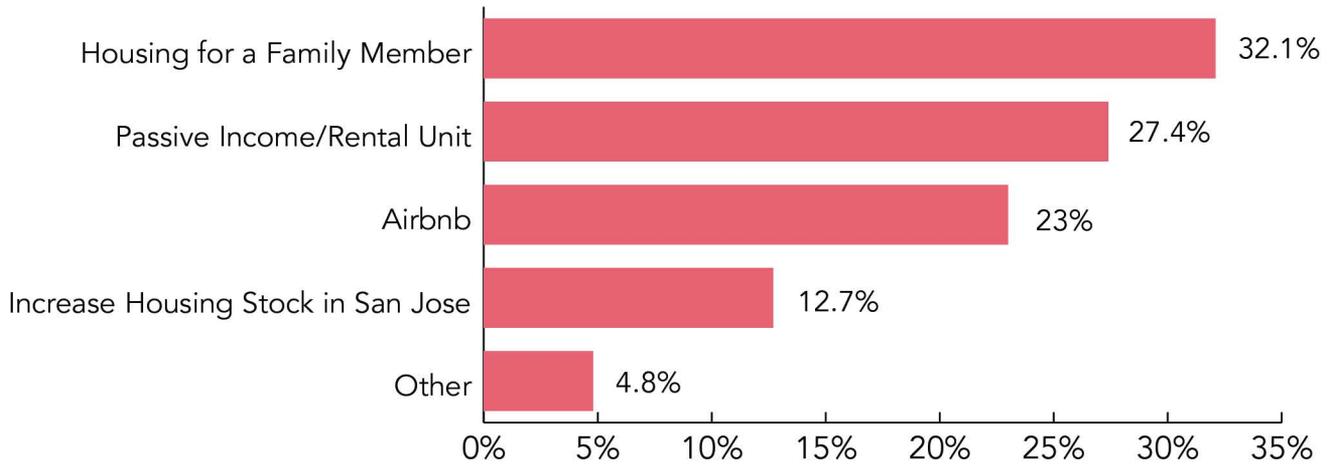


**Question 3:**

If you have or are seriously considering an ADU, what is your main motivation? (Ranked)

**Objective:**

What is the biggest motivation to have an ADU in San Jose? Understanding the motivation could also help the city understand need for future housing development types.



**“Other” Responses:**

For myself

Guest Cottage

Help provide more affordable housing options for all. Especially in the high cost living area of the bay.

Increased privacy at a more cost-effective rate than renting a house

On site home health care provider.

Possible future housing for us; renting main house

a temporary shelter for those in need

housing for friend

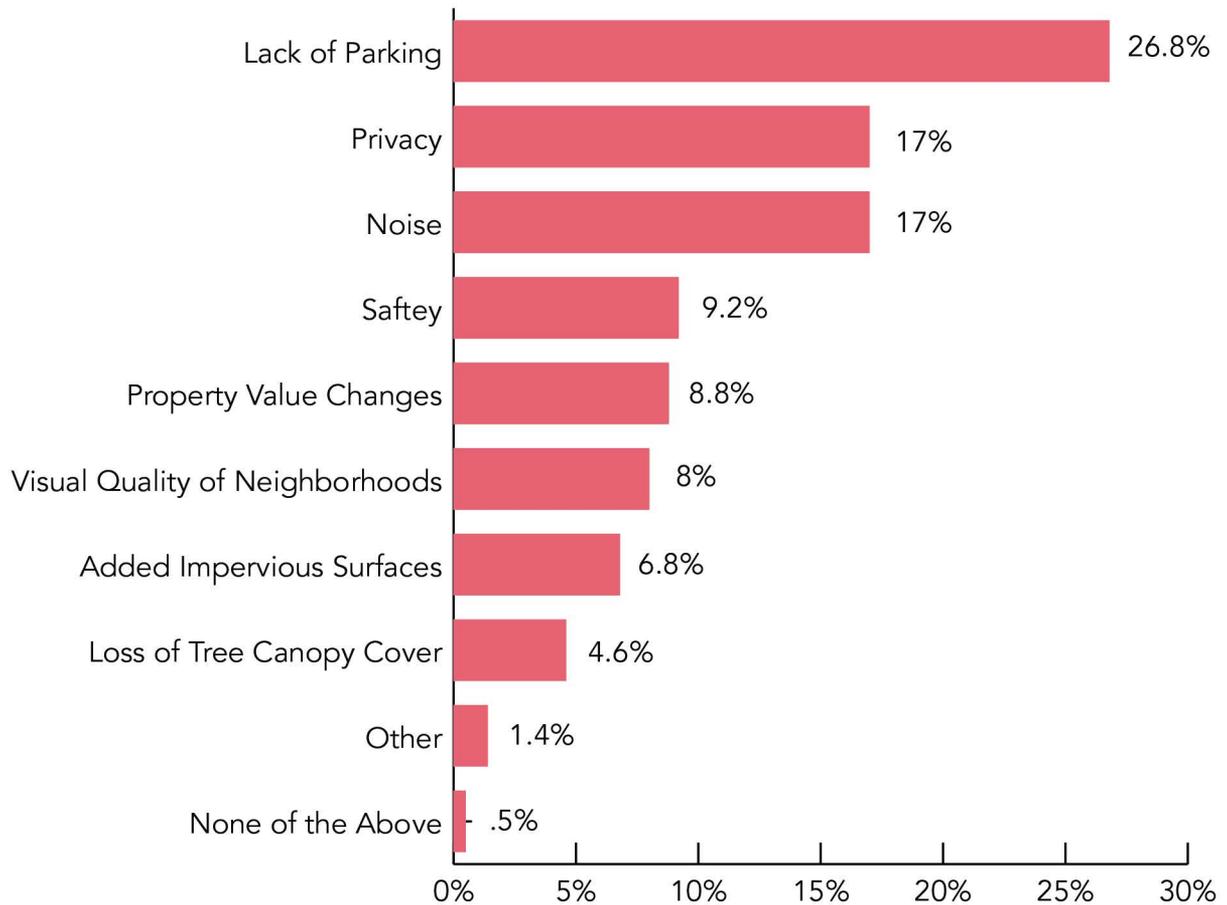
possibility to retire and stay in the area (live in the smaller unit and rent the larger house).

Question 4:

If ADUs become prominent in your neighborhood, what would be your main concern(s)? (Ranked)

Objective:

What concerns do residents have at the neighborhood extent if ADUs become widespread in San Jose?



***“Other” Responses:***

Infrastructure support (sewer)

Reduction of personal space

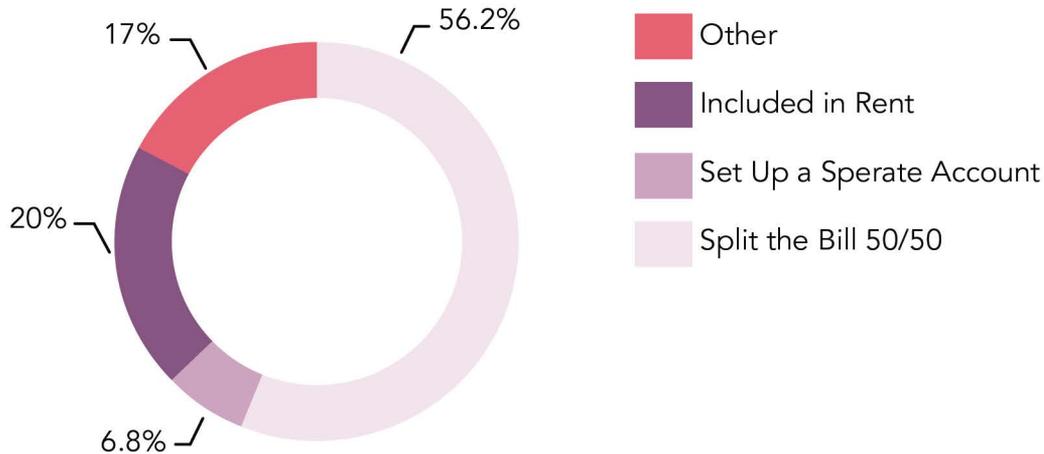
Resale

Question 5:

If you were to build an ADU, how would your tenants pay the utility bills?

Objective:

Reducing energy consumption is a main driver for this project, it is important to understand if greater energy demand and the cost of that energy is a concern for the homeowner. Consideration for how the utility will be divided indicates that it may be a financial concern.



**“Other” Responses:**

- Case-by-case approach
- Contracted per tenant
- Currently utilities are included in the rent.
- Estimate/flat-rate
- Flat monthly fee
- Free for family
- I would likely just pay the bills myself and
- Include a flat rate amount for utilities in with the
- rent. Advertise it as all utilities included.
- Incl in rent
- Include utilities in rent
- Included in rent
- Included in rent.

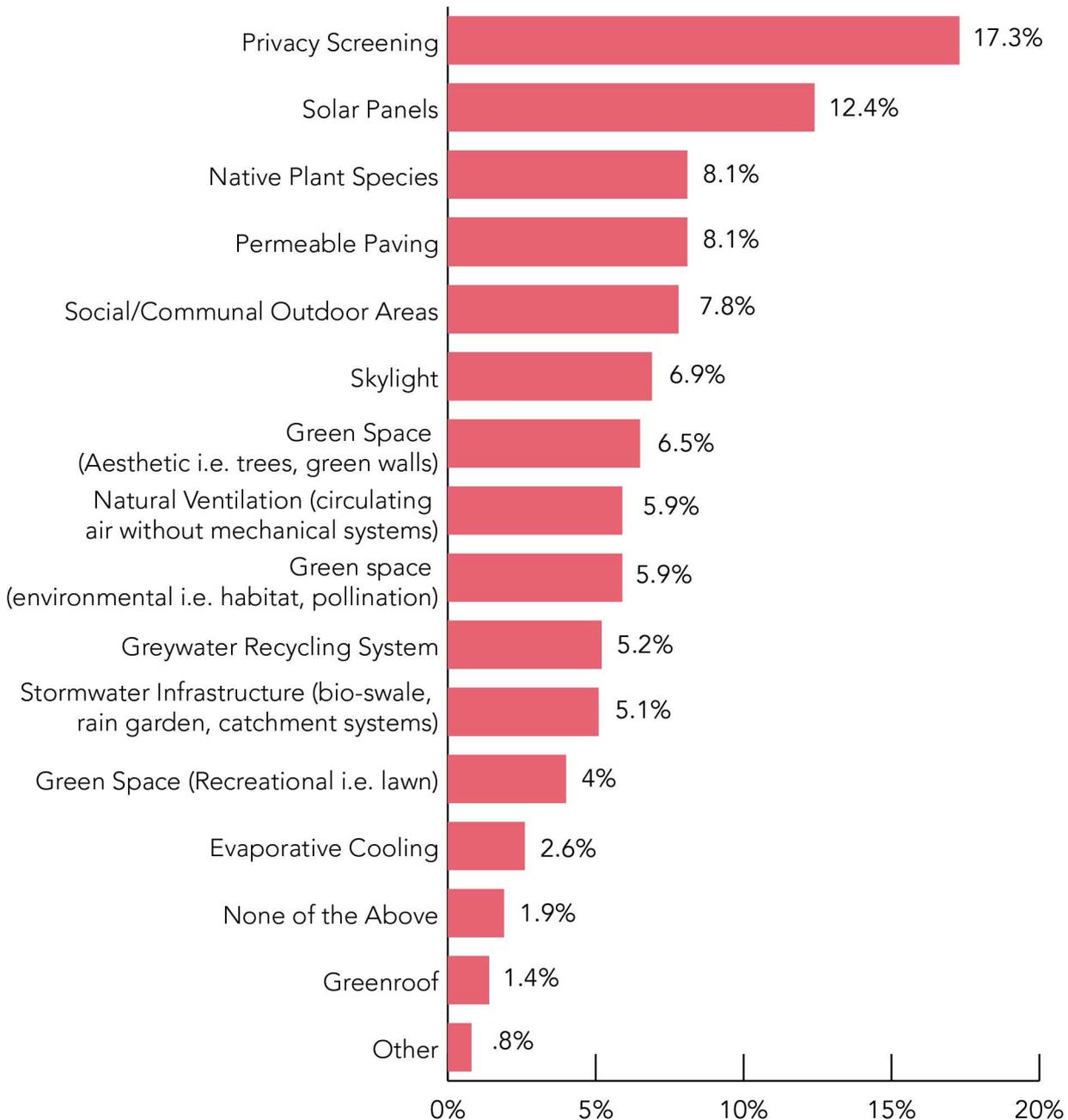
- I'd pay
- Maybe separate meter
- Percentage based on situation
- Split 60/40 or 70/30 because the ADU would be much smaller than the main house.
- Tied into owner unit
- add base cost to rent
- based on increase of usage
- fixed cost added to rent
- included in rent agreement
- interesting question i believe we would look at our past monthly bills and pro-rate on the increase

**Question 6:**

If you were to build an ADU, which sustainable improvements would you be interested in implementing? Consider that many of these options may add to the initial cost of construction. (Ranked)

**Objective:**

The ranking of these intervention types define what the general public deems most important in their outdoor space and responses will factor heavily in determining policy recommendations and site design interventions.

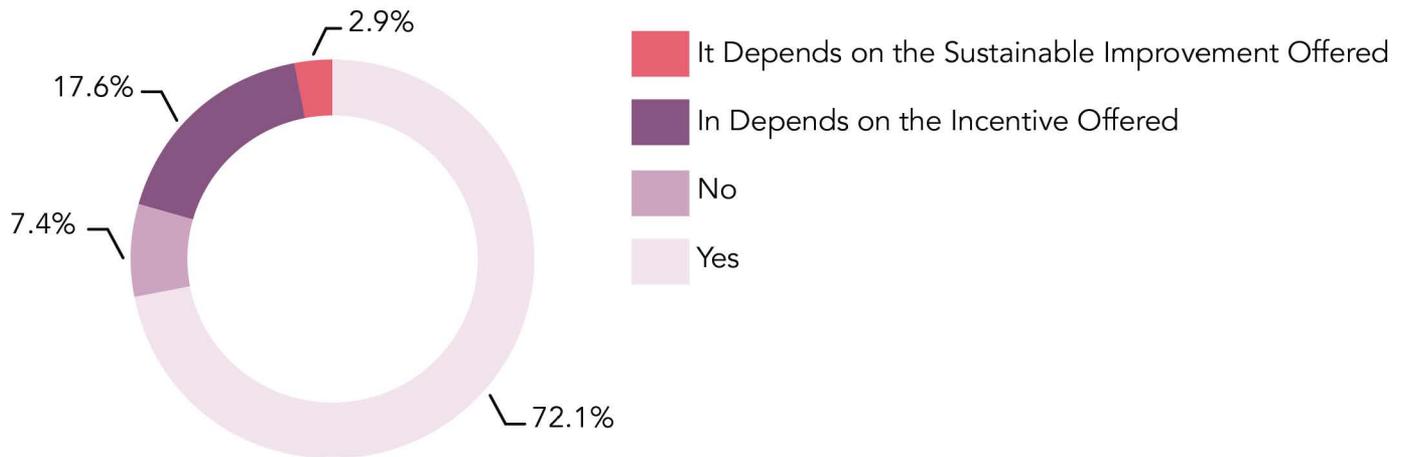


Question 7:

If San Jose were to offer incentives for sustainable ADU development, would you be more likely to implement one or more of the above improvements? (I.e. subsidies, accessible financing)

Objective:

Will people utilize incentives for sustainable design to reduce cost of ADU construction if it is available to them?

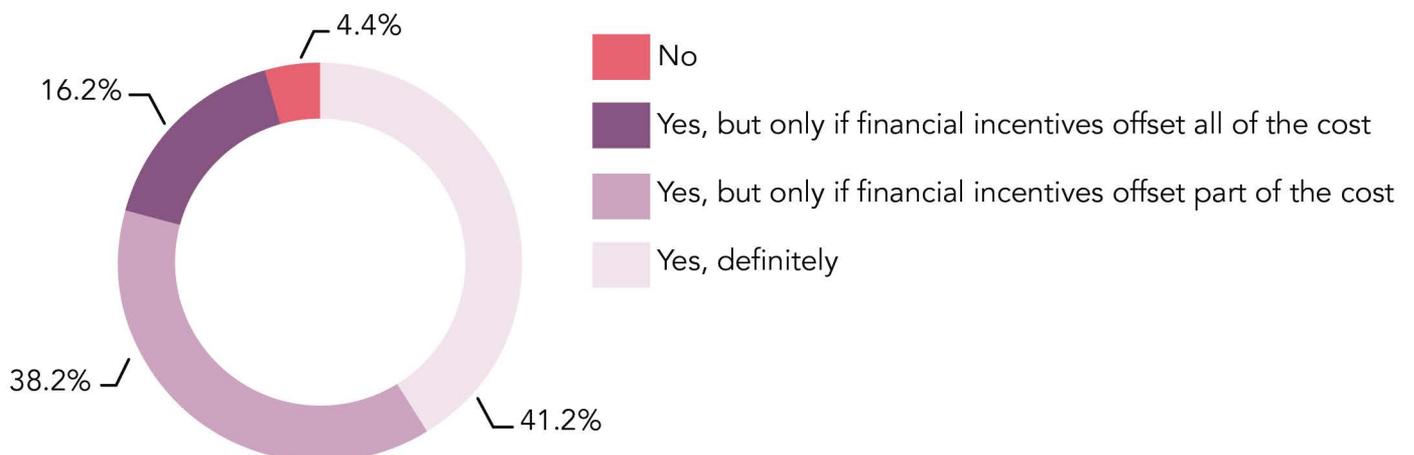


Question 8:

Low energy heating and cooling techniques include passive solar heating (the capture of sunlight to heat a space), movable insulation and shading on windows, evaporative cooling. Would you consider incorporating these techniques in your ADU or would you like to see these incorporated in your neighborhood, assuming design guidelines were provided by the City?

Objective:

How willing are people in San Jose to try passive or low impact heating and cooling techniques instead of or in tandem with traditional mechanical means?

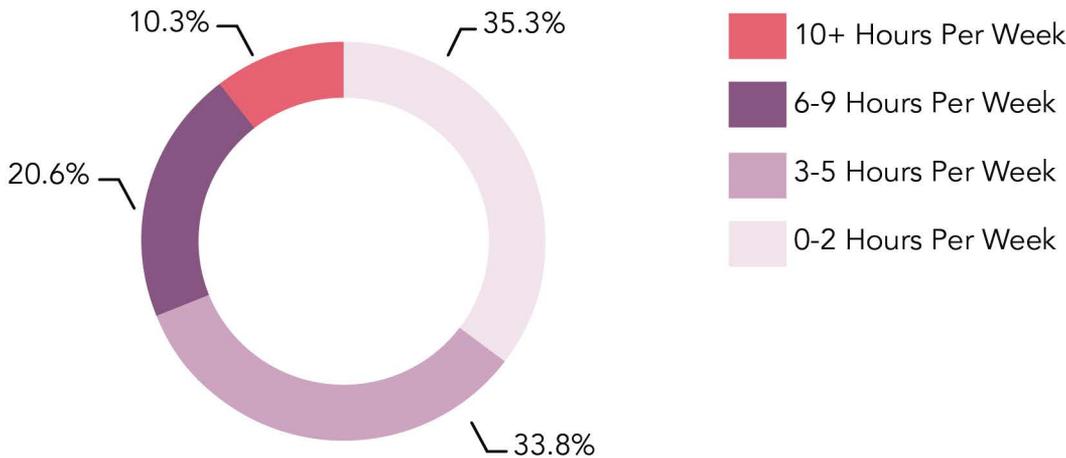


Question 9:

How many hours do you spend outdoors on your property? (front or back yard)

Objective:

Understanding the amount of time spent in the yard can help me when designing the shared outdoor space.



Question 10:

I am developing sustainable ADU design guidelines that can be useful for homeowners as well as the city. Are there specific activities or improvements that would positively change the amount of time spent in your yard? Please suggest any idea for the product that would be most helpful for you.

Objective:

What would be the most helpful outcome from this project from a homeowner standpoint? This open ended question allows the homeowner to broadly talk about their needs and concerns.

**Open-ended Responses:**

A hot tub

A kitchen garden, well placed shade

A well-kept garden or lawn space would keep me outside.

ADU should be self-sufficient and minimize interaction with primary homeowner

Adding a pool or hot tub, having neighbors who didn't stink up the yard with pot smoke

As long as it helps our environment and prolongs longevity for our resources, I say why not :)

Don't spend much time in it except for hanging laundry.

Drought friendly vegetation, more dog parks

Easily maintained green space

Functional space that can be a place of relaxation but also low maintenance. I would like a blending of garden and aesthetics.

Greenery, plants, shade

Grilled cheese maker

Guidelines have a way of becoming requirements. Requirements have a way of becoming barriers

## Question 10: Continued

Having a yard. Most places in SJ don't have yards.

If the city had an incentive to improve our environment by planting certain things in our area, I would spend a ton of time outside planting the correct things to improve our area. I would even offer to help the neighbors.

Incentives implementing sustainable plants in revamping the yard.

Kitchen unit. Ability to store food then cook or eat inside or out. Double as guest sleeping space or reading space. Windows and skylights.

Landscape friendly for toddler and baby...  
Lighten up on the limitations as to ASF: lot size!

Looking at some basic plans that would be approved by the City of San Jose for garage conversion. They have them for master bedroom conversion but garage conversion would be our interest.

More shade trees

My neighbors smoke too much weed. I need a way to be in my yard and not smell it

No

No.

No. I garden regularly and entertain. Not interested in having a renter onsite.

Noise reduction from street traffic

Our yard is not large enough to add such a unit, but I wish you great success, and would like to see more such units for the homeless who are capable of living in community with others.

Our yard time is not standard. We haven't landscaped yet which is limiting.

Pool. Garden. Deck.

Questions of privacy for various occupants.

Shading, such as pergolas. But time spent in yard is not dictated by aesthetics, but overall available time

Since we are all so close together, it would be nice to have some noise mitigation measures. I

have no idea what this might include, but might possibly be something like landscaping that helps to soften hard surfaces of all the buildings so the noise doesn't carry as much. Taller fencing, etc may be another option. I don't know anything about this, so am not sure what sorts of measure could be put into place, but having to listen to my neighbors' conversations or music or children minimizes my enjoyment of my own backyard.

Some green space between the home and ADU. Have it sort of like a little Norman Rockwell garden with a small cottage.

The things that would affect my time outside are privacy while maintaining a communal space, canopy cover and permeable surfaces.

To maintain a private entertaining space

Veg garden and/or patio for ADU

Water feature, serene landscaping, shade trees, flowers

We need to install a backyard deck and covering for more shade. We would be outside more in the summer with better shading

Landscaping, dead lawn from not being able to water due to drought restrictions has left the backyard dusty when dry and a mud pit when it does rain

Noise reduction, higher fences for privacy

Pool or spa, designed landscaping

Time is my biggest problem in spending time in my yard

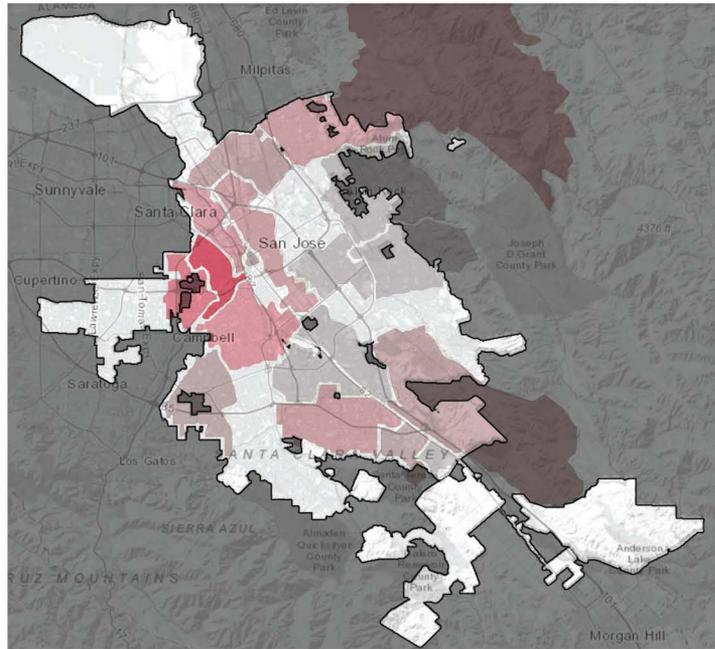
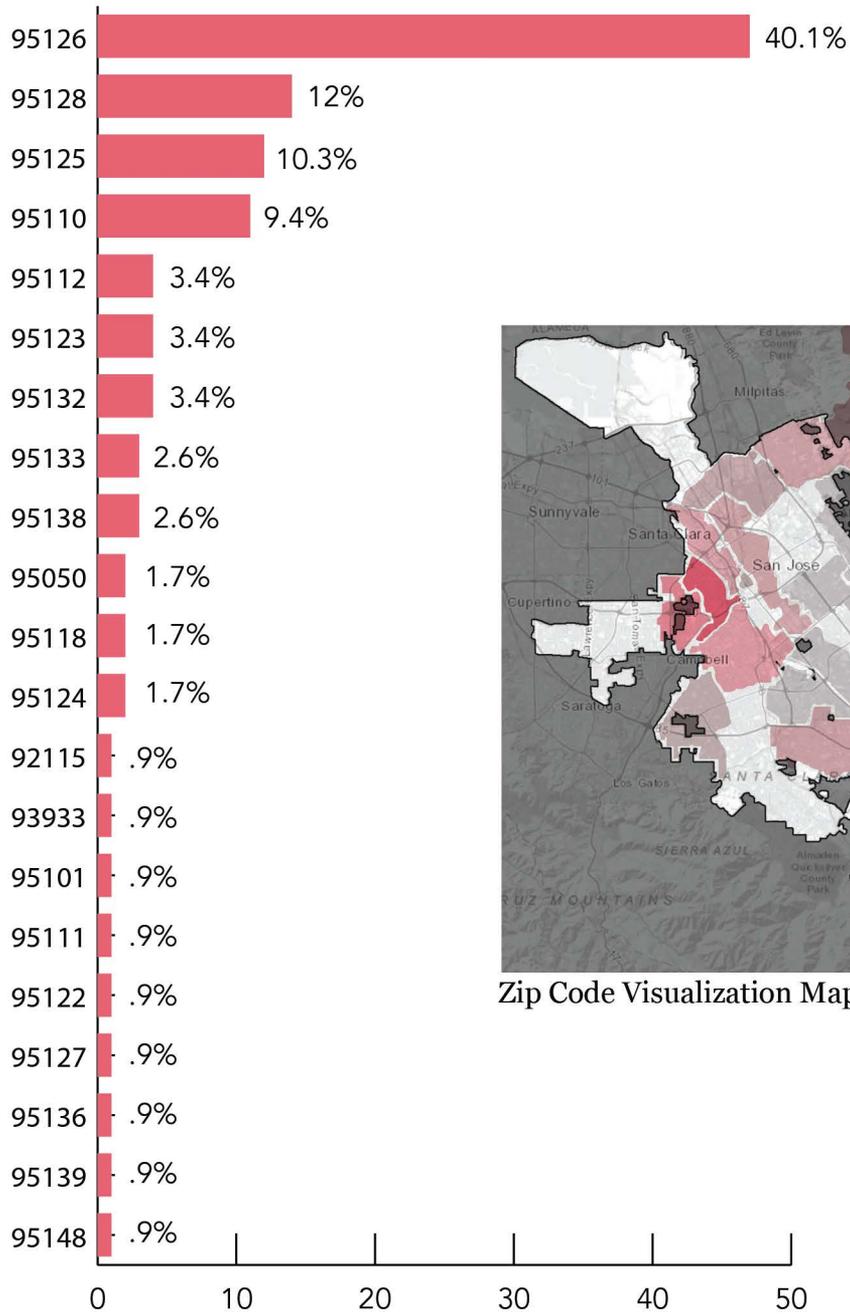
Having no grass and more natural and native plants makes yard work easy so not necessary to spend more time doing yard work. Having a cover over part of the patio is a great improvement so can spend more time outdoors most of the year; having a nice size garden area is also an excellent improvement as gardening is healthy.

Question 11:

In which San Jose zip code do you reside?

Objective:

Zip code helps us to understand sample distribution across San Jose.



Zip Code Visualization Map





# APPENDIX B

## ***Design Toolkit***

The Design Toolkit consists of landscape elements that help to facilitate comfortable and sustainable outdoor spaces for the residential landscape to offset and complement the added impermeable surfaces that are necessary when densifying.

# DESIGN TOOLKIT

This toolkit is intended to demonstrate sustainable design components, giving a brief overview of the strengths and weaknesses as well as the general cost and functionality of each element. The design toolkit should not be considered a comprehensive list of sustainable options for landscape design, but as a quick guide for thoughtful landscape intervention. This short list was curated from interest shown by the general public in San Jose and takes into consideration ease of maintenance, cost and benefits.

Cost indicators in the top right corners show generalized price points (per square foot) for the design elements, it is not possible to specify a specific cost for each element due to the broad range of, aesthetic preferences, materials and quality and varying installation and maintenance charges.



Image courtesy of [www.sightline.org](http://www.sightline.org)

## Design Elements:

- Skylight
- Solar Panels
- Rain Garden
- Permeable Pavers
- Native Vegetation
- Turf/Lawn
- Evergreen Tree Cover
- Deciduous Tree Cover
- Hardscape

# SKYLIGHT

A skylight is a window that is installed into roofs of structures; they are used to let in natural light, and can contribute to warming up the space through passive heating. It is important to consider the roof angle and square footage of the skylight(s) to have effective heating and cooling results.

## Benefits

Skylights offer a passive heating option (utilizing sunlight to heat a space) with little maintenance, allows natural light indoors, and can be a decorative design element.

## Constraints

Skylights can come at a somewhat high cost per square foot and requires specific timing of movable insulation (airtight blinds or custom panels) to best maintain comfortable room temperatures.

\$\$



Image courtesy of Accessorydwellings.org

# SOLAR PANELS

Solar Panels or photovoltaic cells are a renewable, an alternative energy source used to collect natural energy from sunlight. They are attached to the exterior of a structure usually the roof, or can be free standing. Solar panels are an accessible method for home owners to reduce energy costs.

## Benefits

Solar energy is renewable, has low maintenance costs, and can lower monthly electric bills.

## Constraints

The initial cost of installation can be high, efficiency of energy collection can vary due to weather, and the panels have the potential to take up a lot of space to reach the desired energy production. Solar energy can be stored in batteries that charge during daylight hours; however these battery systems can be pricy.

\$\$\$



Image courtesy of Tinyhouseliving.com

## RAIN GARDEN

A rain garden is a shallow depression in the ground that collects rainwater, they are often planted with specialized plants and grasses.

### Benefits

Rain gardens retain stormwater runoff, clean pollutants from roofs, roads and other hardscape slows water during storm events, and if rain gardens are allowed to percolate (soaks into the ground, i.e. no drainage barrier) they help to recharge the water-table. Rain gardens do not require irrigation and often utilize native vegetation.

### Constraints

Rain gardens take some specialized knowledge to implement and maintain however there are a lot of resources out there for people interest in implementing them.

### Resources

Santa Clara County Rain Garden Guidebook:

[http://www.sevurppp-w2k.com/pdfs/1213/BASMAA\\_Rain\\_Garden\\_Fact\\_Sheet\\_11\\_26\\_12\\_CORRECTED\\_online\\_ver.pdf](http://www.sevurppp-w2k.com/pdfs/1213/BASMAA_Rain_Garden_Fact_Sheet_11_26_12_CORRECTED_online_ver.pdf)

City of Portland, Oregon Rain Garden Guidebook: [www.portlandoregon.gov/bes/article/188636](http://www.portlandoregon.gov/bes/article/188636)

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Image courtesy of Smart Yards Cooperative

## PERMEABLE PAVERS

Permeable/pervious paving are pavers or natural materials like decomposed granite, that allow water to filter through or around the material, there are specialized pavers or pavers can be set into an aggregate and sand base to allow water to infiltrate.

### Benefits

Permeable pavers allow for rainwater to permeate into the soil and recharge the water-table, there are a variety of colors and styles of permeable pavers available.

### Constraints

Without proper installation the pavers may shift and the gaps in between the pavers must be maintained to retain their permeability.

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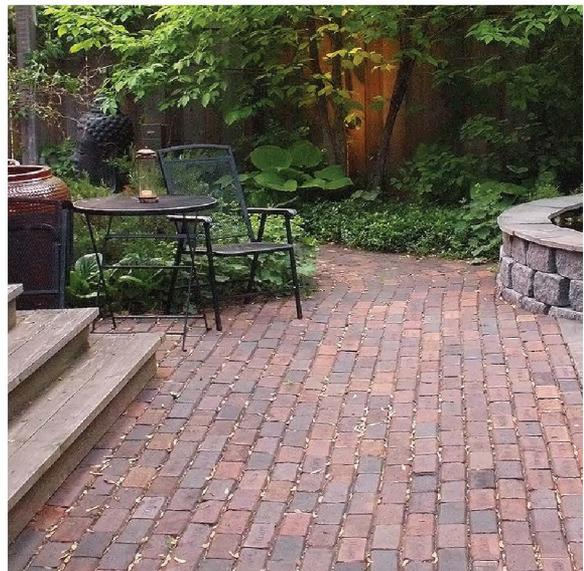


Image courtesy of www.houselogic.com

## NATIVE VEGETATION

Native vegetation is flora or plants species that naturally occur in a local region or habitat ecology. They provide much needed habitat to native fauna, including food and shelter that non-native species often cannot mimic.

### Benefits

Native vegetation is considered a resilient landscape form because they are adapted to local climates and soils, offer benefits such as food to native fauna, and usually don't require irrigation after establishment. They provide habitat for animals and help to rebuild local ecologies.

### Constraints

Sometimes Native plants are harder to find in large quantities and varieties; some native plants can be finicky in garden environments.

\$



Image courtesy of Smart Yards Cooperative

## TURF GRASS/LAWN

Turf or lawn is grass or a mix of different grass species cut or mown short - between 2"-4". Lawns are commonly used for recreation and are found in a variety of maintained landscapes including yards, parks and golf courses. Turf can be purchased as a seed mix or as sod, price ranges vary depending on type.

### Benefits

Lawns are permeable, walkable for most of the year (it can get soggy in rainy months), good for recreation, and some varieties can be drought tolerant, native and/or pollinator friendly.

### Constraints

Lawns often lack biodiversity, they usually need irrigation to survive year round, and to maintain the bright green coloring year round, lawns are often fertilized which can pollute nearby water sources.

\$



Image courtesy of www.gardeners.com

## EVERGREEN TREE COVER

Evergreen trees are trees that stay green year-round; they are often associated with coniferous species such as Douglas fir and Pine trees however the term also refers to broad-leaf species such as the Southern Magnolia or some varieties of Oak or for example.

\$\$

### Benefits

Evergreen species provide year round protection from wind and harsh sun, they can provide privacy screening; they also provide habitat and serve to filter pollutants from the air and reduce loss of soil moisture. Planting evergreen species on the north side of the home will reduce problematic shading and act as windbreak in wintertime. Of course evergreen species are not always trees and can be found in a variety of sizes to suit the needs of the site.

### Constraints

The soothing shade of evergreen species can become overbearing due to the often great heights that these trees often grow; thoughtful placement should be considered before choosing the proper tree for a given location.



Image courtesy of [www.meadtree.com](http://www.meadtree.com)

## DECIDUOUS TREE COVER

Deciduous trees are tree species that drop their leaves in colder months, and leaf out again in spring.

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### Benefits

Deciduous trees are advantageous to have in a yard because they block out hot sun in summer but lose their leaves in winter to allow for maximum solar access in the colder winter months. Placing deciduous trees on the east and west sides of the home offer the greatest benefits. Deciduous trees offer habitat for animals and can provide many other benefits based on the species including food production, aesthetic color changes in fall, filtering air pollutants and soil building.

### Constraints

Deciduous trees require some maintenance and that widely varies based on species but may include raking fallen leaves and irrigation. It is important to choose the right species for the site for the best results.

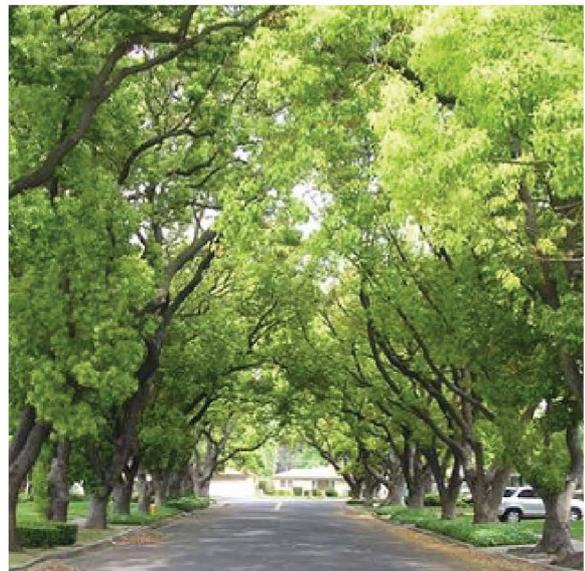


Image courtesy of [www.sanjoseca.gov](http://www.sanjoseca.gov)

# NON-PERMEABLE HARDSCAPE

The term “hardscape” refers to any non-permeable paved areas in the built environment including walkways, driveways, paths and parking lots. Hardscape is often referring to man-made materials such as cement, concrete, asphalt and pavers that are installed using highly compacted or concrete base.

## Benefits

Hardscape is ADA accessible, it is walkable in all weather, comes in a variety of finishes and colors, and is a cheaper option with little maintenance and easy installation.

## Constraints

Concrete and concrete-set pavers are not permeable, meaning that rainwater cannot infiltrate into the soil. Hardscape does not offer any ecological benefit to the area in which it is installed and is difficult to remove. There are also undesirable social and environmental impacts to consider when installing hardscape.

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Image courtesy of [www.landscapingnetwork.com](http://www.landscapingnetwork.com)

# OTHER ELEMENTS

## Other Sustainable Design Elements to Consider:

- Raised Garden Beds/Backyard Agriculture
- Rainwater Collection
- Small Livestock (Chickens, Ducks, Goats, etc.)
- Greenroof
- Greywater Irrigation
- Urban Beekeeping
- Pollinator Plants
- Compost Collection



Image courtesy of [www.tilysnest.com](http://www.tilysnest.com)