

serene senescence
modular aging in place in fargo, north dakota

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serene senescence:
modular aging in place in fargo, north dakota

A Design Thesis Submitted to the Department
of Architecture and Landscape Architecture
of North Dakota State University

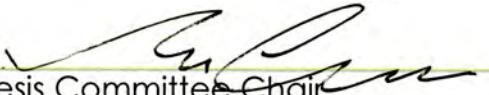
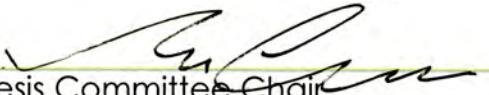
By

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In Partial Fulfillment of the Requirements for the
Degree of Master of Architecture



Primary Thesis Advisor

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abstract

As the population of baby boomers reaches retirement age, the question of how to house and properly care for this generation comes to mind. Many of the smaller living spaces geared toward the senior population are not always designed to address their changing physical, social, and emotional needs. By creating a system of modular spaces to be combined to readily create accessory dwelling units--more commonly known as "granny flats"--on the properties of their children or close friends, these needs are more easily met.

The inclusion of universal design principles ensures that these accessory dwelling units are fit to meet the needs of the resident without giving the sterile feeling of a nursing home. Different sized options for each space allows the resident to choose the spaces that fit their specific needs to reduce excess wasted space. By creating a living space on the property of a child or friend, anxiety is reduced for both the senior and their child and the social and emotional bonds between the two are strengthened.

thesis proposal

How can modular
accessory dwelling units
facilitate aging in place in
Fargo, North Dakota?

thesis narrative

thesis explanation

This thesis aims to design modular accessory dwelling units for seniors in Fargo, North Dakota. The inclusion of furnishings and materials that coincide with universal design principles will also play a major role in the design. Oftentimes, many of the homes that seniors live in are not tailored to their needs and therefore make life more difficult for seniors to live there comfortably. I want seniors to be able to age in the most comfortable and accommodating environment that they can.

Because Fargo, North Dakota does not currently include accessory dwelling units in their land development code, the creation of an addition that outlines the stipulations for accessory dwelling units will be proposed to add to the land development code

project emphasis

Although this project, as with any design, has many different facets, there are two aspects that will have the main emphasis. The first is the proposed zoning code. Without a set of rules, the rest of the project would be free to expand into whatever it would like to be and become an eyesore on the existing sites. Every good project needs a set of rules to adhere to. The second emphasis will be on the programmatic design of the modules. This requires a balance of the space required for universal design and the lack of space allowed for designing these tiny homes. The modules will need enough space for movement and for storage, but also be compact enough to occupy any single residential site in Fargo.

project typology

The goals of this project led to the creation of modules to be assembled into small homes to be placed on the properties of adult children for an aging parent to live in. These small homes will be designed with universal design principles in mind and will include appliances, finishes, and furnishings that align with these principles.

By allowing the addition of small homes on lots with existing homes, the population density of Fargo will be slightly increased. This could help to offset the effects of urban sprawl. It can also help to increase the density in these newly developed areas.

project goals

The final goals of this project will result in two outcomes:

1. The first will be a proposed zoning code for the city of Fargo to add to their existing Land Development Code that regulates the addition of accessory dwelling units on lots with primary dwellings on them.
2. The second will be a set of modules that include the spaces needed to create a comfortable home for seniors. These modules will be combined to create a home for a senior. Four randomly chosen sites of varying sizes, zones, and locations within Fargo will be selected and assigned a randomly chosen client. By analyzing the existing site conditions and the client, modules will be selected to create an example solution for each site.

thesis narrative

audience description

The project has two main audiences:

1. The first audience will be the users of the project. This includes senior parents that could currently be living anywhere, but would enjoy the opportunity to live in a small home on the property of their adult child or a friend. Another set of users include the owners of the sites in Fargo. They must be willing to allow an extra home to be built on their lot and another person or couple to live in such close proximity to them
2. The second audience is the city planners of Fargo. They need to see the benefits that accessory dwelling units can bring to the city and how they can be implemented in the city.

research design plan

This project will be accomplished through the use of many different paths of research. These paths correlate with the research question. The main topics include:

1. General Research on Seniors
2. Modularity & Connections
3. Accessory Dwelling Units
4. Aging in Place & Universal Design
5. Zoning & Regulations

After an investigation of each topic, the findings will be used to form a design that responds to each topic appropriately. The process is laid out in a schedule located to the right.

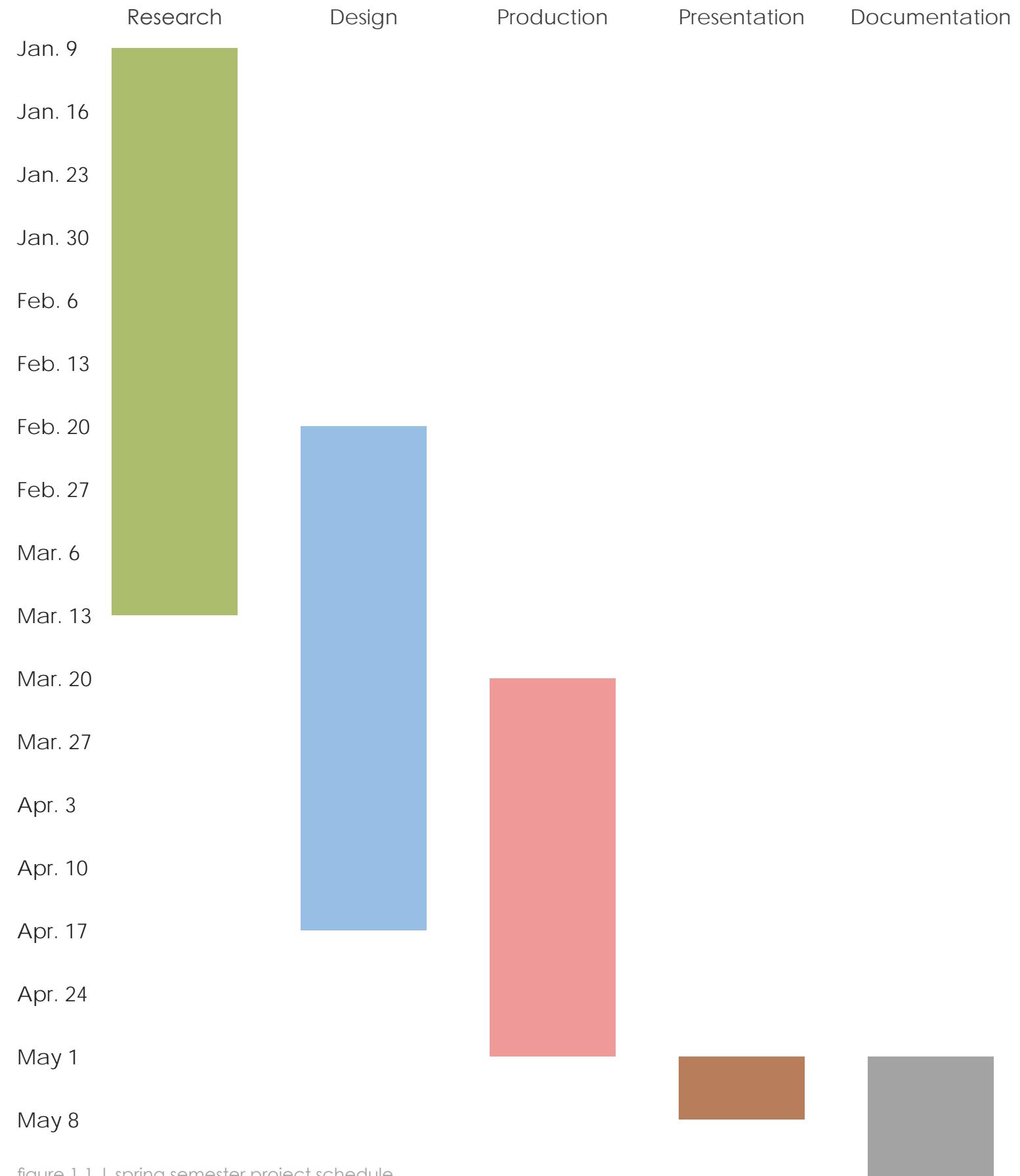


figure 1.1 | spring semester project schedule

project justification

"A design thesis is a student-generated project that poses and architectural question or theoretical premise/unifying idea that [the designer has] not investigated in a substantial manner" (Thesis Manual). The design has so much more meaning than this, though. It has an importance to the designer, and an importance to the world. Not every student is trying to save the world. The thesis project is an exploration of new ideas that have a tendency to be suppressed in the real world. Every project has a reason. Here is mine..."

inspiration

The image on the facing page is one of myself and my grandfather at my wedding, less than a year before he passed away. Although we did not have an extremely close relationship, I will always treasure the hard working and God loving values he taught me.

My grandfather was diagnosed with Parkinson's disease in 1996, when I was only three years old. His disease was present for a large portion of my life, but only a small portion of his. At first, the disease was unnoticeable to the naked eye, but as the time went on, the degenerative process of the disease became more and more apparent.

As he slowly lost his muscle control, more assistive devices became necessary. First a walker, then a standard wheelchair, then an electric wheelchair, and finally a larger, more comfortable wheelchair.

With the new assistive devices, came the need for more accessible housing for my grandparents. When I was born, my grandparents lived in an old two story farmhouse located about ten miles from town. The house was heated by an exterior wood stove, which required someone to go and add wood every so often. Not long after their barn burned down one night and with my grandfather's deteriorating physical condition, my grandparents decided to build a one story home on a nearby lake.

They ended up placing a prefabricated double wide home on a CMU basement on their lake lot. My then retired grandfather particularly enjoyed this because he could take his four wheeler down the large hill to the dock and go fishing whenever he liked. He took his four wheeler many places, sometimes more often than he should have. Because the house was raised a few feet off of the ground, my grandparents had ramps built up into the home, knowing that they would eventually be needed.

The less muscle control Grandpa had, the more he had to sit in the house by himself. My grandmother worried about him while she was at work and they decided to move into a facility in town. This facility consisted of two floors of apartments. Half of the apartments were assisted living apartments, and half were independent senior living apartments.

Because my grandmother needed no assistance, they moved into an independent living apartment. This gave my grandmother more peace of mind, because she knew that while she was at work, my grandfather could go have meals with other residents and participate in the many activities that the facility offered, including Bingo, his favorite.

The less control he had, the more effort it took to get him anywhere. My grandmother could not lift my



figure 2.1 | myself and my grandfather

grandfather in and out of the car, so she would push him in his wheelchair to church or call the Friendly Rider bus to pick him up and bring them to his doctor's appointments.

Eventually it just became too much work for my grandmother to take care of my grandfather by herself. They made the decision to put him in a nursing home almost 20 miles away where he could be cared for at all hours of the day. My now retired grandmother could visit him whenever she wanted, but it was extremely hard on her emotionally.

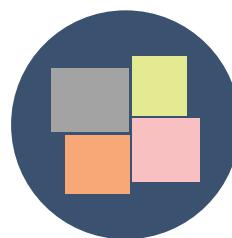
With my grandfather moved out, it was no longer necessary for my grandmother to live in the expensive independent living apartment, so she moved to another apartment in the same town. She lived there until my grandfather passed away about a year later.

After my grandfather passed, and without his social security check, my grandmother could no longer afford to live in the apartment, so she moved back to the farmhouse, full circle back to where this story began.

Over the course of about fifteen years, my grandmother has moved four times. I believe this number could have been reduced significantly by an accessory dwelling unit. She would have had at least one of her children and their families to help her with my grandfather. They would have also been there for more moral support and just a relaxing break from being a caregiver. It also would have reduced the stress on my parents and aunts and uncles, knowing that she and my grandfather were safe and cared for.

My grandfather never let his disease get to him. He didn't give up. Even when the nursing home staff told us he would be leaving this earthly home soon, he fought for ten more days. He always put God first, and his family close behind. He is greatly missed by everyone in our family and his many friends.

research question



How can **modular accessory dwelling units** facilitate **aging in place** in Fargo, North Dakota?

I want this project to be based on the **needs** of each individual client. A modular design allows the client to choose which modules fit their physical, social, and emotional needs best. By doing so, they can create a home that allows them to age in place more successfully.

Accessory dwelling units are a **smaller, more intimate space**. This allows the designed spaces to be **more personal** for both the designer and the client. It assures that the home is being built for that client specifically as opposed to an apartment building which is built with the owner's needs in mind instead of the resident's.

People prefer to **age in their own homes for as long as they possibly can**. We as designers should focus on designing spaces that are useful for people of all ages and abilities. This can help to alleviate the stresses of moving, especially on seniors, who can find packing and moving more stressful than those of use who are younger.

Fargo currently **does not have a section of their land development code that addresses accessory dwelling units**. I believe that ADUs would be well utilized in the city and help to create some urban infill in a quickly sprawling city.

unifying idea research

This section contains the following topics:

Research Methodology
Seniors and Their Needs
Modularity & Connections
Accessory Dwelling Units
Universal Design & Aging in Place
Zoning & Regulations

research methodology

system of inquiry

Emancipatory

An emancipatory approach to the research process is one that recognizes that there are multiple overlapping realities in our world. There is not one correct answer, but multiple acceptable solutions. This approach allows for many opinions without judgment as to which is the singular correct one.

research strategies

Interpretive: Interpretive strategies include the use of historical precedents to reach conclusions.

Qualitative: Qualitative strategies includes social, cultural, and anthropological research to reach conclusions.

Simulation: Simulation includes the use and comparison of models to reach conclusions

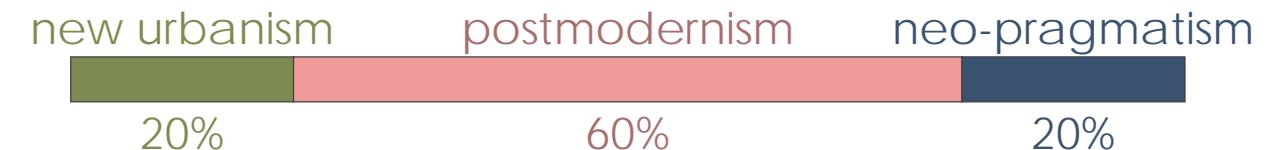
research tactics

Literature Review: Literature Review employs the use of books, articles, videos, etc. to find appropriate information to utilize.

Case Studies: Case Studies utilize existing projects to compare to determine aspects that are useful and not useful to the new design.

Logical Iterations: Logical Iterations require a trial and error process and documentation of this process. It is an evolution of changes formulated by the realization of what solutions will not work and why.

personal design philosophy



New Urbanism: The New Urbanist theory is one that believes that new design should match the style and design methods as the surrounding neighborhood.

Postmodernism: The Postmodernist theory is one that believes in multiple realities, much like the emancipatory system of inquiry. This theory speaks to the modular aspect of the design.

Neo-Pragmatism: The Neo-Pragmatic theory is focused on functionality. It does not care what the design looks like, as long as it is functional.

role of design

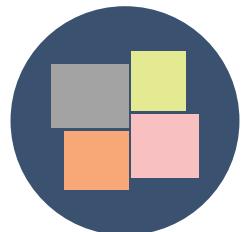
1. The design is responsive to the spatial needs of the residents
2. Modularity leads to ease of design, reduces costs, and shortens construction time
3. The design incorporates the use of universal design principles, so that it is accessible for everyone
4. The design is aesthetically pleasing to fit with existing structures
5. The design addresses the living needs of the community

research topics

1. Preliminary Research

2. In-Depth Research

How can **modular accessory dwelling units** facilitate **aging in place** in **Fargo, North Dakota?**



**modularity
& assembly**

logical iterations:

Google SketchUp

Hand Sketching

literature review:

sips.org
Structural Insulated
Panel Association

Diamond Pier Footings
Pin Foundations, Inc.

Tiny House Design & Construction Guide
Dan Louche



**ADUs
& tiny homes**

literature review & case studies:

In-Laws, Outlaws, and Granny Flats
Michael Litchfield

*Backyard Cottages: A New Choice for
Seattle Families*
City of Seattle Dept. of Planning
and Development



**universal design
& aging in place**

literature review:

*The Accessible Home: Designing for All
Ages and Abilities*
Deborah Pierce

*Housing for the Elderly: Privacy and
Independence in Environments for the
Aging*
J. David Hoglund

Residential Design for Aging in Place
Drue Lawlor & Michael A. Thomas



**regulations
& zoning**

case studies:

Minneapolis, Minnesota

Austin, Texas

Seattle, Washington

In-Laws, Outlaws, and Granny Flats
Michael Litchfield

Land Development Code
Fargo, North Dakota

preliminary research

According to Mark Mather in his writing for the Population Reference Bureau titled "Fact Sheet: Aging in the United States," there are 46 million Americans over the age of 65 and that number is projected to double by 2060 (Mather, 2016). As the baby boomer generation continues to age, the number of seniors in the United States continues to rise. This increasing number of seniors has led to an increase for the need in living accommodations for these people whether it be nursing homes, assisted living, or independent living.

As we age, we often find it harder and harder to come to terms with the changes we encounter physically, mentally, and emotionally. This becomes especially prevalent as we approach the title of "senior." Seniors are constantly faced with the fact that they want to continue to do what they have been doing their entire lives and not taking into account that they may have become physically or mentally weaker. The need for comfort and familiarity become more and more necessary. Many seniors prefer to continue to live in the home they have lived in for a majority of their lives, but these homes are not always suited to the older generation. Almost all of the houses built and designed today and in the past are tailored to the majority of the population that is middle aged. They include features such as stairs, high and low shelves, doors that may be heavy or require a certain amount of dexterity to open, and paint colors and finishes that are chosen

without taking into consideration how reflective or blinding they might be to someone with more limited vision.

Along with certain features in almost every home that can make living there difficult for the elderly occupant, the daunting task of maintaining a home becomes increasingly more and more difficult as well. With less strength and mobility, cleaning and taking care of a home becomes a task that requires extra thought and preparation. It requires much more effort to go out and mow the lawn, rake the leaves, or shovel the snow. Sure, these tasks can be passed off to younger, more agile family members or services for hire, but not everyone is willing to give up this symbol of independence.

"Youthful and fit, we are allowed to be forgetful; the elderly are senile. We make mistakes; the elderly are confused. We use drugs to forget, to calm down, and to escape; the elderly often derive the same results from medications they cannot avoid. We lose sight of the individual amongst a plethora of labels, stereotypes, and behavioral theories." (Hoglund, 1985)

Aging is often seen as a time of loss: loss of strength, loss of muscle control, and loss of sight or hearing. Instead of focusing on what seniors are still able to do and achieve, society focuses on the negative stereotypes of aging and what an individual can no longer do.

Along with these labels applied to seniors, they also face feelings of obsolescence or that they contribute little to a society filled with youth (Green, Fedewa, Johnston, Jackson, & Deardorff, 1975). This leads to psychological barriers facing seniors and research has shown that feeling psychologically well is extremely important for successful aging (Demirbilek (Saritabak) & Demirkhan, 1998). They believe that they are unable to perform certain activities because they are told they cannot do them. This is what Hoglund refers to as learned helplessness (Hoglund, 1985). Seniors restrict themselves to tasks that they know are safe and fits into society's norms, instead of doing what they know they are still capable of doing.

With increasing age comes an increase in disabilities and difficulties. These disabilities and difficulties deserve design strategies that are supportive of the changes occurring instead of only pushing toward a more sterile and mechanical environment (Hoglund, 1985). Although the senior population may be capable of more than we typically think of them doing, growing older does come with some difficulties both visible and invisible. Visible changes include features such as gray hair, lost teeth, an increase in weight, sagging, and wrinkles. There are also features that occur that may not be visible to the passerby, but are a very real piece of aging as well including stiff joints, shortness of breath, a decrease of blood flow, diminished muscle strength, and

the inability to sustain physical stress (Hoglund, 1985). These features, both visible and invisible, must be accounted for when it comes to designing housing for seniors. Our current built environment is based on the younger generations, those with a quicker reaction time, more strength and agility, and a better memory. Elevator doors close a little too soon, crosswalk signals change a little too fast, buildings have confusing layouts, and elevator lobbies on each floor look the same. Senior housing can be designed to help alleviate the stresses created by these features that the younger generations do not even realize exist.

The activities that seniors participate in can fall into two theories. The first is disengagement theory. This theory states that as people grow older, they withdraw more and more from society (Schroots, 1996). The world is changing increasingly more and more and seniors feel that it is just safer for them to withdraw into their own little safe bubble away from those changes. This theory applies to a select group of seniors, but it is not the norm for many.

The second theory that has been applied to the mindset of seniors is activity theory. Studies have found that the activities that some seniors participate in are at the same levels of participation as pre-retirement (Atchley, 1982). Sometimes when people retire, they actually become more active than they were when they had a job to occupy all of their

time. These people can be found helping out in the church garden, volunteer groups, or other clubs in society. Many newly retired individuals fall into this category, but there is a large number of older individuals who are also active members in society.

Just like those of us who are younger, we must remember that seniors are individuals as well. Every person has different needs, and what works for one person or what they need may not work or be needed by another. By designing senior housing on more of a small scale, the needs and desires of each individual can be addressed more fully and the resident can feel that they are still a contributing member of society and that their life matters even though they may have been around a little longer than others.

The word "home" can evoke different feelings in each individual, but there are overarching terms that can define the feeling of home for just about everyone. Words such as comfort, retreat, security, and familiarity can describe a home. These are emotions that we all want to feel when we are at home. These descriptors of home are especially important for seniors. Their world is constantly changing around them. One day a body part may work and the next it may not. A place that feels comforting and secure is necessary for those to whom the outside world feels threatening (Hoglund, 1985).

As homes for seniors become

more and more like hospitals, we increasingly ignore the senior's need for privacy and independence. Of course with each individual the definition for each of these words reaches different degrees, but every person is entitled to a comfortable level of privacy and independence based on their abilities. Many times these aspects of life are ignored or lost in traditional nursing home settings. They are compromised to make the work of the nurses and staff easier and more efficient. They are also reduced to create room for as many individuals as possible. I appreciate the fact that we want to help and be available to as much of the senior population as we can, but am disgusted at the fact that this comes at the price of their privacy and independence. Many nursing homes have shared rooms, rules that state that the door must remain open, and treat the residents in an assembly line fashion. Just a few small changes to room layout, observation strategies, and focusing more on the individual can increase the privacy of the residents and make them feel slightly more independent.

The privacy and independence of those who live in independent homes or assisted living facilities must also be critiqued. Society is based on cooperative activity: everyone contributes something to society and everyone receives something in return (Hoglund, 1985). Although we all may want complete independence, we know that our independence must also be balanced with our

dependence on others. Some of the definitions of independence include not depending upon something else for existence or operation, and not relying on, or even rejecting others aid or support (Dictionary.com, 2016). It can mean strength, self-reliance, or leadership (Hoglund, 1985). One important thing to remember, though, is that your personal definition of independence may change as you age. It may mean that when you were younger you were able to perform a task completely by yourself, but as you age you require a little more help with it. You are still able to perform the task and accomplish your goals, it just requires a little extra assistance. No one can be completely independent; we all must be dependent on each other to some degree.

This thesis aims to design affordable needs-based independent living options for seniors. It will focus on modular design to create living spaces for seniors based on areas where they need more or less space. These needs include bedroom, bathroom, living space, food preparation, and storage needs. These living spaces will be combined to create accessory dwelling units that can be placed on the sites of the homes of their children or close friends.

Often when apartments are designed for seniors they are not always tailored to the specific needs of the individuals. Every apartment is the same with the same size bedrooms, kitchens, bathrooms, and amenities. A shower with a lip may be ok for

someone who can physically step into the shower, but a roll-in shower would be more ideal for someone in a wheelchair and their caregiver. A bathroom may be big enough for the required wheelchair turning radius, but is it big enough for a caregiver to also be in the room helping out?

Some people may have a large number of items that they have accumulated over their lifetime. They may need extra storage space for these items. Others may not have as many items, and therefore would like to use the space that would be designated in one apartment for storage as living space or cooking space. Maybe someone really likes to cook so they would like a larger kitchen, or perhaps they like to have friends and family over so they would like a larger living space. Some may need more space for wheelchairs to move through, while others do not need as much because they do not have the extra equipment.

One of the perks of independent living is that it is usually cheaper than assisted living facilities or nursing homes. Some assisted living facilities can cost up to \$1,800 per month and nursing homes can cost even more (U.S. Department of Health and Human Services, 2003). This can be a concern for seniors because they have a set income with no way to increase it (Atchley, 1982). If a middle-aged person finds themselves in need of more money they can go out and find a second job. A retiree may not have the energy or strength to go out

and find a job for a little extra income, especially if they are someone who needs to be in an assisted living facility or nursing home. By creating a home that is modular and hopefully partially funded by another family member, the cost of living near can be greatly reduced.

One of the most important aspects of designing a living space for seniors is to understand how each space is used. It must become personal. It needs to focus more on the feelings and abilities of the user than the requirements of the building code. So often the minimum requirements of the international building code and Americans with Disabilities Act become the maximums that designers adhere to. We want to be able to fit spaces together as tightly as possible and therefore use the minimum square footage and requirements for grab bars, hallway width, and shower size. We need to realize that these standards are set for clearance size, not comfort. A wheelchair may fit in the bathroom, but is it an easy fit, or does it require tricky maneuvering to turn around and position the user? Can you spend your time in the room relaxing and feeling comfortable or do you have to spend your time trying to figure out the easiest way to make your next move?

When designing for seniors, as for any universal design, Susan Behar's "four A's" should become the basis for successful design. They are as follows: accessibility, adaptability,

aesthetics, and affordability (Demirbilek (Saritabak) & Demirkan, 1998). Accessibility is necessary for any user whether they have poor vision, poor hearing, or require a wheelchair. Adaptability is crucial in order for the space to be useful for current and future users. It allows for aging in place. Aesthetics means to make to design visually beautiful, but also make it helpful for the user without appearing different from surrounding buildings. Affordability is essential in every project, but especially so when designing for seniors because of their limited source of income.

Design for elderly housing needs a fresh approach. The senior population needs to be seen as individuals and active members of society. They need to be treated as humans, not grouped into a section of the population that we compartmentalize into their own matching spaces to wait until they die. They all have different needs and we should design to tailor to their needs. If we were to design for a middle aged member of society with some of the same difficulties, we would make sure to focus on aspects of the design that are beneficial to the occupant and tailor the design to that particular person. Why, then, can we not do the same for seniors? They are the ones that have shaped society into what it is today. They were once the same age as you or me. They deserve the opportunity to live in a way that works for them the best way it can.



modularity & assembly

The modularity aspect of the research process included mostly logical iterations. Through a process of trial and error, the final form of the modules was created.

iteration 1

The iterations began with a focus on square footage of the spaces. These spaces were then laid out so there was a minimum of wasted connection space. After consideration, this design was replaced with iteration

2 because the only modular aspect of the design would be the floor plan. The wall and roof components would be custom for each solution. This would add cost and time to the construction of the project.

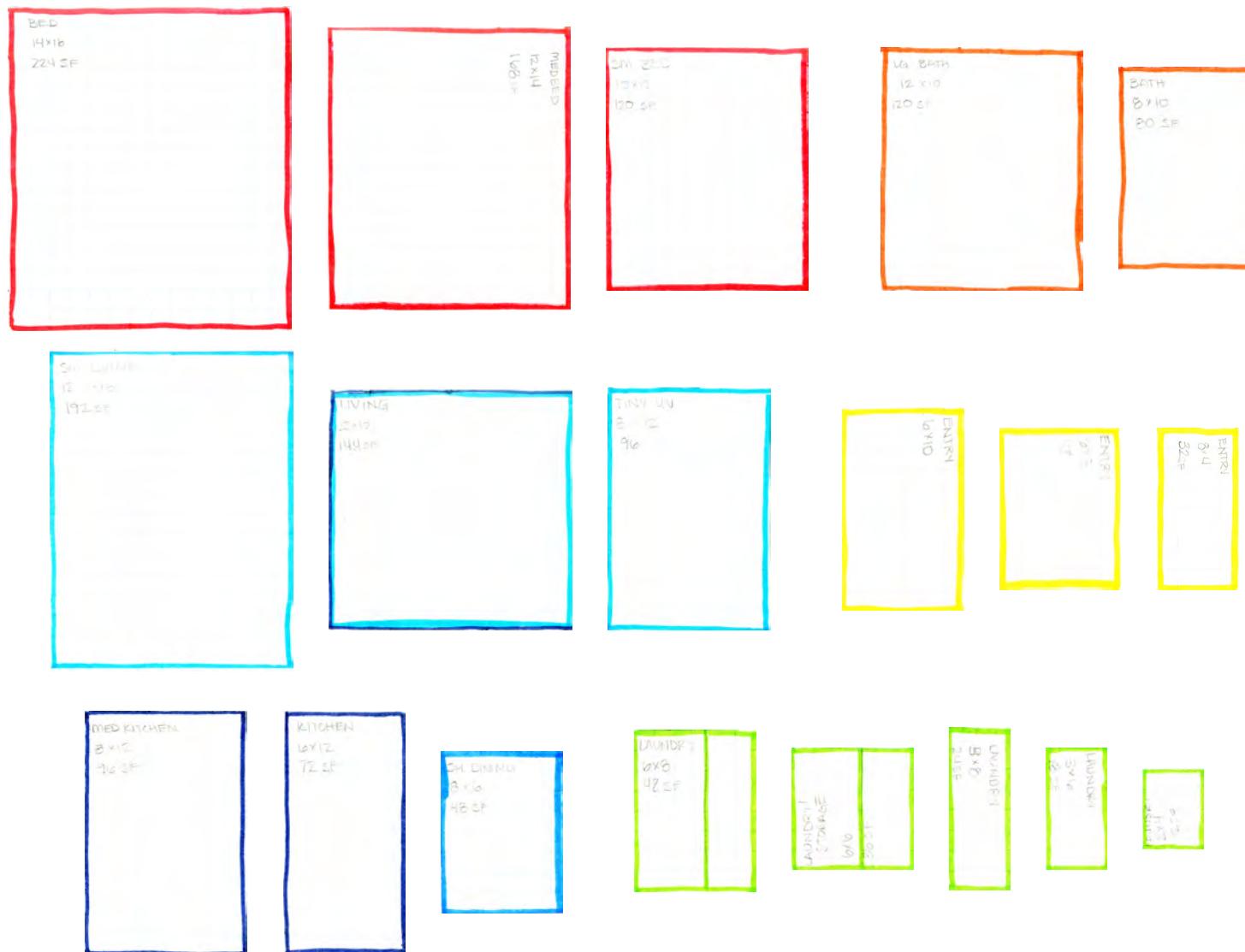


figure 3.1 | iteration 1 modules



figure 3.2 | iteration 1 module combinations



modularity & assembly

iteration 2

Iteration 2 consisted of digital models with each module representing one or two programmatic spaces. These spaces were connected by hallways and included different sizes and

layouts in an effort to find the best layout for the spaces. This iteration was deemed to consume too much square footage as each space had a large single loaded corridor.

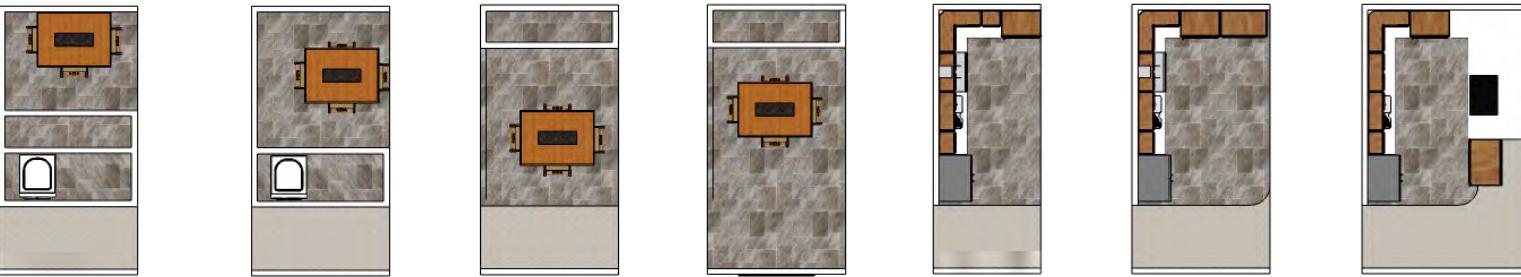
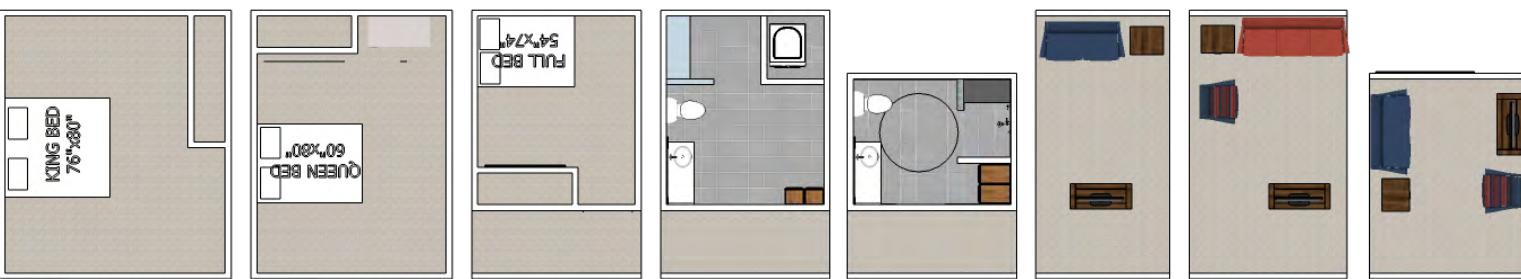


figure 3.3 | iteration 2 modules



figure 3.4 | largest combination: 1334.5 square feet



figure 3.5 | smallest combination: 681 square feet

Iteration 3 included module layouts closer to the final design. The floorplans of the modules were a combination of two programmatic spaces. In this iteration, the roof form was included. The roof pitch matched the pitch of the home on one of the example sites and it included clerestory windows. No matter the depth of the module, the eaves of the roof on both sides were at the same height, which led

to some complicated connections between the modules. From this iteration the final design was created with a few changes to the floor plans, reducing the slope of the roof to keep the interior spaces from feeling too tall, and matching the roof pitch throughout the modules and cutting it off when the width of the module was met.



figure 3.6 | iteration 3 modules



modularity & assembly

structural insulated panels

Structural insulated panels, more commonly known as SIPS, consist of a solid foam core insulation sandwiched between two sheets of oriented strand board. The panel is solid and does not have any framing members which reduces thermal bridging. Because of this, SIPS are considered "one of the most thermally efficient wall systems available" (Louche, 2016). Figure 6.5 on page 84 demonstrates the energy efficiency of SIPS compared to the typical 2x framing techniques.

Another positive of SIPS is that they are easy to make and manufacture and the wall panels can be delivered to the site with all of the openings readily cut out. A negative aspect of this is that if anything is cut wrong, the panels will have to be returned and cut again which adds time to the project.

The panels themselves usually cost more than traditional framing, but their energy efficiency and labor saving aspects quickly make up for the additional cost, making the costs comparable to traditional techniques (SIPS.org).

One reason SIPS were chosen for this project is their connection details. SIPS employ the use of cam locks to connect the panels together. These locks are located in the foam core portion of the panel and use a hook that is turned from the exterior of

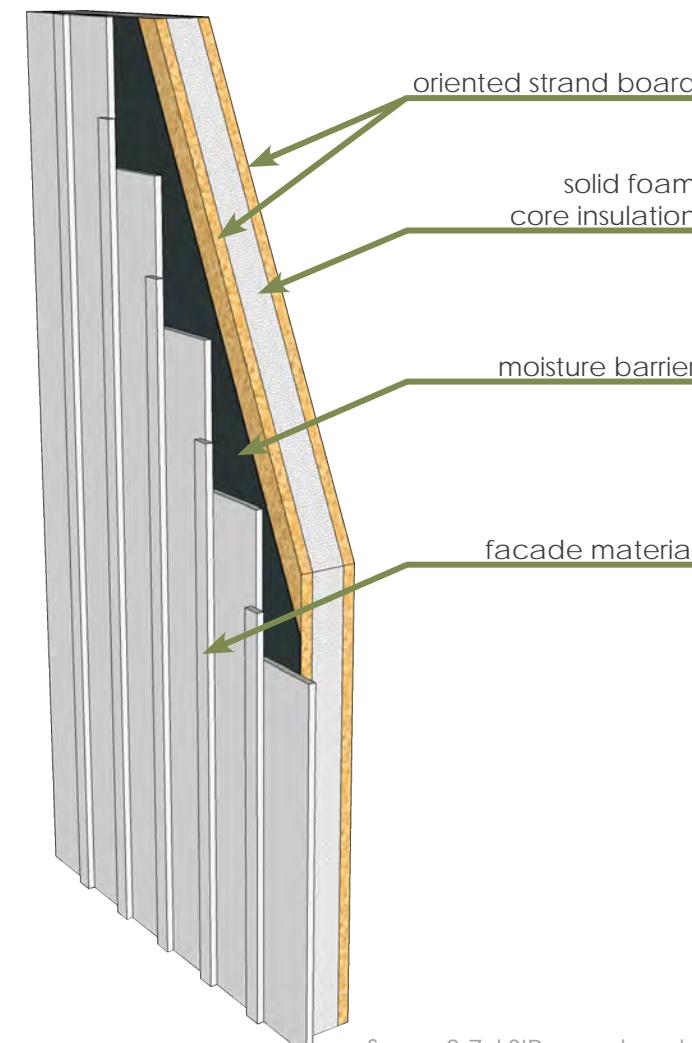


figure 3.7 | SIP panel parts

the panel by a screwdriver-like tool. This turning motion locks the panels together to create a tight seal. This connection detail is also perfect for disassembling the modules to be taken apart and moved to a new site or to storage when the ADU is not in use. This can be seen in figure 7.13 on page 116.

Diamond piers are pre-engineered footings that can be put in place without any excavation. They only require four easy steps for installation (Diamond Pier Foundation System, 2016):

1. Set the Pier
2. Drive the Pins
3. Connect the Bracket
4. Start Building

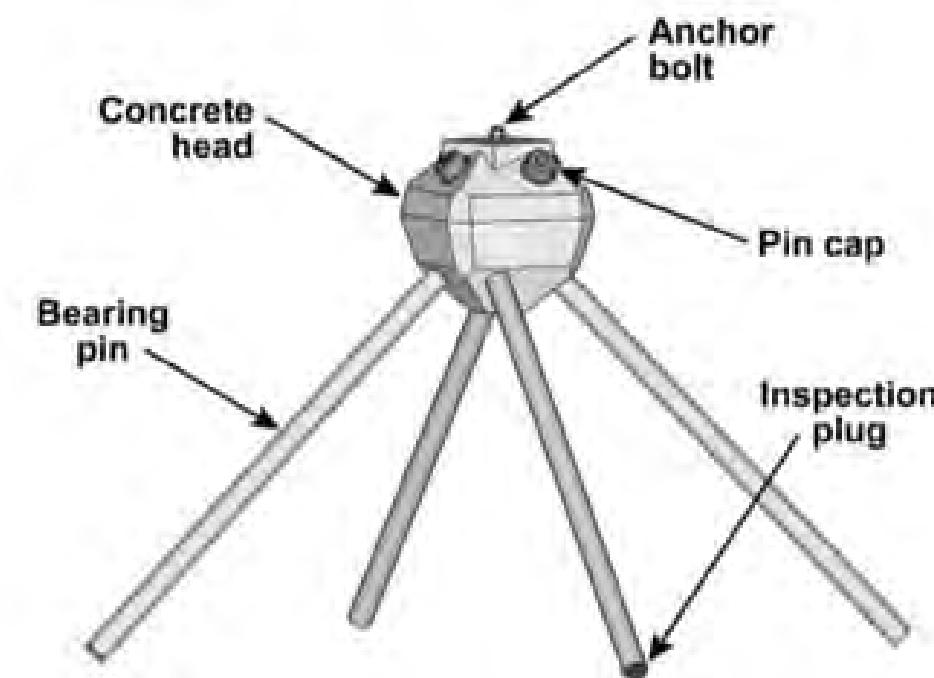
The inclined pin pile system spreads out the loads over a larger bearing area than standard concrete footings.

diamond pier footings

This allows for more bearing capacity with less work and excavation than conventional footing procedures.

The pins also increase the resistance for uplift of the building holding it firmly to the ground on windy days.

The use of the piers allows for easy foundation installation in spaces that are difficult to reach with standard construction equipment such as in a backyard, where many accessory dwelling units are located.



Diamond Pier Foundation

figure 3.8 | diamond pier footing parts



accessory dwelling units & tiny homes

what is an accessory dwelling unit?

"A secondary, usually smaller unit on a property with a primary house. It is self-contained with its own bathroom and kitchen. ADUs come in all shapes and sizes and can include stand-alone one-story and two-story units as well as those above garages"

-Austin, Texas Land Development Code

"A room or set of rooms with its own cooking, sleeping, and sanitation facilities, and which is located on the same lot as a single- or two-family home."

-Minneapolis, Minnesota Administrative Review for an Accessory Dwelling Unit

"An accessory dwelling unit or detached accessory dwelling unit (sometimes called a mother-in-law apartment) is a separate living space within a house or on the same property as an existing house."

-Seattle, Washington Department of Construction and Inspections

"Typically, the second unit includes sleeping and living areas, at least a simple kitchen, and a separate entrance, though the unit often shares parking areas and a yard with the main house."

*-In-Laws, Outlaws, and Granny Flats,
Michael Litchfield*

Accessory dwelling units can take on many shapes, sizes, and appearances. Despite their many different looks and locations, they all serve roughly the same purpose: as an additional living space.

Attached units are units that are attached to the main house on the property. Basement and attic conversions are one way that attached units are created. They can also be found in the way of "carving out" a couple of rooms within a house, or adding on a few rooms.

Attached units are favored because they typically cost much less to build than a detached unit.

Detached units are units not directly connected to the home. These units include garage conversions and stand alone units. These types of units typically require more funds because they need a little more work to be finished. Detached options usually allow for more design options, greater privacy, and a more resident tailored design.

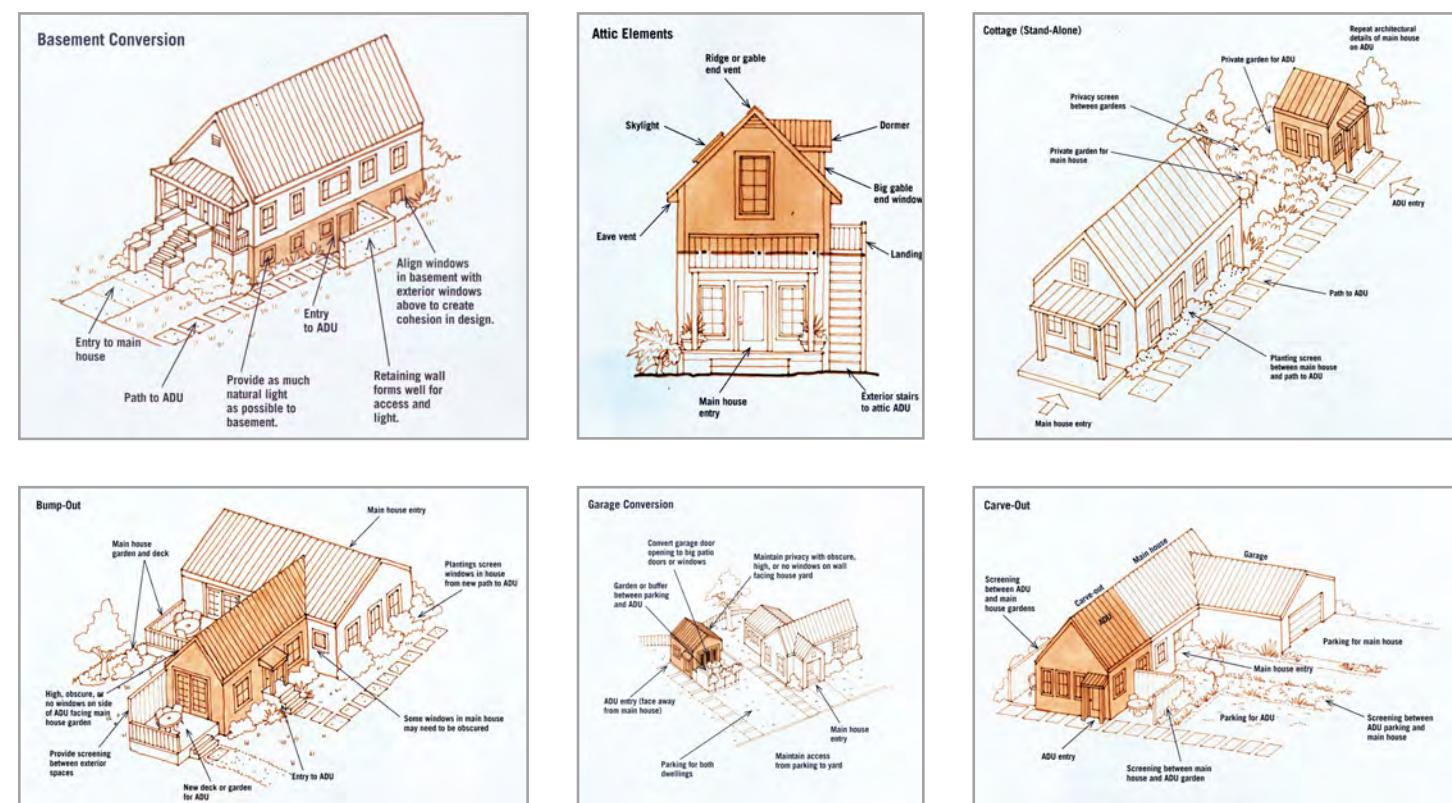


figure 3.9 | accessory dwelling unit types



universal design & aging in place

In order to successfully create homes that facilitate aging in place, universal design principles need to be considered. By incorporating these principles, a home can be occupied by someone of any age. It still looks like a "normal" home, but has the ability to accommodate accessibility features if the need should arise.

what is aging in place?

About 76 million Americans are classified as "baby boomers"--born between 1946 and 1964 (Lawlor et al, 2008). They are all quickly reaching, or have reached, retirement age. While most of these people have been planning and saving for retirement, they may not have realized or anticipated the changes that they are now or soon will be facing. Many of these people plan to stay in their homes, but have not prepared for the changes they will need to make in their homes to comfortably continue to live there.

what is universal design?

Universal design aims to create spaces, both public and private, that are accessible to and usable by the greatest number of people (Litchfield, 2011). These spaces are designed for anyone to be able to use them no matter their age or physical condition. Although often we think of these design features to be accessible for disabled people, a good universal design is welcomed by everyone. A wider doorway is useful for both someone in a wheelchair, and a mother with a baby on her hip. The list on the next few pages is a culmination of universal design principles that I have created through research of many sources.

overall

Physical Objects

- Address number is visible from the street
- Handrails for all steps and steep ramps
- Easy cleaning, durable wall surfaces

Moving Space

- 42"-48" Aisles
- 5 foot turning radius in center

Acoustics

- Acoustically absorptive surfaces (carpets and window coverings)

Doors

- At least 36" opening
- Less than $\frac{1}{2}$ " or no threshold
- Sliding or pocket doors where possible
- Bi-fold on closets when sliding are not possible
- Lever handles instead of knobs

Windows

- Egress windows at least 30" wide
- 18"-20" maximum sill height
- Minimal effort to operate
- Casement, Awnings, Hoppers, Jalousies are best
- Power operators when possible

Lighting

- Combination of task, ambient, and uniform lighting throughout house
- Non-glare light fixtures combined with appropriate surfaces
- Reachable switches
- Preprogrammed dimmers
- Back-lit keypads and switches for ease of location in dark
- Contrasting face plates with walls for easy visual
- Motion sensor lights in garage, hallways, entry, exterior
- Variety of fixtures for different layers of lights, ease of use
- Ceiling bulbs are more difficult to change
- Types of Lighting
 - Ambient (10-20fc)

- General room illumination
- Wall sconces or ceiling fixtures (Cove lights)
- Task (30-50 fc)
- Pendants over tables
- Under-cabinet lights
- Accent lighting (3 times ambient fc)
- Points of interest
- Picture lights and track lights
- Egress lighting (10 fc)
- Illuminates path of travel
- Emergency
- Battery operated wall packs

Floors

- Contrast floor surfaces and trim
- Contrast counter tops and cabinets

Controls & Switches

- Remote controls for heating and cooling
- Light switches 42"-48" from floor
- Thermostat controls located no more than 48" from floor
- Electrical outlets located 18"-24" from floor
- Contrasting electrical outlet covers
- Audible and visual alarms for doorbell, smoke detector

Hardware

- D-shaped cabinet pulls on all drawers and doors

approach & arrival

Physical Objects

- Hooks for hanging coats
- Small closet for storing coats, boots, etc.
- At least 48" bench for putting on and removing shoes
- Space for storage of mobility devices
- Inset floor mats

Doors

- Sidelightss so the resident can see who is arriving

Lighting

- Uniform lighting

building connections

Physical Objects

- Separate spaces with furniture, not walls
 - Visually larger
 - Easier to see moving lips with hearing loss
 - Less sound barriers for hearing loss
 - Better cross ventilation
 - Better daylight

- Angle walls at corners for better turning abilities and widen space where it is most needed
- Align doors across the hall to shorten path of travel
- Use wainscoting to protect walls from crashing mobility devices and as handrails
- 9" baseboard moldings

living & dining

Physical Objects

- Soft furniture and cushions for acoustics
- Table with pedestal or trundle base

preparing & cooking meals

Physical Objects

- Single row of cooktop burners
- Front controls
- Radiant surface
- Warning light
- Fire extinguisher within easy reach
- Wall mounted oven
 - Side swing door
 - Base is 32" from floor
 - Pull out rack is same height as adjacent counter top
 - 30" of counter space beside
- Compact dishwasher
 - Dishwasher raised so top rack is level with counter top
 - Front controls
- Side by Side refrigerator
- Lazy susans in corner cabinets
- Lever, touch, or sensor style faucet
 - Faucet located on side of sink, not back
- Drain located on back of sink for more knee space underneath
- Pantry with adjustable height shelving

Cabinets & Counter tops

- 32"-34" High Counter tops, 20" deep
- Rounded counter top corners
- Set down areas by sink, stove, fridge
- Uppers 12"-15" above counter top
- Multi level counter tops
- Rolling cabinets with finished surface allow for flexibility, extra worktop space and openings in spaces when removed

Reaching Space

- Maximize space in the 22"-44" zone

Controls & Switches

- Outlets located on front of cabinets for easy reaching

Hardware

- D shaped cabinet pulls

personal hygiene & care

Physical Objects

- "Wet room"—no enclosed shower
- Blocking for future grab bars
- Include inconspicuous grab bars that have multiple uses
 - Grab bars match existing decor
- 32" high counter top, 20" deep
- 18" high shower seat
 - Slightly angled vertical portion so it is easier to get in a position to stand up
- Comfort height toilet (17"-19")

Floors

- Textured, non-slip flooring material

Hardware

- D-shaped cabinet pulls
- Adjustable hand held shower head
- Lever, touch, or sensor style faucet

- Flush handle is on side farthest from wall
- Full length mirror
 - Anti-fog features

dressing & sleeping

Physical Objects

- Solid supports in headboard and nightstand
- Ample shelf space beside bed
- Drawers, hanging bars and open shelves
- Include bench seats at 17"-19" from floor
- Full height mirror
- Located near laundry

Moving Space

- Generous path of travel

Reaching Space

- Locate rods that are less than 48" from floor

Acoustics

- Closets between bedrooms or between bedroom and street acts as sound barrier

Privacy

- Locate bed with view of door
- Skylights and high windows for daylight without giving neighbors a view inside

Doors

- Egress door to outside is preferable

Lighting

- Swing arm fixtures or sconces or lamps for reading
- Dimmer switches
- Ability to operate lighting from bed as well as entrance
- Adequate lighting in closet

Controls & Switches

- Enough electrical outlets located near bed

utility spaces

Physical Objects

- Laundry
 - Front loading washer and dryer
 - Front controls
 - Turn dial with distinct stopping points or push buttons with tones
 - Located side by side so they are easier to reach from a seated position or stacked for space saving
 - Shelves for detergent, etc.
 - Ironing station
 - Storage for other cleaning devices (Vacuum, Broom)
 - Wire racks & built in counter
 - Located near center of home

Storage

- 50% of storage no more than 54" high
- Adjustable height closet rods and shelves

Moving Space

- Does not require much space, can be located as a closet

Reaching Space

- 20" deep counter top
- Shelves no more than 44" high

Lighting

- Adequate lighting to see detergent quantities and folding clothing

outdoor spaces

Physical Objects

-Garage

- Floor level same as interior of home
- Vehicles do the climbing
- Close to house
- Covered space between car and house
- Cars are generally 8'x20'
- Accessible vans need 11' wide

-Outside

- Gradual sloped ramp to entrance
- No step entry
- Eliminates puddles (slippery in winter)
- Needs clear head room of 80"
- Snow melt system installed
- Large overhangs and deciduous trees block hot summer sun and allow warming winter sun, controls glare, keeps indoor air temps comfortable

Covered entry

- Seat next to door for a visitor to sit and wait for the door to be opened

A place to put packages while opening doors (shelf, bench, table)

- Sturdy enough railings to be able to lean on

Separate areas for cars and people

- Garden box
- Privacy screen

Moving Space

- Minimum landing space of 5'x5'

Lighting

- Exterior lighting at all entrances
- Motion sensor



zoning & regulations

Currently, Fargo, North Dakota has no mention of accessory dwelling units in their land development code. This means that anyone who would like to build a detached unit must either obtain a conditional permit or build what Michael Litchfield calls an "outlaw"--a unit built without a permit. After comparing the ADU codes in nearby cities and cities with successful ADU programs, I have created a code to propose to the city of Fargo.

A more detailed description of the code decisions can be found in the performance section of this book on page 78-79.

	ADU footprint compared to primary house	allowable zones	property owner occupancy	total allowable lot coverage	setbacks	minimum square footage	maximum square footage	distance from primary structure	maximum height	parking	materials	entrance
minneapolis, minnesota	ADU must be smaller than the primary dwelling	residence, office, commercial, downtown, industrial living	property owner must live in either the primary residence or the ADU	ADU + parking cannot exceed 676 square feet or 10% of lot area, whichever is greater	front: ADU must be in rear side: rear: 3'-5' depending on zone		1,300 sq. ft. total habitable and parking OR 16% of lot, whichever is greater; no larger than 1,600	20 feet from habitable portion of house	cannot exceed the height of the primary OR 20 feet., whichever is less	no additional parking space required	exterior materials must be durable	entrances encouraged to face public street or alley
seattle, washington		single family 2, single family 3 lots larger than 5,750 square feet		impervious cover of the site cannot exceed 45%, buildings cannot exceed 40%		300 square feet	1,000 square feet or 0.15 FAR, whichever is less; maximum of 550 square feet on the second story	at least 10 feet from primary structure	limited to two stories, and may not exceed a height of 30 feet	one additional space req. if the property is more than 0.25 miles from an activity corridor		
austin, texas		single family, low rise	property owner must live in either the primary house or ADU for at least 6 months per calendar year	on lots 1,000-5,000 sq. ft: 15% on lots larger than 5,000 sq. ft: 35%	front: ADU must be in rear side: rear: 5 feet, 10 feet on corner lots		including garage and storage areas: single family-800 sq. ft.; lowrise-650 sq. ft.	5 feet from primary structure	12-23 feet, depending on lot width	one additional space except in urban centers and low rise zones		entrance must not face side lot line or rear lot line unless there is an alley
common standards listed in In-laws, Outlaws, & Granny Flats			property owner must live in either the primary residence or the ADU	minimum lot size of 5,000 square feet, maximum lot coverage of 30-40%	front: 20 feet side: 5 feet rear: 10 feet		750 square feet or it can be listed as a percent of the footprint of the primary structure	10 feet, may be closer to non-habitable spaces	separate ADU: 12 feet above garage: 22 feet		siding, trim, and roof pitch should match existing house to help unit blend in to surroundings	both entries cannot face the street unless unit door is screened from view
current fargo building code				20-50% depending on zone, most lots have maximum coverage of 25-45%	front: no acc. structure side: 4-15 feet rear: acc. struct. cannot be closer than 3 ft.		the total sq. ft. of accessory buildings may not exceed the footprint of the house	none, a building closer than 6 ft. to the primary structure must have adtl. fire protection	accessory buildings may not exceed 15 feet in height			
proposed fargo ADU code	ADU must be smaller than the primary dwelling	sr-1, sr-2 sr-3, sr-4	property owner must live in either the primary house or ADU for at least 6 months per calendar year	no change to current code	no change to current code	300 square feet	1,200 square feet OR 12% of the lot, whichever is less	8 feet from habitable portion of primary structure	18 feet or height of primary, whichever is less	one additional space required unless the property is within 0.25 miles of a transit stop	siding, trim, and roof pitch should complement the existing house	entrances encouraged to face public street or alley

figure 3.10 | zoning comparison table

historical, social,
& cultural context

multi-generational housing

Since the beginning of human existence, extended families have lived together, whether it be sharing a home or living in the same complex. In many parts of the world, this tradition is still a reality.

In 1860, about 80 percent of Americans who were over the age of 65 lived either with their children or in the home next door (Litchfield, 2011). At this time, parents usually aged in place in their home and eventually the children would inherit the property. This was also a time when farming was one of the main professions. Hiring helpers was expensive, so often these helpers were family.

As Western Europe and North America entered the industrial revolution, farmers became factory workers, and family size decreased. Because of these factors, multi-generational housing decreased. The only exception to this was during the Great Depression. During this hard time, families found it more beneficial to pool their resources and share homes.

After World War II, the nuclear family housing boom occurred thanks to loans from the government for veterans, abundant cheap land, and the improving economy. This reduction in household size left elderly parents to age in their own homes by themselves, but they could afford it with the addition of Social Security. By

1990, less than 15 percent of elderly parents lived with their children, but thanks to accessory dwelling units, these statistics are changing (Litchfield, 2011).

The 2000 census showed that the number of multi-generational households had actually increased for the first time in more than a century. This shift reflected not only parents moving in with their children, but also young adults continuing to live with their parents. This shift is partially economic, partially cultural, and partially spiritual. Between 2007 and 2009 the number of multi-generational households jumped from 46.5 million to 51.4 million, a 10.5 percent increase in just a few years. The 2010 census showed 16.1 percent of the population lived in multi-generational housing (Generations United, 2016).

There are many reasons that people have chosen to live in a multi-generational household. Some of these reasons include marrying later, immigration, an availability of family, health and disability issues, and economic conditions. Just like during the Great Depression, the Great Recession had an impact on the number of multi-generational households. People with hardships found it more economically wise to pool their resources together and live together than living on their own.

As a counter to urban sprawl, urban infill has become a focus of governments. Accessory dwelling units are helping to achieve those infill goals.

By increasing infill, many benefits are also given to the residents of the city. More people using existing utilities creates a lower per-resident cost. ADUs are typically cheaper to build, thus reducing their cost for seniors and making them more affordable than a new home or a move to assisted living or a nursing home.

case study 1

the fosters

location: santa cruz, california

size: 640 square feet

description:

Herb and Ellie Foster raised their children in an old farmhouse that was considered to be the heart of the neighborhood. As they aged, and the stairs became too difficult, they tried to think of a way to stay in the neighborhood. Building their second unit became an adventure after an initial cold reception of the idea by the city planning department. It wasn't until their son's connections in the department helped to see a change in the eyes of the city that the couple got their new home. The walls of the unit are built with straw bales, and the construction was like the barn raising techniques of the past: the whole community joined together to help them build the home.

Finding the perfect location for the home was a struggle. Putting the unit near the home was not possible because it would have eliminated the garden that had been tended for the past century. It also would have ruined the neighbor's views and privacy. The back of the lot was an option, but it was too far away from the house and the street for the elder Fosters' limited mobility. Eventually they decided to tear down the dilapidated garage and start new on the site.

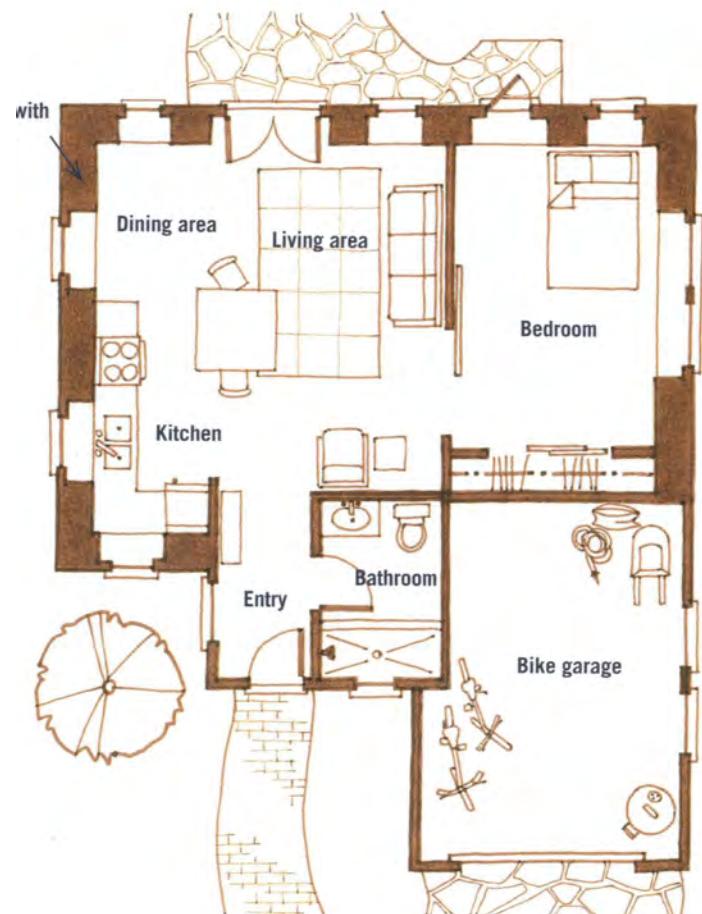


figure 4.1 | the fosters floor plan

Pros:

"Overlapping" spaces

Large sliding barn door into bedroom makes the space feel larger when open

Patio is accessible from living area and bedroom



figure 4.2 | the fosters interior image



figure 4.3 | the fosters exterior image

Cons:

A large amount of square footage is occupied by the thick straw bale walls

A full size garage is more acceptable in a colder climate like ours

Small bathroom possibly meets ADA standards

case study 2

the shaws

location: oakland, california

size: 537 square feet

description:

This unit came with the property when Don Shaw and his wife bought it. They thought it was perfect because it could house Don's mother, who had been circulating between her children's homes for many years. The unit needed work but his mother could live with them in the big home until it was finished. What they thought was six months of work turned into almost a year.

The unit, which was built in 1917 for a total of five dollars, was too close to the property line, but because they found the original building permit stating that it was legal when it was built, they didn't have to move it. They did, however have to beef up the original framing: 2x3 studs located anywhere from 24 to 36 inches on center and laid horizontally instead of vertically, as typical framing techniques call for today.

To lighten up the dark home, the bearing wall between the kitchen and living room was removed and replaced with a beam. This also created a more open space

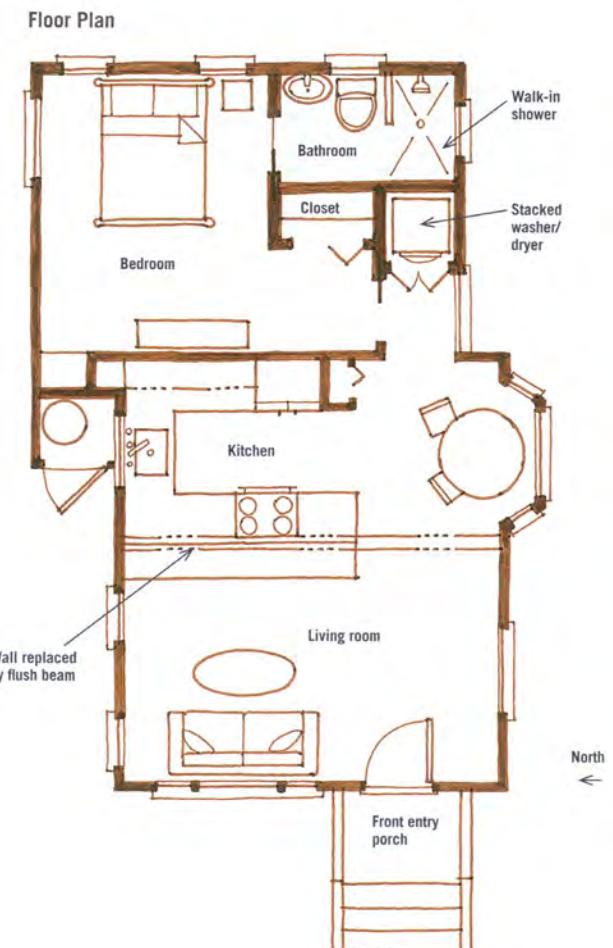


figure 4.4 | the shaws floor plan

Pros:

On-Demand water heater saves valuable space

Easy access walk-in shower

Dedicated dining alcove creates an intimate eating space



figure 4.5 | the shaws interior image



figure 4.6 | the shaws exterior image

Cons:

Renovation of existing ADU led to many construction and space issues

Spaces clearly defined which does not allow for overlapping spaces to make the home feel larger

Very small non-ADA bathroom

Stairs to entry could be a barrier in the future

case study 3

FabCab

location: seattle, washington

size: 550 square feet

description:

This unit began as an exhibit at the Seattle Home Show. The architect gave himself the challenge of designing an accessible modular house in which the accessible features were hidden from the naked eye. The bathroom is fully accessible, and so is the kitchen. The sliding panel doors between the bedroom and living spaces can be opened to create a

larger feeling space during the day and closed at night for privacy.

The home was purchased at the show and placed on a site with a breath taking view. The large glass facade opens up to this view and makes this accessible and energy efficient home even more worth living in.

Floor Plan

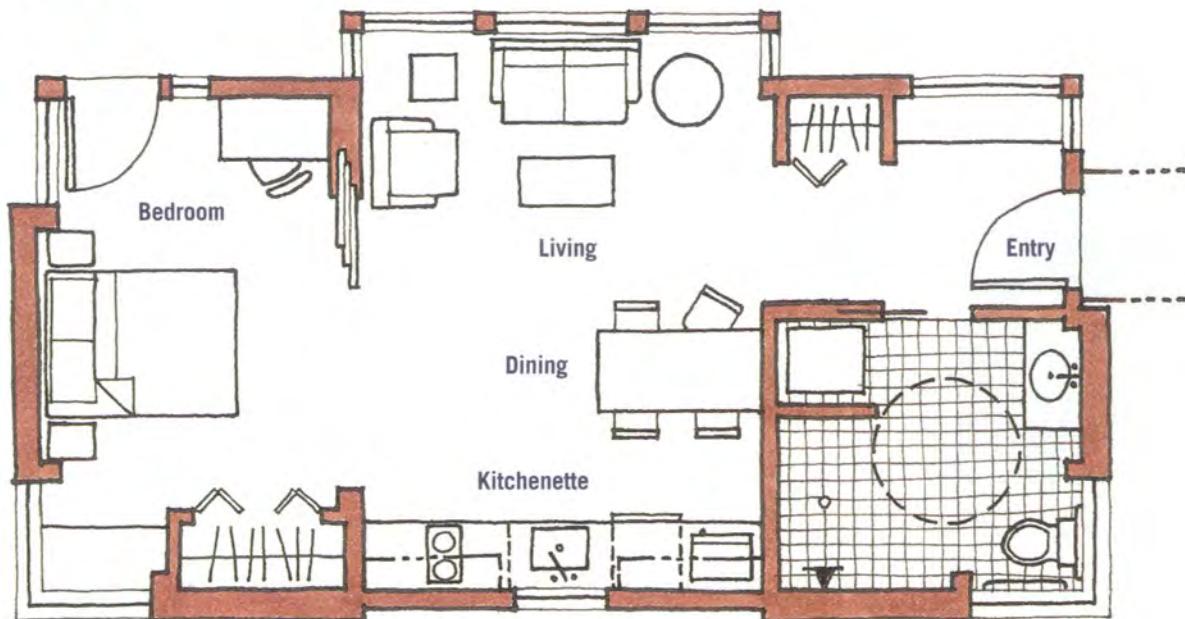


figure 4.7 | FabCab floor plan

Pros:

"Overlapping" spaces

Large sliding door into bedroom gives the option to make the space feel larger or close off a private space

Patio is accessible from bedroom acting also as a form of egress

Bathroom meets ADA standards

Can be placed anywhere



figure 4.8 | FabCab on final site



figure 4.9 | FabCab exterior image

Cons:

Large amount of glass (although southern facing) could be expensive to heat during the winter months in our location

Not much storage space

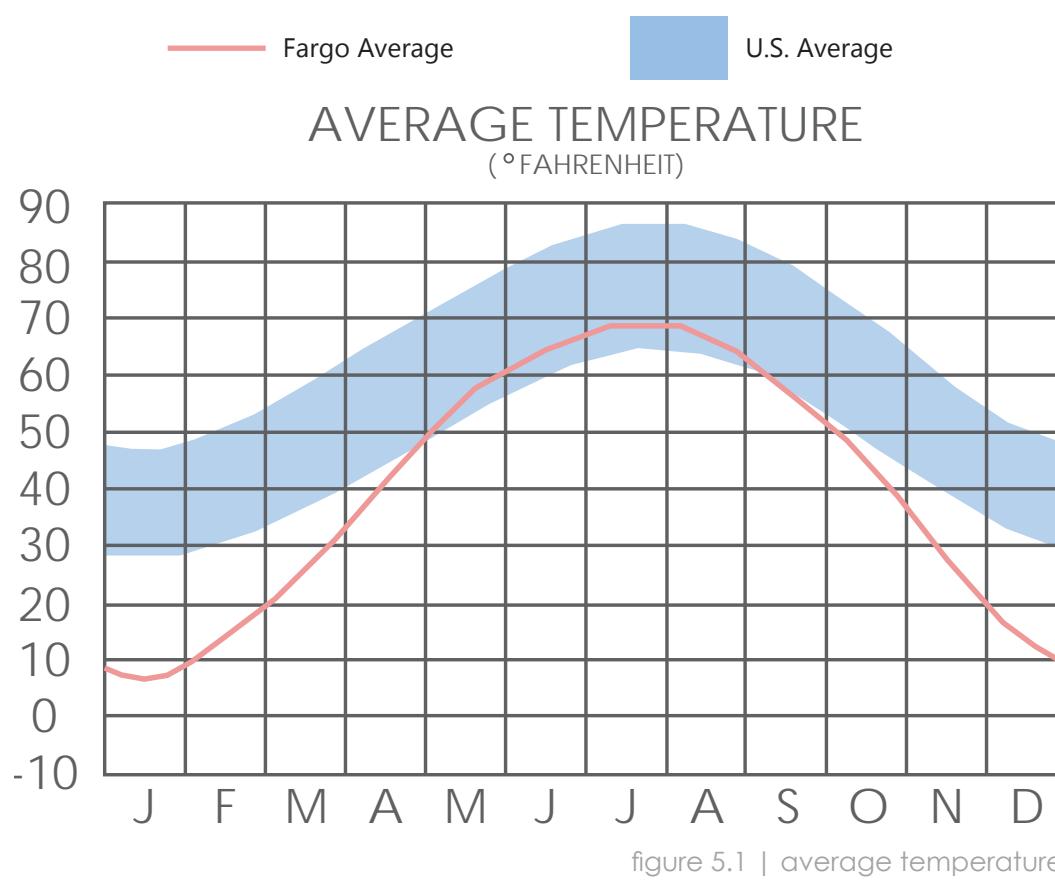
site & context analysis

Because of the current lack of zoning regulations for accessory dwelling units, Fargo, North Dakota was chosen as the location for this project. Fargo also brings an interesting climate and demographic spread to accommodate through the design. To show the versatility of the modular design, four individual sites of varying sizes, locations, and zones were chosen within Fargo city limits. Each site poses its own challenges to the design including the location and layout of the existing buildings, size of the site, location of buildings on neighboring lots, and proximity to busy streets. Clients of varying ages, mobilities, activity levels, and household size were also chosen for each site at random to create a guideline for the units selected.

fargo, north dakota

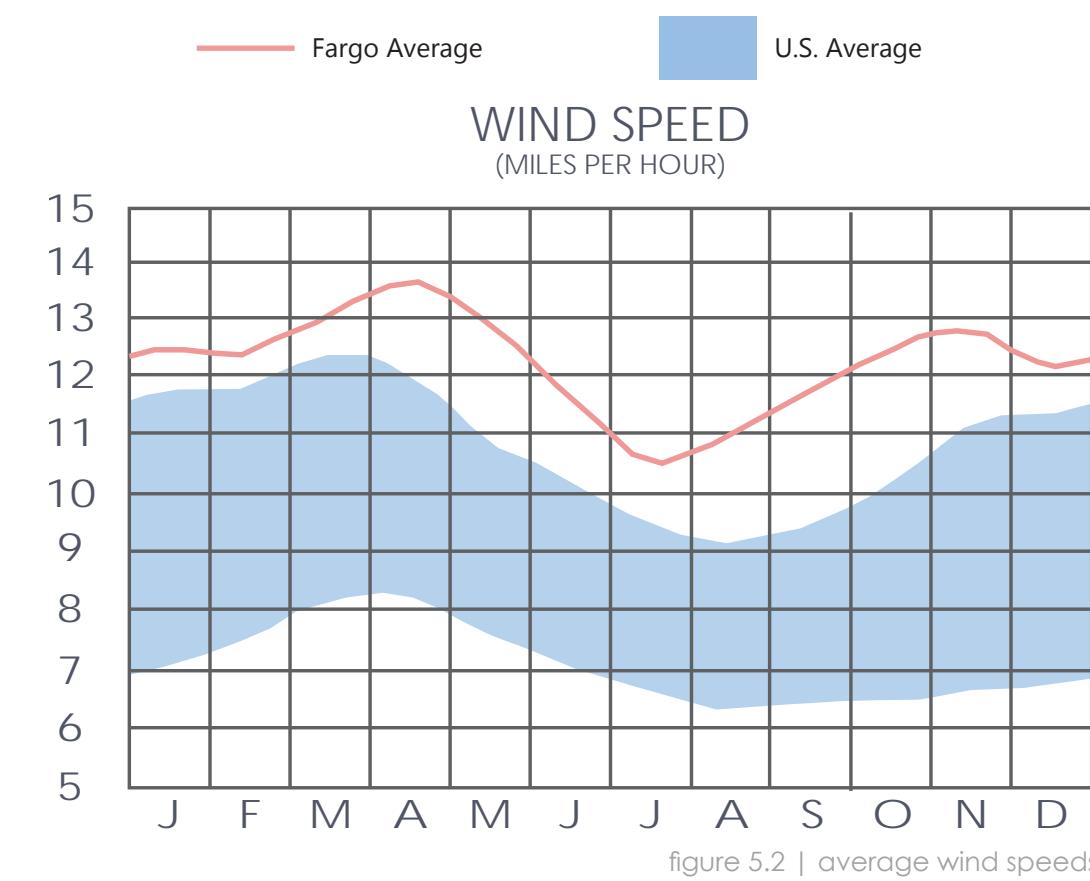
temperature

Because of its northern latitude, it is expected that Fargo would have lower than average temperatures for much of the year as compared to the rest of the United States. This reduces the need for cooling systems and the associated costs during the summer, but elevates the need for quality heating systems in the winter and the increased costs associated with them. A design challenge will be to incorporate passive ways to heat during the winter to keep costs down. This is especially important for the elderly residents because they have a higher need for staying warm, but a reduced source of income to pay for heating costs.



wind

As the image shows, the average wind speed in Fargo as compared to the rest of the United States is on the higher end. This means that there is more wind than average and this wind could become a problem or could be used for good in the design. It could be a problem because the elderly tend to get cold easier than the younger generations because of their poor circulation. The wind could be used for good, though, as well. It could be used to ventilate the design which would reduce heating and cooling costs, therefore making the residences somewhat more affordable.



fargo, north dakota

precipitation

Fargo receives lower to average amounts of precipitation compared to the rest of the United States, especially in the winter. This is nice because that means there are more days for the residents to walk around and enjoy the city and less chances of flooding. This would not be beneficial, though, if there was a gardening piece to the design because it would probably need its own irrigation system instead of solely relying on nature to take care of it.

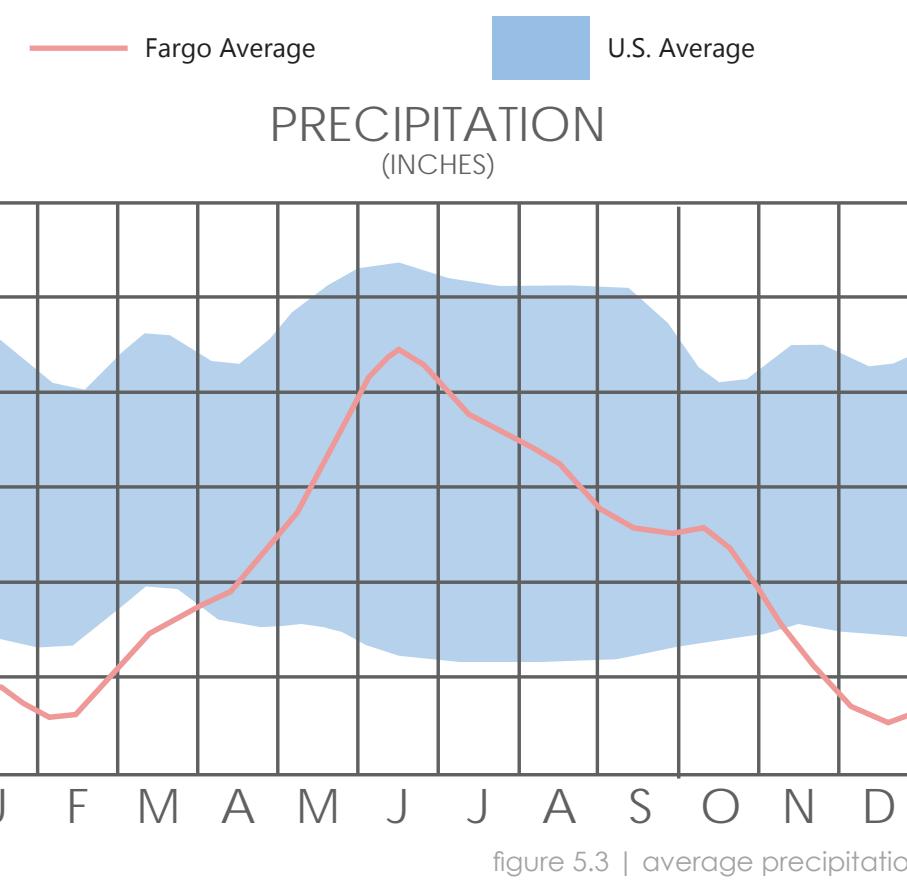


figure 5.3 | average precipitation

snowfall

Compared to the rest of the United States, Fargo receives a higher than average amount of snow. This is to be expected because it is located in North Dakota, which receives a large amount of snow due to its northern latitude. The large amounts of snow can become a hindrance to the residents because the snow itself can be difficult to remove and along with snow usually comes ice which can be extremely slippery, especially for those who already have limited mobility. Considering the amount of snow is an important aspect of this design, because it must be controlled to increase the safety of the residents.

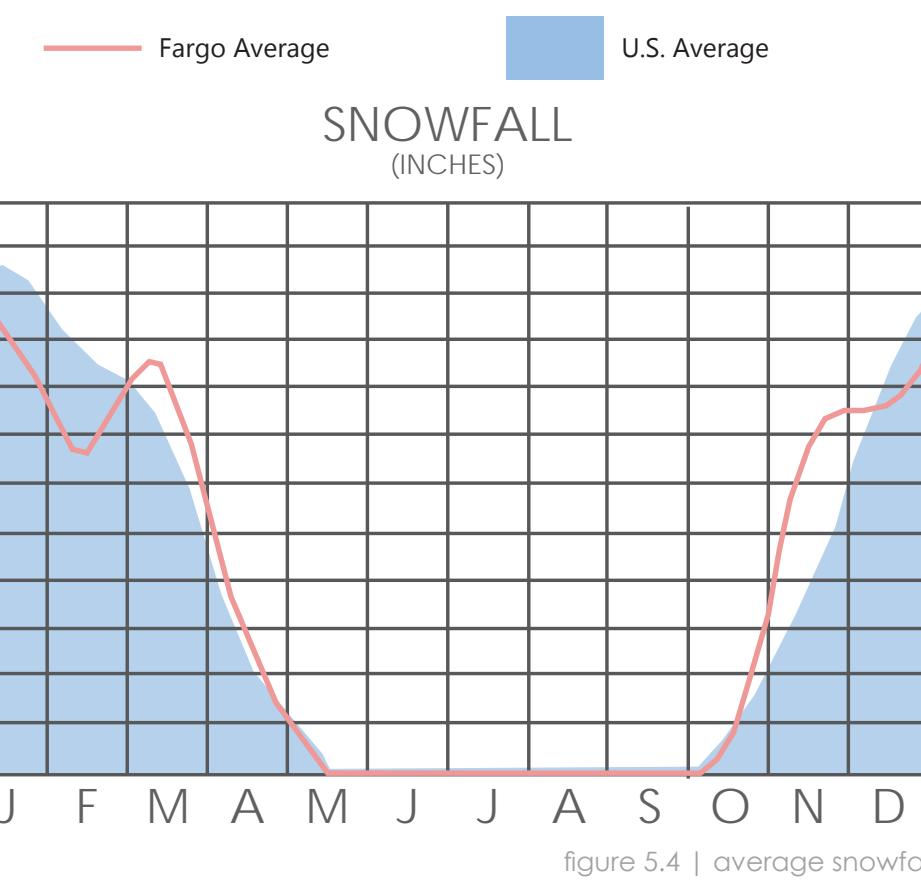


figure 5.4 | average snowfall

example site 1

3750 10th street north



figure 5.5 | aerial view

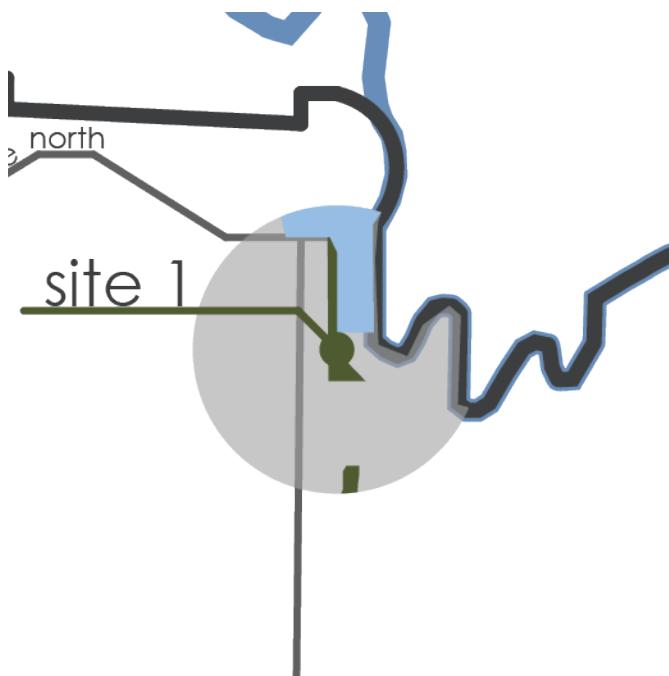


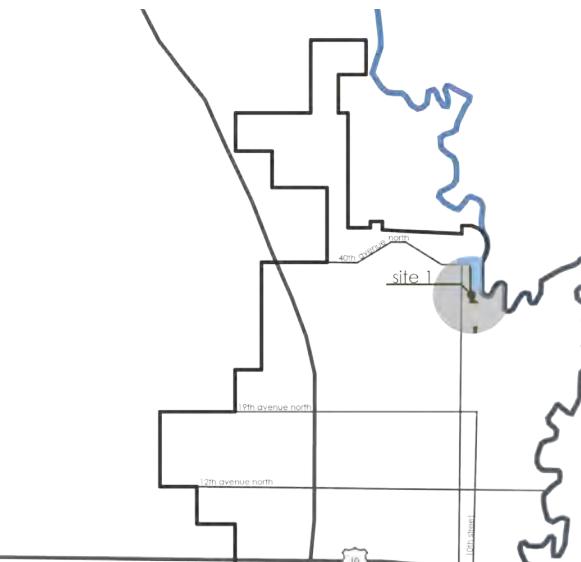
figure 5.6 | enlarged surrounding zoning



figure 5.7 | street view

total lot: 5,890 square feet		
allowable lot coverage: 45% (2,650.5 square feet)	setback coverage: 21.7% (1,267 square feet)	other use: 33.3% (1,972.5 square feet)
existing buildings: 18.5% (1,088 square feet)	ADU allowable: 12% (706.8 sq. ft.)	

figure 5.8 | lot coverage table



zone: SR-4

lot dimensions: 46' x 130'

setbacks

front: 15'-0"
rear: 3'-0"
side: 4'-0"

Pros:

- Zoning allows for almost half of the lot to be covered, increasing allowable room for ADU
- Field and tree line give the ADU a feel of the country while still being located in the city

Cons:

- Site is very long and narrow which leaves a very minimal width for the ADU
- Home is set so far back that there will be minimal back yard with the addition of an ADU

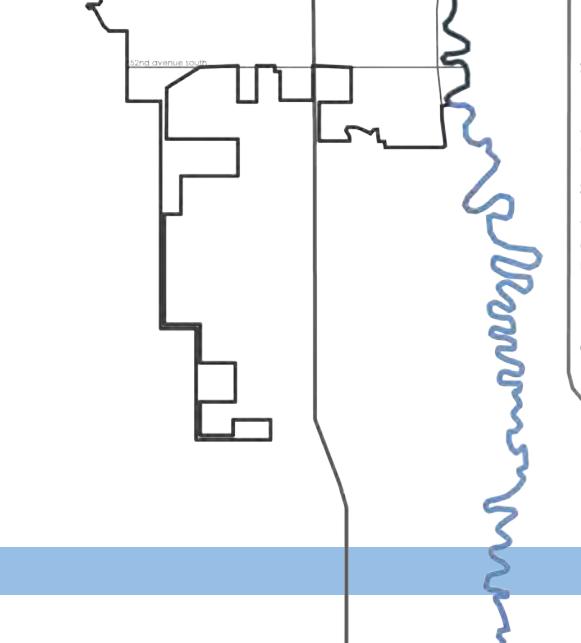
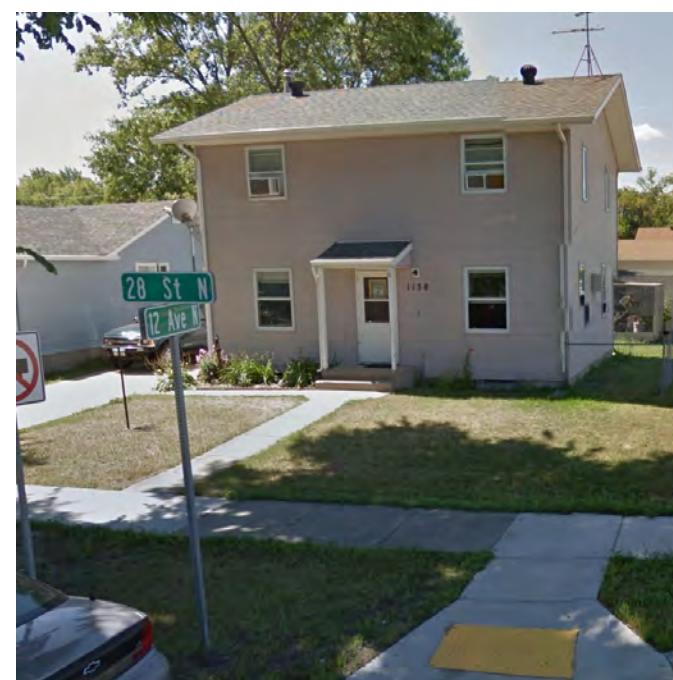
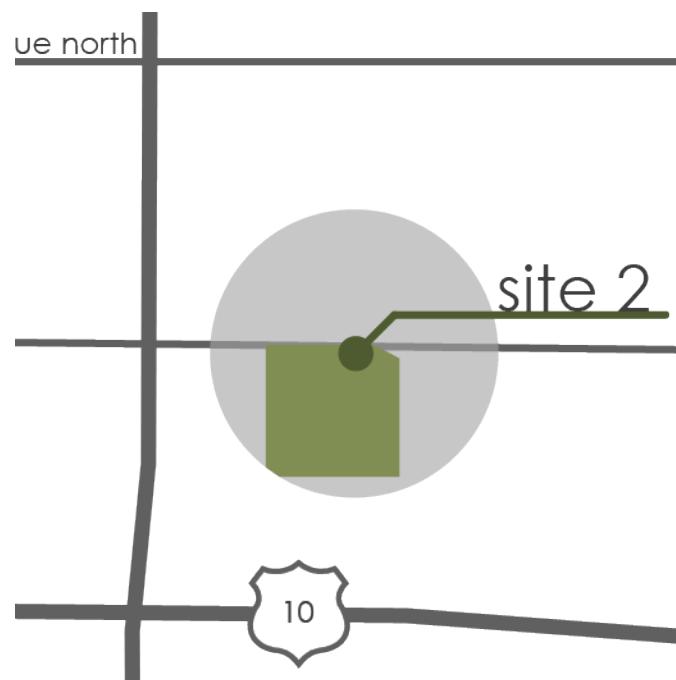


figure 5.9 | site 1 location

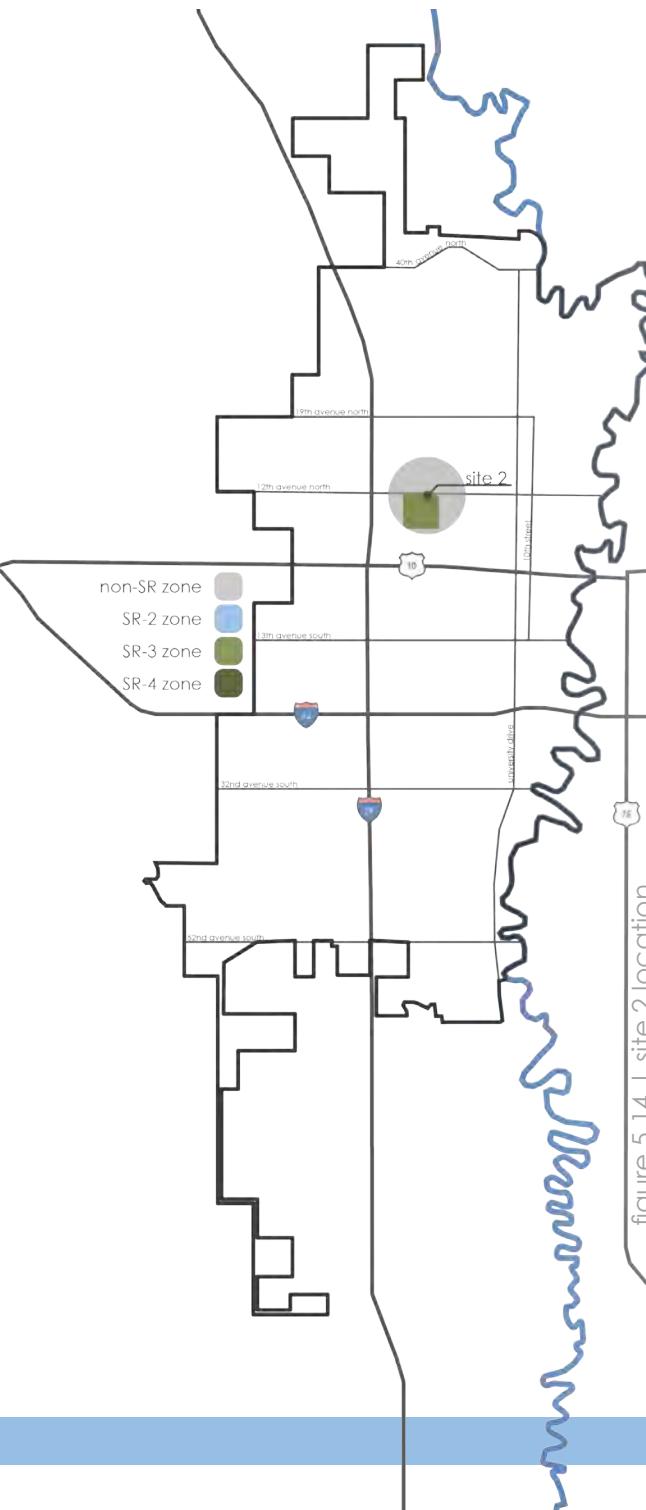
example site 2

1138 28th street north



total lot: 7,000 square feet		
allowable lot coverage: 25% (1,750 square feet)	setback coverage: 54.1% (3,790 square feet)	other use: 20.9% (1,460 square feet)
existing buildings: 11% (1,239 sq. ft.)	ADU allowable: 12% (840 sq. ft.)	

figure 5.13 | lot coverage table



zone: SR-2

lot dimensions: 50' x 140'

setbacks
front: 30'-0"
rear: 3'-0"
side: 5'-0";
15'-0" street side

Pros:

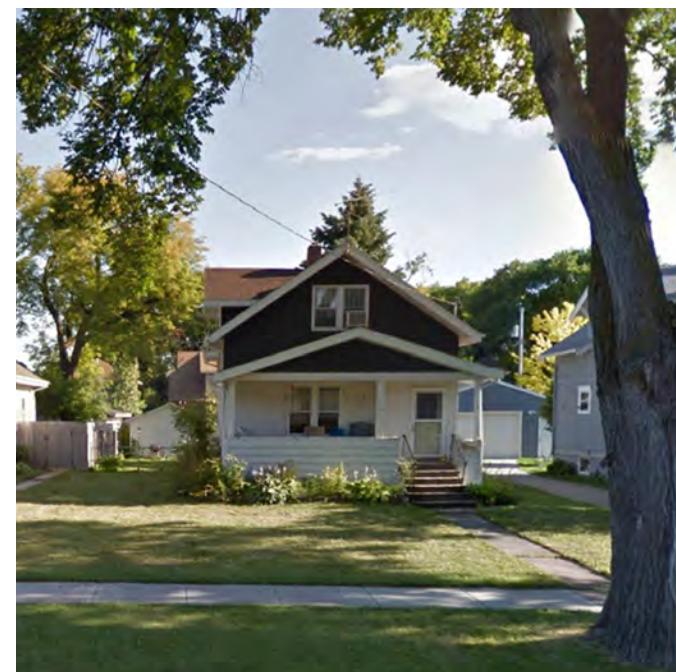
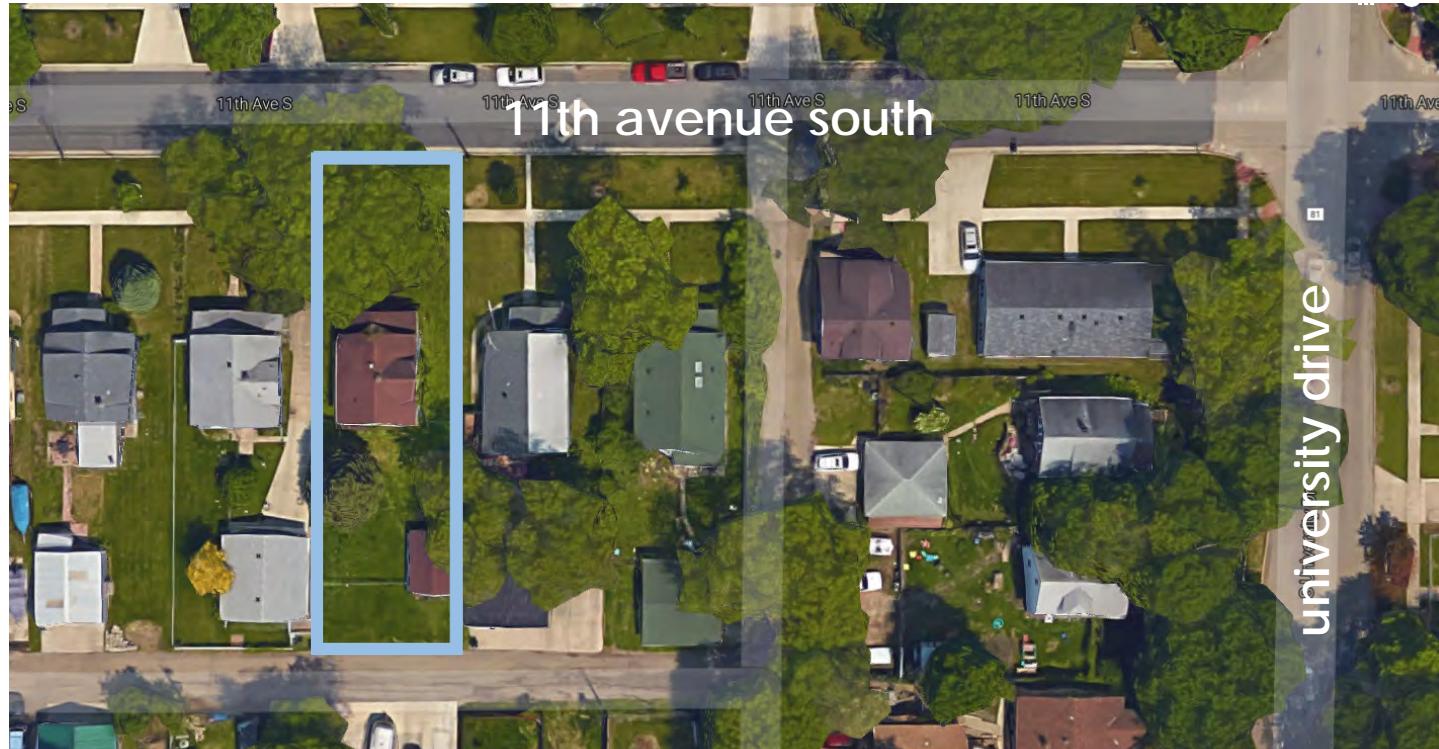
- ADU gets a large street view
- Alley access
- Existing buildings only occupy 11% of lot, allowing for full 12% coverage by the ADU

Cons:

- Corner lot has much larger street side setback
- Over half of the site is consumed by setbacks

example site 3

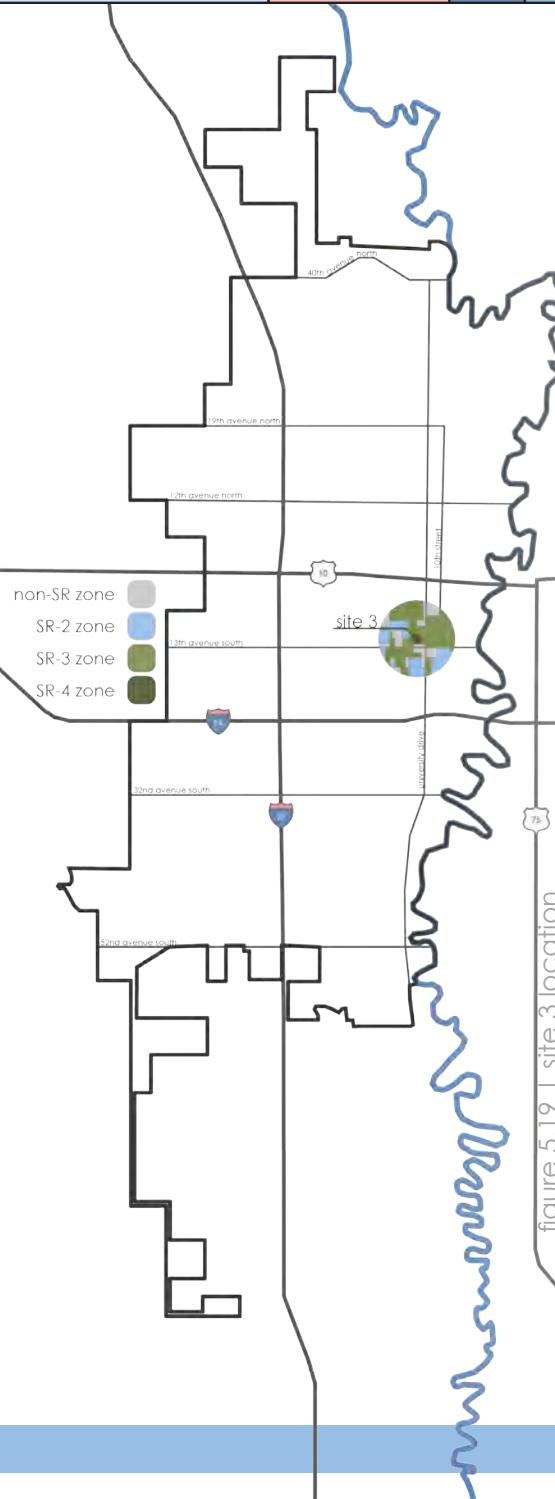
1324 11th avenue south



total lot: 6,692 square feet		
allowable lot coverage: 35% (2,342.2 square feet)	setback coverage: 33% (2,222.6 square feet)	other use: 32% (2,127.2 square feet)
existing buildings: 18.5% (1,239 square feet)	ADU allowable: 12% (803 sq. ft.)	

figure 5.18 | lot coverage table

zone: SR-3
lot dimensions: 47.8' x 140'
setbacks
front: 20'-0"
rear: 3'-0"
side: 4'-10"



Pros:

- Existing house faces North so worrying about sunlight to the accessory dwelling unit is not an issue
- The house is not built to side setbacks so there is access to the street
- The site is located on an alley so it is easy to access the ADU by vehicle and create an additional parking space

Cons:

- Site is very long and narrow which leaves a very minimal width for the ADU

example site 4

5069 rose creek parkway



figure 5.20 | aerial view



figure 5.21 | enlarged surrounding zoning

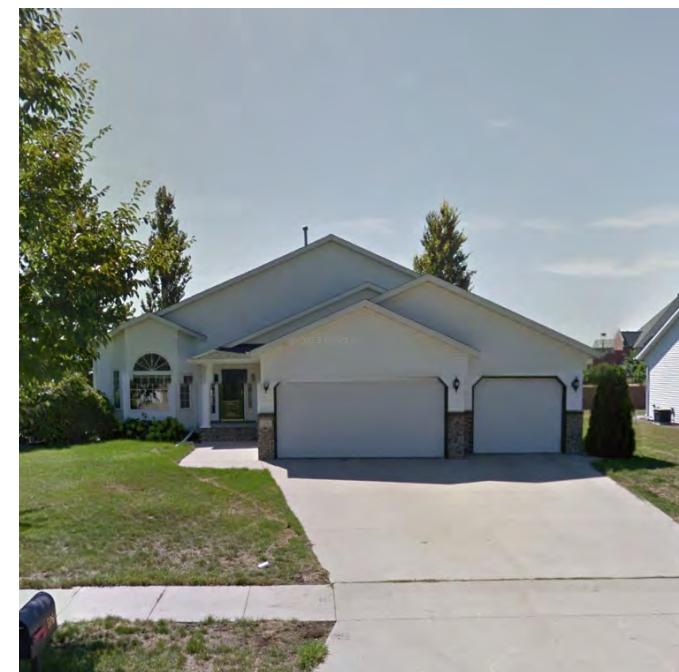


figure 5.22 | street view

total lot: 12,667 square feet		
allowable lot coverage: 25% (3,166.8 square feet)	setback coverage: 37.5% (4,747 square feet)	other use: 37.5% (4,753.2 square feet)
existing buildings: 16.2% (2,064 square feet)	ADU max.: 8.8% (1,103 sf)	

figure 5.23 | lot coverage table

zone: SR-2
lot dimensions: 85' x 149'
setbacks
front: 30'-0"
rear: 3'-0"
side: 8'-6"

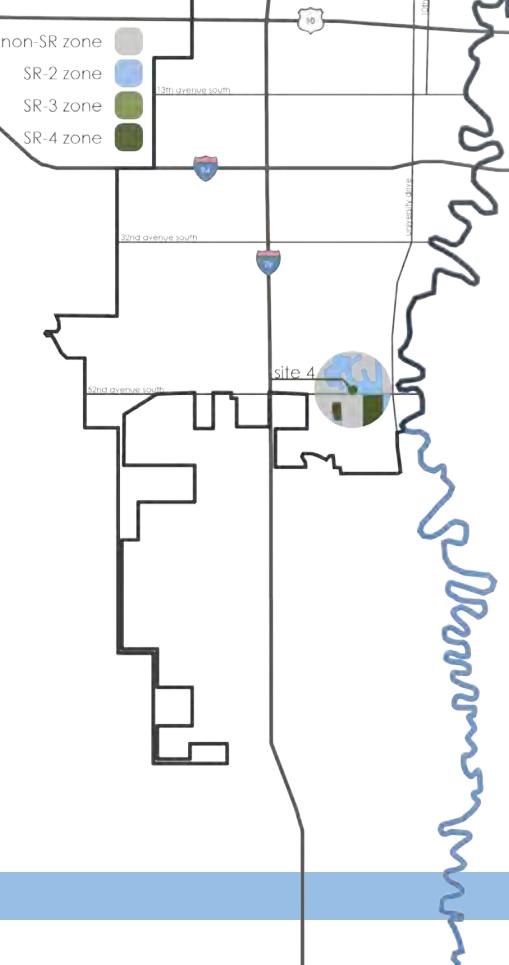


figure 5.24 | site 1 location

Pros:

- Large lot to work with
- Garage attached to home, so there are no other buildings on the lot to build around

Cons:

- Existing building occupies over 16% of the lot not leaving much left over for the ADU
- House is built almost to setback lines, not allowing for much access to the back yard from the street

performance criteria

proposed zoning code analysis

	ADU footprint compared to primary house	allowable zones	property owner occupancy	total allowable lot coverage	setbacks	minimum square footage	maximum square footage	distance from primary structure	maximum height	parking	materials	entrance
minneapolis, minnesota	ADU must be smaller than the primary dwelling	residence, office, commercial, downtown, industrial living	property owner must live in either the primary residence or the ADU	ADU + parking cannot exceed 676 square feet or 10% of lot area, whichever is greater	front: ADU must be in rear side: rear: 3'-5' depending on zone		1,300 sq. ft. total habitable and parking OR 16% of lot, whichever is greater: no larger than 1,600	20 feet from habitable portion of house	cannot exceed the height of the primary OR 20 feet., whichever is less	no additional parking space required	exterior materials must be durable	entrances encouraged to face public street or alley
seattle, washington		single family 2, single family 3 lots larger than 5,750 square feet		impervious cover of the site cannot exceed 45%, buildings cannot exceed 40%		300 square feet	1,000 square feet or 0.15 FAR, whichever is less; maximum of 550 square feet on the second story	at least 10 feet from primary structure	limited to two stories, and may not exceed a height of 30 feet	one additional space req. if the property is more than 0.25 miles from an activity corridor		
austin, texas		single family, low rise	property owner must live in either the primary house or ADU for at least 6 months per calendar year	on lots 1,000-5,000 sq. ft: 15% on lots larger than 5,000 sq. ft: 35%	front: ADU must be in rear side: rear: 5 feet, 10 feet on corner lots		including garage and storage areas: single family-800 sq. ft.; lowrise-650 sq. ft.	5 feet from primary structure	12-23 feet, depending on lot width	one additional space except in urban centers and low rise zones		entrance must not face side lot line or rear lot line unless there is an alley
common standards listed in In-laws, Outlaws, & Granny Flats			property owner must live in either the primary residence or the ADU	minimum lot size of 5,000 square feet, maximum lot coverage of 30-40%	front: 20 feet side: 5 feet rear: 10 feet		750 square feet or it can be listed as a percent of the footprint of the primary structure	10 feet, may be closer to non-habitable spaces	separate ADU: 12 feet above garage: 22 feet		siding, trim, and roof pitch should match existing house to help unit blend in to surroundings	both entries cannot face the street unless unit door is screened from view
current fargo building code				20-50% depending on zone, most lots have maximum coverage of 25-45%	front: no acc. structure side: 4-15 feet rear: acc. struct. cannot be closer than 3 ft.		the total sq. ft. of accessory buildings may not exceed the footprint of the house	none, a building closer than 6 ft. to the primary structure must have addl. fire protection	accessory buildings may not exceed 15 feet in height			
proposed fargo ADU code	ADU must be smaller than the primary dwelling	sr-1, sr-2 sr-3, sr-4	property owner must live in either the primary house or ADU for at least 6 months per calendar year	no change to current code	no change to current code	300 square feet	1,200 square feet OR 12% of the lot, whichever is less	8 feet from habitable portion of primary structure	18 feet or height of primary, whichever is less	one additional space required unless the property is within 0.25 miles of a transit stop	siding, trim, and roof pitch should complement the existing house	entrances encouraged to face public street or alley
why this option was chosen	the ADU is a secondary home on the property. it should not have more square footage than the primary home, otherwise it becomes confusing which home is the primary dwelling.	initially all five of the single family zones were allowed, but after analyzing, I found that the sr-5 lots were barely large enough to house the existing homes, let alone a secondary dwelling	forcing the property owner to live on the property is more likely to make the owner care what the property looks like. only making them live there for half the year allows for travel to warmer southern states in the winter	accessory dwelling units can be added without the need to allow more lot coverage. by not allowing more coverage, the lot will not seem overtaken by buildings	setbacks are made for the safety of property owners and their neighbors. ADUs can be placed on the lots without needing to infringe on setbacks, thus reducing risk for intruding on safety measures	this limit ensures that the accessory dwelling unit is a livable space. anything smaller than this could be considered just a bedroom and not house the proper amenities and universal design principles.	this ensures that the ADU does not become too large and overtake the lot. it still allows for homes to have plenty of space for amenities and universal design principles.	the distance between the homes is far enough that the opportunity for fire to jump between the buildings is reduced, yet they can be close enough for short utilities connections	this distance is measured to the mid-point of the roof slope. it allows for height and clerestory windows, and is the height change that the land development code task force proposed to accommodate taller garage doors	this ensures that the occupant of the ADU has access to the rest of the city, whether it be by car or by bus, without relying on the occupants of the primary home	the ADU should match the existing style of the homes around it so that it looks like it fits in the neighborhood and therefore will be more likely to be accepted by the neighbors	an entrance facing a street or alley makes the ADU feel more like it is a home and not just another accessory building on the property. it give the feel of a "front" door.

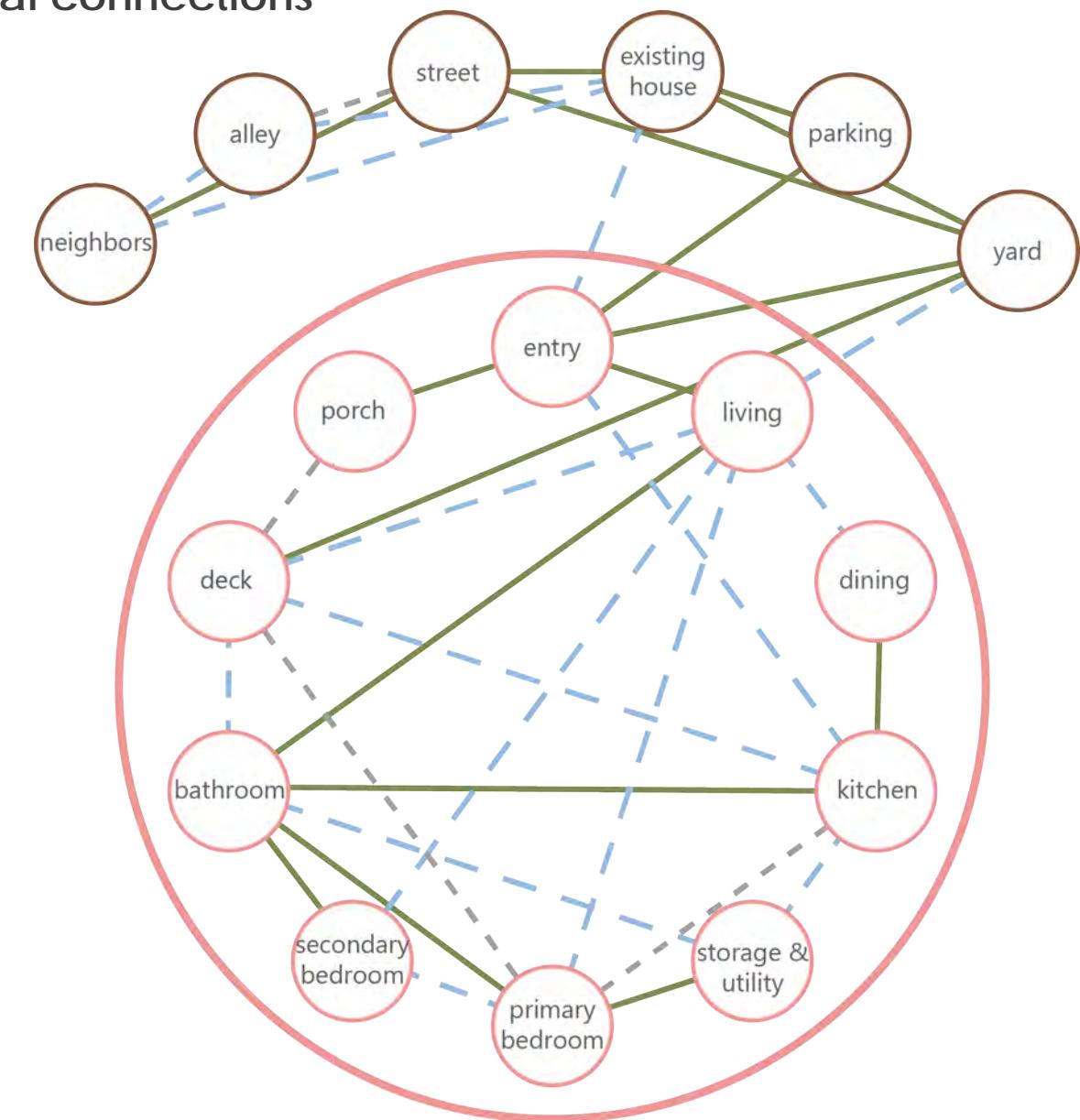
figure 6.1 | zoning code analysis table

programming

spatial needs

entry	40-50 square feet
living	125-200 square feet
dining	40-50 square feet
kitchen	80-100 square feet
storage & utility	50-75 square feet
primary bedroom	150-250 square feet
optional secondary bedroom	100-125 square feet
bathroom	100-125 square feet
deck	100-150 square feet
optional porch	50-100 square feet

spatial connections



— strong relationship | spaces should be near each other

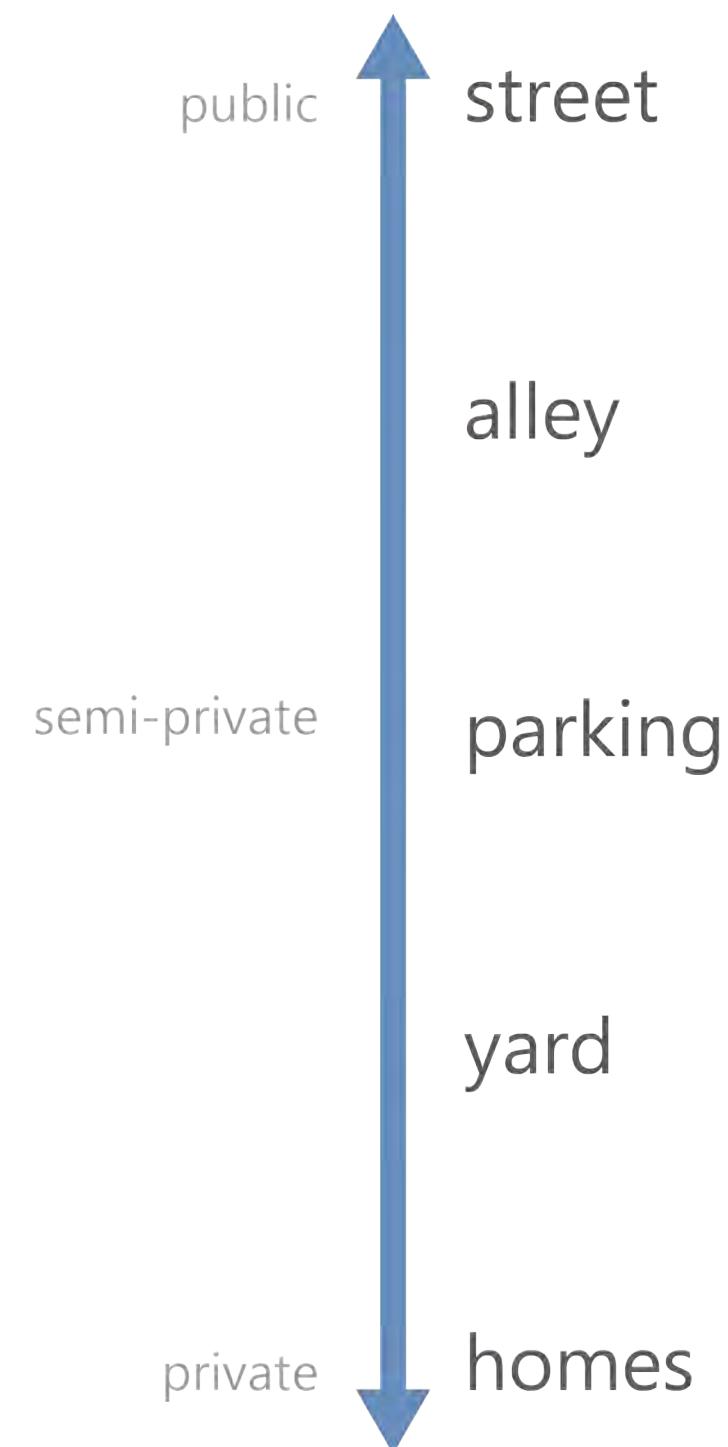
- - medium relationship | spaces should be close, but it is not necessary

- - - weak relationship | spaces have a relationship, but do not need to be near each other

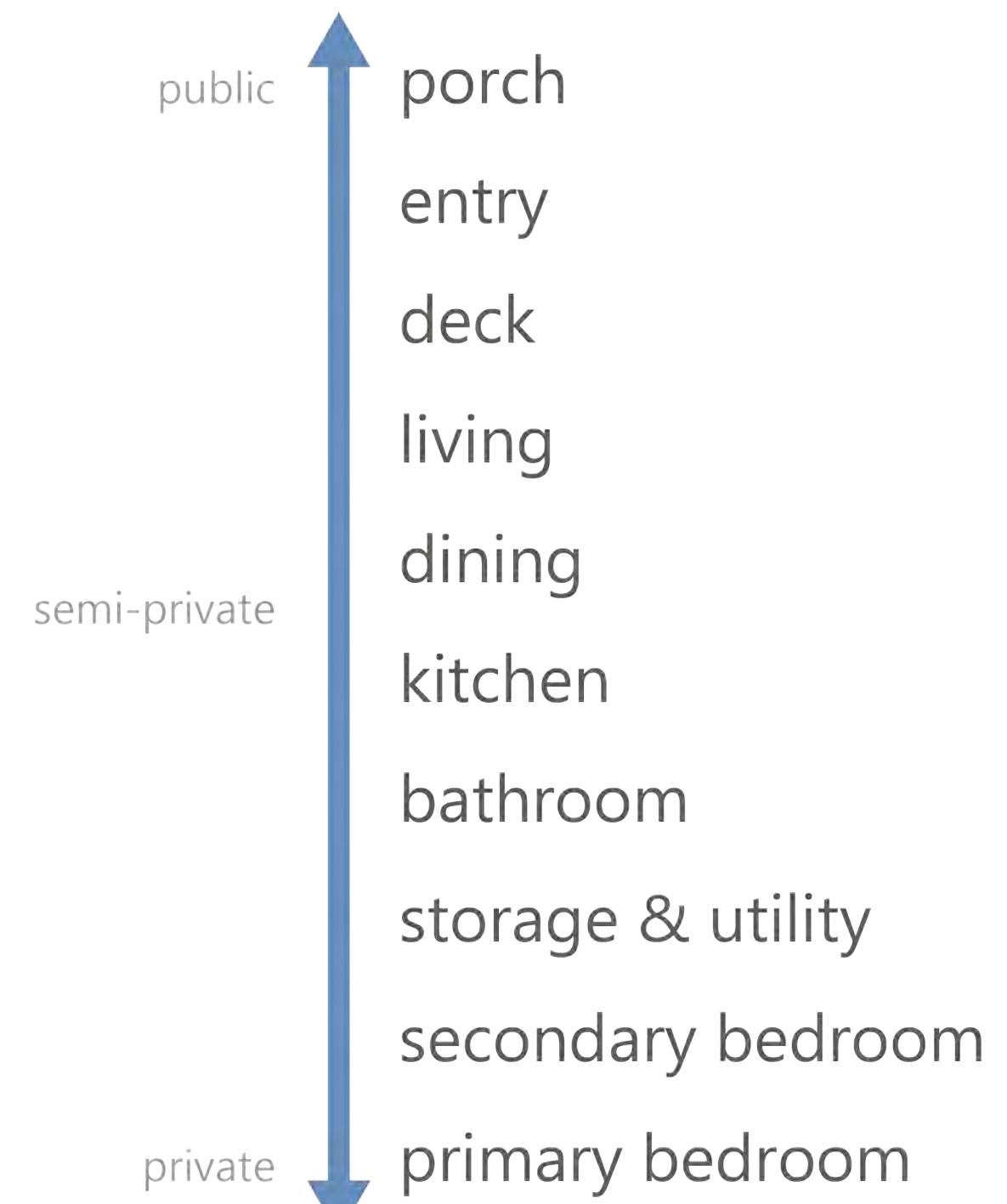
figure 6.1 | spatial connections diagram

programming

public to private spaces: exterior



public to private spaces: interior



energy efficiency

structural insulated panels

Structural insulated panels were chosen as the structure for this project for many reasons. Besides their transportability, rigid structure, and easy connections, they are also one of the most energy efficient framing techniques we have today. As seen in the table below from sips.org, SIPS allow only about 7 percent of the air infiltration of a wall of the same size built with traditional framing techniques.

The table also shows the R-values of walls of various thicknesses

and insulation types. A 4" SIP has about 1 1/2 times the R-value of a traditionally framed wall of the same size. To create a wall that could achieve the same insulating values, the wall would have to be 1 1/2 times as thick and have high quality insulation. This creates a thicker, more expensive wall, and occupies more precious square footage.

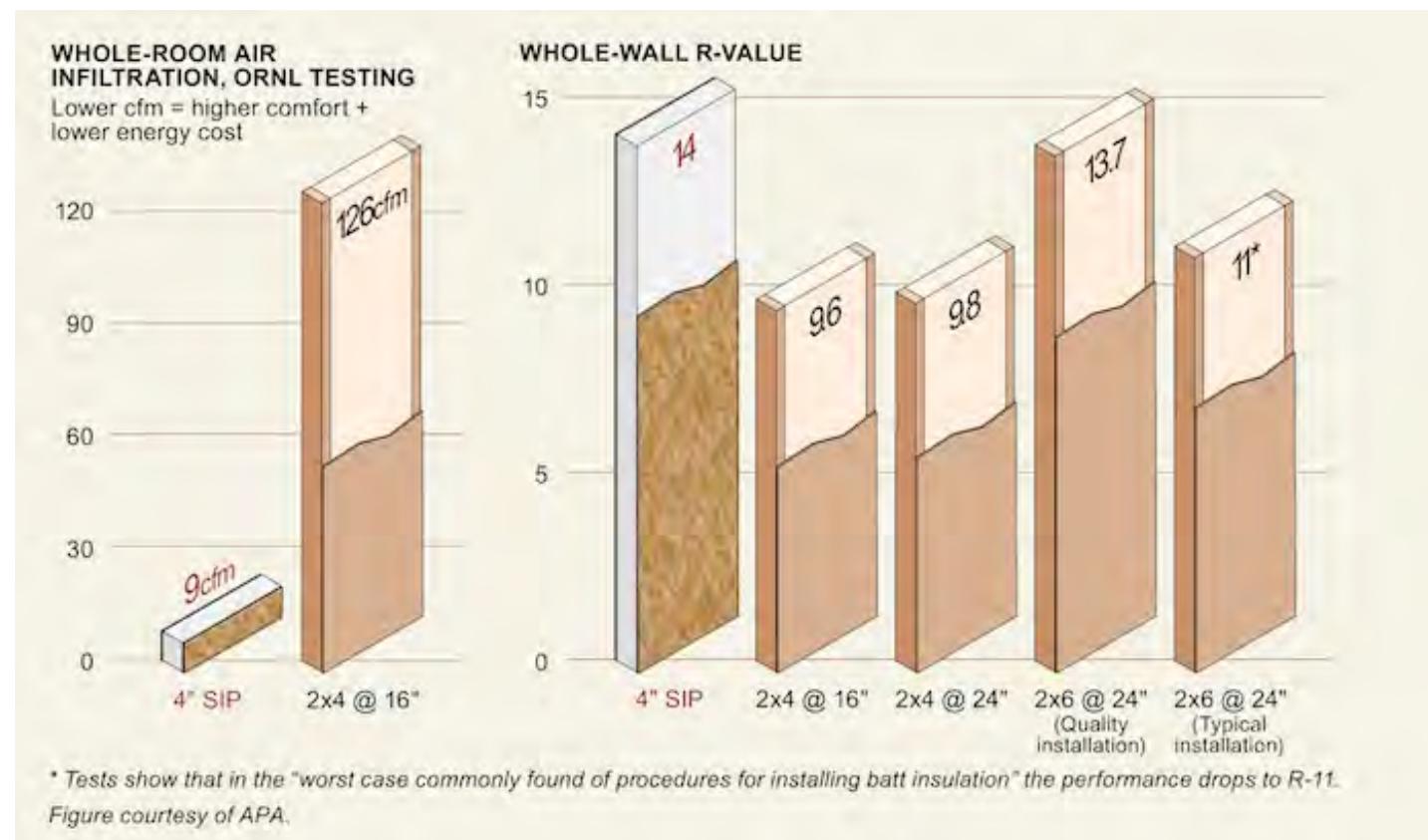


figure 6.2 | SIP efficiency

triple pane, low-e glass

Any time there are two or more panes of glass, the air space separating them acts as insulation and works to keep the outside air out and the inside air in.

Triple pane glass can be anywhere between 53%-74% more energy efficient than a single pane window (Pella, 2017). This also helps to insulate the home and reduce heat loss through large windows.

A low E, or low emissivity, glass has an extremely thin transparent

metal layer on the glass which stops radiative heat flow and reflects the heat from the interior back into the home, which reduces heat loss through the glass (Marvin Windows and Doors, 2017).

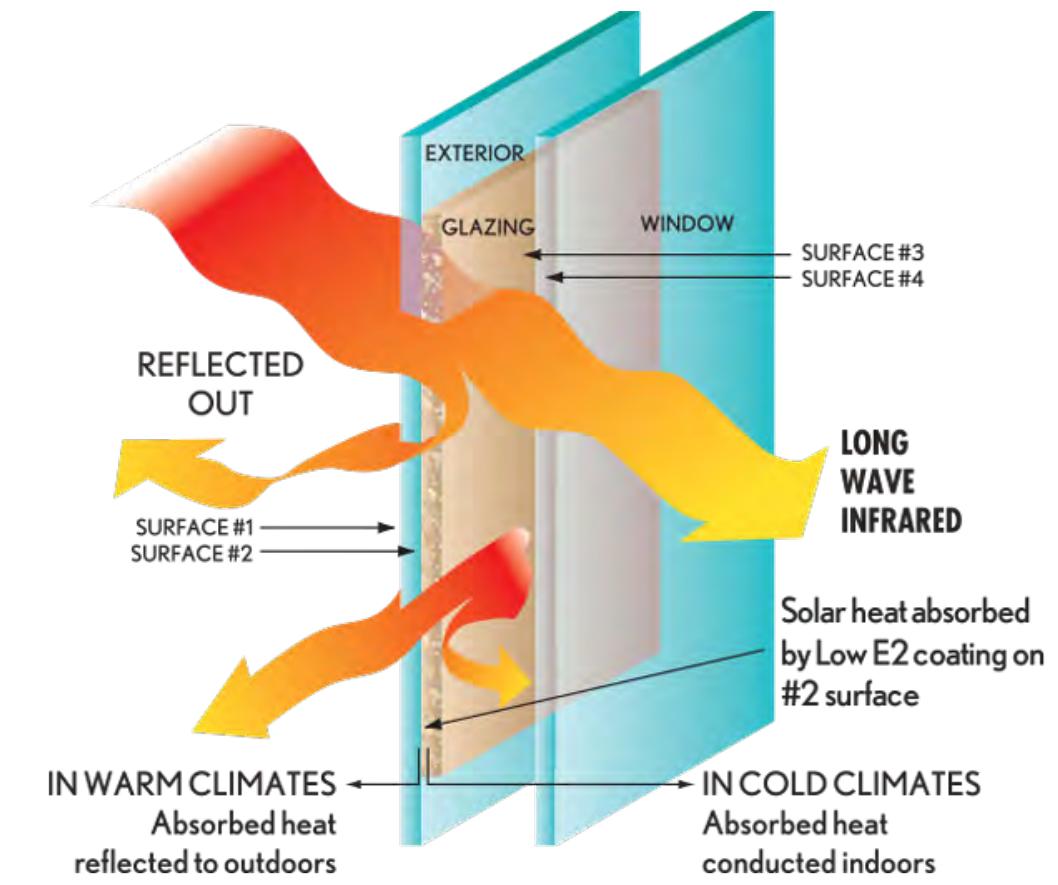


figure 6.3 | low-e glass diagram

appliances & materials

A wide variety of appliances and materials need to be specified in a universally designed home, such as this one. The following pages list examples of appropriate appliances and materials to be used in this project.

materials

Flooring

- Carpet
- Tile

Cabinetry

- Cabinets
- Counter Tops

Exterior

- Siding
- Structure

Windows & Doors

- Windows
- Doors

Walls

- Paint

appliances

Kitchen

- Oven
- Range
- Sink
- Faucet
- Dishwasher
- Refrigerator
- Cabinetry Features

Bathroom

- Shower Drain
- Shower Head
- Toilet
- Faucet
- Sink
- Grab Bar Items

Laundry

- Washer & Dryer

appliances

kitchen



figure 6.5 | wall mounted oven

Side Opening Wall Mounted Oven

- Side opening door allows for easier access to contents of oven
- Wall mounted so racks are at counter top height for easy transfer of food to and from oven
- Mounted flush with cabinetry so it is not in the way



figure 6.7 | under-mounted shallow sink

kitchen

Under-mounted Shallow Sink

- Shallow depth means less reaching to grab items from the bottom or finding the drain
- Drain at the back of the sink to allow more leg room underneath for a seated user
- Offset drain reduces probability that dishes will block it and prevent draining
- Under-mounted design for easy cleaning of counter tops
- High gauge stainless steel to reduce effects of wear and noise dampening



figure 6.6 | electric cook top

Built-In Knob-Controlled Electric Cook Top

- Knobs do not require grasping to turn on and off
- Knobs are contrasting color and back-lit when on for easy visibility
- Knobs located at front for easy reach
- Smooth surface cook top is easy for moving pots around
- Smooth surface cook top is easy for cleaning
- Tri-Ring Element allows for different pan sizes
- Hot surface indicator lights to know when elements are too hot to touch and also help user to know which elements are on



figure 6.8 | kitchen faucet

Single-Handle Pull-Out Sprayer Kitchen Faucet

- Handle faucet is easier to use than knob controls
- Hand-held sprayer makes washing dishes and cleaning out the sink easier because it can be pulled closer to the user

appliances



figure 6.9 | side-by-side refrigerator

kitchen

Side-by-Side Refrigerator

- Side-by-side design allows for access to both the refrigerator and the freezer at all levels
- Water and ice dispenser for convenience



figure 6.10 | built in dishwasher

18" Built in Dishwasher

- Slim Design fits well in small kitchen while still holding enough for 8 place settings
- Contrasting handle is easy to locate
- Washing phase indicator lights to notify if it is in use or done
- Can be raised from the floor for easy transfer of dishes from the counter top



figure 6.11 | accessible cabinets

Accessible Cabinets with Pull Down Upper Shelves

- Taller and deeper baseboards to allow for front wheels of wheelchair to fit underneath
- Upper cabinets are 12"-15" from counter top
- Counter top is lower than standard height cabinets
- Pull down shelving in uppers for easy access of stored items from a seated position



figure 6.12 | pull down upper shelves

appliances

bathroom



figure 6.13 | linear shower drain

Linear Flush Shower Drain

- Placed along back wall so it is not a tripping hazard
- Entire bathroom floor slopes to it so standing water is not an issue
- Flush with floor tile to collect all water



figure 6.15 | toilet

bathroom

17"-19" Seat Toilet

- Taller seat is more comfortable
- Taller seat means less distance to squat down onto



figure 6.14 | hand held shower head

Adjustable Hand Held Shower Head

- Adjustable height is good for all heights, standing or sitting
- Hand-held head makes cleaning hard to reach places easier.
- Water pressure can be adjusted for comfort
- Water can temporarily be shut off if necessary



figure 6.16 | vanity faucet

Single-Lever Vanity Faucet

- Handle Faucet is easier to use than knob controls
- Single handle is easier to find the right temperature than adjusting two handles
- Placed on side of sink instead of the back making it easier to reach

appliances

bathroom



figure 6.17 | under-mounted vanity sink

Under-mounted Contrasting Sink

- Under-mounted design allows for easy cleaning of the surrounding counter top
- Contrasting color allows for differentiation between sink and counter top



figure 6.19 | toilet paper grab bar

bathroom



figure 6.20 | toilet paper grab bar



figure 6.18 | shower control grab bar

Integrated Grab Bars

- Integration into other elements makes them blend into surroundings more
- Finishes match decor to reduce sterilized hospital feel
- SIP structure creates blocking in all locations for installation of future needed grab bars



figure 6.21 | corner shelf grab bar

appliances

laundry



Slanted Drum Washer Dryer

- Slanted drum is ergonomically perfect for all users, whether they are standing or sitting and any height
- Machine washes and dries clothing all in one
- Front controls for easy reach
- Lighted screen for visibility

figure 6.22 | slanted drum washer dryer



figure 6.23 | ergonomics of washer dryer

materials

flooring



figure 6.24 | carpet tiles

Carpet Tiles

- Tile aspect allows for coverage of module seams
- A singular tile is easy to replace if damaged or stained
- Low profile pile gives comfort of carpet, but is thin enough for wheels to easily glide over
- Many different colors and patterns give option for personalizing
- Contrast with walls, baseboards, and cabinetry to distinguish horizontal surfaces from vertical surfaces



figure 6.25 | vinyl floor tiles

Vinyl Tile Flooring

- Tile aspect allows for coverage of module seams
- A singular tile is easy to replace if damaged
- Many options allow for personalization
- Contrast with walls, baseboards, and cabinetry to distinguish horizontal surfaces from vertical surfaces
- Easy to clean



figure 6.26 | cabinet door

cabinetry

Cabinetry Color

- Contrasting cabinetry and counter top colors allow for distinction between the vertical and the horizontal



figure 6.27 | corian counter top

DuPont Corian Counter Tops

- Works well in both kitchen and bathroom
- Easy to clean
- Resistant to bacteria growth
- Easy to repair if scratched
- Variety of colors and patterns to choose from

materials

exterior



figure 6.28 | board & batten siding

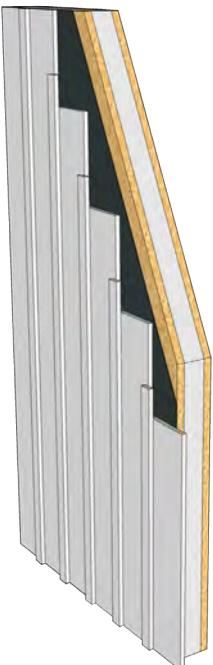


figure 6.29 | structural insulated panels

Vertical Board & Batten Siding

- Vertical nature allows for seamless coverage of module connections.
- Cedar finish give illusion of real wood siding without the maintenance
- Many color options for personalization

windows



figure 6.30 | powered window motor



figure 6.31 | triple pane windows

Power-Operated Energy Efficient Casement Windows

- Allows for large windows without worrying as much about heat gain/loss
- Power operation is easy for everyone, no matter strength or dexterity
- located 18"-20" from floor and at least 30" wide for egress purposes

materials

doors

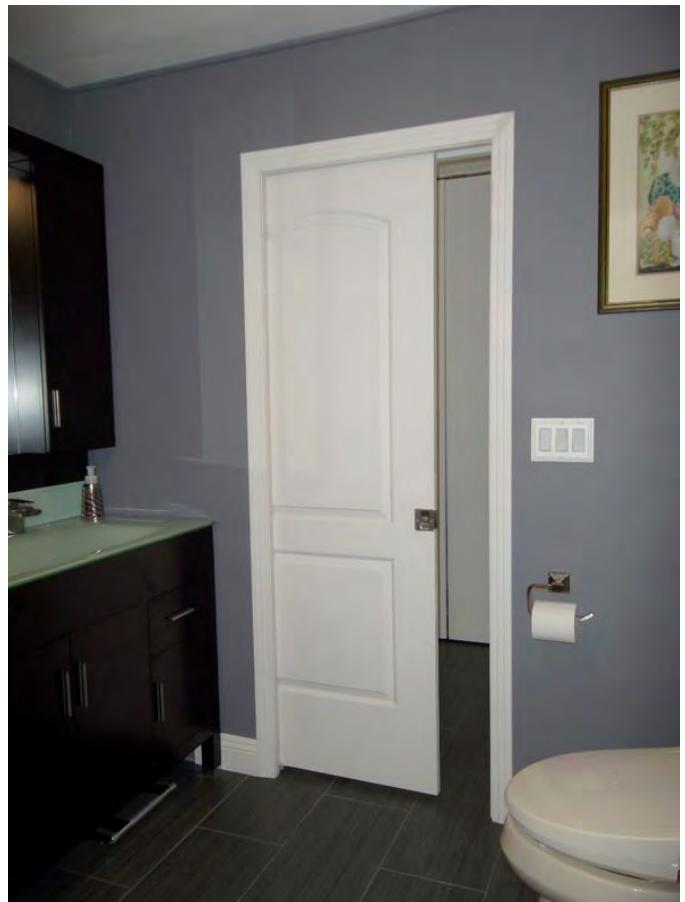


figure 6.32 | pocket doors

Pocket Doors (Where Possible)

- Increases usable square footage in rooms
- Easier to operate from a seated position
- Easy to open from both sides, no need to move with the swing of the door

walls

Durable, Easy to Clean Paint

- Light colored to make space feel larger
- Many colors to choose from
- Durable to resist blemishes
- Easy to clean



figure 6.33 | durable, easy to clean paint

design solution

modules

set 1: bedroom

1a

king or queen bed
306.50 square feet



figure 7.1 | module 1a

1b

queen or full bed
247.25 square feet

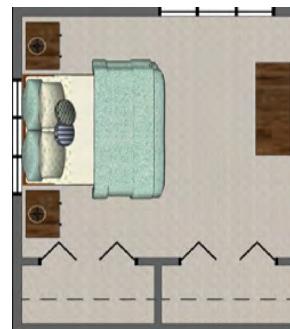


figure 7.2 | module 1b

1c

full or twin bed
180.50 square feet



figure 7.3 | module 1c

1d

full or twin bed
214.50 square feet

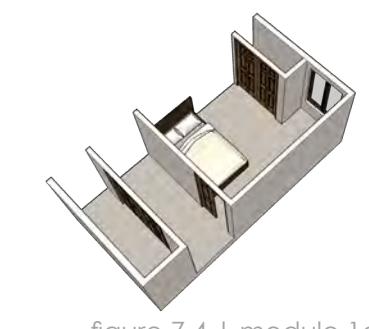
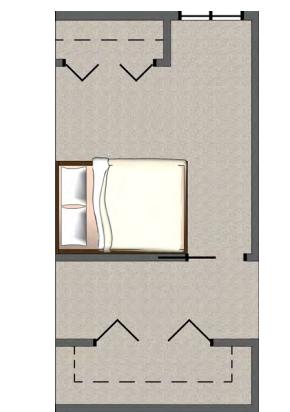


figure 7.4 | module 1d

universal design principles

at least 42"-48" path of travel

ample shelf space next to the bed

bed has view of the door

high windows add daylight without compromising privacy

lights are operable from bed

lamps for reading

variety of drawers, shelves, and hanging space in closet

adequate lighting in closets

full height mirror

adequate electrical outlets near bed

36" pocket doors where possible

modules

set 2: bathroom & laundry

2a
large
204.25 square feet



figure 7.5 | module 2a

2b
small
162.75 square feet



figure 7.6 | module 2b

universal design principles

front loading washer and dryer located side by side for easier access from a seated position

laundry located in a central location

"wet room" bathroom--no enclosed shower

18" high shower seat with slightly angled vertical portion

mirror with anti-fog features

textured, non-slip flooring

adjustable, hand-held shower head

skylights add daylight without compromising privacy

36" pocket door

modules

set 3: kitchen & entry

3a
open
165.25 square feet

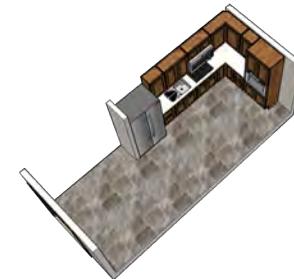


figure 7.7 | module 3a

3b
enclosed
165.25 square feet

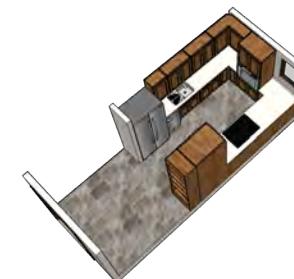


figure 7.8 | module 3b

universal design principles

front controls on single row of cooktop burners

wall mounted oven with side swinging door

lever, touch, or sensor style faucet

32"-34" high countertops with rounded edges

upper cabinets 12"-15" above base cabinets

flooring continues under cabinets for future removal if needed

9" high, 6" deep baseboards on cabinets to accommodate wheelchairs

electrical outlets located on front of base cabinets for easy access

d-shaped cabinet pulls

modules

set 4: living & dining

4a
large
257.50 square feet

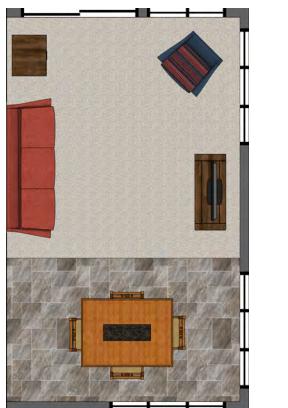


figure 7.9 | module 4a

4b
small
174.75 square feet

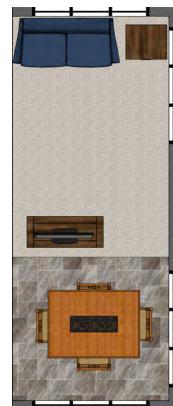


figure 7.10 | module 4b

universal design principles

soft furniture and cushions for acoustical dampening

dining table with trestle or pedestal base so seats of all sizes can fit on all sides

separate spaces with furniture, not walls

variety of lighting types

power operated window openings

18"-20" window sill height

modules

set 5: combination



figure 7.11 | module 5a



figure 7.12 | module 5b

tiny house principles

in general:

- the use of large windows gives the feel of a larger space and helps to connect to nature
- open floor plan to create overlapping spaces
- utilize light colors to make the space feel larger
- the addition of a deck adds more space without adding square footage
- having a sloped roof makes the home seem more like a house than an RV trailer
- using a tankless water heater saves space and energy

details

connections

SIPS can be connected through the use of cam locks. These are hooks that are embedded into the foam core of the SIP. Using a screwdriver like tool through a hole in the face of the SIP, the hooks are turned, hooked into the connecting SIP, and locked into place with an extra turn. This ensures a tight seal between the panels and modules.



figure 7.13 | SIP connections

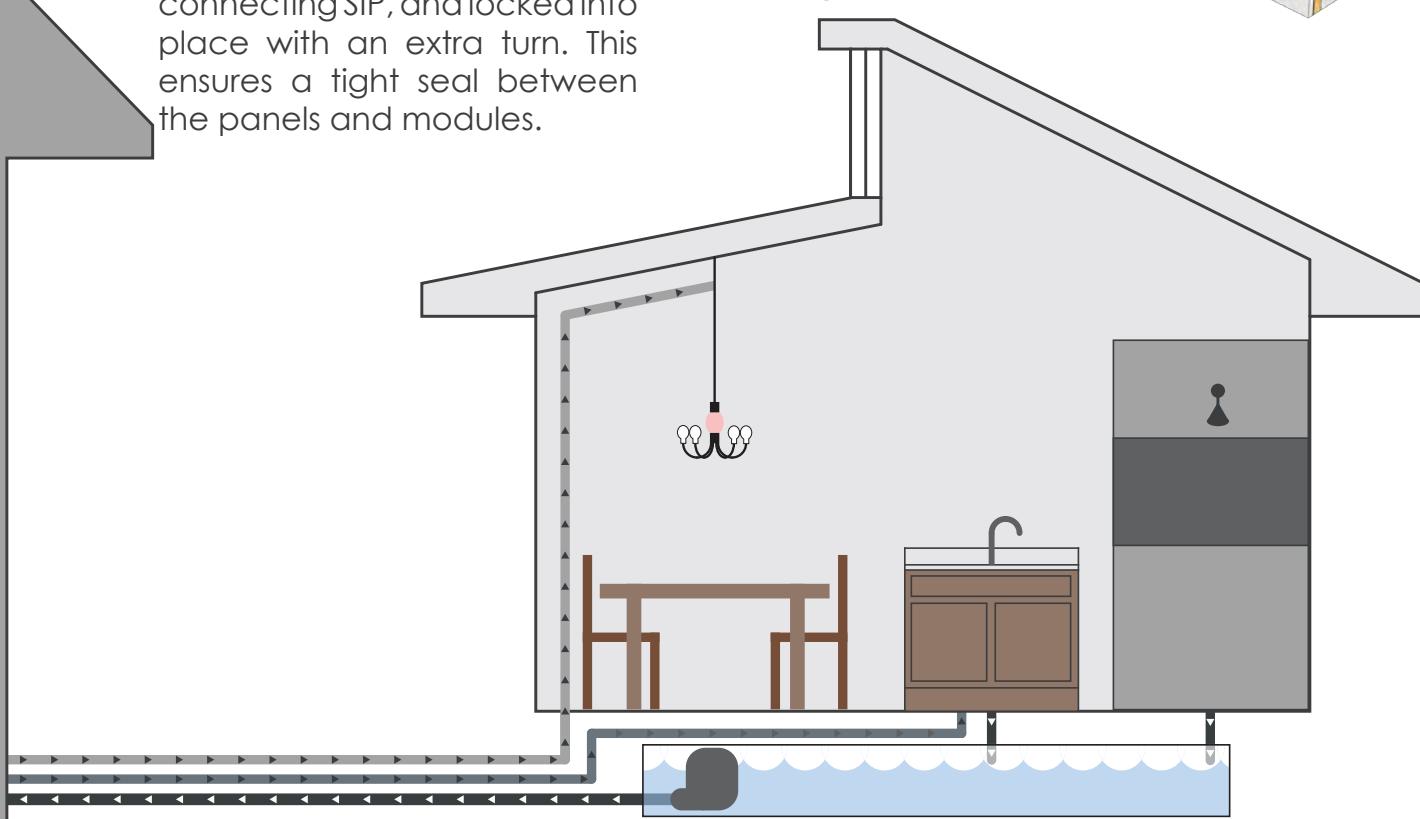


figure 7.14 | ADU connection to primary home

The ADU is connected to the primary dwelling to receive water and electricity, and to return sewer. These connections are insulated and can either be above ground for minimal disturbance to the yard, or below ground to be hidden.

foundation

This image shows the foundation system and how the units connect to it. The units have a bolted C channel underneath the floor. This channel is then bolted to the diamond pier foundation, thus holding the ADU in place against lateral and vertical forces. This type of system also has minimal impact on the site and can easily be removed when the unit is no longer needed.

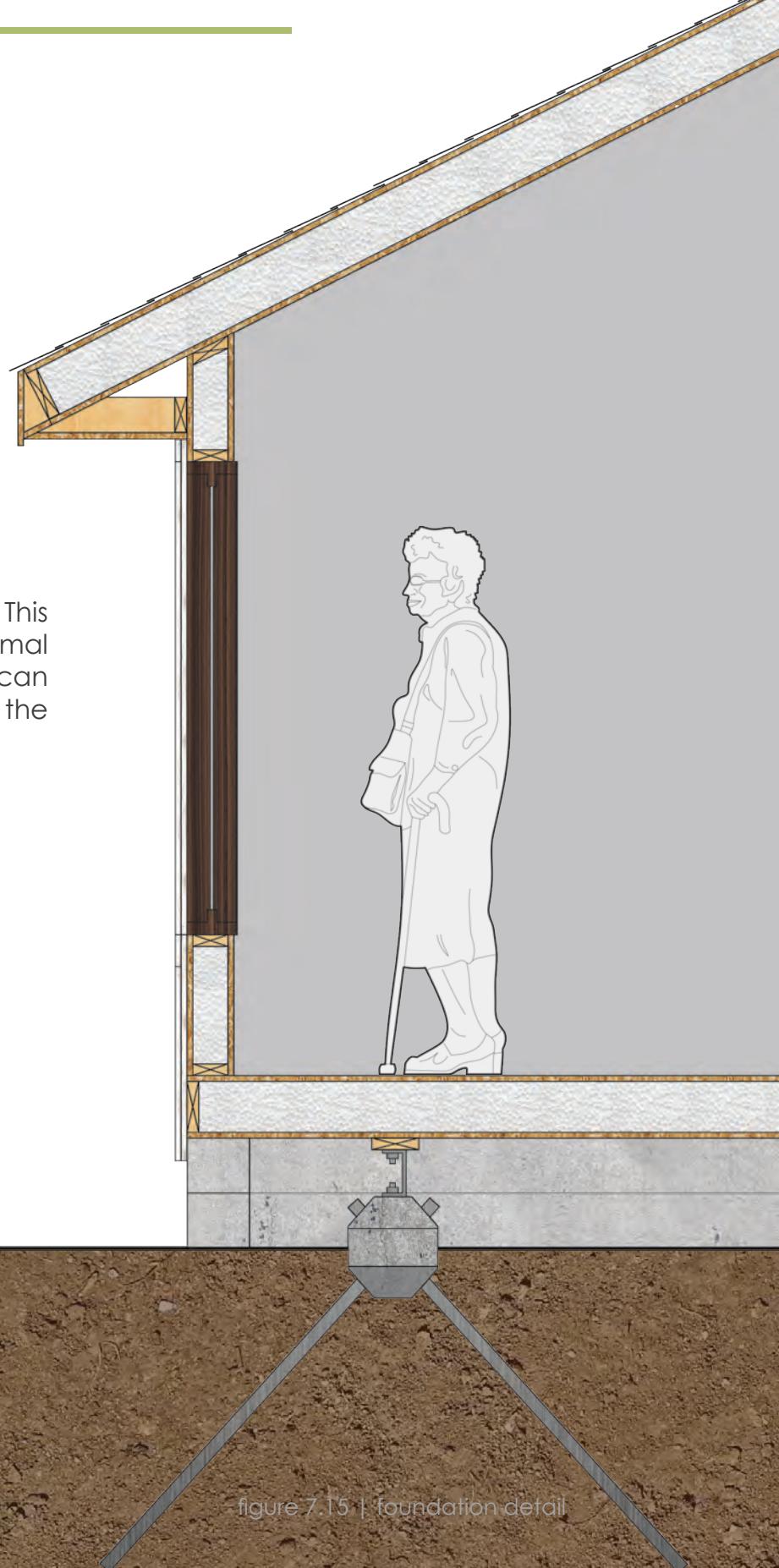


figure 7.15 | foundation detail

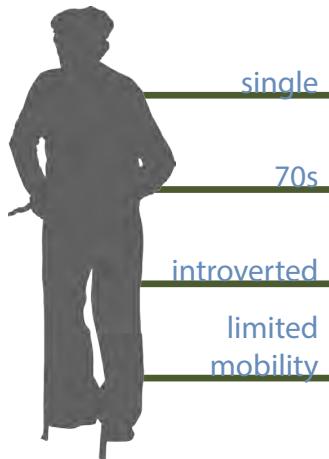


figure 7.16 | site 1 client

This combination of modules was chosen as the best solution to fit a single person in their 70s who is introverted and has limited mobility. The combination bedroom and bathroom fits a single person because they do not need as much space as a couple, yet still has enough space for someone with limited mobility and allows for even less mobility in the future. This client has more of an introverted personality, therefore he or she does not need a large entertaining space. The open floor plan kitchen was chosen to give the more public spaces a larger feel and to accommodate a possible reduction in mobility in the future.

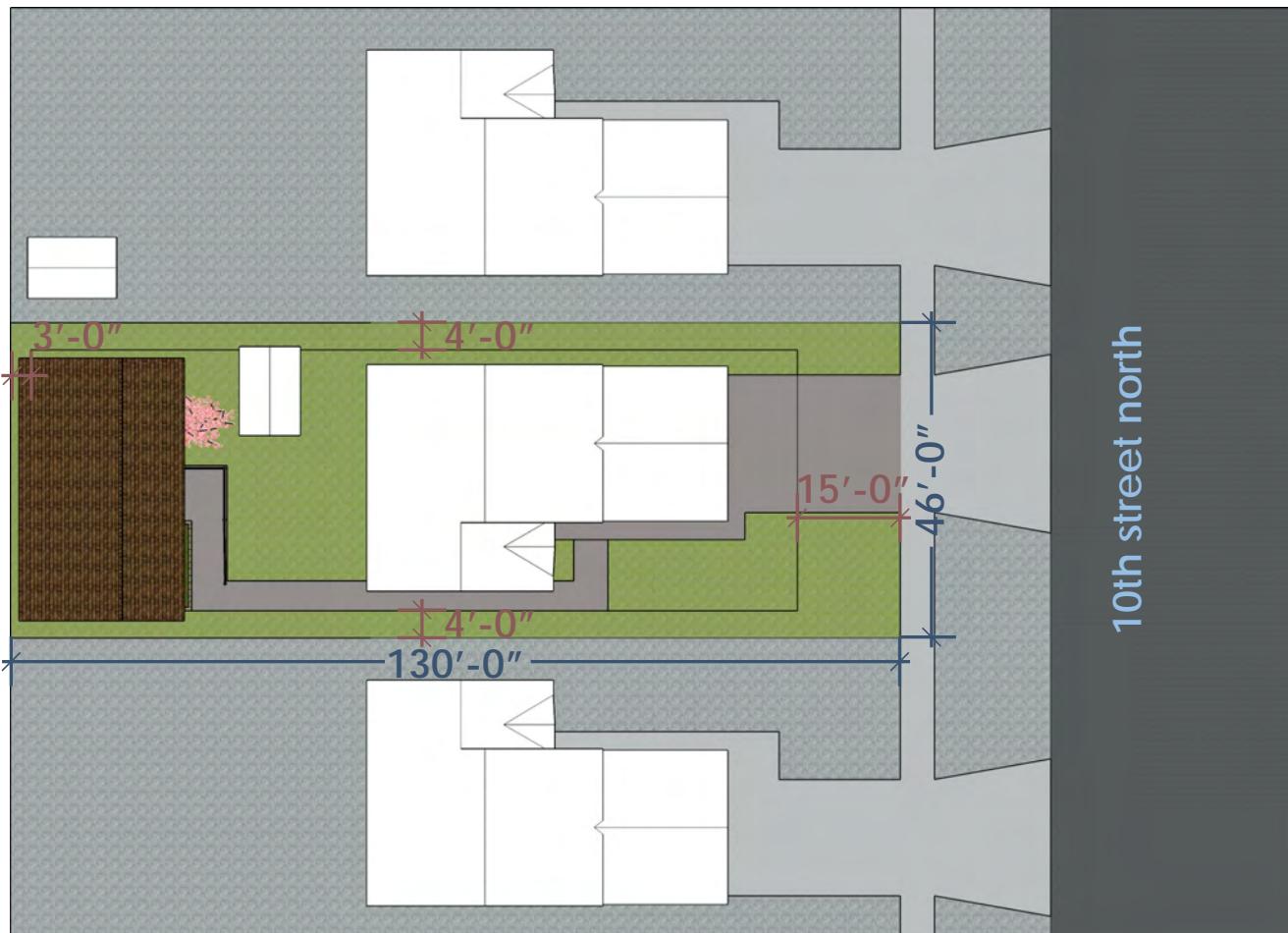
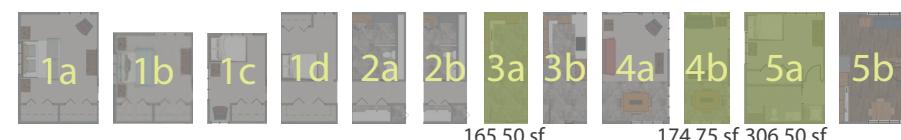


figure 7.17 | site 1 site plan



= 646.75 square feet



figure 7.18 | site 1 floor plan



figure 7.19 | site 1 rendering

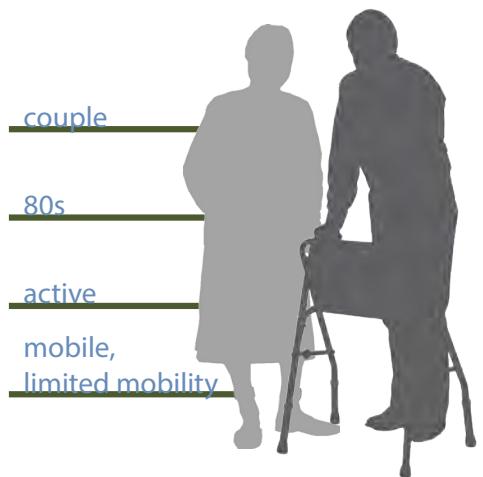


figure 7.20 | site 2 client

This combination of modules was chosen as the best solution to fit a couple in their 80s who is active and outgoing. One person has full mobility and one person has limited mobility. The largest bedroom was chosen to accommodate extra space needed for the resident with limited mobility. The couple was given the kitchen with more storage space for more resting places and to hold more of their belongings. The couple can invite friends over to visit in their living room or go out with their friends.

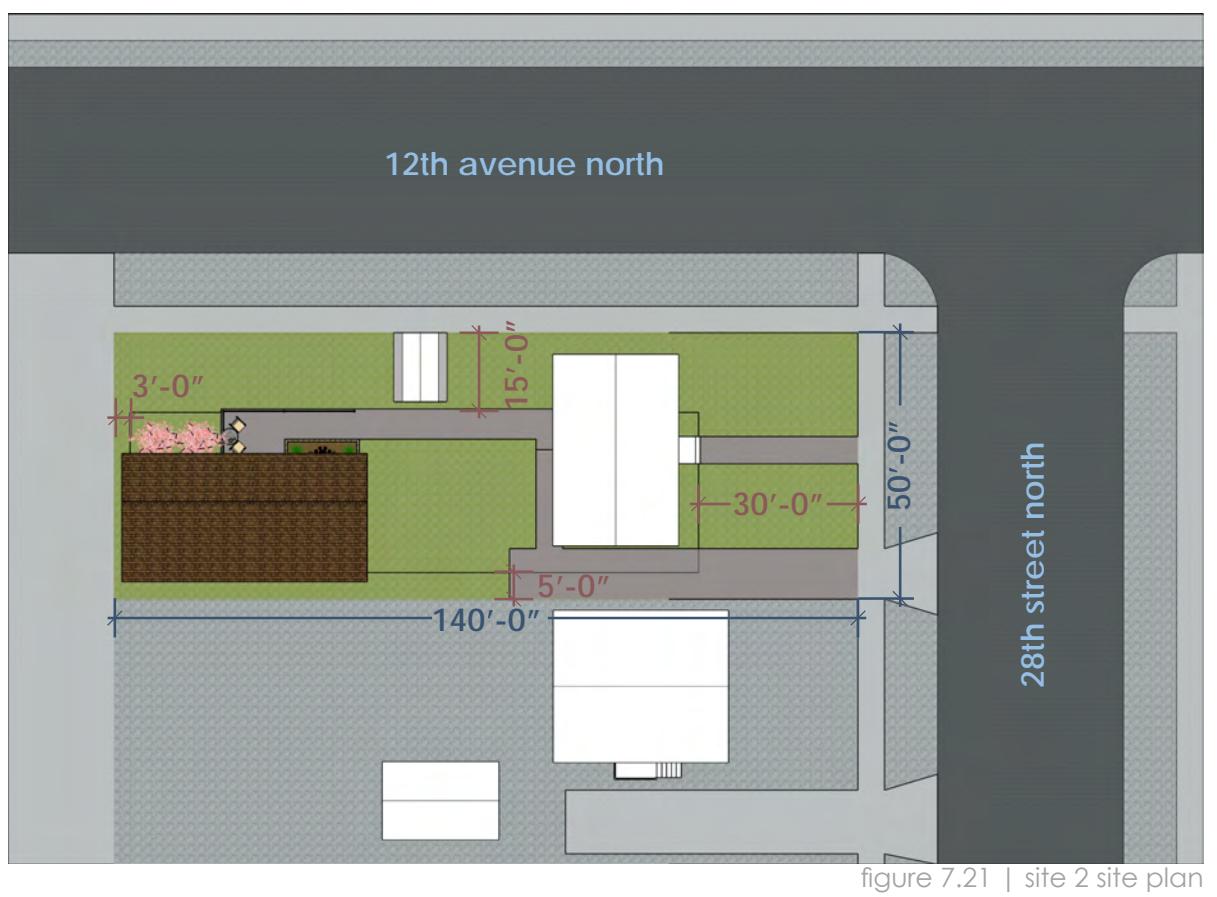
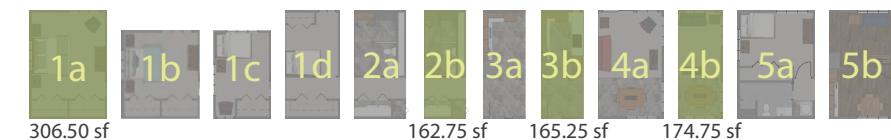


figure 7.21 | site 2 site plan



= 809.25 square feet



figure 7.22 | site 2 floor plan



figure 7.23 | site 2 rendering

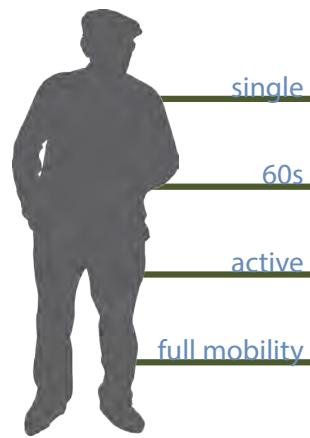


figure 7.24 | site 3 client

This combination of modules was chosen as the best solution to fit a single person in their 60s who is active and has full mobility. The smallest bedroom and bathroom were chosen for this person because he or she does not need the space of two people but still has a comfortable amount of personal space for himself or herself. This person does not need a large living space because he or she is active and extroverted and the home is also near a bus stop with quick access to the shopping area of the city.

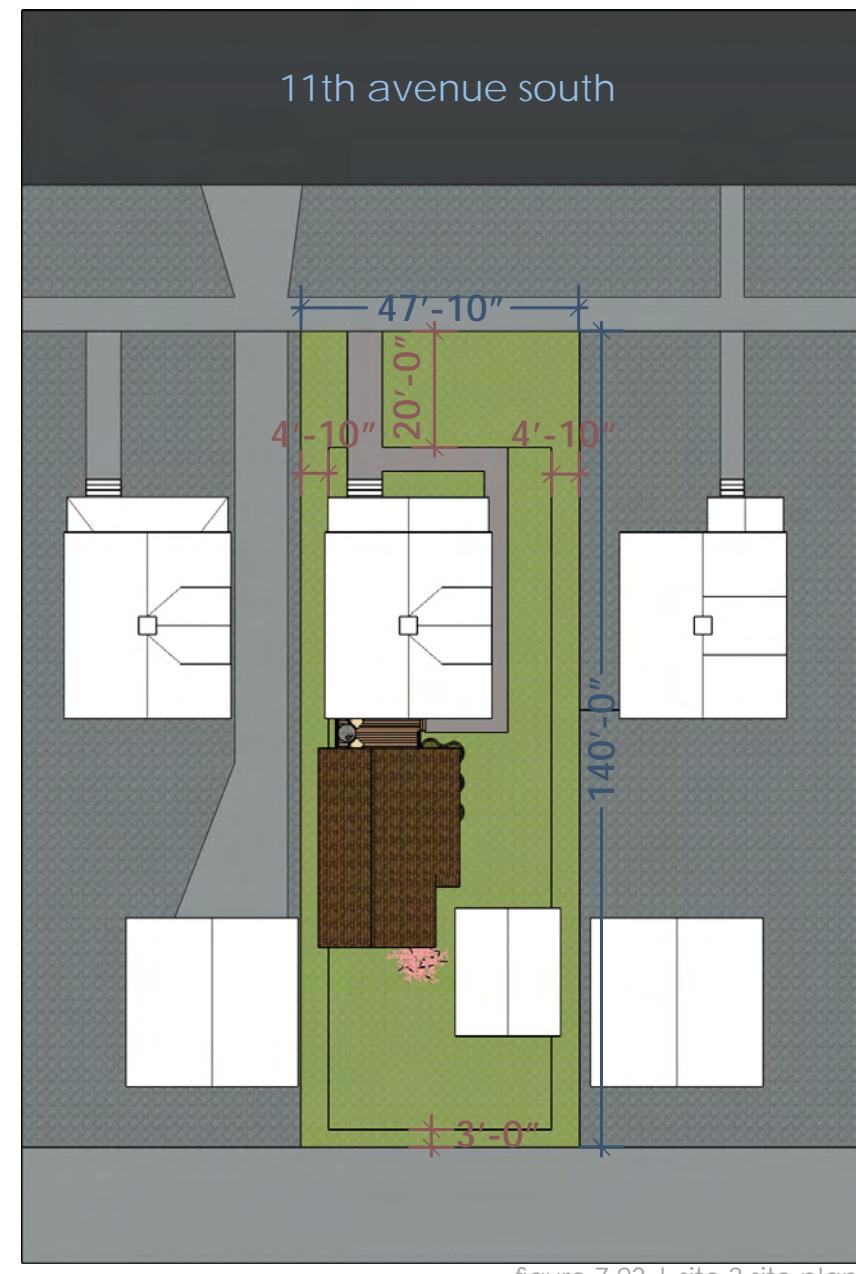
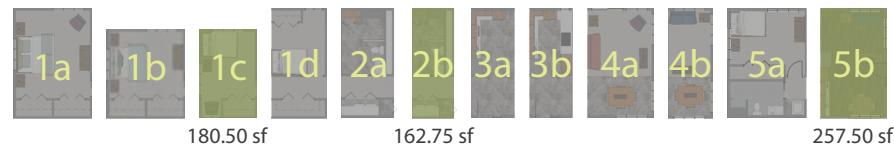


figure 7.23 | site 3 site plan



= 600.75 square feet



figure 7.24 | site 3 floor plan



figure 7.27 | site 3

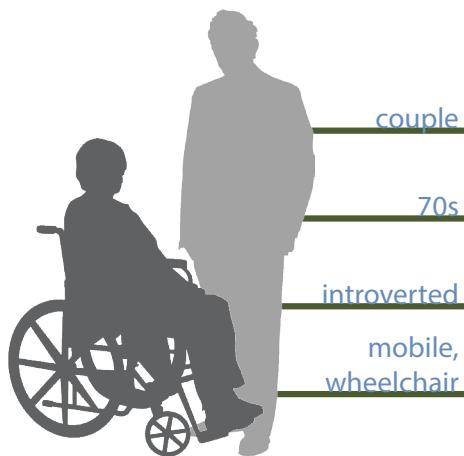
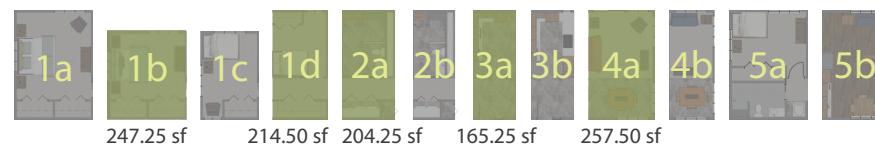


figure 7.28 | site 4 client

This combination of modules was chosen as the best solution to fit a couple in their 70s who is introverted and keeps to themselves. One person has full mobility and one person is in a wheelchair. Their home has two bedrooms. One bedroom is for them to sleep in, and one is to house mobility equipment needed for the resident in a wheelchair. The larger bathroom was chosen to allow for more room for a caregiver's assistance if needed. The open kitchen and larger living room allow for extra moving space and a more comfortable space because the couple likely spends much of their time in their home.



= 1,088.75 square feet

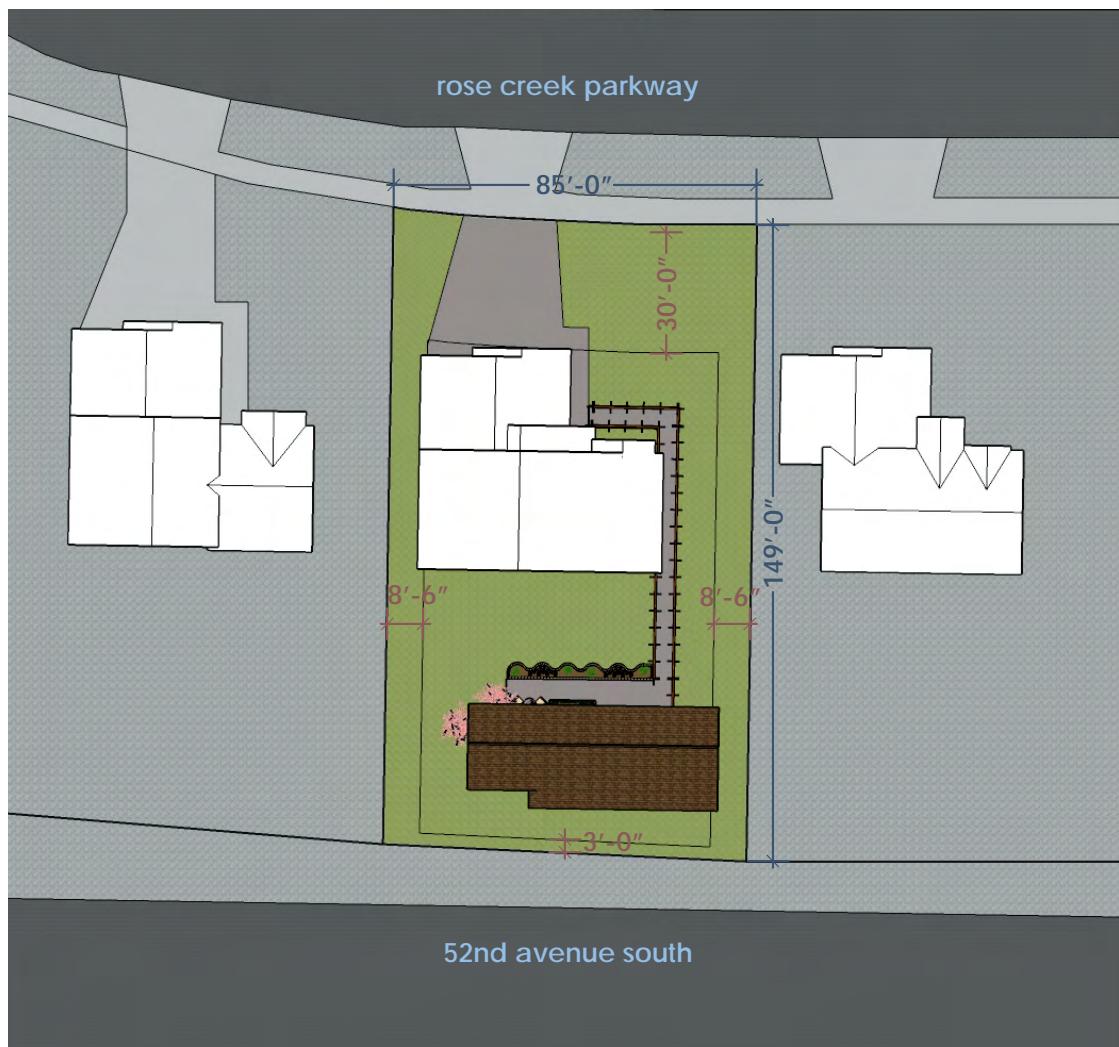


figure 7.29 | site 4 site plan



figure 7.30 | site 4 floor plan



figure 7.31 | site 4 rendering

documentation

display



research agenda

how can modular accessory dwelling units facilitate aging in place in fargo, north dakota?

modularity & assembly	tiny homes & accessory dwelling units	aging in place & universal design	zoning & regulations
logical iteration: Google SketchUp Hand Sketching	literature review: In-Laws, Outlaws, and Granny Flats Michael Ulichfeld	literature review: Backyard Cottages: A New Choice for Small Families City of Seattle Department of Planning and Development	case studies: The Accessible Home: Designing for All Ages and Abilities Deborah Pierce
structure insulated panel Association Diamond Pier Footings	sips.org Structure Insulated Panel Association	Backyard Cottages: A New Choice for Small Families City of Seattle Department of Planning and Development	Housing for the Elderly: Privacy and Security in Residential Environments for the Aging J. David Heggard
	Diamond Pier Footings		In-Laws, Outlaws, and Granny Flats Michael Ulichfeld
			Land Development Code Fargo, North Dakota

what is an accessory dwelling unit?

A secondary, usually smaller unit on a property with a primary house. It is self contained with its own bedroom and kitchen. ADUs come in all shapes and sizes and can include many different amenities. They are often referred to as "tiny houses".

zoning

Currently, Fargo, North Dakota has no mention of accessory dwelling units in their land development code. This means that anyone who would like to build an ADU must do so through the zoning department. In order to successfully build an ADU, they must create a code to propose to the city of Fargo. This proposed code will then be reviewed by the zoning department and presented to the residents for consideration before being put into effect.

ADU types compared to primary houses	minneapolis, minnesota	washington	washington, dc	common standards	in-laws, outlaws & granny flats	current legal building code	proposed fargo, adu code
ADU must be located on the property of the primary dwelling							
allowable zones	residential, office, commercial, dwelling	single family 2 lots larger than 5,000 square feet	single family, lot size				
property owner occupancy	property owner must be the primary residence or ADU	property owner must be the primary residence or ADU	property owner must be the primary residence or ADU	property owner must be the primary residence or ADU at least 6 months per calendar year	property owner must be the primary residence or ADU at least 6 months per calendar year		
total allowable lot coverage	ADU - parking cannot exceed 10% of the lot area, which is greater than 20% depending on zone	minimum lot size of 1,000 square feet or 10% of the lot area, whichever is greater, but cannot exceed 40% of the lot area	minimum lot size of 1,000 square feet or 10% of the lot area, whichever is greater, but cannot exceed 40% of the lot area	30% dependence on lot area, most lots in a neighborhood will have a minimum lot coverage of 30-40% of the lot area, which is greater than 20-40%	30% dependence on lot area, most lots in a neighborhood will have a minimum lot coverage of 30-40% of the lot area, which is greater than 20-40%		
setbacks	20 feet from property line, 20 feet from rear property line, 10 feet on each side, 10 feet on corner lots	20 feet from property line, 20 feet from rear property line, 10 feet on each side, 10 feet on corner lots	20 feet from property line, 20 feet from rear property line, 10 feet on each side, 10 feet on corner lots	20 feet from property line, 20 feet from rear property line, 10 feet on each side, 10 feet on corner lots	20 feet from property line, 20 feet from rear property line, 10 feet on each side, 10 feet on corner lots		
minimum square footage	200 square feet	200 square feet	200 square feet	200 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet	200 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet		
maximum square footage	1,000 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet	1,000 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet	1,000 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet	1,000 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet	1,000 square feet or 1.5 times the square footage of the primary residence, whichever is greater, but cannot exceed 400 square feet		
distance from primary structure	20 feet from habitable portion of house, or 10 feet from garage structure	5 feet from primary structure	10 feet from primary structure	10 feet, may be closer to non-habitable spaces, but must be 10 feet from the property line	10 feet, may be closer to non-habitable spaces, but must be 10 feet from the property line		
measured height	height of the property line, or the highest point of the property, whichever is greater, but cannot exceed the highest point of the highest object on the property	height of the property line, or the highest point of the property, whichever is greater, but cannot exceed the highest point of the highest object on the property	height of the property line, or the highest point of the property, whichever is greater, but cannot exceed the highest point of the highest object on the property	height of the property line, or the highest point of the property, whichever is greater, but cannot exceed the highest point of the highest object on the property	height of the property line, or the highest point of the property, whichever is greater, but cannot exceed the highest point of the highest object on the property		
parking	no additional parking space required	one additional space, except in urban centers and areas served by transit	one additional space, except in urban centers and areas served by transit	one additional space, except in urban centers and areas served by transit	one additional space, except in urban centers and areas served by transit		
materials	exterior materials must be durable			cladding, trim, and roof glazing should match the exterior of the primary residence, and its surrounding elements, and its surrounding elements	cladding, trim, and roof glazing should match the exterior of the primary residence, and its surrounding elements, and its surrounding elements		
entrance	entrances encouraged to back public street or private driveway			entrances encouraged to back public street or private driveway	entrances encouraged to back public street or private driveway		
details	connection detail, foundation detail, plumbing & electrical connections	connection detail	connection detail	connection detail	connection detail		

krishna clarkehouse arch 712 design these are not intended for field software, sketchup, ambient disclosure, adobe illustrator, adobe photoshop, adobe indesign

figure 8.1 | display boards



figure 8.2 | full display

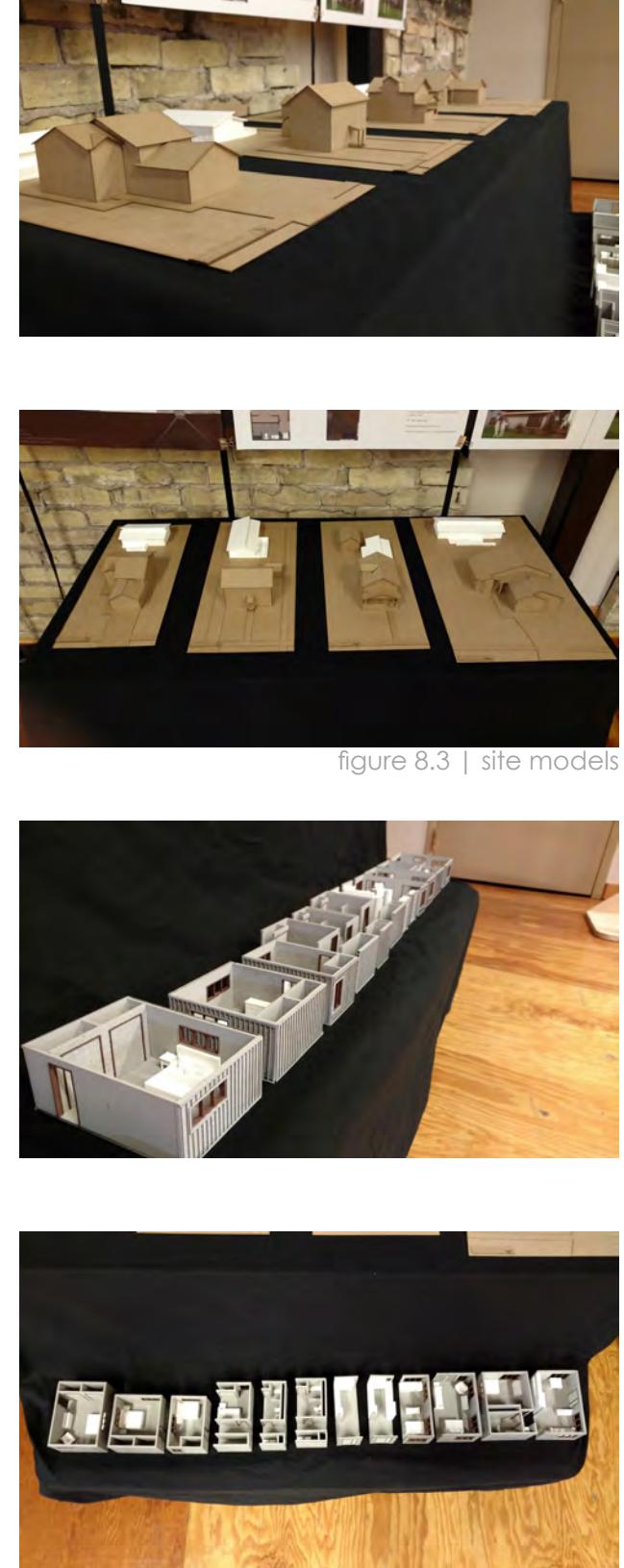


figure 8.3 | site models

figure 8.4 | module models

physical models

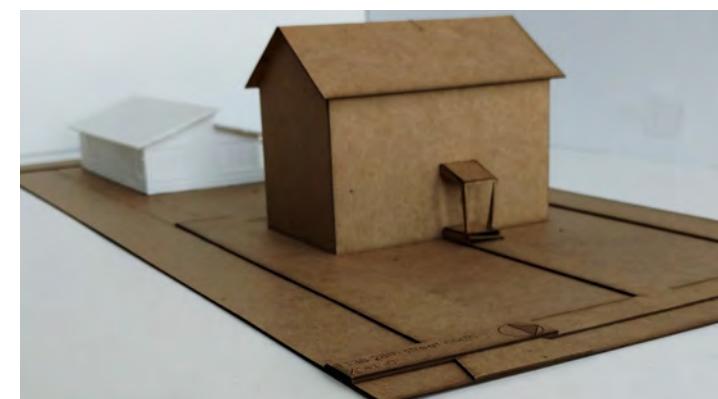
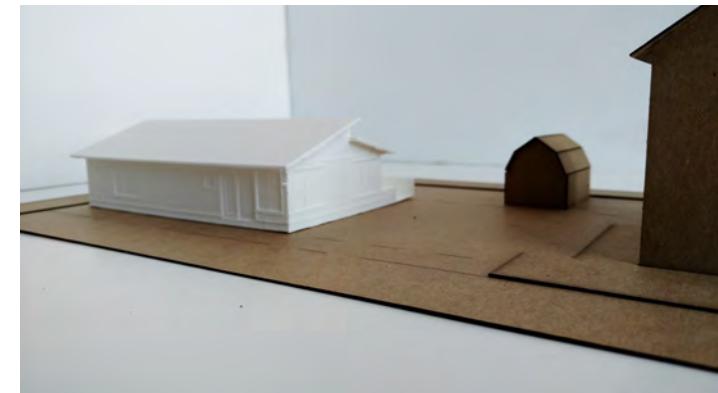
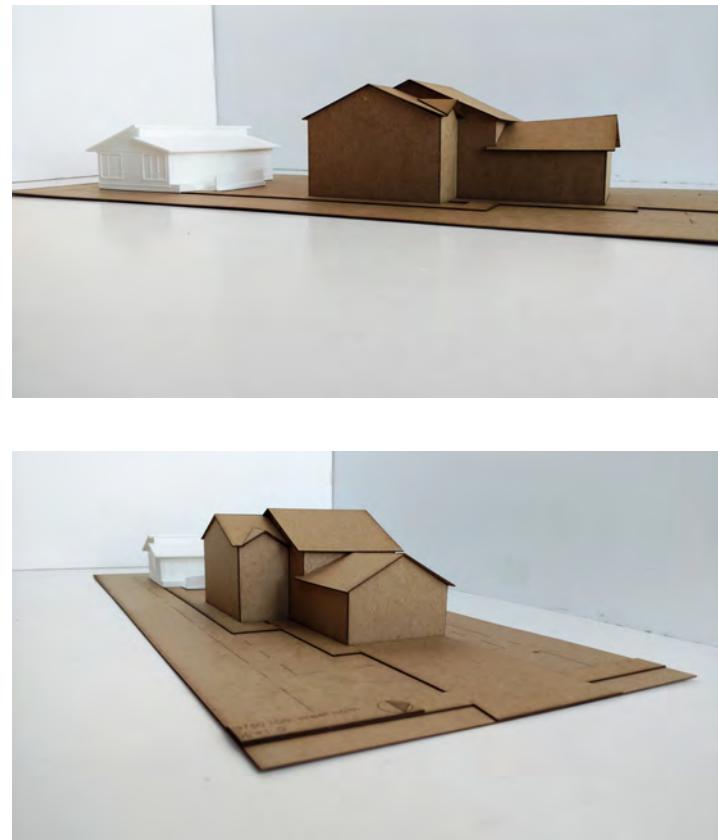
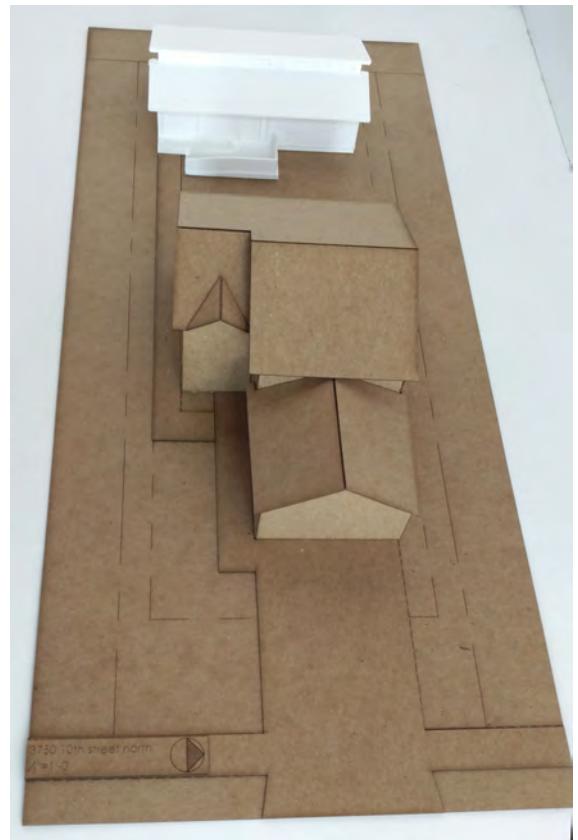


figure 8.5 | site 1 model

figure 8.6 | site 2 model

physical models

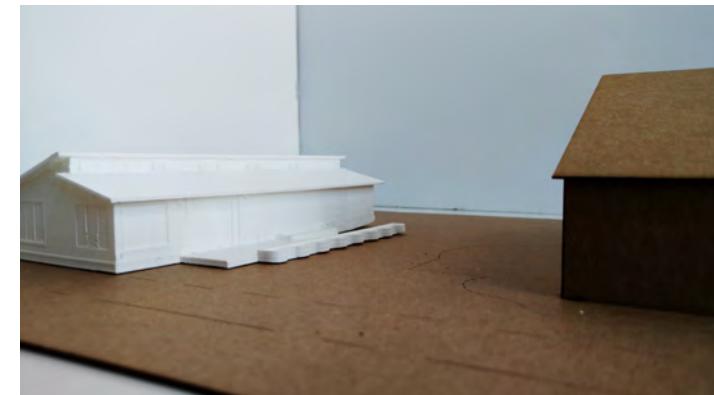


figure 8.7 | site 3 model

figure 8.8 | site 4 model

physical models



figure 8.9 | module 1a



figure 8.10 | module 1b



figure 8.11 | module 1c



figure 8.12 | module 1d



figure 8.13 | module 2a



figure 8.14 | module 2b



figure 8.15 | module 3a



figure 8.16 | module 3b



figure 8.17 | module 4a



figure 8.18 | module 4b

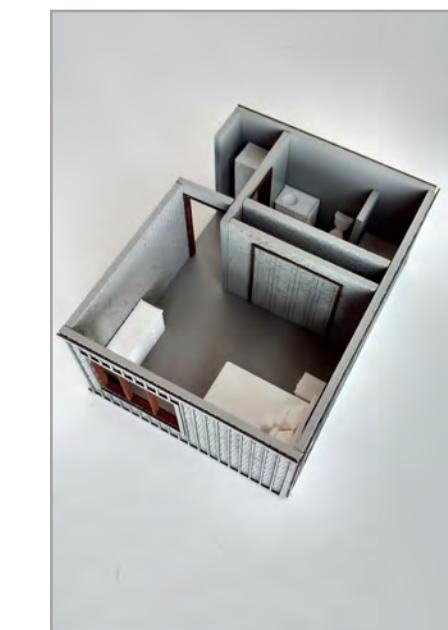


figure 8.19 | module 5a



figure 8.20 | module 5b

final images

site 1: 3750 10th street north



figure 8.21 | site 1 rendering



figure 8.22 | site 2 rendering



figure 8.23 | site 3 rendering



figure 8.24 | site 4 rendering

title

appendix

studio experience

2nd year

fall 2013 | Darryl Booker

The Sensory Garden

Typology: Japanese Tea House & Tea Master Cottage
Location: Moorhead, Minnesota

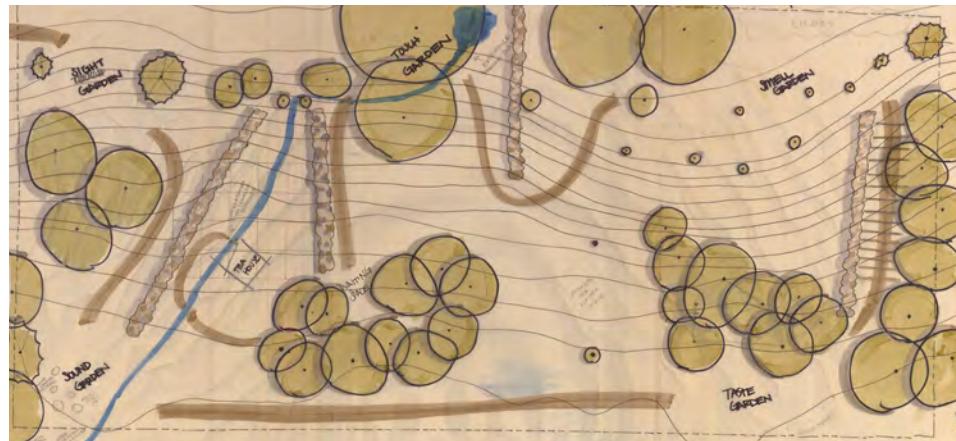


figure 9.1 | garden plan

spring 2014 | Joan Vorderbruggen

Jazz: Ballet with Attitude

Typology: Dance Studio
Location: Concordia College | Moorhead, Minnesota

Dwelling: The Fitzgerald Residence

Typology: Community Living
Location: Cripple Creek, Colorado



figure 9.2 | dance studio east elevation



figure 9.3 | dwelling model

3rd year

fall 2014 | Ronald Ramsay

Wickersham Hall

Typology: Restoration; Barn to Performance Hall
Location: Rural New Lebanon, New York



figure 9.4 | wickersham hall



figure 9.5 | konecky residence

spring 2015 | David Crutchfield

The Hive

Typology: University Library
Location: North Dakota State University | Fargo, North Dakota

The Spirit of Innovation

Typology: Research and Development Lab
Location: SC Johnson & Son Company | Racine, Wisconsin

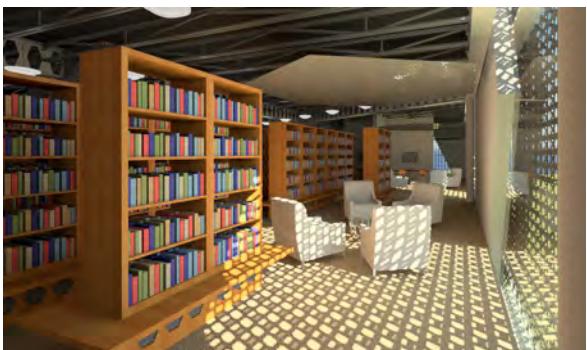


figure 9.6 | the hive



figure 9.7 | the spirit of innovation

studio experience

4th year

fall 2015 | Bakr Aly Ahmed

Mission & 2nd

Typology: Mixed-Use High Rise

Location: San Francisco, California



figure 9.8 | coffee shop rendering

5th year

fall 2016 | Ronald Ramsay

Joseph F. O'Sullivan Residence

Typology: 1915 Single Family Residence in the style of Ralph Adams Cram

Location: Boston, Massachusetts



figure 9.10 | exterior rendering

spring 2016 | Don Faulkner

Mon Louis

Typology: Hot & Humid Climate Sustainable City

Design

Location: Mon Louis Island | Alabama



figure 9.9 | mon louis medium density residential zone sketch

spring 2017 | David Crutchfield

Serene Senescence: Modular Aging in Place in Fargo, North Dakota

Typology: Modular Accessory Dwelling Units

Location: Fargo, North Dakota



figure 9.11 | example solution exterior rendering

the designer



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As much as I would like to take credit for every part of this project,
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especially these last few weeks. You have both kept me on track
throughout the year and it is because of you that I have finished
everything on time.

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this last semester, but you understood that it just was not possible
with my schedule. Also, thank you for always supporting me in
everything I have done. I am lucky to have such a great foundation
for love and work ethic.

Third, to my Thesis Advisor, David Crutchfield,
Thank you for your endless wealth of information and help with the
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but you helped to point me in the right direction. I thank you for
being a supporter of the project and not a controller.

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last five years, and now we must all go our own directions. Good
luck everyone!

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