

# TRANSITIONAL HOUSING SOLUTIONS

Bellingham, Washington

ENVS 474 - Spring 2020



**AN URBAN TRANSITIONS  
STUDIO PROJECT**

**TRADITIONAL  
HOUSING  
SOLUTIONS**

**BELLINGHAM, WASHINGTON**



Huxley College of the Environment  
Western Washington University  
Bellingham, Washington 98225 USA  
2020

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Planning Studio Publications

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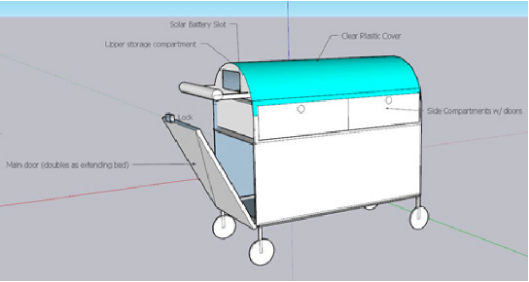
# Design Team 1: Potter Street Site

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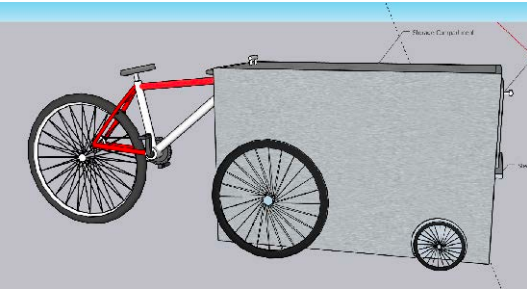


# Design Team 1: Shopping Cart

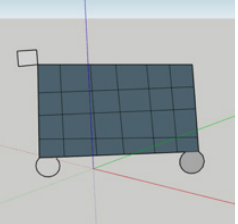


The design of the cart is a combination of a stagecoach wagon mixed with the common shopping cart. The cart needs to be highly mobile and light, while offering amenities that a shopping cart cannot provide. Familiarity is also an aspect of this design, as the wagon can be constructed using existing tooling from shopping cart manufacturing facilities. This design also offers an internal compartment that can be used as a sleeping chamber or a storage area for large objects or even a pet, which is secured with a locking mechanism. A solar powered battery will also be installed underneath the clear plastic cover that can charge cell phones, flashlights, and other electronics while also offering power to items such as a small electric heater or kettle. Altogether, this cart will total less than \$1400

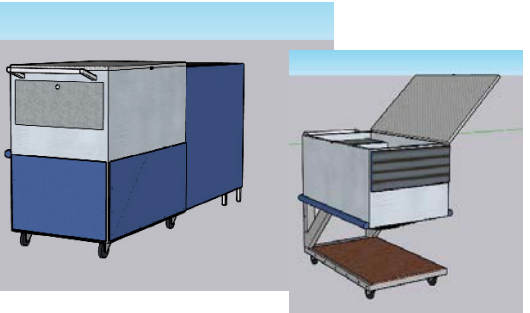
A 70 x 28 x 1 x 1 hollow aluminum frame at 1/8" thickness will need to be constructed  
 Four 8 inch wheels will be attached to corners of lower frame by welding. After lower frame is built, the main frame constructed out of the same cart materials is made and mounted onto the low frame  
 1. After this has been completed, compartment door will be made and mounted onto the side and have handles to open  
 2. Main door will be attached, and locking mechanism will be equipped on main door  
 3. Solar battery will be mounted in designated spot, then plastic cover will be added  
 4. Cart assembly complete and additional personalized items can now be added



1. Screw or solder the metal wall pieces together
  2. Screw or solder the middle shelf into the wall pieces to create the sleeping compartment and the storage area.
  3. Using hinges and screws attach the seat/table addition, screw on handle
  4. Insert carpeting into the sleeping compartment
  5. Attach steering handle on back wall
  6. Insert tambour storage compartment door
  7. Lastly, screw/solder the half bike onto the cart
- \*Solar Panel is provided inside the storage compartment and is not attached to the cart.
  - \*Bike lock is provided to lock storage compartment closed or to lock up cart.



The idea behind the Sustainable Shopping is to provide individuals who finds themselves living without a home a dry and warm place to sleep at night, along with providing security for their belongings. The cart will also provide them with a source of power, either to charge a mobile device or a personal heat source. The cart also comes with a lock to prevent it from being stolen while the occupant sleeps. Although the cart is a simple design, the camping equipment that comes with it will drastically improve the life of anyone sleeping outdoors.



The most important aspect of the Homeless Mobility Cart is the portable shelter. The cart provides a small tent of sorts by utilizing the structure of the cart itself along with some additions. One of these additions is the folding cover that is attached to the front of the cart. Structured panels with tarp drapes attached unfold and provide four additional feet of cover off the front of the cart. A sliding panel attached to the undercarriage of the cart provides a platform elevated from the ground to sleep on.

The cart is designed to be easily converted from a normal shopping cart. A solid cart (not meshed metal) is ideal for security and shelter. Then, each of the features can be easily attached to the cart. The lid can be screwed onto the upper edge of the cart with hinges and is lockable with a simple padlock. The expanding cover will be provided and can be easily attached the front of the cart with zipties. The cargo net can similarly be attached on the underside of the cart. The tarps along the sides can also be so attached. The lockbox is installed by removing the child seat in most carts and screwing the cart into the inner side of the cart.

- Costs
- Shopping Cart: \$200, Lid: \$50, Solar Panel/battery: \$200, Lockbox: \$75, Expanding Cover: \$50, Tarps: \$15, Cargo Net: \$10, Sliding Platform: \$50, Cooler: \$50, Lamp: \$20, Small Space Heater: \$40, Total: \$760

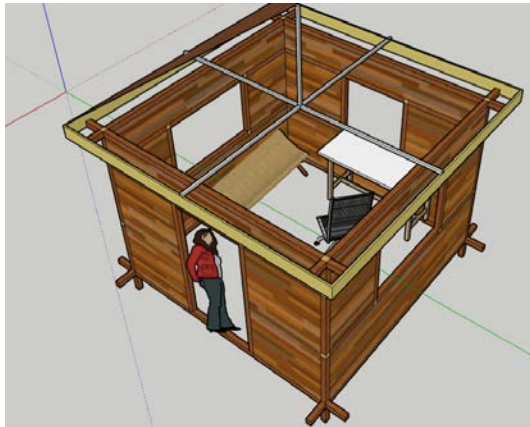


# Design Team 1: Sleeping Units



Expenses  
 Shipping Container: \$2000/2 \*, Cabinet: \$150  
 Drawer Bed: \$200, Desk: \$50  
 Small Fridge: \$150, Solar Panel/Battery: \$500

Overhead Lights: \$20, Total: \$2,070  
 \*It is important to note that the cost of the shipping container is divided by 2 to account for the fact that there will be two

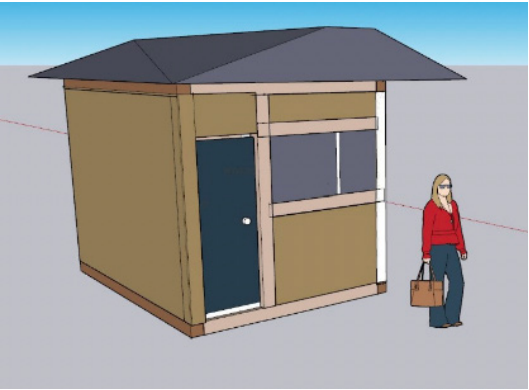


An idea originally proposed by Steve Maxwell's "Build This Cozy Cabin", for just over \$6,000 you can build your very own 14 x 20 ft. cabin with basic carpentry skills. In my take on the Maxwell's design I have provided the potential resident with their basic needs, such as; a sleeping cot, sleeping mat, and sleeping bag. There is a wonderful work space and chair where any number of activities could be completed as well as serving a dual purpose work bench when your cabin is in need of repairs along with a solar panel charger for any electronics. This cabin is a little bigger than I originally intended, but still small enough to build multiple and a small plot of land. I have provided enough materials for one resident, but the cabin is easily big enough to host a small family. The solid structure of the cabin makes it a great place for anyone in need of secure, affordable, and long-term housing.

Floor (\$900): Two 20' 6 x 6 beams, Two 14' 6 x 6 beams, 27 14' 2 x 10, Nine 5/8' plywood tongue-and-groove subfloor panels  
 Walls and porch frame (\$1000): 50 8' 2 x 8 studs (walls), 15 14' 2x 6 boards (wall plates), Five 8' 6 x 6

The only structural set-up required for the shipping container is to install the dividing wall which can be easily done by cutting two pieces of plywood to fit the interior dimensions of the shipping container, in this case 7'10"x8', and then screwing them to the shipping container itself with some insulation in between. The furniture can be purchased from any large store, IKEA is a good option and then the occupant can assemble it themselves. The fridge similarly can be purchased at any department store. The solar panel and battery will require some installation as the power cables will need to be run from the roof down into the container to the battery which will then need to be wired to the fridge and the lights, but this can be achieved with the help of a few volunteers.

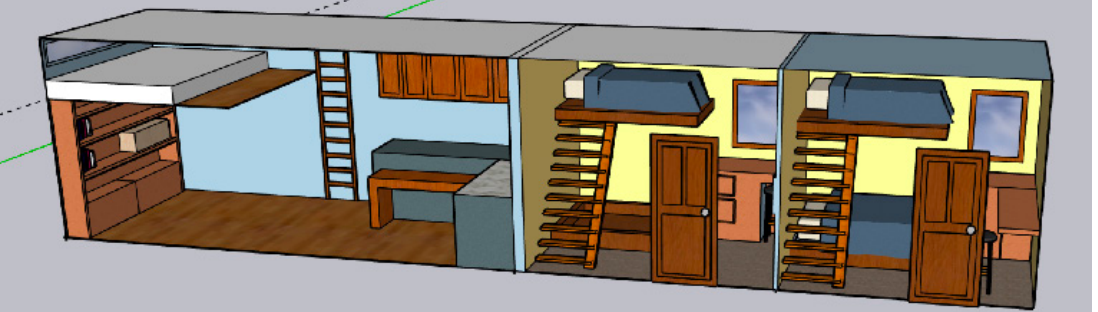
wooden posts (porch), One 14' 6 x 6 beam (porch)  
 21 7/16' oriented stand board wall sliding panels (wall planks), Six 14' 2 x 6 fascia boards (exterior wall trim)  
 Roof (\$1,500): 34 12' 2 X 8 boards (rafters), Two 12' 2 x 10 boards (ridge board), 17 14' 2 x 6 boards (cross ties), Four 8' 2 x 4 boards (rafter support), Two 20' 2 x 8 boards (blocking), 17 3/4" spruce plywood panels (roof planks), Wooden shakes for 550 sq. ft. of roof  
 Hardware (\$350): Six 12" spikes (foundation markers) 10 10" Sonotubes (pier form), 10 5/8" threaded rod anchors (foundation), Eight 1/2" x 6" carriage bolts (header anchors), 10 pounds of 3 1/2" ardox nails 10 pounds of 2 1/2" ardox nails, Eight 1/2" x 8" lag bolts 15 pounds of 1" roofing nails  
 Additional Material Items (\$767), Sleeping bag - \$28 (Home Depot), Sleeping Pad - \$15 (Home Depot) 2 Pad locks - \$14 (Home Depot), 9-Watt Amorphous Solar Panel Charger - \$104 (Home Depot), Portable Propane Heater - \$148 (Home Depot), Solar Portable lighting - \$37 (Home Depot), Hinged locking industrial tote storage - \$15 (Home Depot), Cot - \$190 (Target), Benchpro Workbench / desk (\$147) Svelti Blue Office Desk Chair (\$69)



Constructing a tiny home is far more difficult than a cart, but it is a better and safer thing to build for homeless peoples. The largest difficulty with building any wood structure is that wood prices do fluctuate. In building this I spoke to my dad who has done a lot of personal construction to help get estimates and what a structure this size would need to be habitable and comfortable. With a budget of \$6,106, an adequate tiny home should be able to be constructed with free volunteer labor that will provide electrical hookups, ability to be moved, security, and warmth from cold weather and a cover from the rain for a single person or a couple.

Building Instructions.  
 1. Base. Use 2 6"x6"x12' boards with 6 6"x6"x8' boards in the middle to disperse weigh, then duplicate the floor and add 4 more build frame using 6"x6"x8' boards to create stability  
 2. Create door frame, add door (which will provide security, and location for window next to door

using 3 6"x6"x8' cut to fit a sliding window  
 3. Add plywood to exterior walls and floor  
 a. For floor, after applying plywood layer then add laminate flooring, which is easier to clean than carpet and cheaper than hard wood flooring  
 b. For exterior walls, after applying plywood you then apply outer layers (shown in image)  
 4. On the Inside, a queen size mattress will be added and a wall-mounted desk beneath the sliding glass window  
 a. The desk is simply finished wood and, on the walls,, more can be added with a shortened length to allow for more storage in the unit  
 5. An electrical outlet will be put on the wall which 4 ports. The electrical will need to be wired to each unit from the outside but this gives the resident access to electricity  
 6. After that, attach the roof, which is a A-frame utilizing 4 6'x6"x12" and 2 6'x6"x6" is made and the plastic roofing pieces are screwed into place and the home is complete



1) Start by separating the shipping container into 4 10 foot units  
 2) Cut out holes for door an windows  
 3) Insert doors and windows  
 4) Build Queen Lift Storage Bed (see attached Instructions)  
 5) Create support structure for loft bed using 3 2x4s  
 6) Insert cabinet

7) Using all 4 hinges, attach Butcher's Block to wall  
 8) Place mattresses/bedding  
 9) Attach solar panels to roof

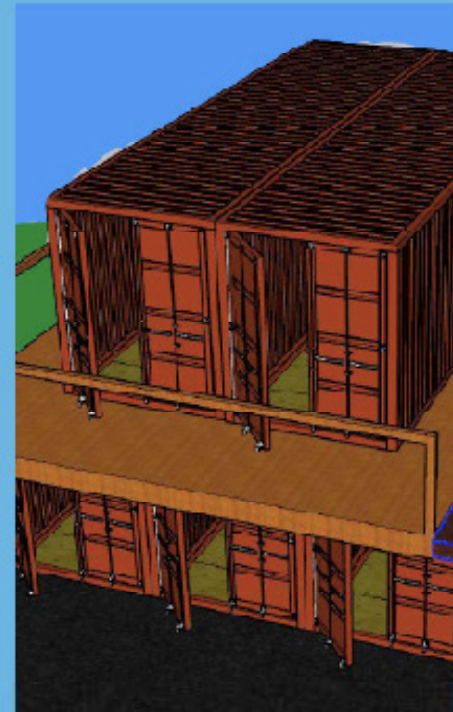
40 foot Shipping Container - \$~2,000/4 = \$500 per unit, Fiberglass Door - \$229 Cabinet - \$118.80, 6' Butcher Block - \$250, 4 4" Door Hinges - \$35, Queen Lift Storage Bed - \$210, Queen mattress - \$190, Plywood - \$9.95, 3 2x4s - \$30 Twin Mattress - \$130, 3 Windows - \$210, Ladder - \$146.58, Solar Panels - \$556.19  
 TOTAL: ~2,615.44



# Design Team 1: Settlement Site Plan: Potter Street Site

## Potter St. Community Living

ENVS 474 - Group 1 - Spring 2020



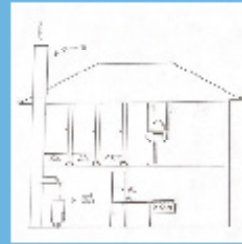
### The Site



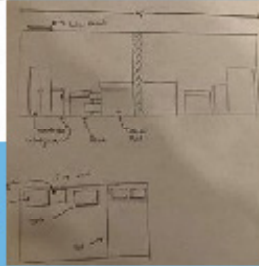
Situated in a quiet residential neighborhood, Potter Street Community Living is just a few minutes walk from a bus line (190) that takes residents to grocery stores, parks, WWU and downtown. Community members have access to city facilities and utilities that are connected at the site.



### The Vision

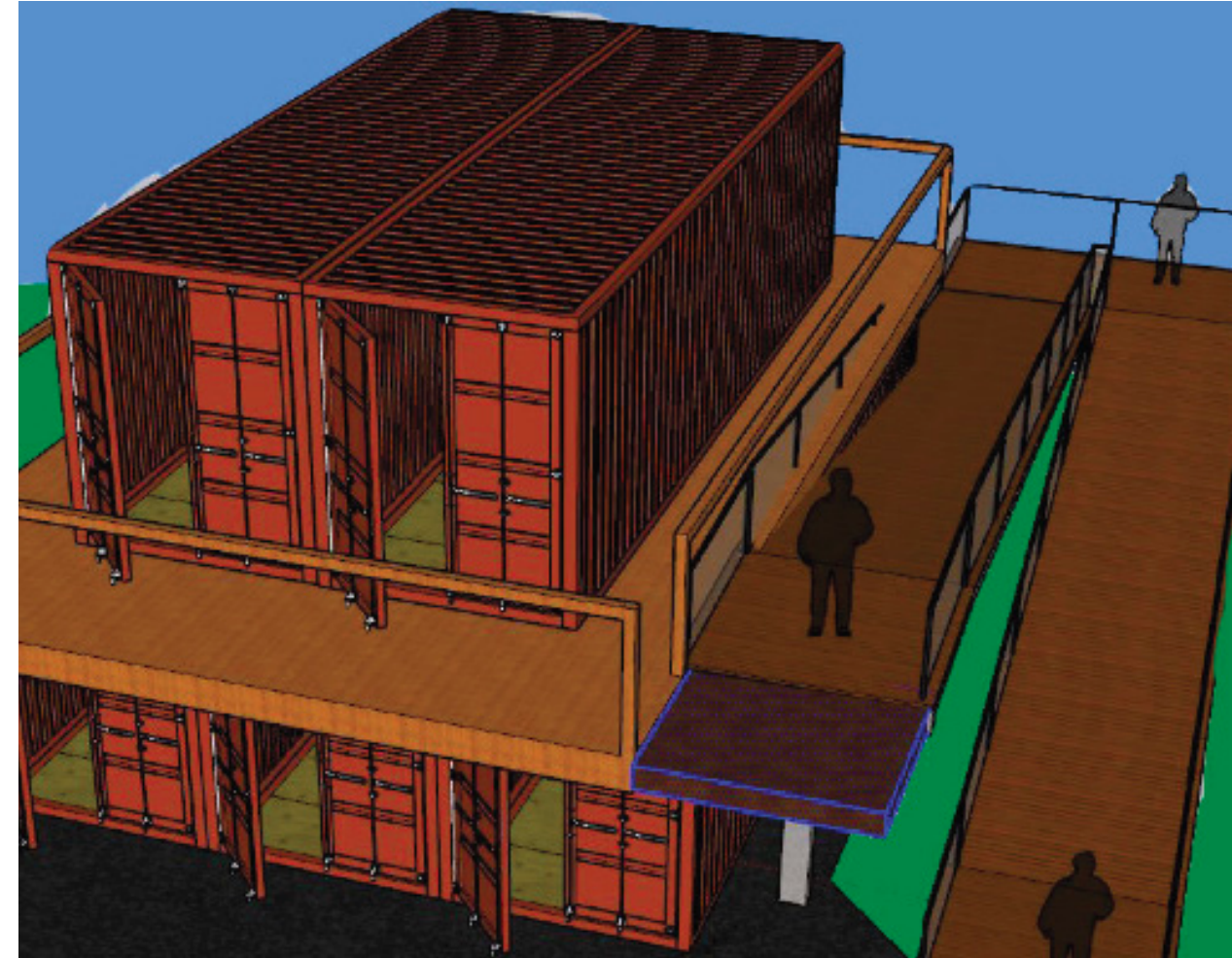
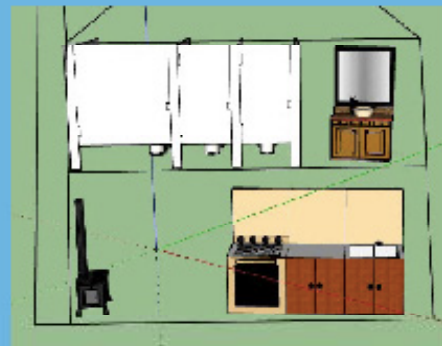


Sketch for the community building that includes a communal kitchen along with restrooms and showers.



Sketch of the shipping container living units.

### The Community Center



A friendly environment, reliable shelter and communal living is what previously homeless and low income Bellingham residents will find at the Potter Street Living Community. With a shipping container exterior and a warm interior, these units are affordable, durable and cozy. The site contains 3 pods of homes, each pod containing 14 units, along with a community center that has a communal kitchen and restrooms for residents.

Materials List & Budget  
 40 foot Shipping Container - \$~2,000/4\* = \$500 per unit  
 Fiberglass Door - \$229  
 Cabinet - \$118.80  
 6' Butcher Block - \$250  
 4 4" Door Hinges - \$35  
 Queen Lift Storage Bed - \$210  
 Queen mattress - \$190  
 Plywood - \$9.95  
 3 2x4s - \$30  
 Twin Mattress\* - \$130  
 3 Windows - \$210  
 Ladder\* - \$146.58  
 Solar Panels - \$556.19  
 TOTAL (4 unit lofted beds): ~2,615.44\*  
 TOTAL (1 full unit): ~3,838.14



## DESIGN TEAM 2: DUMAS AVENUE SITE

Students authors:

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Katie Robinson





# DUMAS AVENUE SITE: SHOPPING CART

## SHOPPING CART 1

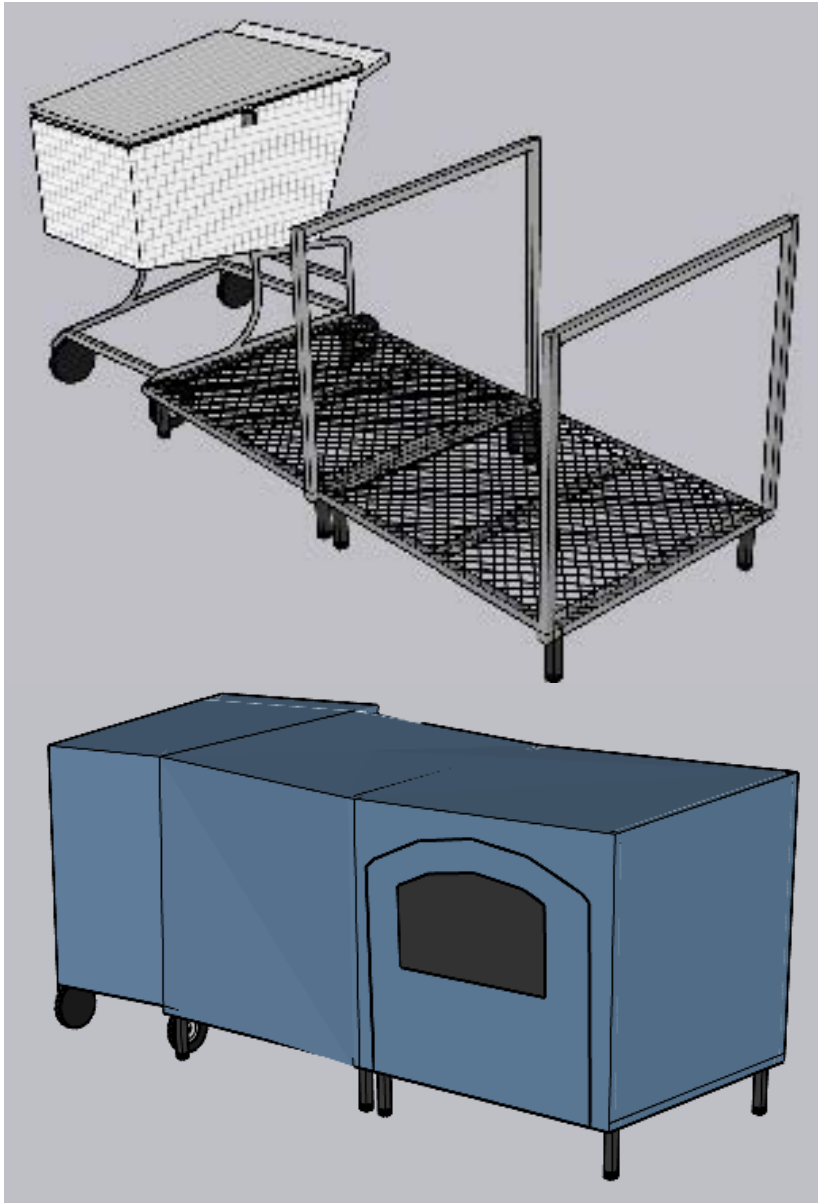
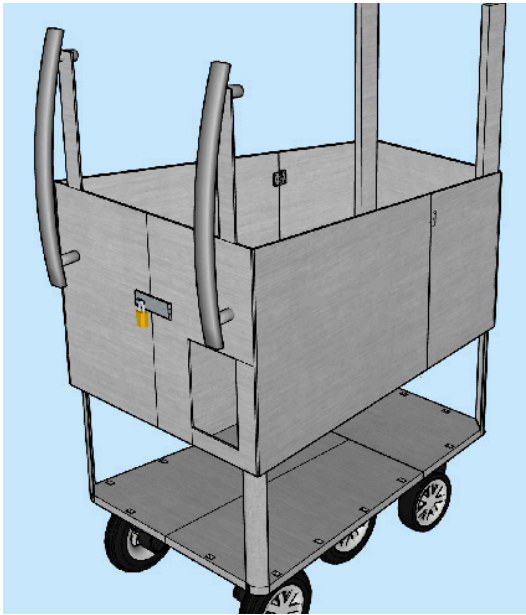
The cart is intended to be:

- Lightweight, yet durable
- A discrete shopping cart appearance to deter unnecessary attraction from others
- Able to fit through a standard exterior door frame of a structure

- An efficient, organized and secure utilization of space
- Able to easily maneuver on and off roads and sidewalks
- Ergonomically considerate of users with differing heights
- Utilized for diverse functions including hanging materials off the sides and from raise stakes



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## SHOPPING CART 2

This Mobile sleeping and storage unit is made from a simple grocery cart, metal tubing, expanded steel, and tent canvas. Featuring a roll out sleeping pad, lockable lid, and a solar charging power unit, this simple cart can provide for the most basic needs of an individual experiencing homelessness. The cart carries a steel, fold-out sleeping platform to keep the person off the ground. The waterproof canvas exterior easily slips over the shopping cart and frame to provide shelter and privacy. This unit has an estimated cost of \$840.



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### SHOPPING CART 3

This design is adaptable in many ways besides just fitting to the person's height. This design adapts to various weather conditions and personal preferences. This design allows one to stay dry and watch the rain fall, allows one to sleep without being rained on, allows one to stay in the shade from the hot summer sun, and it allows for one to stay out of the snow when wanting to sleep if shelters are at capacity. This design also features many different storage opportunities to keep items protected, safe and dry. The pop-up box also allows for a portable solar panel to fit in the protected 8"x10" hole.

This design is adaptable to fit anyone from 5 foot to 6'9 due to the pullout popup baseboard. This board is stored in the underneath storage component, this allows the design to extend farther than what is shown in the images. The bottom storage can store even more than just the popup. The base storage was designed to house the popup and be a way to keep bedding dry in inclement weather. The back storage is meant for clothing but can really store anything. The front pop up storage can hold smaller but important items.



### SHOPPING CART 4

This mobility cart uses a standard metal shopping cart as a base to make the assembly process easier. It is lined with a standard tarp for waterproofing and has an attached lockbox for personal storage. It also has a small battery and miniature solar panel in the child seat area to allow for powered lighting and charging of small electronics.



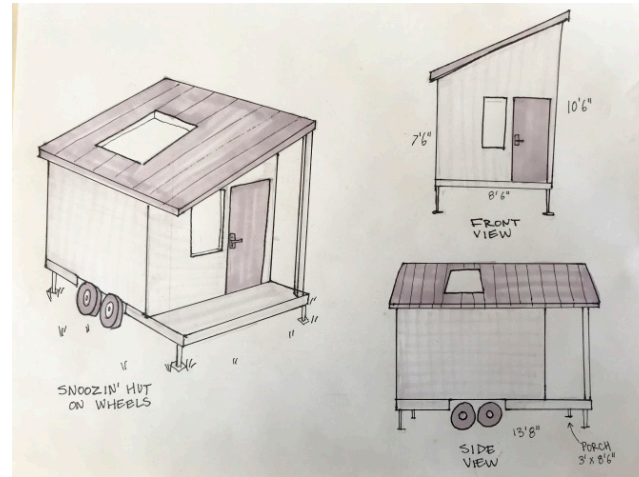
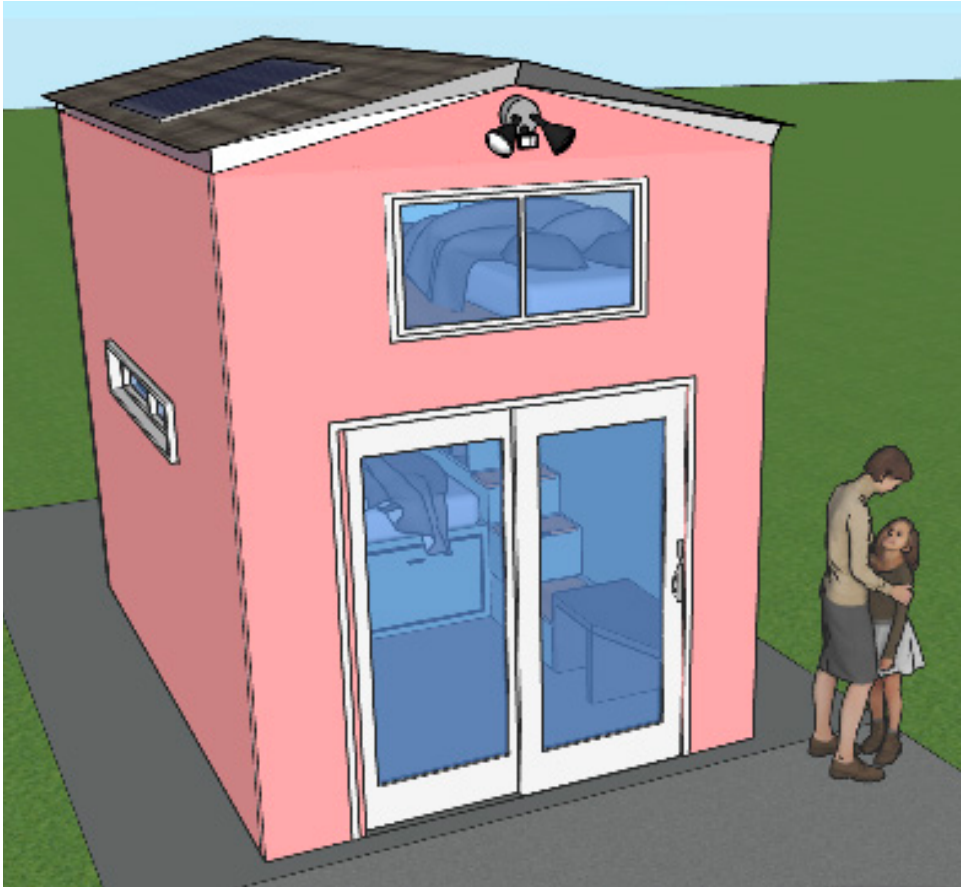


# DESIGN TEAM 2: SLEEPING UNITS

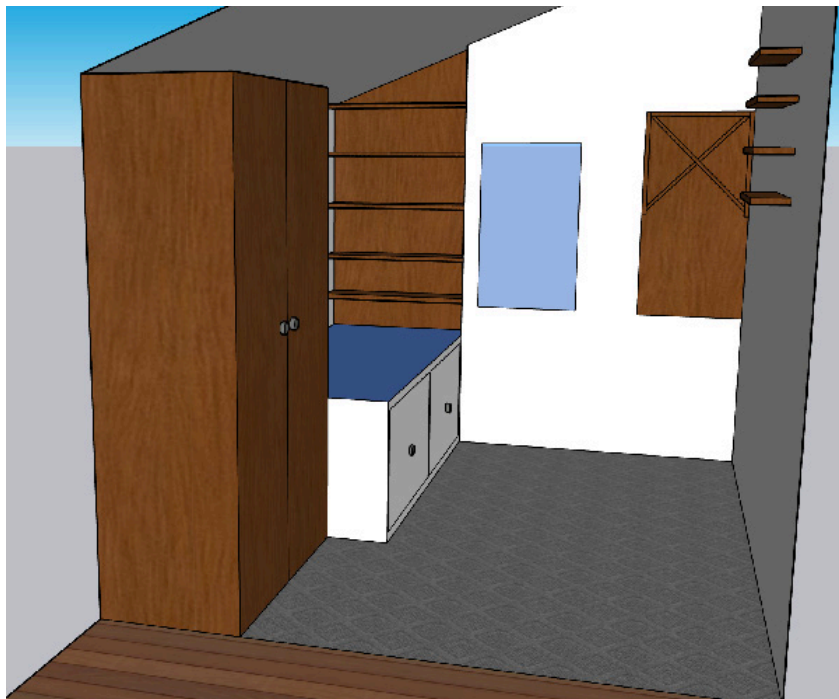
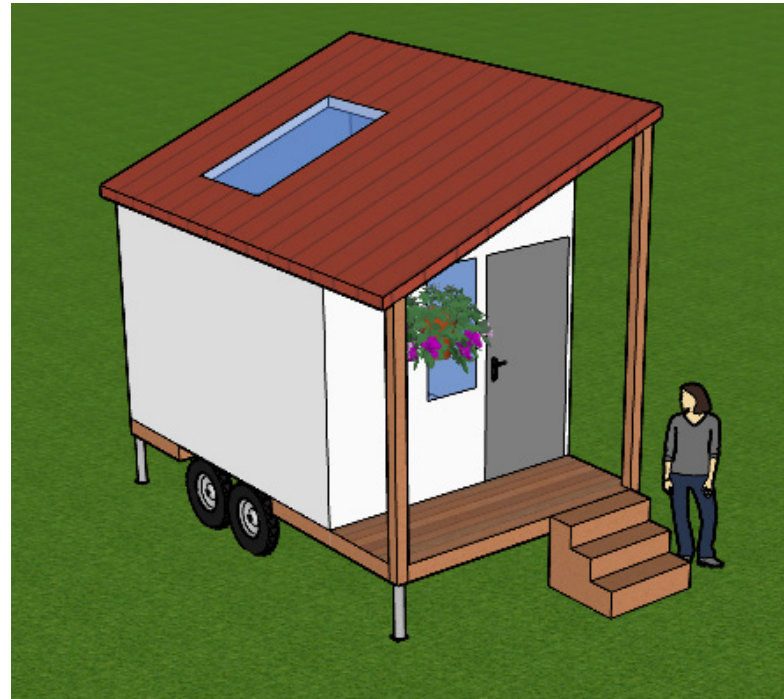
## SLEEPING UNIT 1

This unit sleeps up to 4 with its spacious loft, ideal for families with small children and or pets. Space is maximized to accommodate organized storage inside in virtually every direction. Sliding glass door as front

door to enhance the feeling of connecting with the outdoors as well as provide additional natural light.



This small sleeping hut features a skylight, removable stairs, a small porch, and wheels for easy transport. The front door is lockable for comfort and security. Although unillustrated, there is a solar panel on top of the roof, next to the skylight. The hut should provide as much storage as possible, so there is a wardrobe/cupboard, a bed frame with drawers, and shelving. To keep the space open, there is a built in, fold-up



## SLEEPING UNIT 2

table. It swings up to the wall, allowing for floor space when not in use. Because the room is quite small, it was important to include a porch so the resident can sit outside and enjoy fresh air. This small porch is made of 2x4's and 4x4 support beams, so it is cheap and doesn't take up much space. There are also two windows and a skylight which will limit the need for electricity and provide a good atmosphere. This hut has an estimated cost of \$4,377.



### SLEEPING UNIT 3

Double person design: This design is for a couple, like the single person design it features many of the same things that the single person design has including storage compartments under the bed, storage that is between the roof and the angled ceiling this is accessible outside on the backside of the building, and beside the bed that storage area is designed to contain clothing like a closet but skinnier on both sides. This bed area has enough room for a queen size bed. At the end of the bed there is a separation board that reaches the ceiling, this separation board also hides two pull

out boards that act as more separation between the bed area and where the desk lies. These separation boards allow for more privacy if one person wants to do work while the other is sleeping or just wants some space. The desk lies on the other side of the separation board. This design also has shelves for storage. There also are solar panels located on the roof to provide power, and a secure locking door.

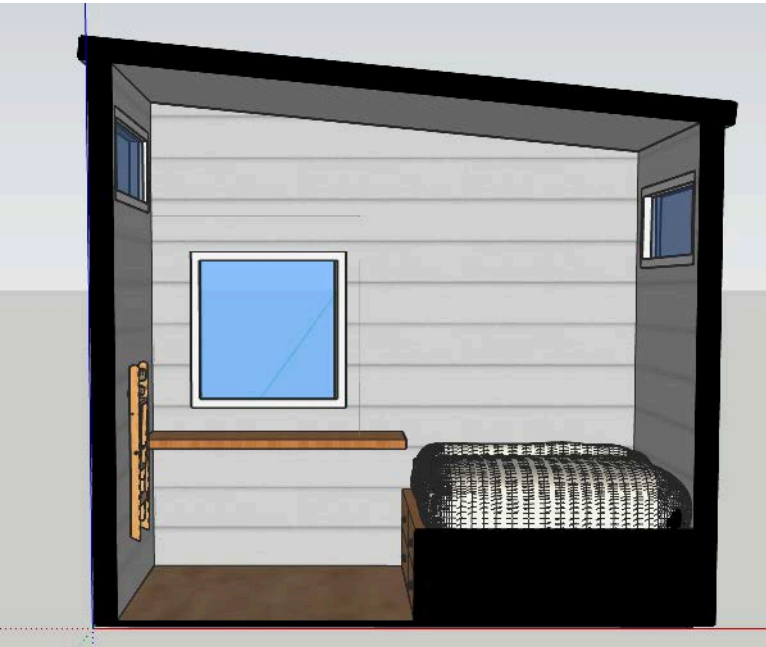
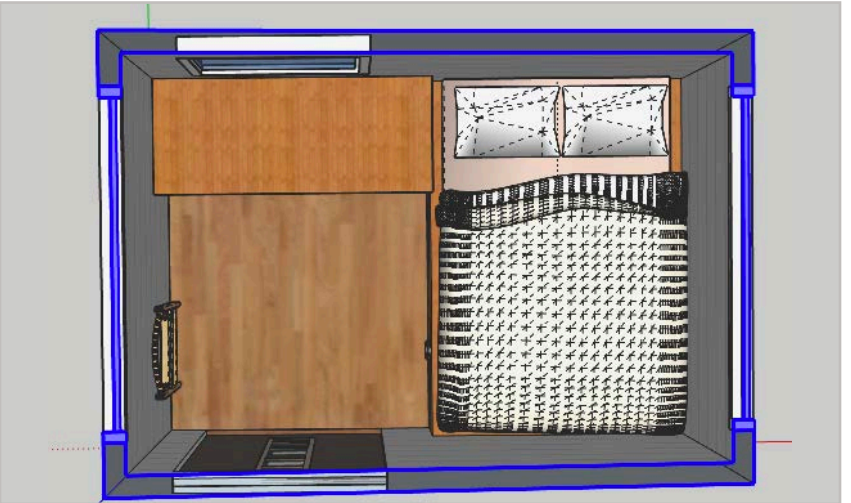
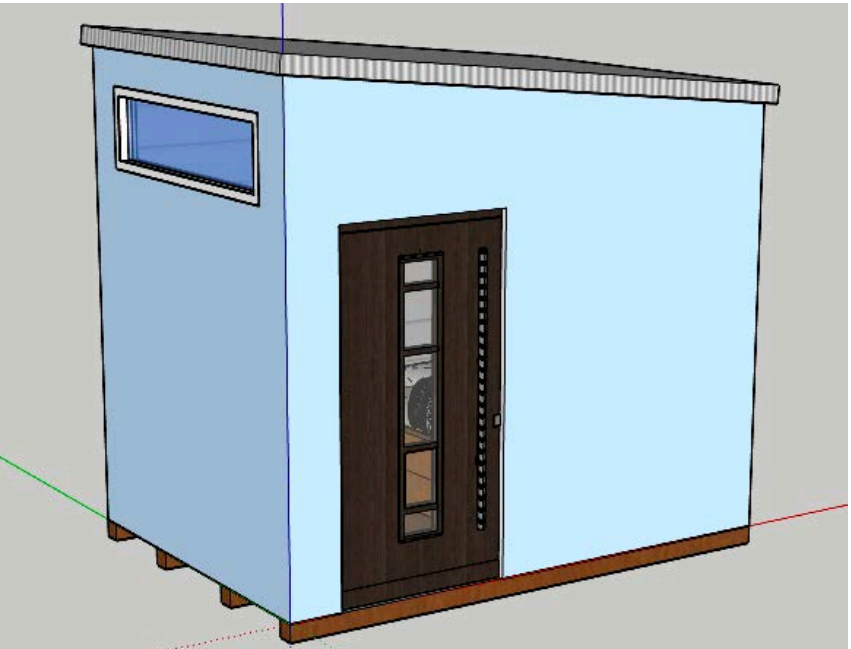
Double- single person: The double single person design is not much different from the single and double designs. This design features all the same storage as the others before. This design has room for two twin XL sized beds that are on each of the walls. Like the

Double person design at the end of each bed there is a separation board that features a pullout board, these boards meet in the middle to provide that quiet/ privacy area. Next to these boards there is also the desk. Next to the desks is the closest storage area. A nice feature this design allows for is a window to look out of from the desks. Like the two designs before there are solar panels located on the roof to provide power, and a secure locking door.



### SLEEPING UNIT 4

The most compact of the sleeping units, this unit is intended for a single person or a couple. The walls have slats that allow pegs to be attached that can be used to add additional shelving or hooks to hang clothing or chairs. The bed has four drawers for storage underneath it as the bedframe. The desk is on hinges and can be laid flat against the wall for more floor space or propped up for use as a desk or table. Because of the slatted walls this unit is very customizable to the residents storage needs.

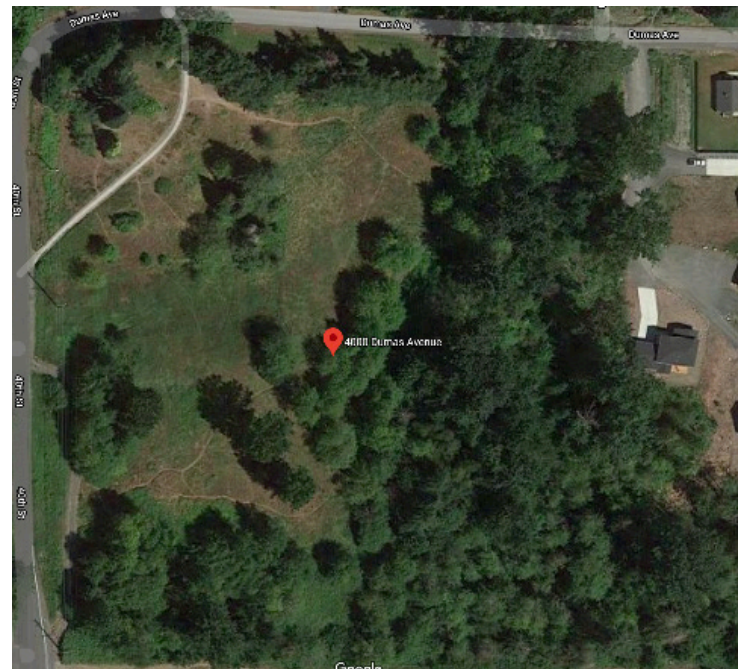




# DESIGN TEAM 2: SETTLEMENT SITE PLAN

## FACTS AND FIGURES

- Located at 4000 Dumas Avenue.
- Zoned as Single Residential.
- Owned by the City of Bellingham’s finance department.
- The land is currently valued at \$926,000.
- This parcel is 389,793 sq. ft.
- Lincoln Creek Watershed.
- 5 current subdivisions that incorporate this property.
- 5 bus stops within a half mile.



## EXISTING SITE

### CONDITIONS

The 4000 Dumas Avenue settlement site is located in an elevated location in the Samish neighborhood of Bellingham, Washington. The site can be easily accessed by walking, biking or driving with connections to two main roads; Elwood Avenue to the West, leading down to the highway intersection and Samish shopping area and Ashley Avenue to the North, leading down to Lincoln Street and in the direction towards the Lakeway shopping area.

The closest shops and resources to the site would be located nearby the Samish Shopping area. Nearby businesses include stores that sell essential such as the Dollar Tree, Ace Hardware, REI, Rite Aid, Haggens and Walgreens. In addition, there are many other types of businesses in the vicinity such as cell phone retailers, health clinics and a wide variety of restaurants offering affordable quick meals.

The nearest public transportation bus stops are located along Lincoln Avenue, known as the “Samish Way at Linclon Street” and the Lincoln Creek Park & Ride.” While the site rests on top of a relatively steep hill, there are sidewalks along both sides of Elwood Avenue and the surrounding area supports biking transportation. Along with a parking lot to facilitate cars, the site will offer bike secured bike storage at the main building.



## SURROUNDING NEIGHBORHOOD

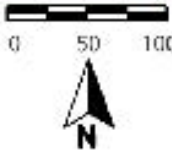
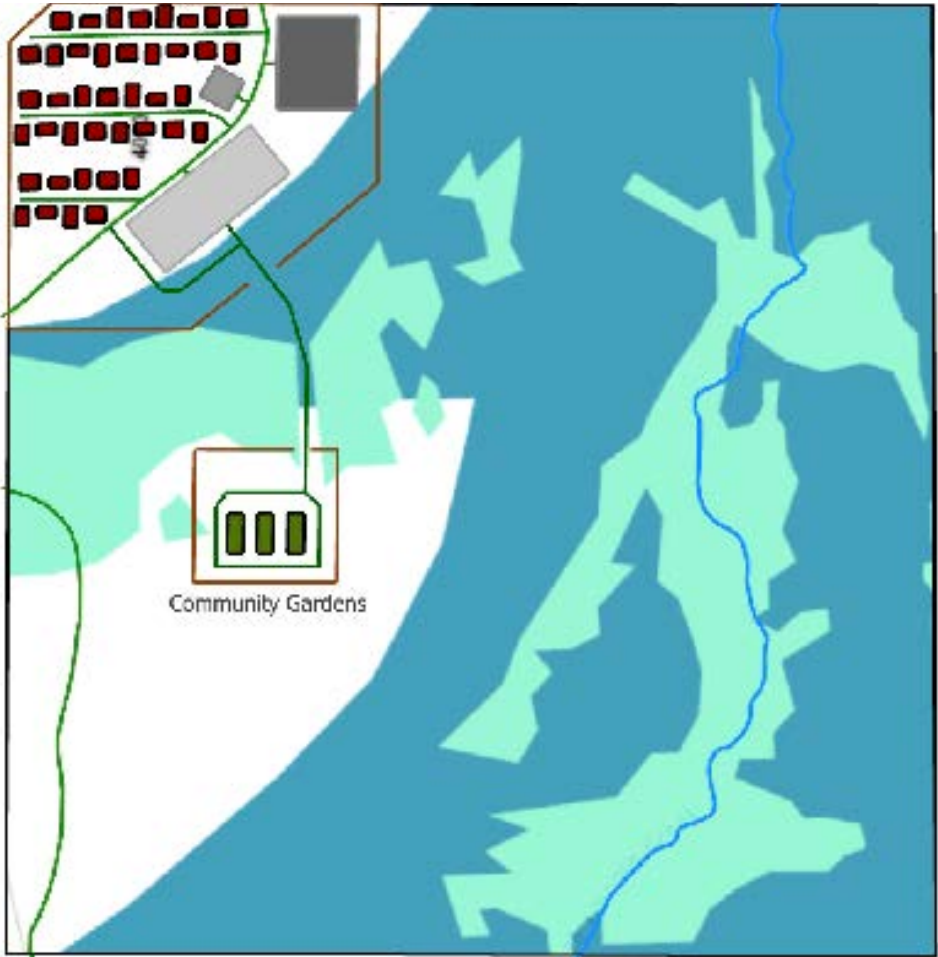
The neighborhood uses this property for biking, walking dogs with family/kids, jogging and walking. The goal is to find a way to make this project much more discreet because people are not going to want to get rid of their neighborhood park.

The surrounding neighborhood to the parcel was full of varying colored and styled house. We found that out structures would best fit the neighborhood by matching the varying aesthetic pleasing colors. If our design didn’t look or feel like a homeless encampment then it may be easier for those neighboring property owners to accept the camp as it is into their neighborhood.



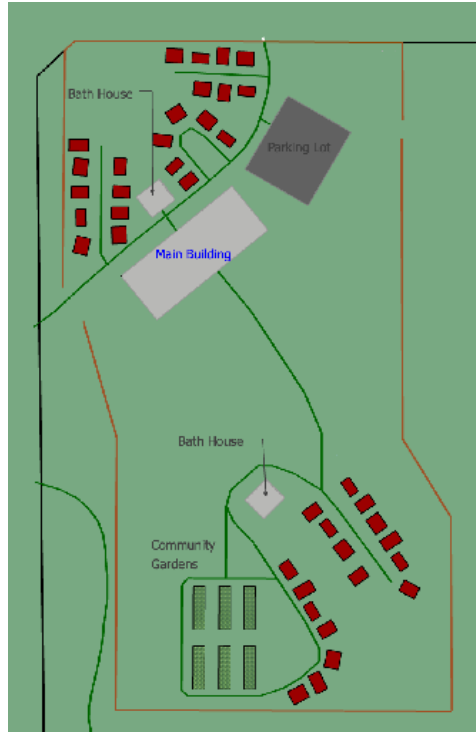
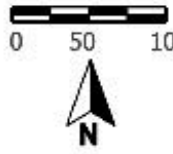
# DESIGN 1

After looking over our original designs, we wanted to provide two alternative layouts to avoid wetland completely. The first option features all of the housing units in the Northwest corner. The forty housing units are in street-like rows with a trail between each set. They are all in close proximity to the bath house (small grey square) and the main building (large grey rectangle). They can follow the trail South to the community gardens which is protected by a fence. Each garden is 25 ft by 10 ft, but that can be changed depending on the needs of the community. The caveat to this option is the required removal of trees in the Northwest corner.



# DESIGN 2

Option two works better with the existing trees and requires no removal. This option divides the housing units between the North and South ends of the park, allowing for more space between each unit and more greenspace for the community. The community is surrounded by a fence, protecting their belongings and giving them privacy from park visitors. For this layout, the original bath house was shrunk by the removal of one shower stall and one bathroom stall, because two of them are required. One bath house will be in the northwest corner and the other in the southern group of homes. This limits the trek for each cluster. Trails connect each cluster to the main building and the community gardens. This layout has six gardens, each one measuring



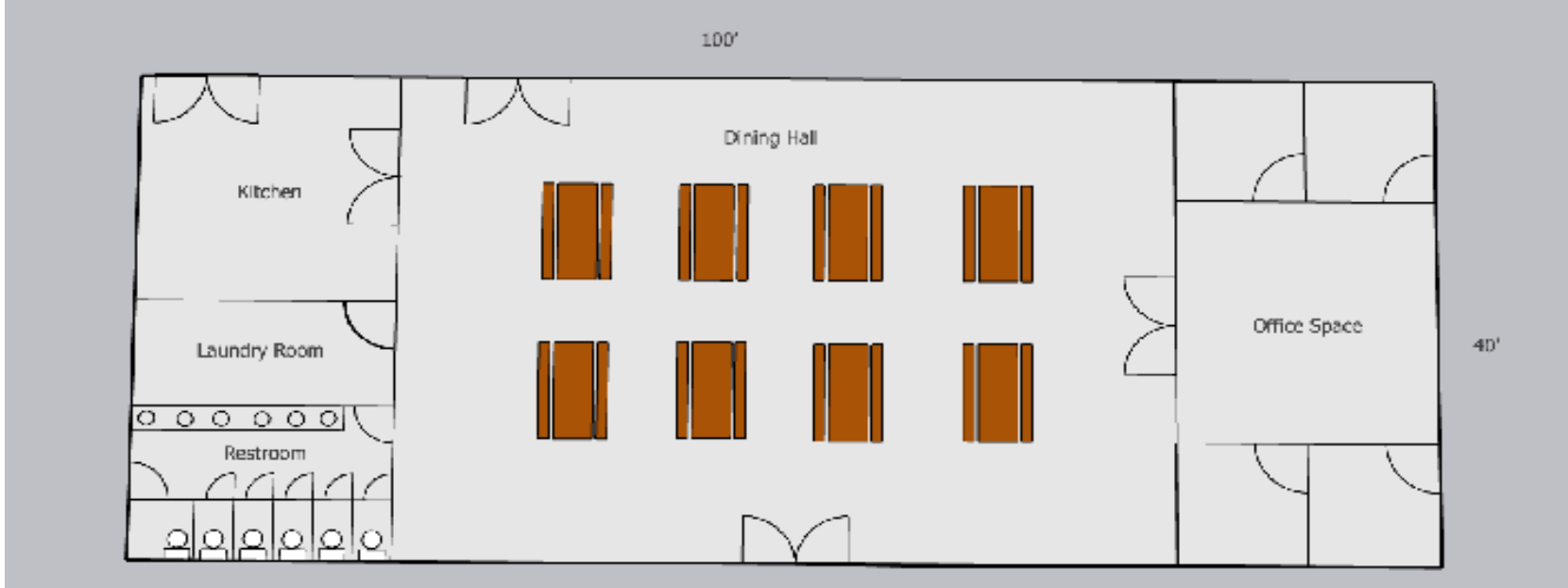
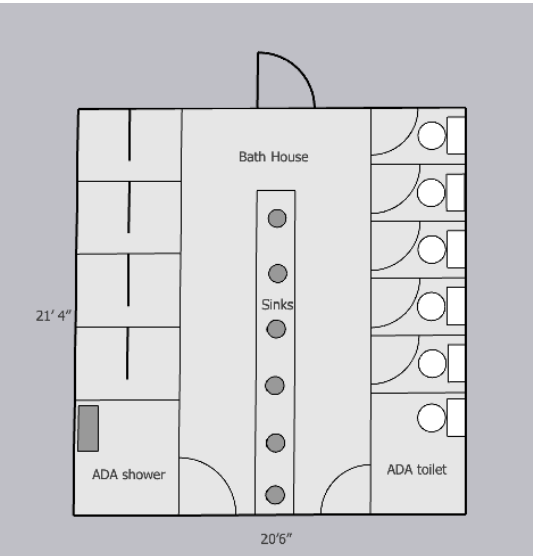


# FACILITIES

The main building serves a few different purposes. Firstly, it is a dining hall with 15 picnic tables and an industrial kitchen. Off of the dining hall is a bathroom with 5 small stalls and one wheelchair accessible stall. The building also has a laundry room and office space which can be used for administrative or counseling services.

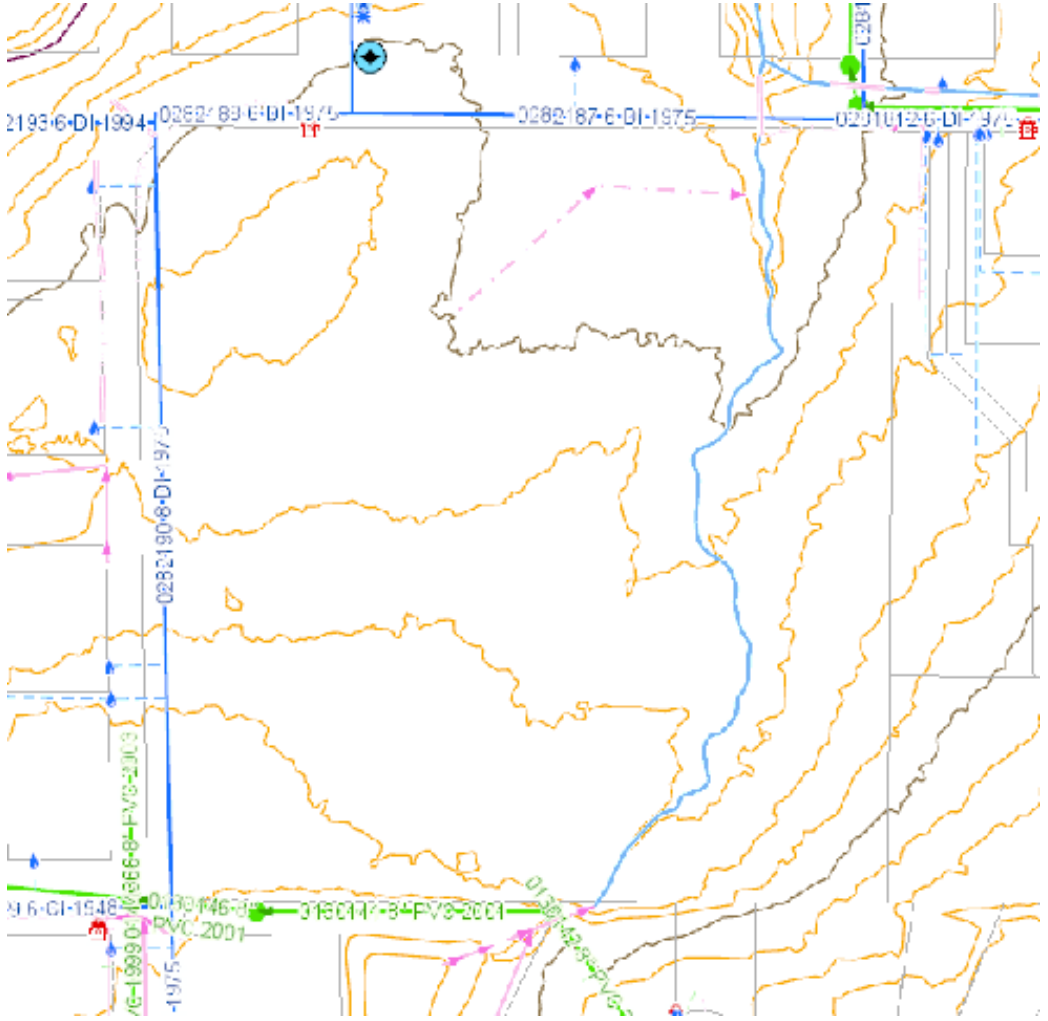
Right next to the main building is the parking lot, allowing for food delivery and easy access for workers. The parking lot fits 10 cars and is 3,000 square feet.

The bath house is centered between the eight housing circles. This is where residents can shower, use the restroom, and have access to sinks and large mirrors. We chose to make the bathhouse and the restroom in the main building gender neutral for the comfort of all residents. For additional safety measures, all shower and restroom stalls have locks on them and the rooms are well lit. There are four standard size shower stalls and one wheelchair accessible stall. Each stall has a small changing area in front of the shower cubicle. There are also five toilet stalls and one wheelchair accessible stall.



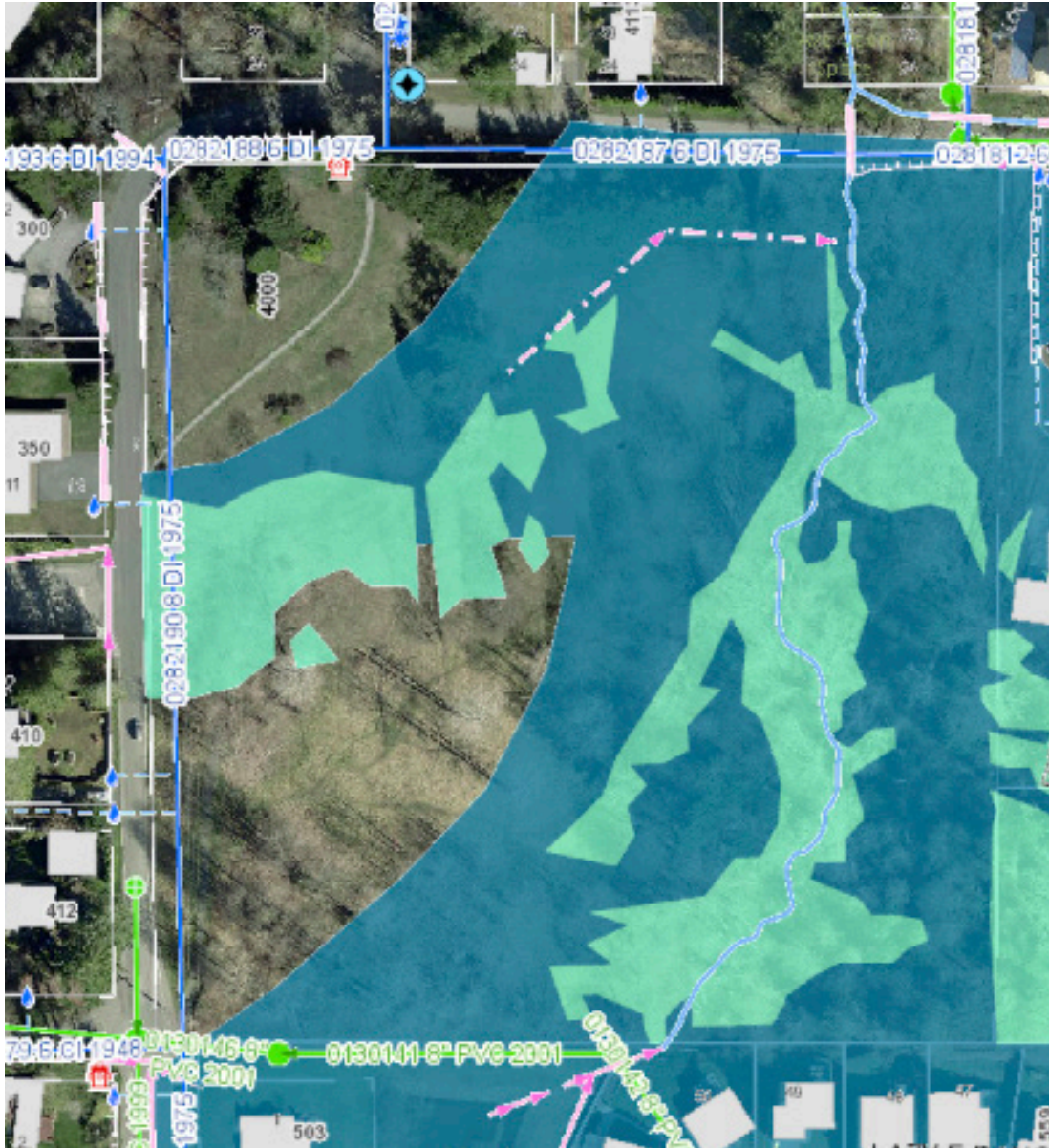
# UTILITIES

To accommodate the needs of the settlement community and blend in well to the surrounding neighborhood, the structures on the site will need to be connected to the public utility infrastructure along the perimeter of the parcel. The connections seen in this image depict approximate pipe placement locations to capitalize upon the slight elevation changes seen in orange within the parcel. The green pipe connections represent a sewer connection, blue piping represents hookups to water pipes and the pink shown in the figure represents existing stormwater utility infrastructure.



## WETLAND SAFETY

Portions of our site were inaccessible for building due to wetland areas with high chances of flooding. We designed our site to avoid placing houses on high risk areas. It was also important to us to preserve the trails and forests that are currently on our site. Our buildings were strategically placed to avoid having to remove any of the current trees on the site, as vegetation is the best way to mitigate flooding in wetland areas.



## COMMUNITY PROGRAMS

Our site plans to provide career services for residents in several ways. First, there will be career services and counseling in the office space in the main building to help residents get jobs in the community. Second, the site will employ inhabitants to take care of and cultivate the gardens, do landscaping and yard work, clean the facilities, and work in the kitchens. Food grown in the gardens will be split in between the kitchen, to provide food for the residents, and be sold to the community, to help raise money for the site. This will also help provide residents with necessary job skills.



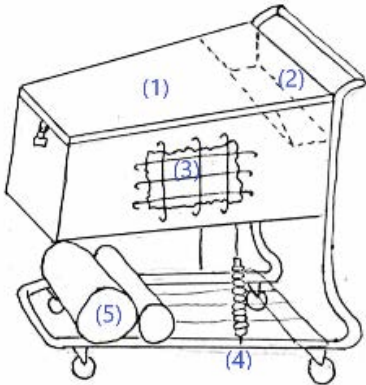
# Design Team 3: Food Bank Site



1815 Ellis Street  
 Charles Campbell, Ella Liddicoat, Emma Pyzer, Josie Rademacher, Yumi-Shika Shridhar

# Shopping Cart Design 1

- (1) Power system: the solar system integrated into this design allows for battery charging in a variety of contexts. The suggested rechargeable LED flashlight provides consistent light source.
- (2) Secured Storage: it protects essentials, general storage, and the cart itself from theft without negatively impacting access.
- (3) Protection from weather: flexible adaptation to weather, and the easy access bin provides continuous protection to water-sensitive items.
- (4) Ease of mobility: it does not significantly increase weight or negatively impact the maneuverability of an unmodified grocery cart.
- (5) Secured Sleeping: in this compact, simplified design, sleeping arrangements are provided by a tent and sleeping bag.



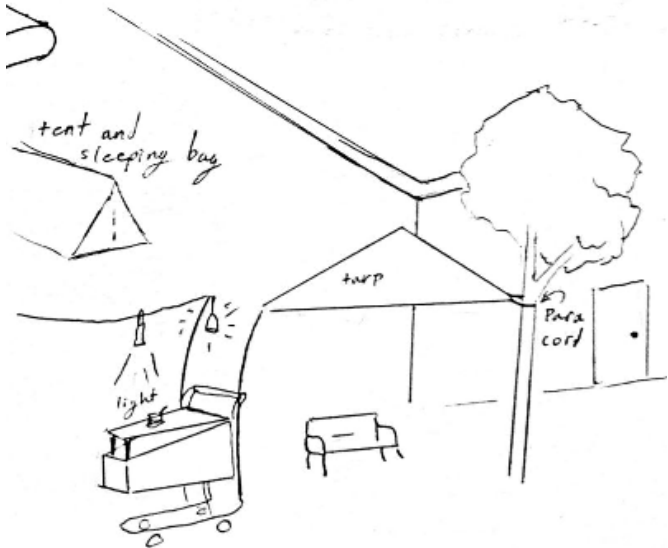
Simple – minimal cost, easy repairs, and adaptable; Reducing the cost increases the bandwidth of the production service to serve a greater population. Easier repairs result in a product that lasts longer. An adaptable cart can also be easily modified to respond to client feedback, increasing the effectiveness of the product.

Intuitive – Using simple, recognizable objects, this design provides tools that can be used in a variety of contexts for people with diverse needs and varying ability levels. Items are intentionally plain so they can be combined in a variety of contexts to provide services as needed.

Sustainable – Ecologically responsible, economically viable, healthy for humans, and equitable; using recycled materials or long-lasting highly effective products, reducing waste. Items can be added to this base model as needed, equitably providing for the unique health and available resources of each client.

BUDGET:

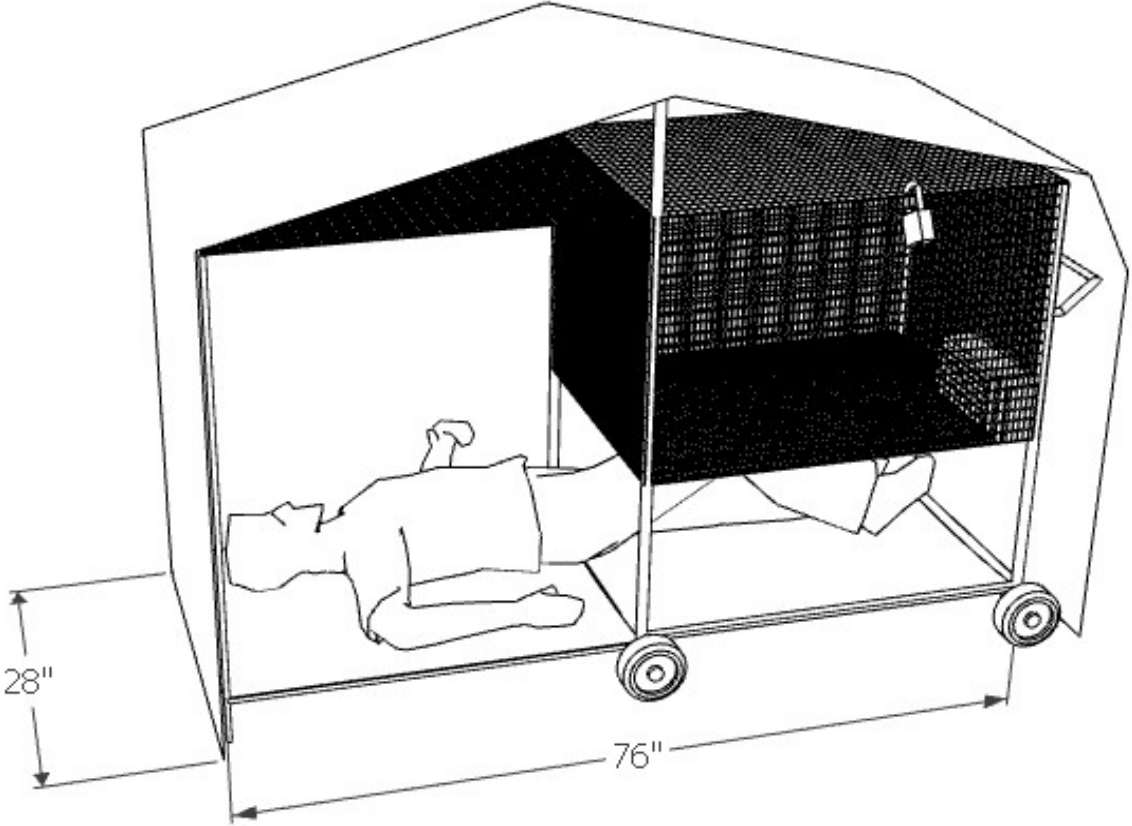
Minimum: \$351.09    Maximum: \$1,434.12



# Shopping Cart Design 2

A mobile cart that transforms into a shelter complete with secure storage space, a cot for comfortable sleeping, and a small battery - powered by a solar handlebar.

Total Cost: \$990

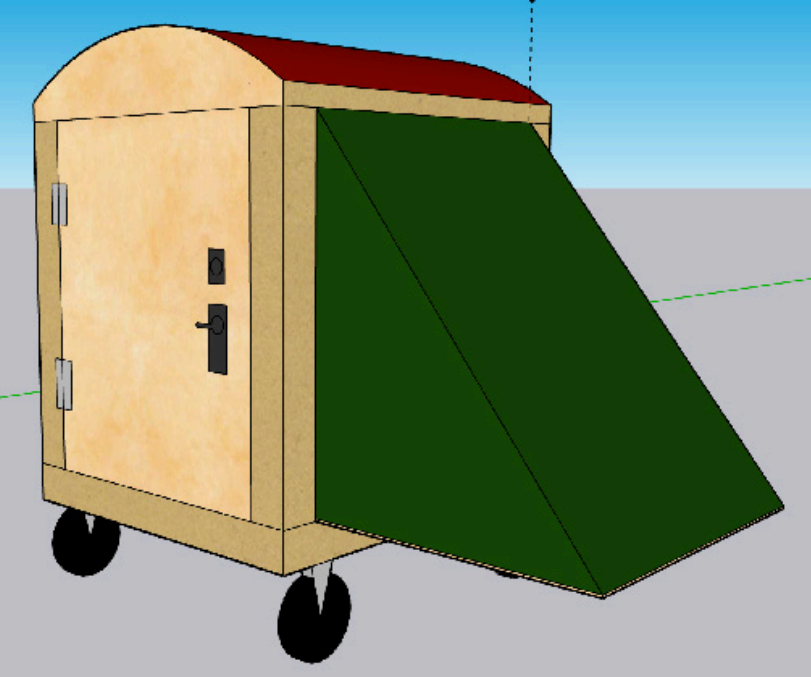


# Shopping Cart Design 3

This design is a cost-effective mobile home that provides protection from the elements and storage for when moving around. It includes a solar power generator that can be used to power a heating source, lights, or charge any devices. The curved roof not only provides protection, but it also prevents the rain from collecting on a flat surface and causing leakage or water damage. The sides open out so it has a maximum width of about 9' so almost anyone can fit and sleep inside comfortably. The outside lock provides security for sleeping at night and prevents theft. This mobile tiny house might not be a forever home, but it provides security and a warm place to stay right now.

BUDGET:

\$458.25



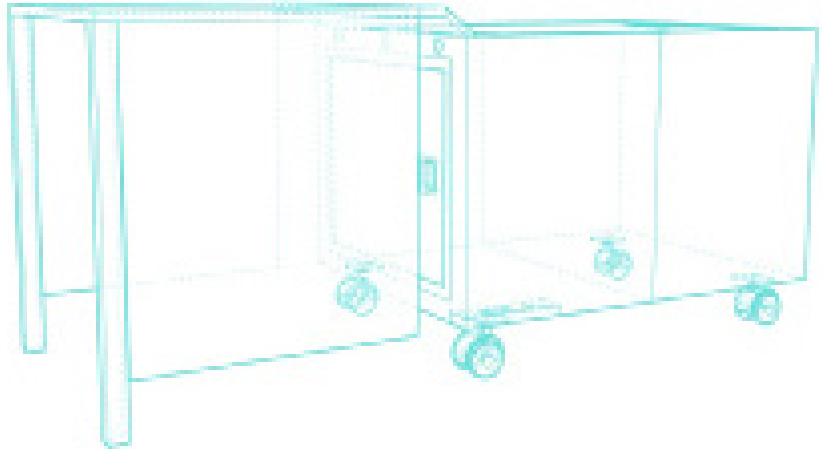


# Shopping Cart Design 4



This model shows the cart with the shelter attachment established. The siding of the cart consists of a light tarp like fabric to protect the user from harsh weather. The siding and the roof board is supported by two wooden beams that fold up with the top board.

Total Budget:  
\$600



This model encompasses several elements through a nodular cart design. With a simple frame, this does not draw attention a something to be tampered with by anyone other than the user. These images show the cart and its shelter feature folded up and in its mobile state.

Materials

- (2) Weatherproof tarp - (4) Wood Panels - (1) Outlet with switch component for lights - (2) Door handles with locks - (4) Door hinges - (1) Weatherproof stain - (3) Lights - (1) Bar with handle - (6) Hinges - (2)Support Beams - (2) Doors for the storage compartment - (4) Wheels that lock

# Shopping Cart Design 5



This mobility cart focuses primarily on the simplicity of the cart’s appearance as well as the assembly. This is so that each part of the cart is intuitive as well as easy for the users to repair. The design is basically just a standard shopping cart with added containers, longer-lasting wheels, and extra coverage.

For the storage of the container, the infant seat of the cart would be removed and the leg holes would be covered up to save space. Inside the cart, there would be two lock boxes at the front and back of the cart where the user can store their personal items. The rest of the inside of the cart can be used for food storage or whatever else they would want to bring with them. The bottom of the shopping cart has three different cabinets that are drilled to the shopping cart to prevent them from falling. The cabinet at the rear of the shopping cart would be used for storing clothes. The middle cabinet, if ice packs are stored inside, can be used as a short-term fridge to hold fruits, vegetables, milk, or dairy. The cabinet at the front of the shopping cart would be used to store items used for sleeping such as, pillows, sleeping pad, sleeping bag, weather-proof tarp cover, and extra blankets.

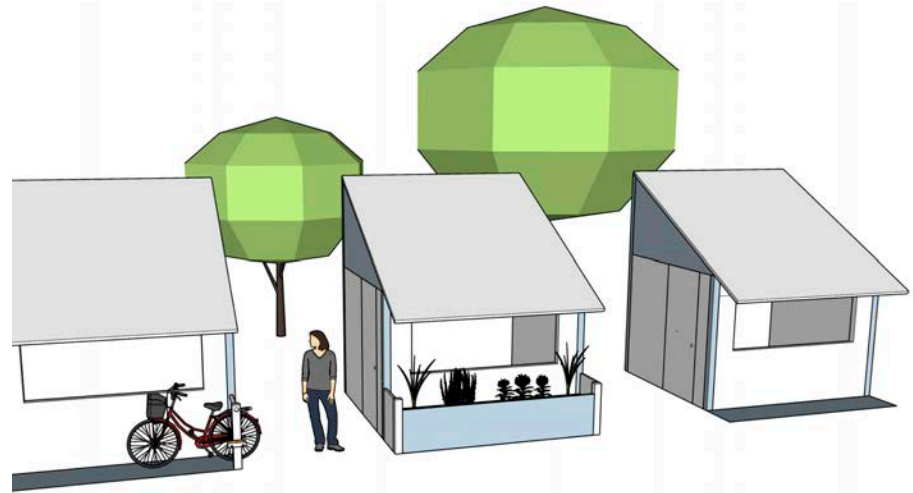
- Assembly step by step:
- (1) Using a standard grocery cart, replace the wheels with a stronger solid rubber set of wheels so that the wheels will be able to handle tougher floors.
  - (2) To apply the three small cabinets at the bottom of the shopping cart, hold 1 inch thick boards of wood underneath the bottom platform of the cart, and put the cabinets above the bottom platform. Drill the cabinets to the wood board to secure the cabinets to the cart.
  - (3) To make the cargo cover for the cart, take a small cargo cover and drill it to the top of the cart near the handlebars, with the flap opening facing away from the handle.
  - (4) Place six command hooks onto the cart: two will stick onto the front of the cart to hang the tarp for sleeping, two would be on the top railing of the cart to catch the cargo cover side bars, and the last two command

hooks would also be on the top rail of the cart, but between the furthest hooks and the handlebars so that the cargo cover can cover the cart halfway. To ensure the hooks stay on for a longer period of time, use strong glue to reinforce the command hooks onto the cart. (5) Take the small portable motion alarm and clip it onto any part of the mobility cart, making sure that the alarm is disabled. Only arm the device when the user is sleeping to ensure that the cart will not be stolen while the user is asleep. Store the weather-proof tarp inside the front cabinet at the bottom of the cart as well as other sleeping necessities like pillows, sleeping pad, sleeping bag, etc.

The concept of the sleeping area of the mobility cart is inspired by the function of tents as it can be quickly built then dismantled, and can be stored in a compact place. There are two command hooks at the front of the cart that the weather-proof tarp can hook onto, and then the rest of the tarp can either be hammered to the ground using tent stakes to shape the sleeping area into any shape to fit however many people are using the cart.

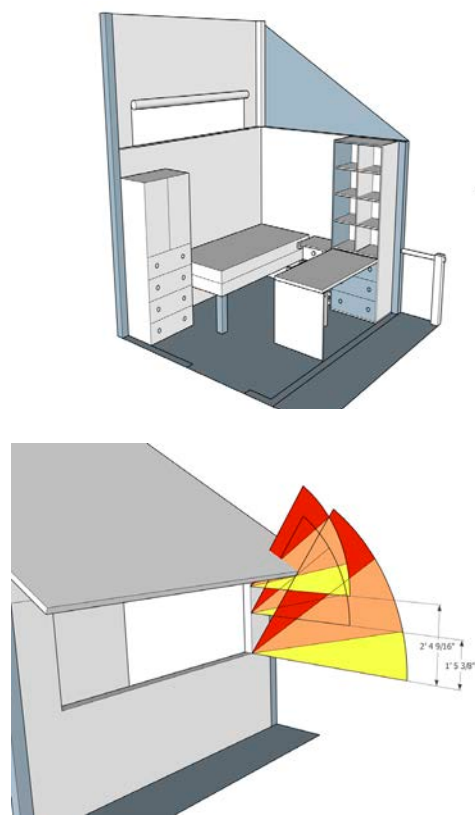
Budget: \$273.47

# Sleeping Unit Design 1



- Design Features:
- Transforming dresser / desk
  - Night stand and chair combo (detail photos below). Legs can be locked together to create secure storage
  - Optional covered bike storage, garden space, or covered porch area
  - Natural light in front of desk space
  - Furniture can be re-arranged
  - Dresser for clothes
  - Overhead lighting
  - XL twin bed and bed frame
  - Venting window with bug-screen
  - Outlet (behind nightstand)

- Two 165W solar panels
- 14.5 R-value insulated walls
- Durable Plexy Glass Window
- Highly customizable design
- Can be deconstructed for easy transport
- 8'8" x 10' concrete foundation
- 2' flexible porch space
- Heavy-duty locking door
- Passive Solar Design;
  - 17.45 sq ft. of solar exposure during Winter (Solstice - Noon)
  - 0 sq ft of solar exposure during Summer (Solstice - Noon)

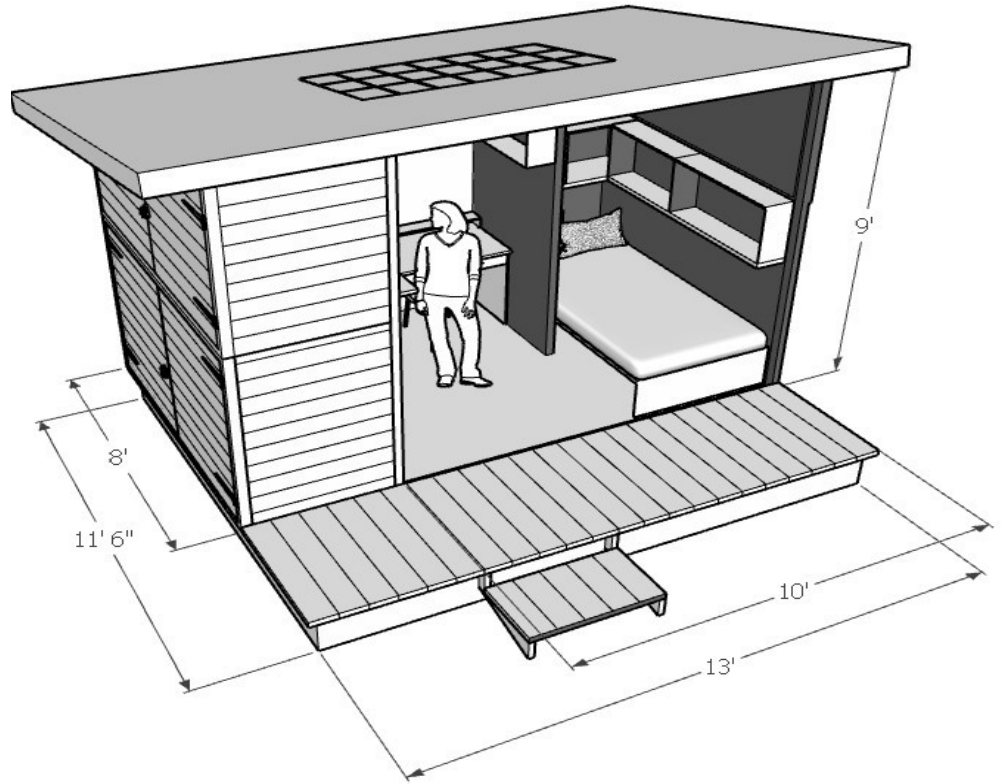


BUDGET:  
\$5,536.67

# Sleeping Unit Design 2

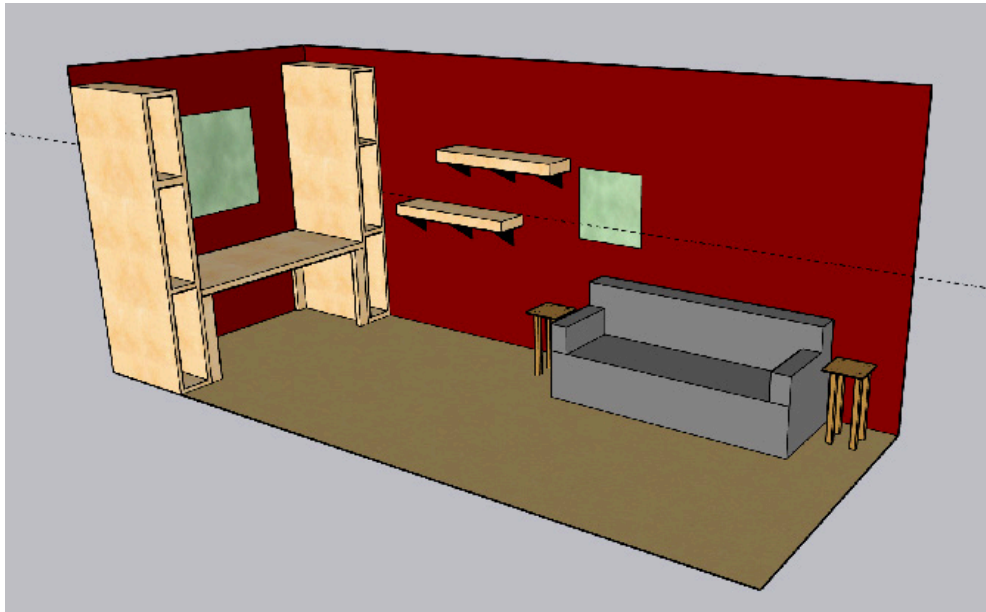
An easy to assemble sleeping and storage unit. Four large windows provide ample light while allowing the user privacy. The bed is tucked away for added comfort with shelving above and storage below. Desk and chair provide a space for work. Closet and coat rack included for dry indoor storage. Outside, there is a shed attached to the home for extra storage — large enough for a bike. A 3'x13' foot front deck invites community interaction. The slanted solar roof design allows for maximum energy capture. Because this house will be replicated in a community setting, each house could be built with a roof slanted in any direction depending on orientation to the sun.

Total Cost: \$3,260



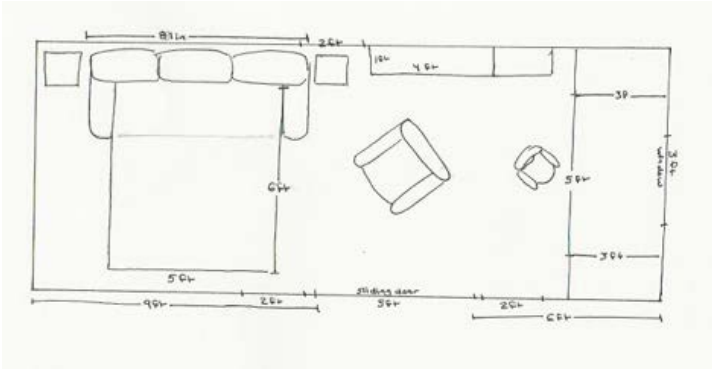
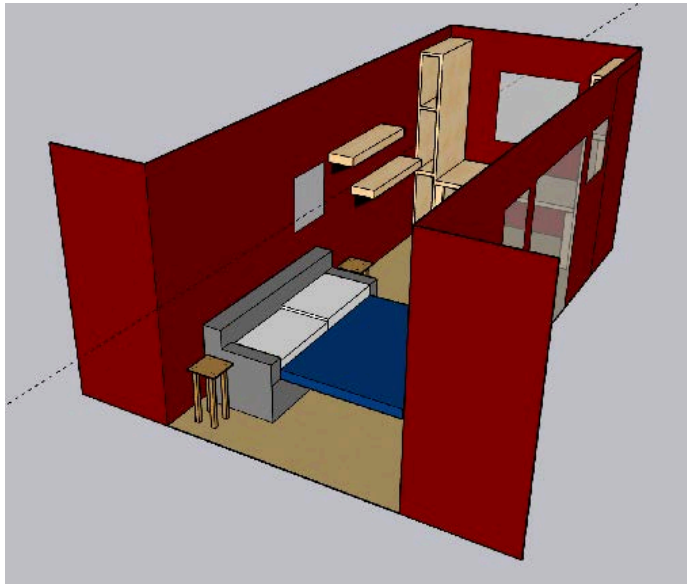


# Sleeping Unit Design 3



This housing unit is made of a used shipping container, converted to make it a comfortable temporary living space. I chose to recycle a shipping container instead of building a completely new space because it saved wood, and it made use of something already existing that could serve a new purpose. It comes equipped with a solar generator and portable solar panels, so its off grid, and plenty of storage space. The couch folds out into a queen bed, so it will fit a single person or a couple just fine. There are several windows and a sliding glass door, so there is plenty of natural light, and in case that's not enough the front of the shipping container still swings open.

BUDGET: \$4,636.53



# Sleeping Unit Design 4

## Design Elements

This sleeping unit was designed to feel like a little home. The front has a small porch mailbox, and porch light for residents to spend time on. Inside the unit is a Twin XL bed, plenty of shelving, storage built into the bed frame and a small desk area. The Unit has a large window in the back of the unit and a large skylight to provide plenty of light. The desk table folds down to give the resident more space if necessary. The interior was kept simple to give the resident enough space to personalize it themselves but also have enough room for any other belongings they may have with them.

TOTAL BUDGET: \$2250



## Structural Components

- 2X4 Frame Supports
- (3) Windows (2 Skylights, 1 Regular)
- Linoleum Hardwood Floor (6X8)
- Platform (6X1X10)
- Roofing Materials
- Front Door with Deadbolt Lock
- Insulation
- Solar Panel

## Other Decorative Amenities

- Bed Frame with Storage
- 2 Sconce Lights, 2 Painted Plywood Table Tops, 4 Hinges and Support Beams, Top Screen Pulldown for Window, Twin XL Mattress, Bedding, Desk Chair, Shelves, Outdoor Light, Mailbox



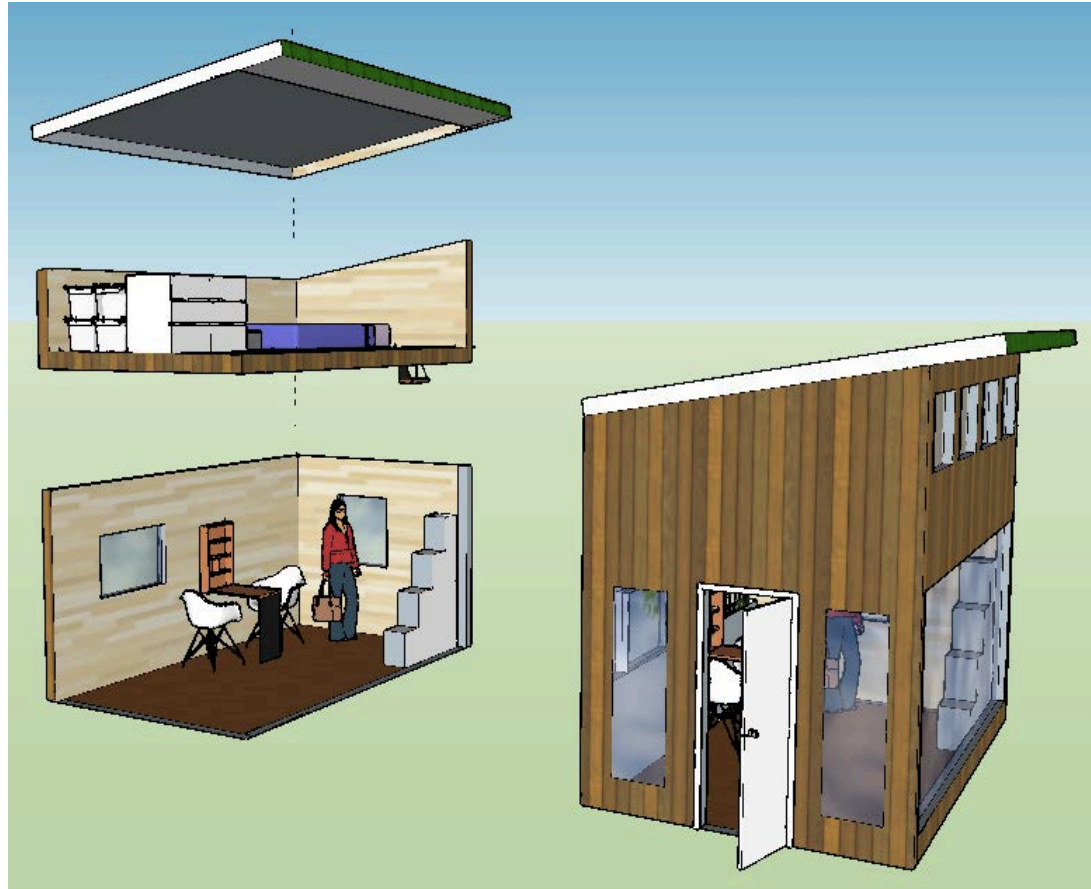
# Sleeping Unit Design 5

This is a design inspired by the tiny houses with loft designs, where the living space is below and a small sleeping space is on top. The living unit also incorporates sustainable engineering concepts such as a large south-facing window with an overhanging roof to provide consistent shade during the summer and maximum sunlight during the winter, as well as a slanted roof to direct rainwater to one side of the house, where there would be a vertical garden containing small fruits, vegetables, and herbs so that the residents can grow some of their own produce.

The furniture used inside of the sleeping unit is inspired by space-saving as well as multi-use furniture concepts. The desk pops out from the wall and folds out into a table to work or eat on, with a stand to support the table. This table can also be used as a small cabinet that can store silverware or office utensils, as there is a shelf also on the wall that is covered by the table. Another piece of furniture in the sleeping unit that is multifunctional to save space is the stairs. The stairs are actually a bookshelf shaped like stairs, and are sturdy enough to stand on, and can be used to reach higher areas in the unit, like the sleeping area.

The second floor of the sleeping unit has a very low 4-foot ceiling. This is to save space, and because standing isn't necessary on a bed-- it is like the top of a bunk bed. Aside from the bed on the top level. There will also be storage space to keep clothes as well as storage bins to avoid having clutter in such a small space.

Total Budget :  
\$6,982.94



# Site Features

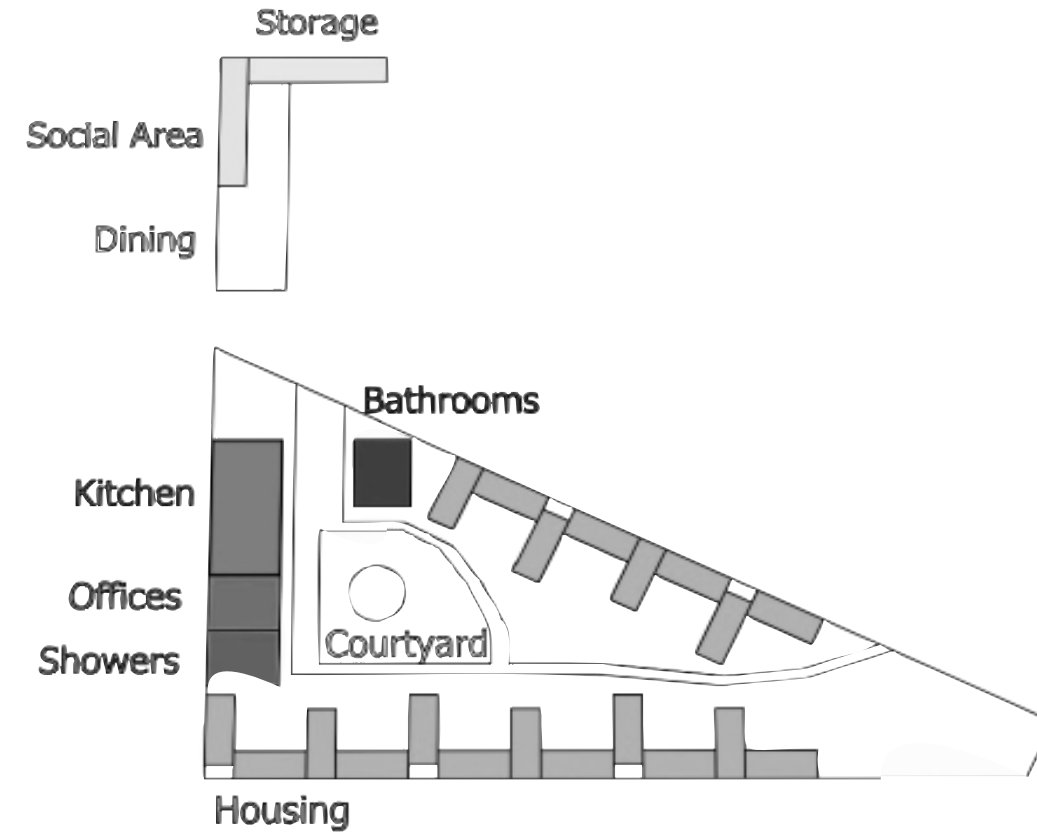
Since the site is currently a garden that provides to homeless and food insecure youth, we wanted to leave as much space as possible for garden boxes to continue the use of the current site as much as possible.

Nestled right above Whatcom Creek and next to the Whatcom Creek Bike Trail, this site has ample amenities nearby. Whatcom Creek Bike Trail abuts the property and connects to the cast bike network Bellingham offers. The site is near the Bellingham Transit Station and the 331 and 75 bus routes. Other amenities located nearby are:

The Bellingham Food Bank; across the street -- Unity Care NW; 0.2 Miles -- Grace Church; 0.2 Miles -- Northwest Justice Project; 0.2 Miles -- Whatcom Housing Alliance; 0.2 Miles -- 331 Bus Route; 0.2 Miles -- Whatcom Housing Alliance; 0.2 Miles -- Bellingham and Whatcom County Housing Authority; 0.3 Miles -- Bellingham Transit Station; 0.3 Miles -- Bellingham High School; 0.3 Miles

The site plan reflects the best adaptation of the space with 28 sleeping units, and a community center that includes services such as community space, kitchen, bathrooms, showers, and dining space.

Since the site is currently a garden that provides to homeless and food insecure youth, we wanted to leave as much outdoor garden space as possible to continue that use, as well as the provide space for the potential to expand upon to provide food for the residents of the community.



## Site Layout, Location, and Amentities

Our site plan resides on 1815 Ellis Street with an overall square footage of 16, 736 feet. The site is currently used by the North West Youth Services as a community garden space. The parcel is oddly shaped and situated among Whatcom Creek, with easy access to the Whatcom Creek trail and the Bellingham Food Bank.

The site plan reflects the best adaptation of the space with 20 total shipping container shipping units. 5 of these units have been converted to house couples or double units whereas the other 15 are split into 2 units to house single occupants, making a total of 35 units total. Also included on site is a community center that includes services such as a community space, communal kitchen, bathrooms, dining space, laundry facilities and offices for services.

# Living Building Challenge

# Site Design

## How the Site Aligns with Green Building Standards

In this task, we aimed to have this community as closely aligned to the Living Building Challenge as much as possible. Below are the different 'petals' of the Living Building Challenge, and how this site follows those standards.

**Place** - The site has a lot of infill potential, as it contains only a community garden at the moment. The site has a lot of potential to keep elements of the community garden in tact as the site changes into transitional housing. The development of this site would not endanger the wetland, or the creek with run off, due to the large buffer between the settlement and the creek near the lot.

**Materials** - All of the buildings used in the site design are recycled and renovated shipping containers, and the design also supports the use of repurposed and recycled materials where possible.

**Health and Happiness** - The main driver in the design for this site is creating and building a community. In the site design, the units are placed to create a small courtyard space where neighbors can interact with each other. The community center building has a communal kitchen along with large seating areas creates spaces to interact with other members of the community. The large designed courtyard space in the middle of the site has the capacity for a garden, preferably native plants, smaller herbs, fruit, and vegetable boxes would help preserve the work of the North West Youth Services community garden space.

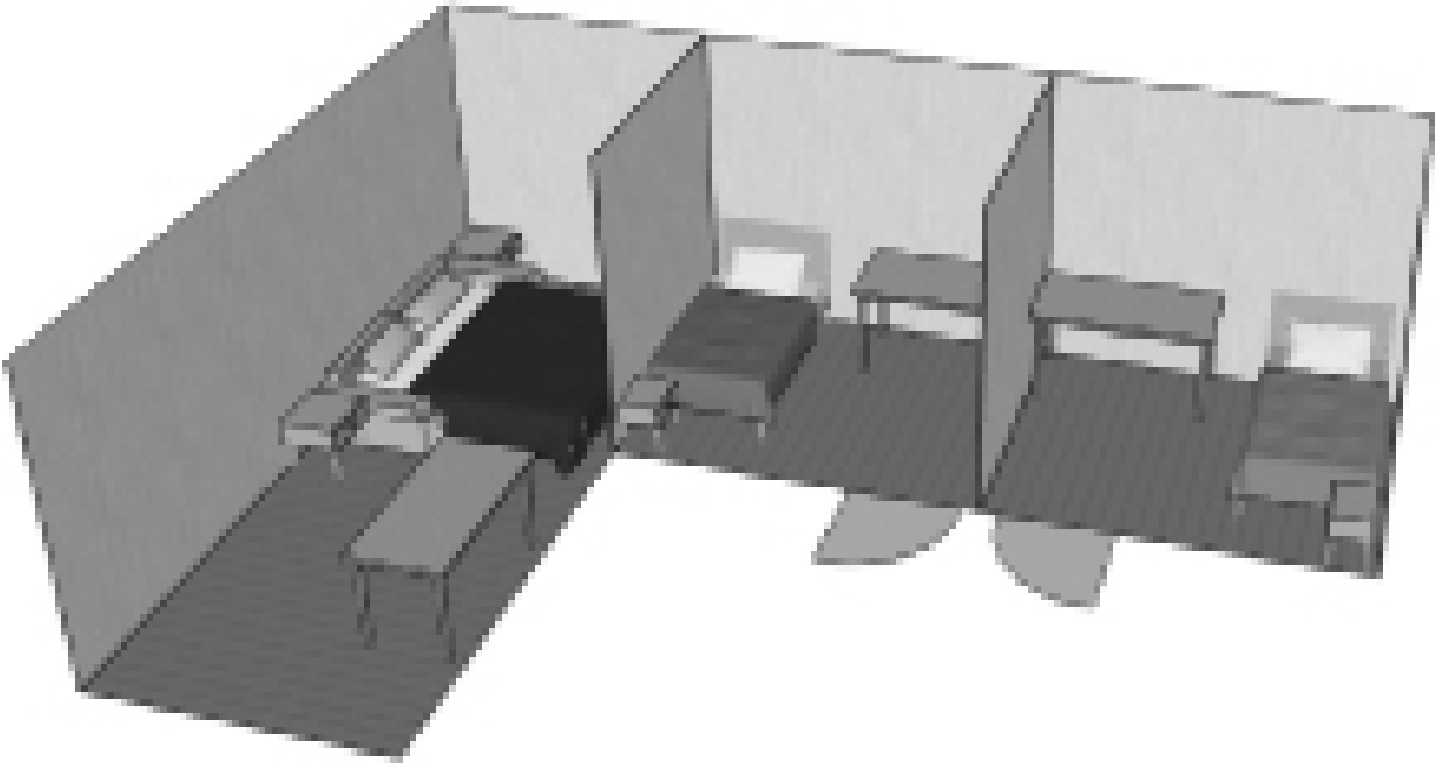
**Equity and Beauty** - The goal of this site is to create transitional housing for those dealing with homelessness. The plan of the site plan does its best to create an open and airy layout to contrast the small size of the sleeping units. The site plan slightly resembles a leaf if viewing it from above. The path creates an organic look to the industrial look the buildings on the site give. The open space on the site is allotted for open and green space for plants and vegetation.

The images on these pages illustrate the layout of the site design.





# Sleeping Unit Design



The site will offer two types of sleeping units, a single unit and a double unit for couples or small families. Both units are simple and only contain a bed, desk, and storage. One shipping container can hold two sleeping units separated by a wall, or just one unit for two people. In the single sleeping unit, there is a standard twin-size bed with storage under the bed, and a simple desk to work. In the double unit, there would be a couch that can pop out into a queen-size bed, and a desk to work, and a shelf for excess storage.

The sleeping unit was designed with intent for simplicity and space for adaptation and personalization. This space provides the basic necessities for a sleeping unit and also allows for ample space to store personal items and bring in other furniture that the resident might want to add to their space.

# Community Center Design

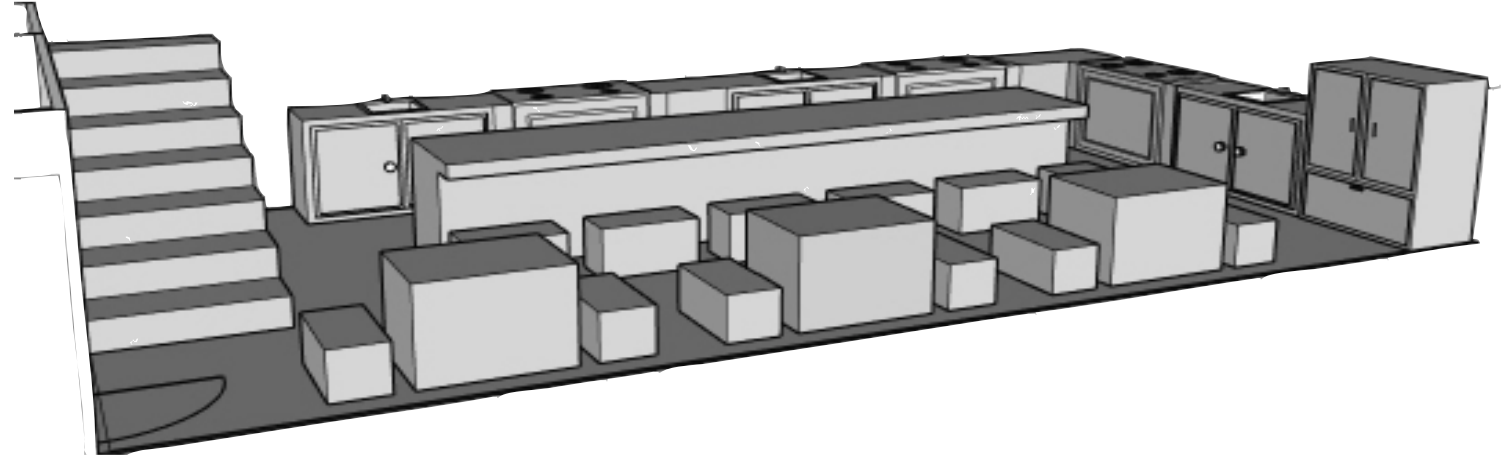


The community space functions as a service to community members to use, and incorporates features not included in the sleeping units themselves, but necessary for a living space. The community space continues to use the shipping containers by combining units to make a bigger functional space.

The space combines and stacks shipping containers to create the space. 5 shipping containers are used to create a kitchen and indoor dining space, 2 shipping containers are used to create space for 12 showers and 12 sinks, 2 shipping containers create office space

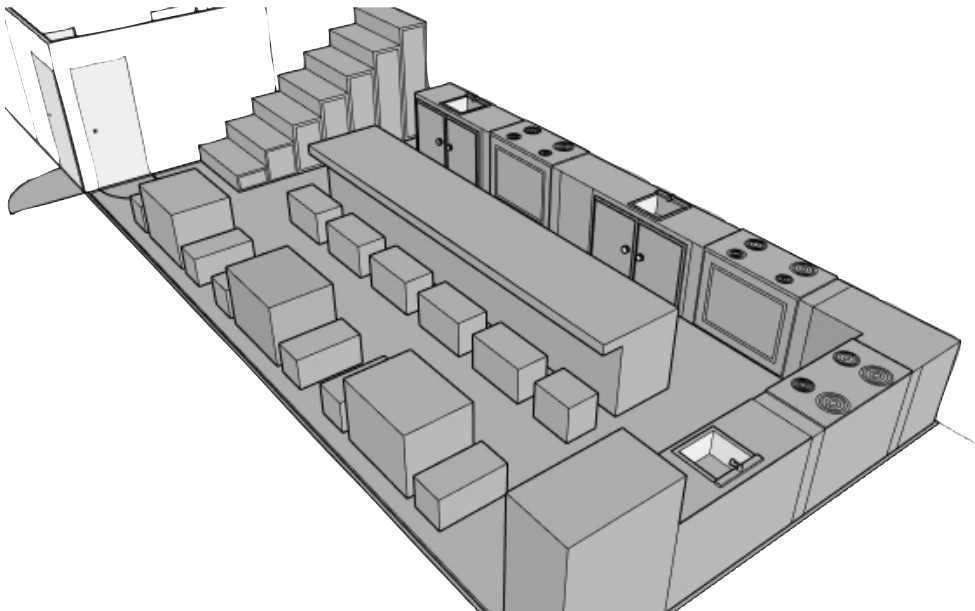
for staff and services, and 2 more shipping containers were used to create 2 restroom facilities. The top 2 shipping containers are available to residents for storage and social space to hang out outside of their sleeping units. Another shipping container was used to create space for a laundry facility. Above the lower shipping containers and adjacent to the social space is a covered dining patio that includes heating elements so that it is comfortable to eat at during all seasons.

# Kitchen and Dining Spaces

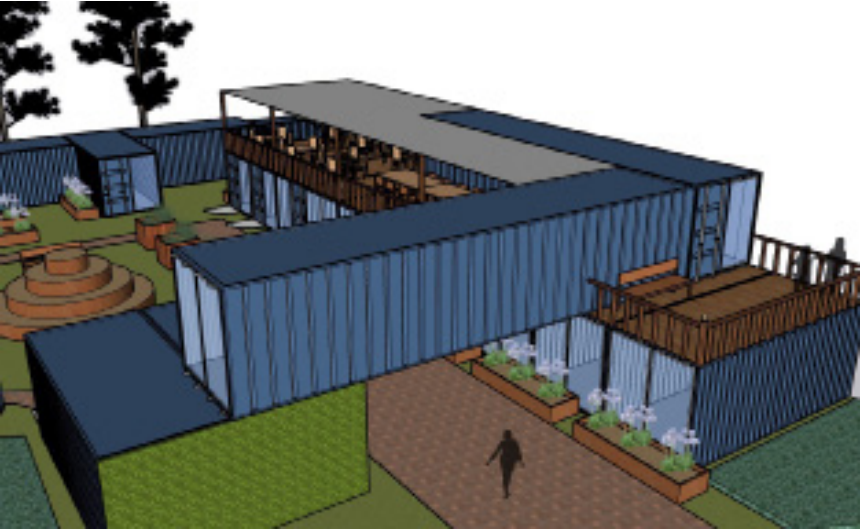


The kitchen space includes 1 industrial sized fridge, 3 sinks, and 3 stoves, as well as an island/bar for extra counterspace and dining space. 3 tables with 2 chairs each, and pantry storage under the stairs is included in the design.

This space is 40X20 feet occupying 5 combined shipping containers. This space is accessible for people with disabilities to dine that may have trouble navigating the stairs. This area is large enough to have multiple people cooking at once and dine as well. The stairs lead to the top patio area and other upstairs amenities.



# Outdoor Community Space



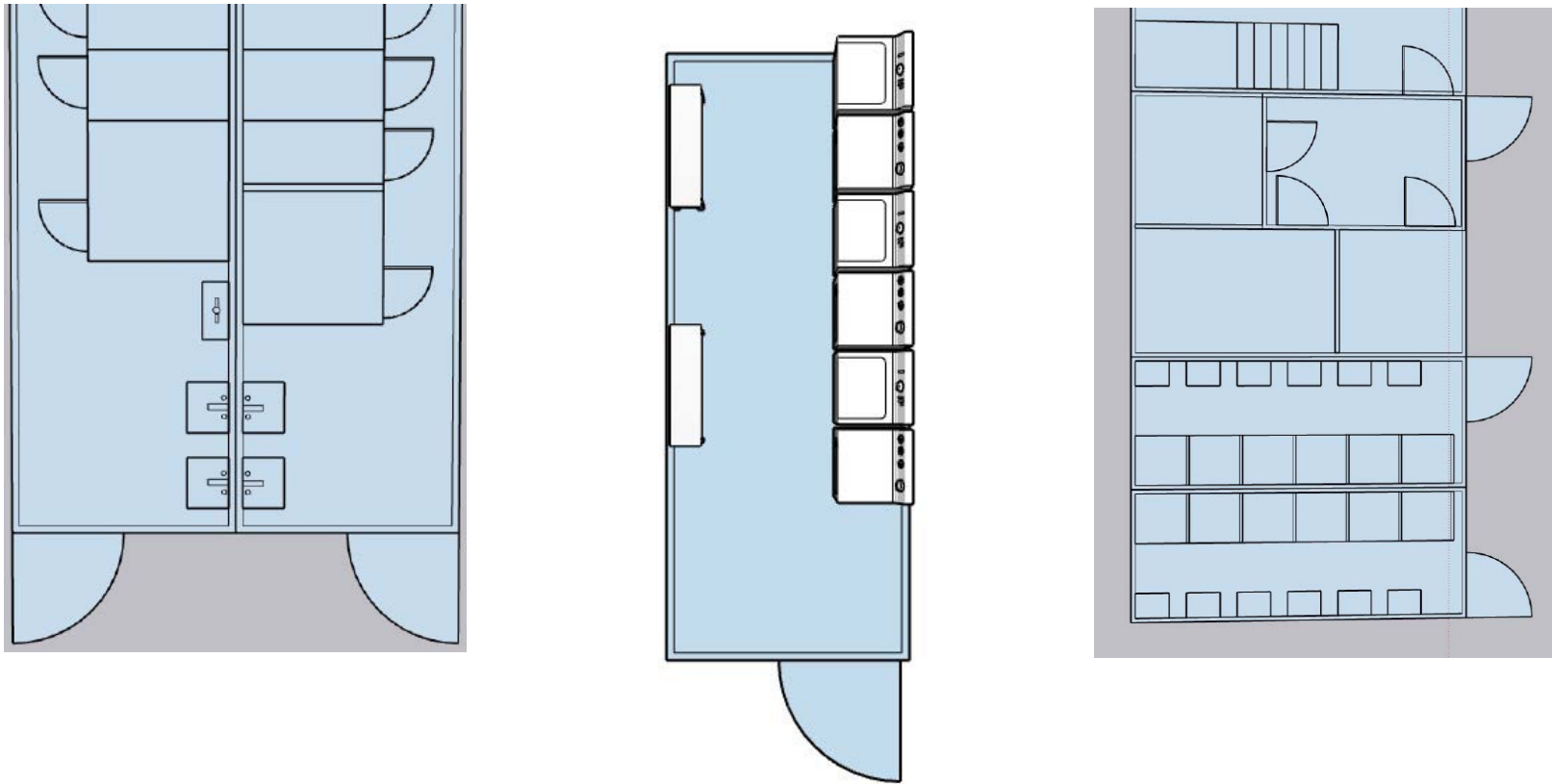
**Front Porch**  
At the entrance to the site, there has been allotted space for a deck outside of the social area upstairs in the community center. It helps to make the site more open, friendly, and inviting. It also allows for the potential for more social space, and/or dining space.

**Dining Patio**  
Above the lower shipping containers and adjacent to the social space is a covered dining patio that includes heating elements so that it is comfortable to eat at during all seasons. This space is accessible through the kitchen below. The space is shown with 9 tables, 4 chairs to each table. The space occupies the top of 6 1/2 shipping containers, and gives residents plenty of space to dine.





## Office, Bathrooms, Showers, and Laundry Facilities



## Courtyard and Garden Space



The bathroom facilities take up the space of 4 shipping units total. 2 for restrooms, and 2 for showering facilities. The design gives space for 12 showers, 16 sinks, and 8 bathroom stalls. Occupying the space of 2 more shipping containers is 3 office spaces that can be utilized by staff for the community. This design gives each space a total of 320 square feet. For the site's laundry facilities, 3 washers and 3 dryers are located in another shipping container in the community center.

The courtyard feature of this design is important in incorporating the current use of the space into this design. The current use of the space is occupied by a community garden that supplies food for food insecure and homeless youth in Bellingham. Garden space where it could be utilized was added to the design to ensure that by creating this transitional housing com-

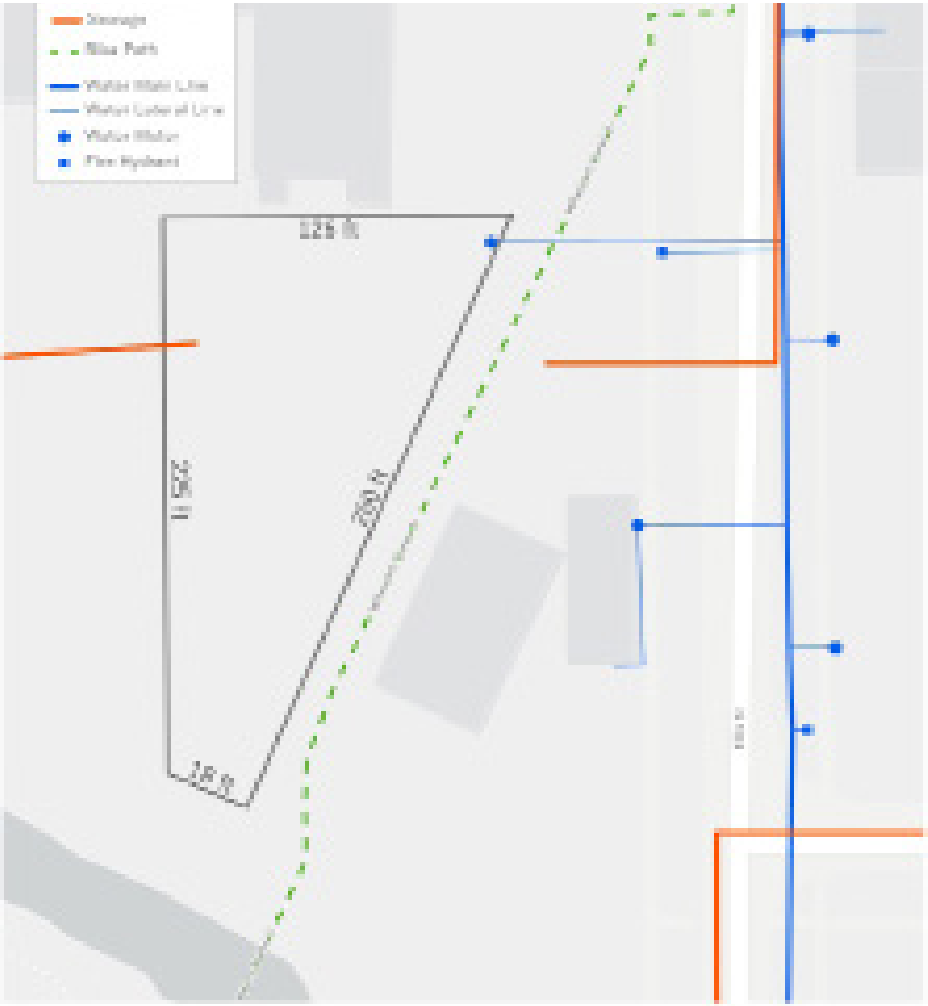
munity, we aren't displacing important services to members of the Bellingham community.

In this space, there is seating, garden beds, and a stacked planter in the center. There is a pathway that helps members of the community navigate around the space. This can easily be created by placing cardboard

down to avoid mud and weeds from consuming the pathway and topping that with gravel. The garden has been placed at the end of the lot to continue the service.

# Uilty Hookups

There are connections to the water main, sewage, and power on the property as displayed in the Utility Map. This utilities will supply power for the sleeping units, and community center as well as provide water for the kitchen and bathroom facilities.



# Phasing and Construction of the Site

**Phase 1:**

- Remove fencing built by North-West Youth Services and relocate to construction waste facility
- Remove garden boxes and place them along the southern tip of the property for storage and later use. Do the same with the gazebo on the property as well.
- Take planting soil from boxes and place it in an industrial container along the northern edge of the property.
- remove any remaining infrastructure, placing anything that could be re-used in the southern edge storage.
- Prepare 12 housing units in industrial shipping containers off-site; 6 double units and 6 single units.

**Phase 2:**

- Move 12 housing units onto site;
- Start with a N-S oriented double unit 55 feet from the southern edge of the property, lined up against the Western boundary of the property such that the doorway is facing east.
- Place a single unit perpendicular to the double unit so that its doors face east and the back end of the unit is along the western property line.
- Repeat the above steps, alternating between a N-S double unit and a E-W single unit along the western edge of the property, moving north. The last unit should line up along the edge of the northern property line. There should not be any gaps between the units.
- Prepare 8 more double housing units off-site

**Phase 3:**

- Move 8 housing units on to site;
- Orient the first unit to be parallel with the Eastern property line that follows the Whatcom creek trail. Place it 1.5' from the edge of the property line, and 62'8" from the southern tip of the property so that the constructed doorway is facing West.
- Similar to the pattern used in phase 2, place another container to the north that is perpendicular to the first unit. This time, move the unit 4'

- further from the eastern property line. Make sure the doorway faces the South.
- Repeat the above steps, alternating between these two orientations as you move north along the property line. There should not be a gap between units.
- Take the planting boxes that were moved in phase 1 and place them in front of the housing units. Fill them with soil that was also saved from phase 1, and spread seeds of endemic wildflowers on the top to prevent erosion. removed the storage unit from the property.
- Prepare internal structures of the community center; do not include furniture.

**Phase 4:**

- Put together the pieces of the community center.
- Place the laundry facility on the edge of the Northern property line running N-S so that the door is facing south. It's eastern edge should be flush against the edge of the last housing unit installed in phase 2.
- Place the two shipping units for the showers right next to the laundry unit, running N-S so the doors are facing south. the long edge should be flush with the edge of the laundry facility.
- Place the two shipping units for the meeting spaces right next to the shower unit, running N-S so the doors are facing south. the long edge should be flush with the edge of the shower facility.
- Place the five shipping units for the kitchen right next to the meeting spaces unit, running N-S so the doors are facing south. the long edge should be flush with the edge of the meeting facility.
- Place the two bathroom units south of the kitchen units by 20 feet, running E-W so their doors are facing West, and their backside (opposite the doors) is aligned with the second most eastern unit of the kitchen facility
- Connect the units to the city's electrical, water, and sewage lines
- Place the 40' long storage unit on top of the bathroom and kitchen units, running N-S, leaving

- room for the second 40' container
- Place the 40' long upstairs unit on top of the kitchen units so that it's long edge is flush with the containers below it, and the doorways on either end are facing E-W.
- Build the deck space; fill in the tops of the containers with 1" wood paneling so that the surface is flat. Attach 4"x4" posts on the edges of the containers to support the roof. Build the railing for the southern out-door space and eastern patio space. Attach the roof to the posts, etc.

**Phase 5:**

- Stake out the pathway for the community, leaving roughly two feet of space from the side of any shipping unit. Dig out the top ~6" of dirt along this designated pathway.
- Place cardboard along the bottom of this path, then fill it back in with gravel (this will prevent weeds from sprouting).
- Place the structures in the middle of the community; benches, plating boxes, etc. Hang vertical gardens along the sides of units that run parallel to the Whatcom creek trail.
- Plant any perineal landscaping in the indicated areas. Also, plant the tiered planter in the center with drought-tolerant plants at the top level and moisture dependent plants closer to the bottom.
- Add furniture and lighting to all of the units, and connect them to the appropriate fixtures.



## Materials and Costs: Community Center Interior Costs

ITEM	COST
10 Small Shipping Containers	\$1650
2 Large Shipping Containers	\$2000
8 Outside Doors	\$880
4 Inside Doors	\$324
Insulation for all Shipping Containers	\$6090
2 Couches	\$700
2 Side Tables	\$40
8 Showers	\$2000
2 ADA Showers	\$3000
16 Sinks	\$848
Bathroom Stalls	\$1575
5 Toilets	\$400
1 Urinal	\$55
2 ADA Toilets	\$276
7 Wall Mirrors	\$256
3 Washing Machines	\$1200
3 Dryers	\$1500
1 Industrial Sized Fridge	\$1700
3 Kitchen Sinks	\$387
3 Stoves	\$260
20' of Island/Counter	\$135
3 Tables	\$72
6 Benches/Chairs	\$210
6 Taller Barstools	\$108
~30' Counter	\$142
~20' Counter	\$75
Stairs	\$191
<b>TOTAL</b>	<b>\$9,590</b>

## Materials and Costs:

### Landscaping and Green Space

ITEM	COST
2"X4" Planter (Reuse Boxes Already on Site)	Budgeted (in case) \$46
Vertical Garden	\$110
Gravel Pathways	\$30-50
Cardboard to use under gravel	Free
4 outdoor park benches	\$2,082
<b>TOTAL</b>	<b>\$2288</b>

## Materials and Costs: Community Center Exterior Costs

ITEM	COST
161.5 Ft. of 2X4	\$62
56 Ft of 4X4	\$80
1440 Sq. Ft. of 1" Flooring	\$9215
1024 Sq. Ft. of Metal Roof	\$1210
4274 Sq. Ft. Outdoor Wood Finish	\$2,785
Hardware	\$50
6 Round Tables, 24 Chairs	\$700
3 Long Tables, 18 Chairs	\$390
1 Bench	\$525
<b>TOTAL</b>	<b>\$15,017</b>

## Materials and Costs: Sleeping Unit Costs

ITEM	Single Unit	Couples Unit
Plywood	\$45.14	
Drywall	\$239.60	\$167.72
Insulation		
3'x3' Windows	\$476.00	
4'x4' Windows		\$308.00
Doors	\$358	\$179.00
Pullout Queen Bed	\$295.58	\$749.99
Twin Storage Bed	\$693.80	
Desk	\$147.79	\$147.79
Desk Chair	\$21.58	\$10.97
Individual Unit Total	\$2,129.70	\$1,563.47
<b>All Unit TOTAL</b>	<b>\$31,945.5</b>	<b>\$7,817.35</b>

# Design Team 4: The Lettered Streets Settlement



- Project Site
- Residential Transition
- Multi-Family
- Single Family
- Public/School

The Lettered Streets Settlement site is located on one square city block on C Street directly across from the Municipal Courthouse, adjacent to the Police Department to the south and adjacent to Whatcom Middle School to the north. The site is roughly 200' x 175', with total usable space just under those



# Design Statement

## Design Statement Shopping Cart

Shopping carts are used for several purposes, such as their relative abundance, storage of personal items, mobility, and for protection as individuals often will sleep outdoors using the cart as a protective barrier.

Each of our renovated cart designs takes these uses into consideration while also building on them to include other important elements for homeless individuals using the cart.

## Design Statement Sleeping Unit

Our sleeping units attempt to “consider the most minimalist space requirement for a sleeping shelter” for individual or couple accommodations.

The sleeping units provide privacy, security, protection from the elements, a sleeping space, a power source, space for storage, living, and working.

These units are intended as semi-permanent structures. But are all easily constructible with minimal help and easily transportable.

## Design Statement Housing Site

Our housing site is designed to provide community based support to its clients. The site tackles both new urbanist concepts of neighborhood and the Living Building Challenge in its design.

The community facilities support the minimalist housing units and encourage group unity.

## Example of client

Our main 8’x12’ units can support either couples or single persons. Those staying in them would be persons excited about the concept of community based minimal living. Priority should be given to those facing financial hardship and home instability.

Our 5’x7’ units can support single persons as emergency overnight shelter.. These units would support shelters like the Light House DIC, which often get overlooked in the winter, in preventing persons from freezing in the street or the cit

## Sustainability Metrics:



The "petals" to the Living Building Challenge

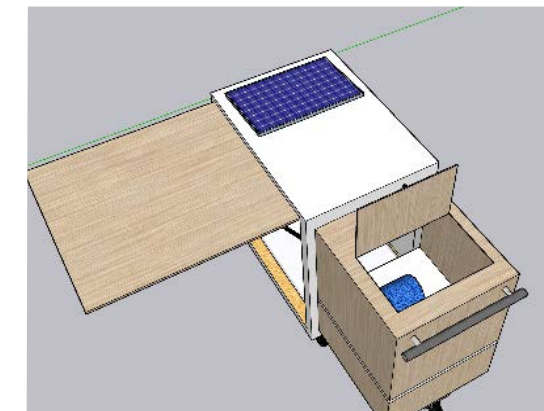
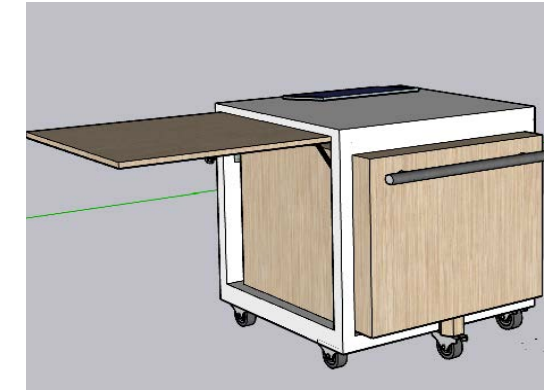
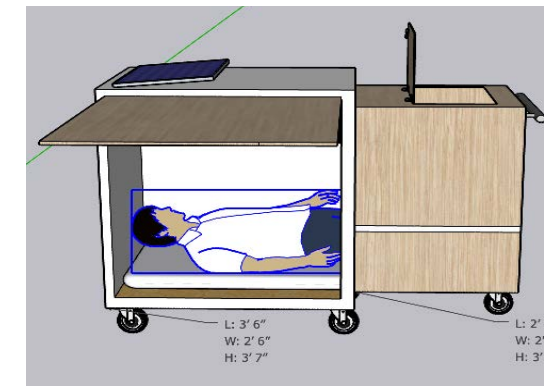
This housing site seeks to meet the petal of site design with it’s high density 63 person max occupancy.

All material sourcing is recommended to be gathered through the urban wast stream. The energy usage on all of the housing units is solar, and energy requirements for heating/cooling are reduced through the installation of green roofs. The green roofs also work to add beauty and green space to the site while also lessening the dependency of the sewer system in purifying rainwater.

**This mobility cart is extractable. There is a smaller cart that extends inwards and outwards into a bigger cart making it more compactable and easier to haul around during the day. At night, the smaller cart can be pushed outwards, similar to a dresser drawer, and can be used as a sleeping shelter. You can protect your belongings and yourself from weather and people. Because it rains a lot, they will also be provided with a tarp to protect themselves from the rain as well. There is a solar panel for more efficient energy as well as clear plastic sheets for windows for natural lighting during the day while also giving them privacy. For storage, there is a shelf on the smaller cart and for easy access, there is a “lid” that you can prop open to retrieve items. The shelf is placed near the middle on the inside of the smaller cart, that way there is space to lay down and rest your feet.**

Materials:	Price/Quantity
Plywood (15/32 in x 4ft x 8ft)	\$18.25 (5)
Lumber (2 in x 12in x 8ft)	\$11.98 (4)
Wheels (6in)	\$19.25 (5)
Latch	\$5 (1)
Down-lid Support	~\$18 (2)
Hinges	\$3.18 (2)
Sm vinyl window (24 x 24in)	\$124 (1)
Solar Panel	~\$105 (1)
Tarp for rain protection	\$10.98 (1)
Paint (1 gal)	~\$35 (1)
Extension slides (36 in)	\$89.95 (1 pair)
	TOTAL: ~\$670

# Design Team 4: Mobility Cart 1



## Instructions:

1. Cut lumber in half widthwise (you should have 8 pieces of lumber that 2in x 12in x 4ft)
2. Layout 4 planks of lumber and align them next to each other (all together = 4ft x 4ft) platform
3. Use leftover lumber nad place them perpendicular to the 4ft x 4ft platform. This makes it more secure to withstand weight
4. Cut plywood in half so dimensions are 4ft x 4ft
5. Using lumber as the base, drill in plywood on only two sides
6. For third side, measure smaller cart, making sure the small cart dimensions can easily slide into the bigger cart. Drill out plywood where small the small cart will slide, then drill in the third wall.
7. Drill in the extension slides on the interior sides of bigger cart.
8. Start sawing the plywood dimensions of small cart.
9. Smaller cart = made of all plywood. Drill in three plywood walls to the plywood base and drill in the top.
10. Carefully flip bigger cart and add the wheels to corners
11. Use a small peg of lumber for the fifth wheel and place it on the side closest to your feet and in the middle. This balances the cart out.
12. Attach smaller cart to the bigger cart with the extension slides
13. Cut out more plywood for the “doors”/opening and drill in the hinges.
14. Add the door lift support hinges for the bigger door.
15. Add a piece of plywood (same width and length as smaller cart) for a shelf for storage.
16. Add handle, solar panel, or any other hardware such as latches for security

# Design Team 4: Mobility Cart 2

## Introduction

As a first step in helping people experiencing homelessness in our communities have secure, temporary shelter and a way to store belongings, we propose reworking the conventional shopping cart. Commercial shopping carts are already commonly used by the homeless to transport their belongings and often assist in providing shelter. This new "mobilty cart" design provides for

- Storage/theft protection in a compartment underneath the basket
- A power source through a battery and compartment in the back of storage, to power outlets in basket/shelter
- Weather protection with a retractable cover over the top of the basket/sleeping area
- Ability to extend the basket/sleeping area as needed to minimize bulkiness while providing ample sleeping room

This cart is aimed for homeless individuals who may be adjusted to living outside, but require greater security if there are no other opportunities.

## Construction Steps:

1. Replace commerical shopping cart with new hand truck wheels
2. Build storage compartment between bottom rack and bottom of cart with scrap metals incuding door and lock
3. In back of storage, install compartment for battery to power outlets and light in space above
4. Scrap pieces from other shopping cart to create extendable front end for increasing sleeping space using drawer slides and lock
5. Use screen material to warp around the sides of the cart basket/sleeping area for greater privacy and element protection
6. Install roller shade mechanism with curtain material rolled inside that can be pulled the length of the basket opening and be secured on the opposite end to protec basket from elements.

## Materials and Budget

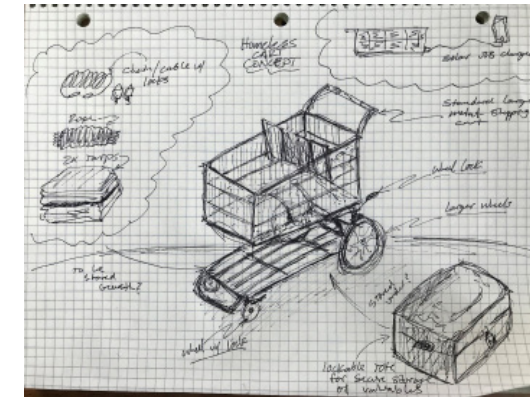
- Metal retail shopping cart (2) - \$300
- Outdoor screen material - \$35
- Waterproof curtain fabric - \$50
- Drawer slides - \$50
- Hand truck wheels - \$120
- Small motorcycle battery - \$80
- Roller shade mechanism - \$40
- Cushions - \$50
- Weatherproofing agent - \$30
- Scarp metal, aluminium \$4/lb
- Labor costs ~ \$20/hr
- Lock mechanism - \$20

Estimated final cost:~ \$800 + labor costs for metal work



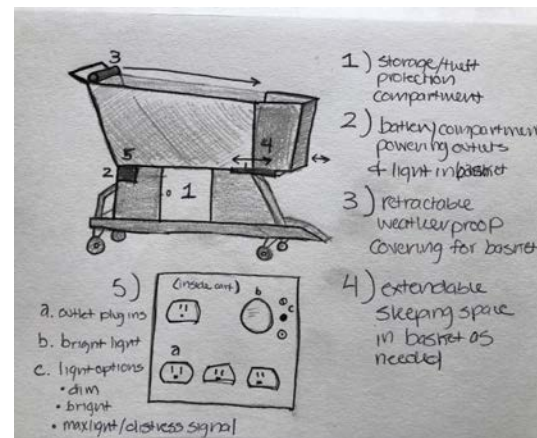
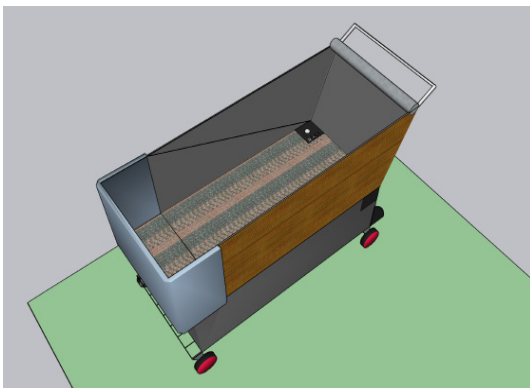
Elements that have been retrofitted include:

- Rear axle to accommodate larger wheels
- Rear wheel locking breaks to improve safety through control and stability
- Front swiveling wheels with locking breaks (also for safety)
- Heavy duty chain and pad lock to aid in securing cart while parked
- Portable solar USB charger
- Mobility Kit: accessory cord, heavy duty tarps and locking storage tote for improved security from theft.
- Metal locking lid for the main cart compartment (increased security)



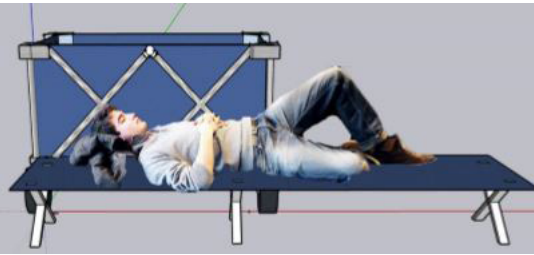
Item	Quantity	Each	Total
Large metal shopping cart	1	\$ 170.00	\$ 170.00
4" swivel casters w/ brake	2	\$ 20.00	\$ 40.00
Bikes at work axel	1	\$ 100.00	\$ 100.00
16" tuff wheel	2	\$ 55.00	\$ 110.00
Solid 16" bicycle tires	2	\$ 20.00	\$ 40.00
composite pull-to-lock wheel locks	2	\$ 42.00	\$ 84.00
Heavy-duty key padlock	2	\$ 11.00	\$ 22.00
6' cable for key padlock	1	\$ 10.00	\$ 10.00
16'x20' heavy-duty tarp	2	\$ 55.00	\$ 110.00
100' of 1/4" accessory rope	2	\$ 10.00	\$ 20.00
Portable Solar USB charger	1	\$ 65.00	\$ 65.00
locking tote	1	\$ 45.00	\$ 45.00
Donated assembly (welding and part installation)	1	\$ -	\$ -
<b>Total</b>	<b>20</b>		<b>\$ 816.00</b>

Construction of the cart would require the skills of a fairly competent team of builders and metal-workers. Ideally this would be donated labor. The original wheels would need to be cut off and the new wheels, break and axel welded on. The metal lid would also need to be attached by skilled volunteers. All materials could be sourced from local producers or from recycled materials, however it is likely most feasible that the cheapest, most available materials and parts are used to expedite construction. Once the cart is complete the user can customize their setup as desired.

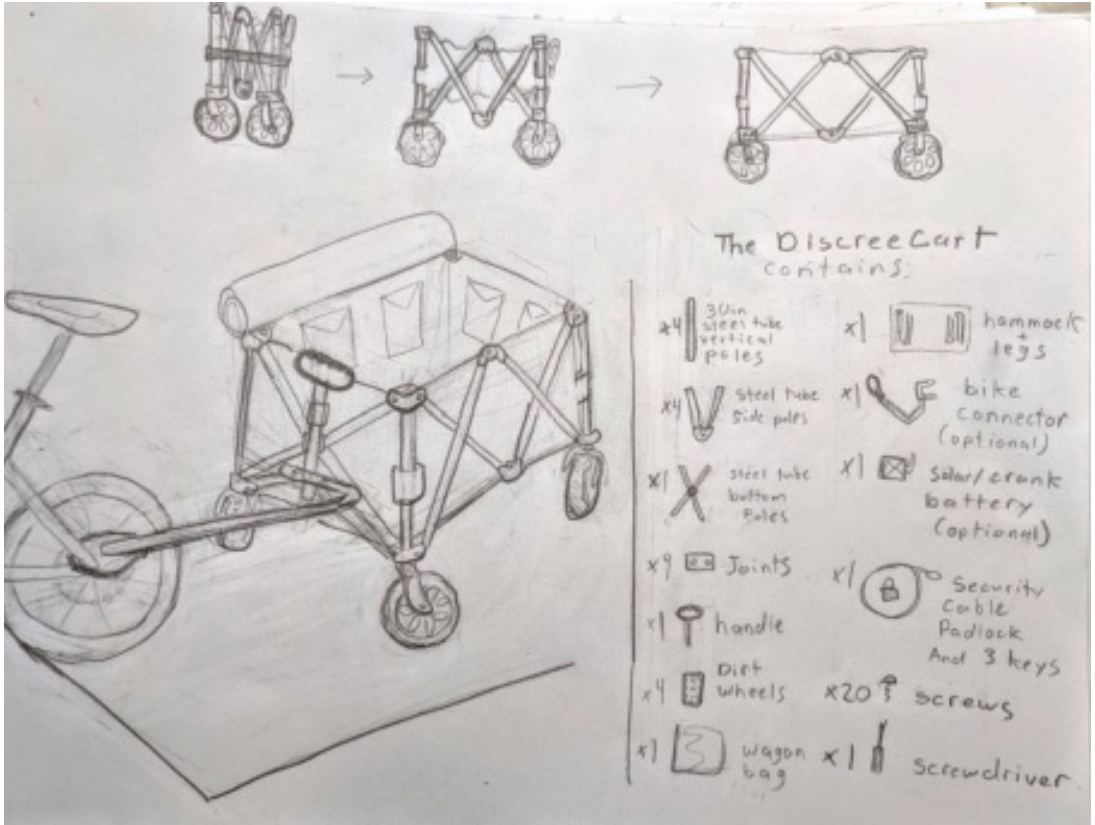
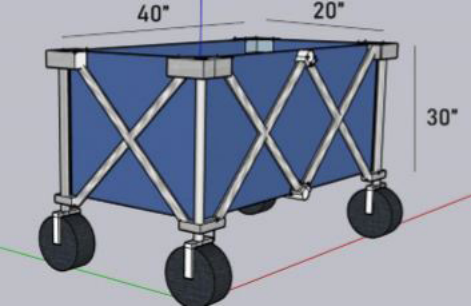




# Design Team 4: Mobility Cart 4

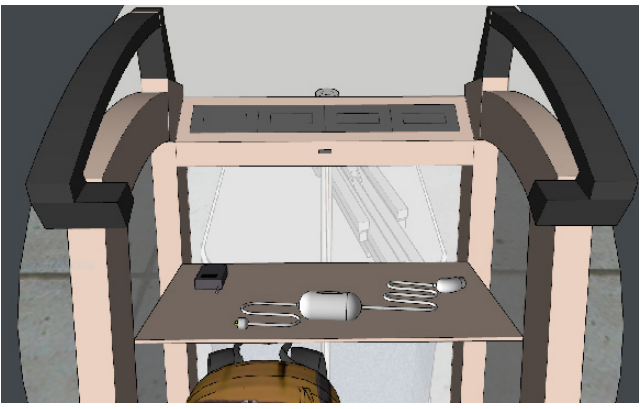
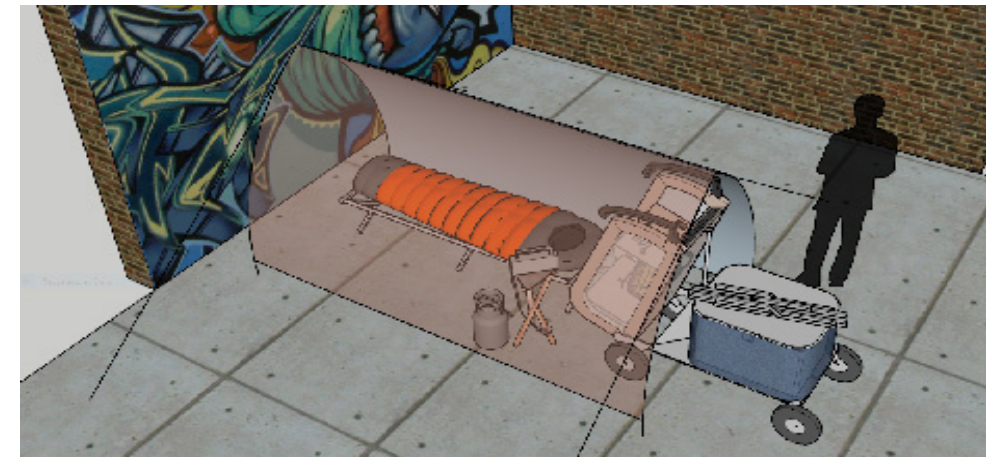
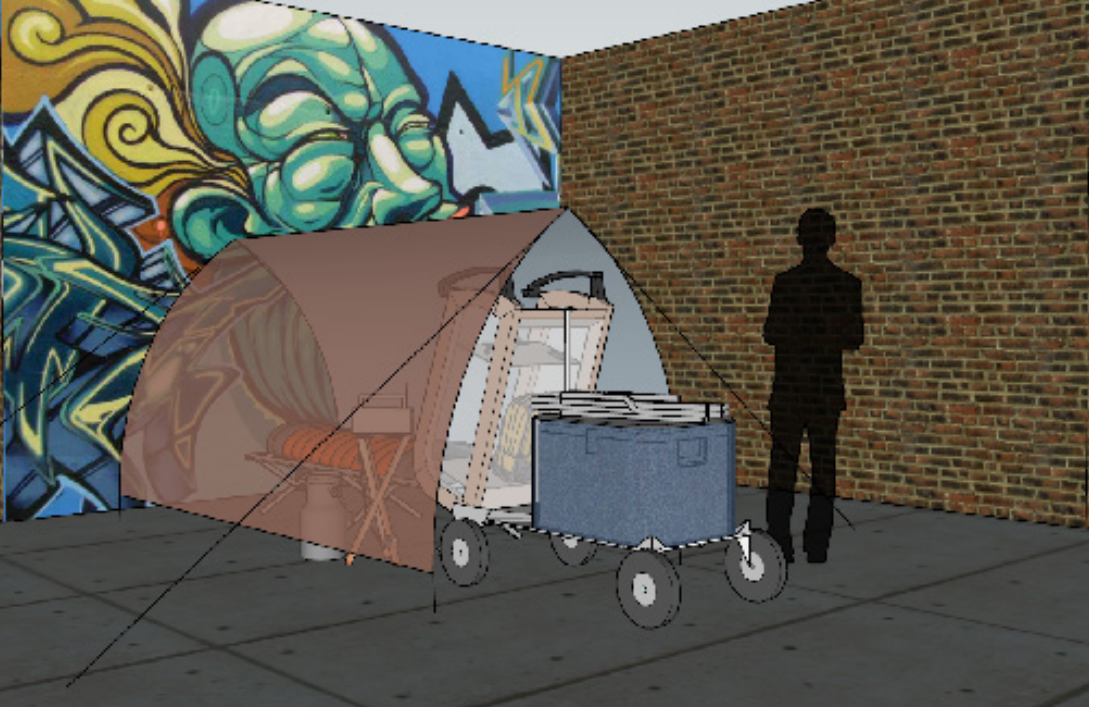
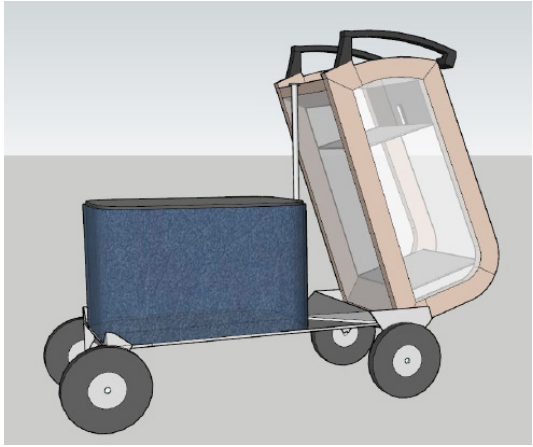


Cost: \$457



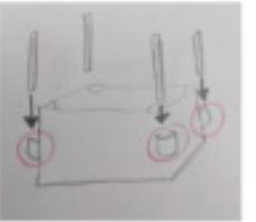
# Design Team 4: Mobility Cart 5

This design concept emphasizes organized storage space, ease of mobility, electricity generation, and compatibility for secured sleeping. The product is equipped with a parking break, a solar powered battery/power station installed in the dash, large wheels, and a collapsible tarpaulin tub-pouch which accommodates larger loads.



View of solar powered dash—multiple outlet configurations possible.

1. Slip the (4) vertical poles into the pockets of the wagon fabric.



2. Secure each of the (4) vertical poles, at each corner of the wagon, by screwing in the screws at the top of the fabric



3. Attach those (4) vertical poles, (4) side V poles, (4) front&back V poles, and (2) bottom poles to the joints with the matching color. Use the provided screwdriver and screws to secure joints to poles.

4. Attach (4) wheels to the joints at the bottom of each of the (4) vertical joints



# Design Team 4: Mobility Cart 5

The cart is designed to operate in a two-wheeled mode when front storage is not needed by the user. The tarpaulin tub-pouch (blue) is collapsible and the frame/front wheels are hinged to allow for ease of storage and transportation.

One of the drawbacks of typical cart options may be the inability of the user to take their cart with them over longer distances. The collapsible design offered in this model decreases the bulk of more traditional cart options.



- Materials:**
- Sheet of high quality/durable tarpaulin
  - 12 ft of 2"x4" lumber
  - One 91-watt computer battery
  - One solar panel
  - Battery recharge hardware
  - Four 7"x2" wheels
  - One 2'x 4'x 1/2" lightweight composite board
  - 7' of 1" aluminum full-round pipe
  - 4' of 1" aluminum half-round pipe
  - Screws
  - Nails
  - Handles
  - One central folding mechanism for collapsibility

Estimated Cost: \$1,100



- Assembly:**
- Cut 2x4 material into appropriate/desired lengths for construction of vertical storage—use screws and dowels to ensure durability
  - Secure solar panel, battery, and electrical components to the appropriate 2x4.
  - Attach half round pipe to composite board to construct chassis of tub-pouch
  - Cut tarpaulin into the desired width and height for tub-pouch. Sew framing into the tarpaulin and sew ends together to create a seam. Finish seam by ironing a waterproofing fabric onto tarpaulin.
  - Cut 7' aluminum pipes for axels and attach wheels/wheel components to pipes. Secure to chassis.
  - Secure tub-pouch to chassis. Insert remaining pipe into tub-pouch frame, then secure to chassis.
  - Attach chassis to folding mechanism, then attach to vertical storage unit.
  - Attach handles to top of vertical unit

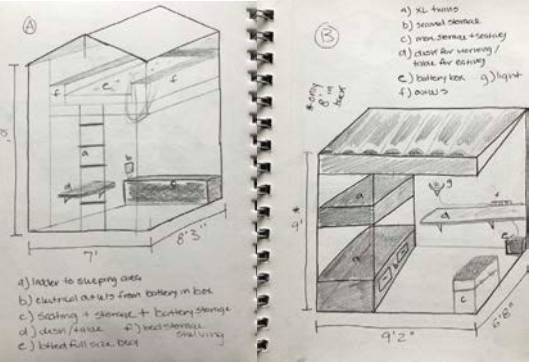
# Design Team 4: Sleeping Unit 1

As a next step in providing people experiencing homelessness with a more established solution to provide shelter and personal storage, the following permanent housing and sleeping unit design seeks to address those issues. This design accounts for:

- Sleeping area for up to 2 people
- Power source for light and electronics charging
- Living/working space
- Secured storage for belongings
- Can be transported to alternate locations within settlement site or to other sites

This sleeping unit design provides two different layouts depending on the needs of the occupants. Design A is designed with couples in mind, who are able to climb a ladder to reach a lofted double bed. Design B uses bunk-style extra-long twin sized beds. The bed at floor level is more ideal for anyone who can not routinely climb up and down a ladder in and out of bed each day.

Below: Design A (left) and Design B (right)



**Infrastructure**

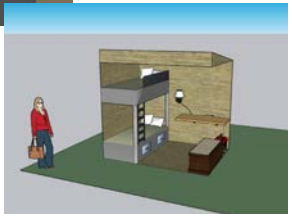
Design A (left) and Design B (right)

- Construction Steps:**
1. Assemble base flooring from cedar planks, using cinderblocks for support
  2. Construct hardware store shed framing kit by following assembly instructions included
  3. Install plywood siding to framed structure
  4. Apply vinyl siding to outside of plywood walls
  5. Run cedar plank beams 7 feet above floor (A)
  6. Place steel roofing material on top to create ceiling and roof
  7. Place and install doors
  8. Apply waterproofing agent to exposed surfaces of structure
  9. Follow instructions with solar outdoor lights

**Materials and Budget**

- DIY shed kit (framing) or equivalent wood supply cost - \$300
  - Cedar wood planking for floor (+ A loft) - \$10/sqft (\$944 A) (\$610 B)
  - Plywood for walls - \$2.40/sqft (\$500 A) (\$662 B)
  - Bench seating with storage - \$200
  - Twin XL bunk (B) - \$300
  - Twin XL mattresses (B) - \$175
  - Full mattress (A) - \$200
  - Portable generator\* - \$400
  - Solar outdoor lights - \$30/each
  - 8 ft corrugated galvanized steel roofing panel - \$15x3 = \$45
  - Glass screen door + front door - \$200
  - Support cinderblocks - \$1/each
  - Wood waterproofing - \$50
  - Vinyl siding - \$4/sqft (\$1,220 A) (\$1,050 B)
- Total A: ~ \$4,100  
Total B: ~ \$4,032  
\*as potential backup depending on settlement power solar power source

Design A (left) and Design B (right)  
Extra room in budget intended for extra labor costs, occupant personalization (garden bed, awning, additional lumber, etc.)





# Design Team 4: Sleeping Unit 2



Materials:	Price/Quantity:
Studs (2in x 4in x 96in)	\$2.86 (37)
Studs (2in x 4in x 120in)	\$4.75 (12)
Studs (2in x 4in x 144in)	\$5.83 (10)
OSD Plywood (4ft x 8ft)	\$18.48 (8)
Shiplap (5 1/4in x 8ft)	\$6.30 (32)
Shiplap (5 1/4in x 12ft)	\$9.75 (25)
Windows (24in x 24in)	\$65 (2)
Door	\$359 (1)
Solar Panel	\$167.70 (1)
Asphalt Shingle Roof	~\$27.80 (3 bundles)
Trundle Bed	\$170.52 (1)
Bookshelf	\$30.70 (1)
Dresser/Desk	\$188 (1)
Light Fixture	\$11.20 (1)
Chair	\$112 (1 pair)
Vinyl Flooring	\$0.68/sq. ft (80 sq ft)
Dry Wall (1/2in x 4ft x 8ft)	\$15.27 (11)

TOTAL: ~\$2,180

**Instructions:**

- Sub Floor:
- 1.) First we need to build the support using lumber, placing them two feet apart.
  - 2.) Make sure the dimensions of the support are 8ft x 10 ft. Saw off any excessive wood
  - 3.) Place more lumber perpendicular across, forming a grid like support system. (See picture)
  - 4.) Cut and apply your plywood panels on top of your support and fasten them with wood screws
  - 5.) Install vinyl flooring

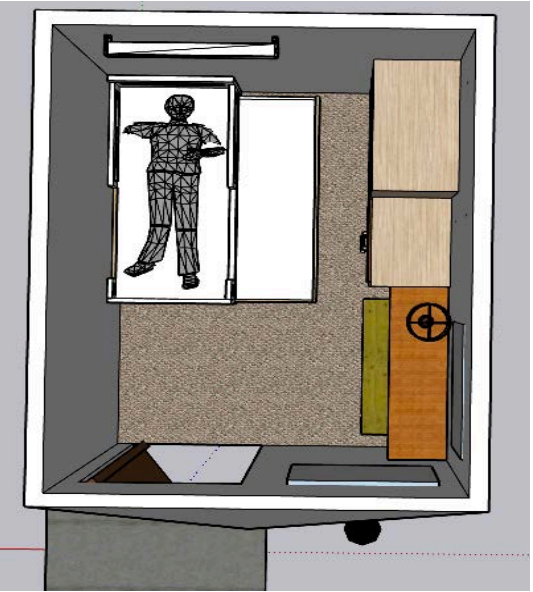
**Framing the House:**

- 1.) Get dimensions for the door and windows so you can cut out the lumber frames to support the door and window headers and sills.
- 2.) Saw out all the lumber you need to frame the house, windows, and door.

Make sure to double frame from the bottom of the window sill to the floor

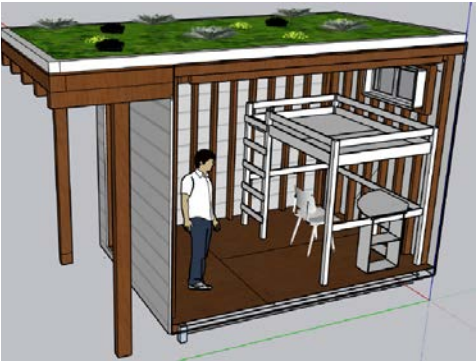
Also double frame the very top of the whole house frame so it can withstand the weight of installing the roof

- 3.) Place and lay out studs on the floor prior to drilling the lumber together (Studs should be 1.5 ft apart from each other to give a uniform strength)
- 4.) Assemble and drill the framing
- 5.) Measure and cut dimensions of the plywood
- 6.) Apply and nail in plywood on both the interior and exterior of the house
- 7.) Once plywood is covering the framing, install shiplap for a more finished look
- 8.) Install door and windows



The design creates a space that's more handicap friendly. With a small space, especially for couples, trying to avoid any use of bunk beds, ladders, or steps can be hard when trying to save room. But everything in this space is made to be within reaching distance and mobile friendly. The use of daybeds, futons, and trundle beds are great alternatives. Trundle beds are an extra bed stored below the normal bed. Rather than bunk beds, it can be more efficient for those who don't have the mobility. The extra bed can be pulled out at night (if needed) and pushed back under during the day for more space. The unit is 8ft x 10 ft, 7ft in height. The unit also comes with a solar panel for more efficient energy usage.

# Design Team 4: Sleeping Unit 3



- Instructions**
1. Build Bottom and top bases
    - 1.a Screw together 4\* 6"x4" planks to form the base of the house.
    - 1.b Place bottom base onto concrete blocks to uplift house from ground.
    - 1.c screw together 2\* 7' 2"x4" with 2\* 10'6" 2"x4" planks
    - 1.d Add 10 7" 2x4" wooden planks onto the bottom. These will support the floor and ceiling.
    - 1.e Connect 3 4'x8' plywood boards and screw onto bottom base
    - 1.f repeat steps 1.a, 1.c, 1.d, and 1.e to form a second base for the roof

2. Build the house frame
  - 2.a align together the 10\* 9' 2"x4" onto the ground. Separate them by 10" each. Put 2\* 9' 6"x4" planks 11" apart on either side.
  - 2.b screw upward onto side of house in this configuration.
  - 2.c repeat 2.a-2.b for the other side of frame.
  - 2.d Gather 8\* 9' 2"x4", 10" apart each, and cut a window size hole in the frame, adding 2" to the top, bottom, and sides in order to allow room for a wooden frame to be built around the window itself.
  - 2.e repeat the previous step, but cut a door sized hole in the frame, adding 2" to the top, bottom, and sides in order to allow room for a wooden frame to be built around the door itself.
  - 2.f screw the front and back frames in these configurations upwards onto the edges of base
  - 2.g Screw the ceiling base from step 1 onto the top of the frames.
3. Build the porch covering
  - 3.a Screw a 4'3" 4"x6" onto each (\*2) tall 9'2" 4"x6" wooden planks.
  - 3.b screw a 8' 6"x4" wooden plank above and on the edge of the 4'3" planks to connect them
  - 3.c Screw 3\* 4' 6"x4" planks, 2" apart, onto the 8' wooden plank.
  - 3.d on each of the 3\* 4' from step 3.c, screw on a 10" 2"x4" wooden plank
  - 3.e Screw porch covering onto house
4. Add siding to the house
  - 4.a cut the siding to 12'x9'9" for each long side of the house
  - 4.b Cut the siding to 8'x6'8.25" for the short lengths of the house. Cut holes for window, door, and porch covering according to pictures below
  - 4.c Attach the siding to the frame of the house
    5. add 4 \* 4'x8' plywood boards to the roof and porch covering
  6. Contact professional for green roof installation

**Design Statement:**

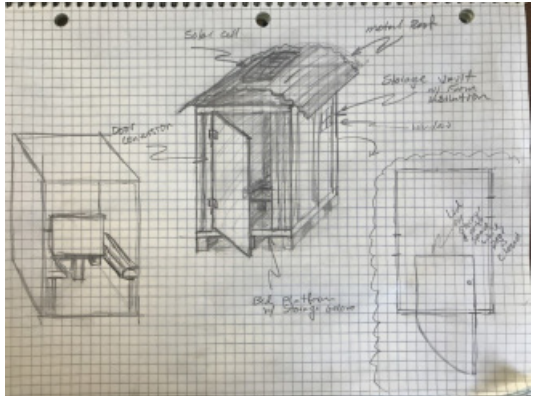
Green Roofs are the future. They are a long-term investment which last on average double the life expectancy of traditional roofing and provide more cost benefits over time (United States General Services Administration, 2010)

**Materials List**

- Total: \$3,473-\$3,673
- 20\* 2"x4" wood planks cut to 7' (for floor and ceiling support on bases) \$60
  - 36\* 2"x4" wood planks cut to 9' (for house framing) \$144
  - 3\* 2"x4" wood planks cut to 10" (for porch cover) \$1
  - 8\* 4"x6" wood planks cut to 7' (for top and bottom base) \$80
  - 4\* 4"x6" wood planks cut to 12' (for top and bottom base) \$68
  - 4\* 4"x6" wood planks cut to 10'6" (for top and bottom base) \$59.5
  - 2\* 4"x6" wood planks cut to 9' 2" (for porch cover) \$25.5
  - 5\* 4"x6" wood planks cut to 4'3" (for porch cover) \$28
  - 2\* 4"x6" wood planks cut to 3' 6" (for porch cover) \$11
  - 1\* 4"x6" wood plank cut to 8' (for porch cover) \$11
  - 7\* 4'x8' plywood boards (for bottom base and roof/top base) \$105
  - 4\* Honeycomb Wood Siding 5.5"x8" (for siding and insulation) \$320
  - Green Roof (128 square feet required) \$2,560
  - Loft bed \$200
  - Dresser \$100 (optional/recommended to buy second hand)
  - Desk and chair \$100 (optional/recommended to buy second hand)

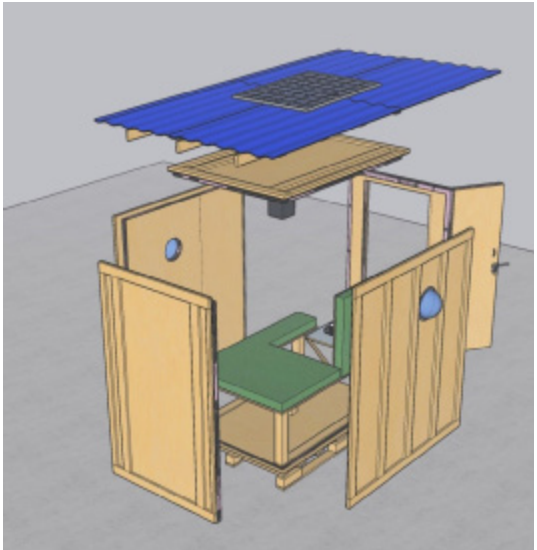


# Design Team 4: Sleeping Unit 4



The construction of the storage vault sleeping unit would require the skills of a fairly competent team of builders. Ideally this would be donated labor. The walls of the vault would need to be retrofitted to include closed-cell foam insulation and some kind of veneer panel to aesthetically hide the insulation while the user is inside. A door would need to be installed on the front/entry wall, windows installed on two of the side walls, minor electrical to connect solar to the lighting and heater, and a roof constructed onto the existing roof. Lastly, a modular bed platform would be constructed for the user to sleep on, cook, read, etc. All materials for this design could be sourced used storage vault sellers, as many large distributors and storage outfits commonly have used vaults for sale. However, it is likely most feasible that the cheapest, most available vaults and materials are used to expedite construction in order to make housing available.

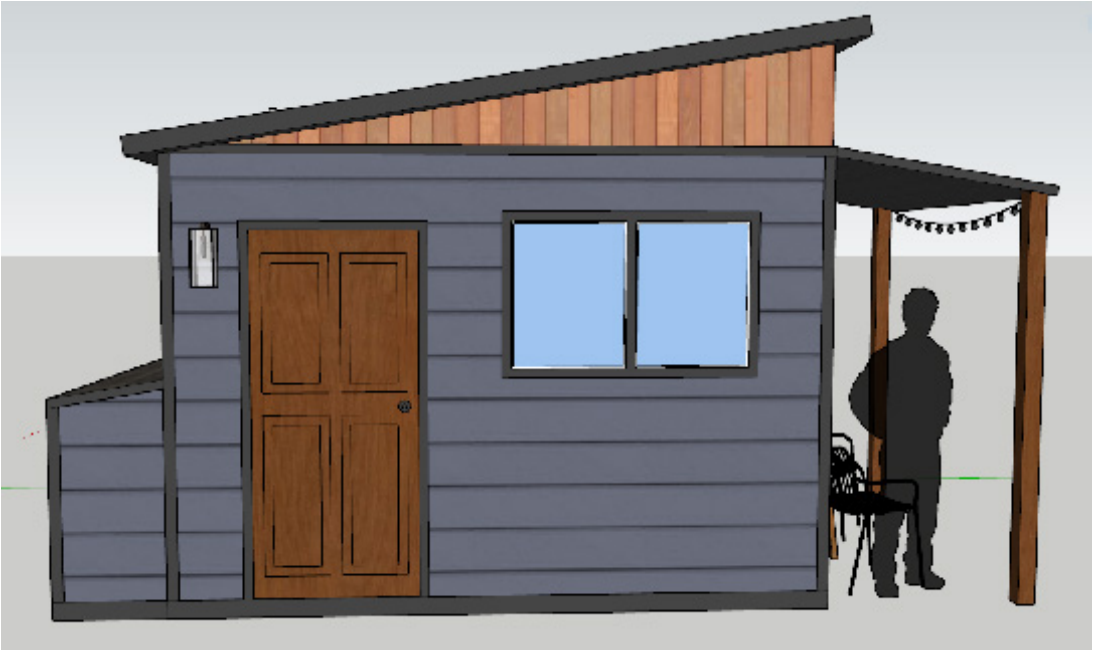
Item	Quantity	Each	Total
Used Storage Vault (5'x7'x7' 10")	1	\$ 200.00	\$ 200.00
Klimps/metal clamps (included with vault)	20	\$ -	\$ -
Ridged XPS Foam Board Insulation (2"x4'x8')	8	\$ 30.00	\$ 240.00
Ridged XPS Foam Board Insulation (1"x4'x8')	2	\$ 20.00	\$ 40.00
1/4 in. x 2 ft. x 2 ft. plywood	8	\$ 7.00	\$ 56.00
Nature Power Solar Panel Power Kit — 110 Watts	1	\$ 150.00	\$ 150.00
DeltaMAX Ceramic Portable Heater, Black, 110V	1	\$ 30.00	\$ 30.00
Ceiling light fixture	1	\$ 12.00	\$ 12.00
Lightbulb	1	\$ 3.00	\$ 3.00
12" Bubble window	2	\$ 20.00	\$ 40.00
2.5" Corrugated 2-ft x 8-ft Corrugated Metal Roof			
Panel	8	\$ 15.00	\$ 120.00
23/32 in. x 4 ft. x 8 ft. Plywood	2	\$ 40.00	\$ 80.00
4 in. x 4 in. x 10 ft. wood (for bed legs)	1	\$ 12.00	\$ 12.00
2 in x 4in x 96 in (for roof)	5	\$ 3.00	\$ 15.00
1 in. x 1 in. x 36 in. Wood Square Dowel	1	\$ 3.00	\$ 3.00
Hinges	7	\$ 4.00	\$ 28.00
Slot lock w/ pad lock	2	\$ 10.00	\$ 20.00
Metal handle	2	\$ 5.00	\$ 10.00
Quick 'N Easy Vinyl Comfort Mattress	1	\$ 150.00	\$ 150.00
wall mounted 5 x coat hooks	1	\$ 10.00	\$ 10.00
<b>Total</b>			<b>\$ 1,219.00</b>



# Design Team 4: Sleeping Unit 5

This sleeping unit measures in with 96 square feet of interior space (8'x12'). Outdoor storage and covered, private seating area provide comfortable amenities without adding to construction costs. Total cost for this project is estimated at \$6,205.

If solar and rechargeable energy technologies are forfeited in construction, this unit could cost as little as \$4,000 to construct with new materials. Using recycled materials could further reduce construction costs dramatically.





# Design Team 4: Sleeping Unit 5

**Materials and Cost:**

**Plywood:**  
 720 square feet of 1/2 inch plywood @ 32 square feet per sheet = ~25 sheets of plywood  
 Cost: \$500

**Drywall and Insulation:**  
 510 square feet of drywall @ 32 square feet per sheet = ~17 sheets of drywall  
 510 square feet of R-13 fiberglass insulation @ 32 feet per roll = ~17 rolls  
 Cost: \$765

**2x4 Lumber:**  
 75 2x4s  
 Cost: \$225

**Siding:**  
 2 packets of barn style wood siding (\$75)  
 12 pieces of trim (\$9 per)  
 48 pieces of 8.25x12' fiber cement siding (\$9.50 per)  
 Cost: \$715

**Roof and Flooring:**  
 190 sq/ft roof @ 38 sq/ft roofing packet = 5 packets  
 100 sq/ft underlayment  
 100 sq/ft of marmoleum flooring  
 Cost: \$500

**Misc Construction/Electrical:**  
 Wire, light fixtures, heater/air circulation, nails, screws, paint, joints, lumber, door, windows, Tyvek, tiger paw, hinges, post brackets, anchors, hangers, 4x4 lumber/foundation materials, etc.  
 Cost: \$1,500

**Solar Energy System:**  
 4 solar panels & 1 car battery  
 Battery/recharge station  
 Cost: \$2,000

**Assembly:**

**\*Important\*** Construction of this unit will require a team of volunteers and guiding knowledge of construction. It is imperative to follow the City's inspection/construction schedule requirements for assembly of this unit and to ensure compliance with safety standards to make sure users are protected. Construction should be supervised, and each stage should be inspected to ensure quality control. The following is a brief overview of the order in which assembly will take place.

First, construct the subfloor of the unit. The subfloor will be secured to a semi-permanent foundation (whether that means put on blocks, secured/placed on gravel, etc.) is the necessary first step. After the subfloor is constructed and secured, anchor load bearing lumber to the floor. Proceed to complete framing

by adding 2x4 posts between anchored ones every 15 inches. Once framing is complete (including the roof and blocking where necessary), nail plywood to the exterior of the building, spacing nails every ten inches on posts and every three inches around doorframes, window frames (and wherever else required by building code).

Once plywood is secured, complete roofing and apply Tyvek to exterior of the building. Then install fiberglass insulation between 2x4 posts (insulation sheets/rolls will fit exactly between posts). Proceed by installing electric system. Once insulation and electrical is installed, hang drywall. Secure drywall joints with drywall tape, and then finish with drywall mud. Return to sand/level off mud when dry. At this point, proceed by painting the interior of the building. Install floors and interior molding/trim after painting. Install windows



# Design Team 4: Housing Site



The common facilities including the toilets/sinks and showers are located in the center of the site so that everyone can be in relative proximity of them, and the kitchen/social spaces including a covered outdoor gathering space are located in the lower right corner, where we have located a resident pedestrian entrance, because it is right near the bus stop.

The main sleeping units selected are 8' x 12', are of simple construction, and utilize green roofs to offset the urban heat island effect of an all asphalt surface for the settlement. We also chose to include another, more compact sleeping unit design to include as temporary emergency shelters for those who need it. These smaller units are 5' x 7' and are more bare in features to provide shelter for anyone in need on a short-term basis. In the site plan shown here, we chose to disperse the different types of units throughout the settlement in a way that centers around the central common facilities, with units facing each other to create a better sense of a neighborhood-like feel. These units could also be reoriented to all face the center as well as an alternative idea.

**House Site accomodates**

- (36) 8' x 12' tiny houses
- (20) 5' x 7' emergency shelter housing
- (1) 36' x 20' bathroom facility
- (1) 16' x 24' counseling center
- (1) 1580 ft<sup>2</sup> kitchen and canopy area
- (3) parking spaces
- several raised sidewalk garden beds

As the site is paved in asphalt in an area not shielded from the elements by any large vegetation, green roofs were utilized on some of the units to help keep units cooler and cut down on energy costs. They can also help provide a more pleasant aesthetic to the surrounding neighborhood, especially in the case where neighbors might not be very receptive to a homeless settlement next door. However, green roofs have been shown to increase local property values. There is a higher cost on initial installation in maintenance, but provides a reduction in stormwater and energy costs while providing a healthier environment for the community.

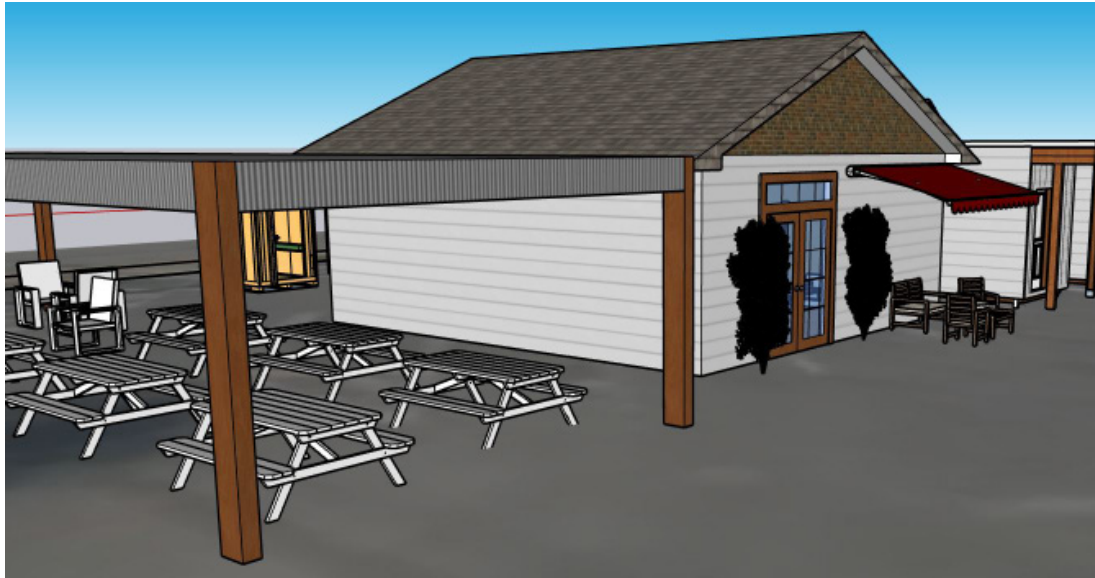


# Design Team 4: Counseling Center



The counseling center has been placed slightly off site in the municipal court house second parking lot for the comfort of it's users. The counseling center can be constructed by combining 4 of the green roof tiny house units and removing interior walls. It's green roof design helps to insulate sound and it's location off site also helps so users may not worry about prying ears.

The shared kitchen and outdoor covered area both incorporate solar panels on their roofs, acting as energy hubs for the shared facilities and non-solar paneled units. Having a large outdoor covered area was important for building community. Locating the canopy near the pedestrian entrances also doubles it as a security hang out spot.

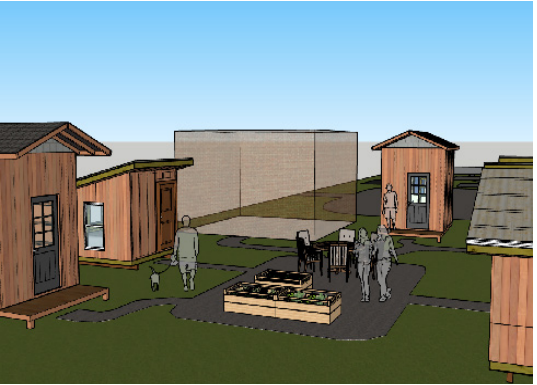


The shared bathroom and showers are located in the center of the site.

Element Type	Quantity	Est. each	Total
5' x 7' Solar Sleeping Unit	20	\$1,300	\$26,000
8' x 12' Green Roof Sleeping Unit	31	\$3,473	\$107,663
8' x 12' Solar Sleeping Unit	9	\$2,000	\$18,000
Counseling Center buildings	1	12,155	\$12,155
Community Kitchen Building	1	\$30,000	\$30,000
Covered community area	1	\$200	\$200
Bathroom/Showers	1	\$25,000	\$25,000
9' x 15' raised beds w/ soil	12	\$200	\$2,400
<b>Total</b>			<b>\$221,418</b>

# Design Team 5: Cornwall on the Waterfront

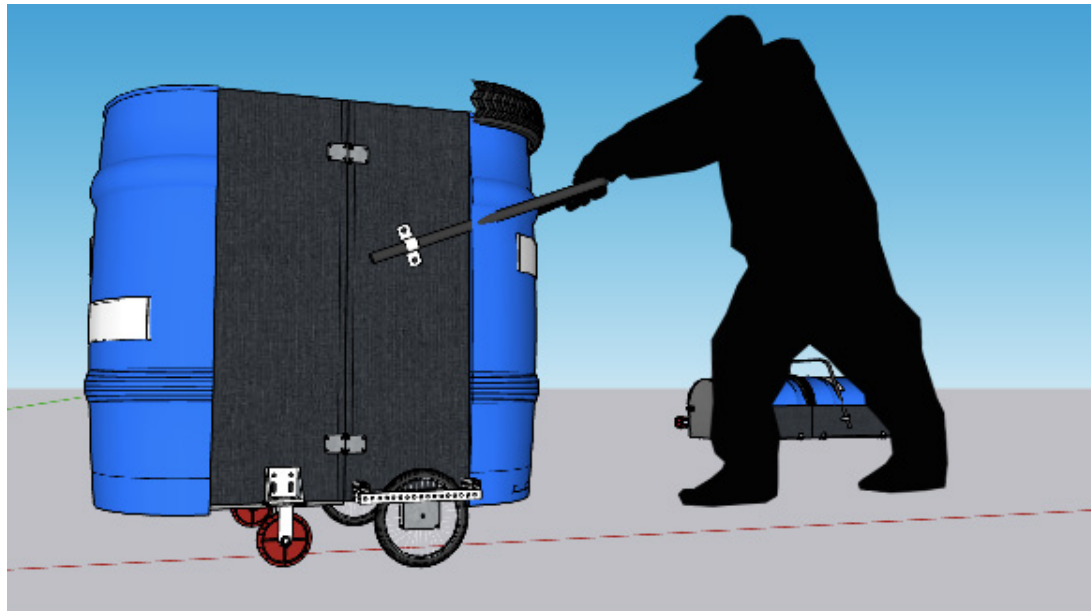
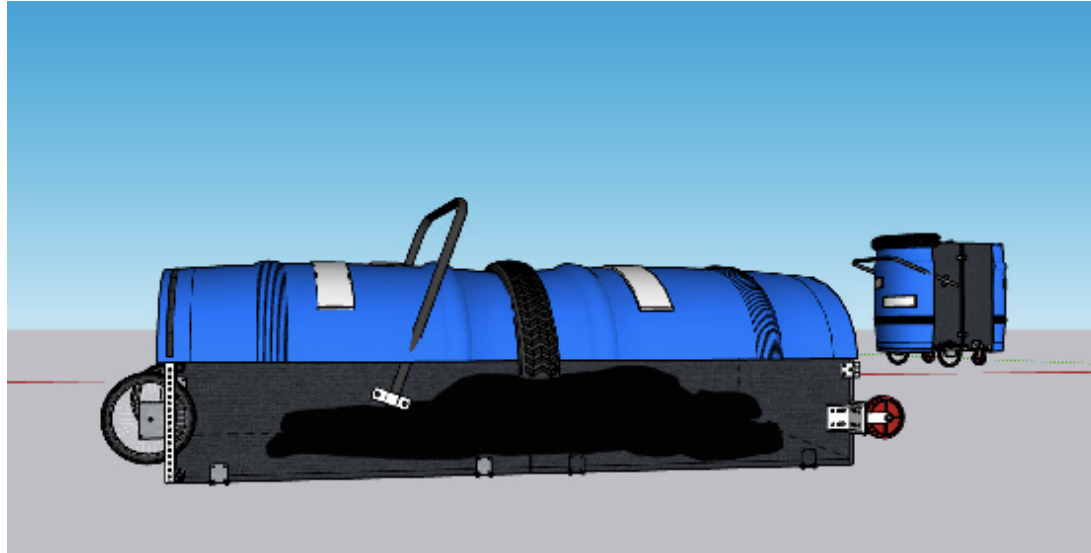
Students authors: Alex Mayberry, Molly McGuire, Jiarrell Michael, Madelyn Nelson, Claire Swearingen





# Design Team 5: Shopping Cart 1

The rain barrel shelter is a folding shelter made out of a rain barrel, plastic plywood, and corrugated plastic. The design prioritizes durability and security with a fully hard-wall shelter to sleep in and store belongings. With simple hardware such as barrel bolts, hinges, and casters, the shelter locks, folds, and can be rolled to the next location. Folded in half, the cart locks, is mobile, and is ready to store belongings. Laid down, shelter can lock, and keep someone safe, dry, and warm. The overall cost of the shelter would be \$502 (full budget, materials list, and assembly instructions available upon request)



# Design Team 5: Shopping Cart 2

This shopping cart alternative is intended for an individual who is experiencing homelessness to use as a safe place to store their things when grocery shopping, looking for a job, using services, or any other activity where one might need to leave their belongings for a period of time.

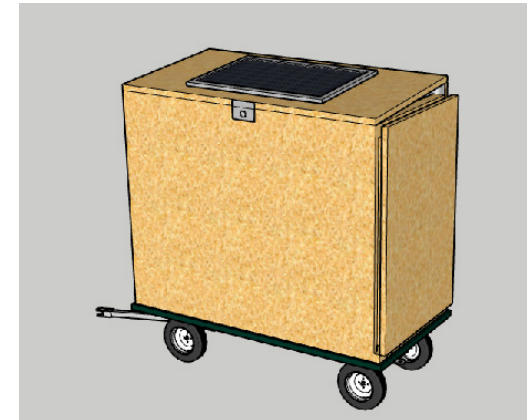


Figure 2.1: An image of the cart closed up and ready to be moved or locked up and left.

The cart stands at about 4' tall, and is built on top of a heavy duty utility wagon that can be pulled for easy transport. Construction of this cart should be completed with the help of a nonprofit organization since a power drill should be used to ensure stability and security. The exterior of the cart can be painted by the owner to add an element of personal expression.

The end of the cart opens up to a sleeping space that measures 7' long and 2' tall, the opening of which can be covered with a custom made tent-like piece, or with an insulated blanket. The inside of the sleeping area is

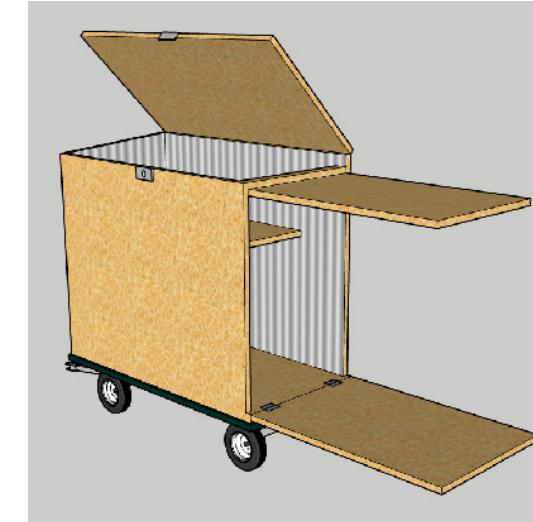


Figure 2.2: This image depicts the cart in its completely open state. The bottom portion is the sleeping area.

lined with insulated wall coverings to retain heat in the winter and repel heat in the summer. A solar panel and solar powered generator provide enough electricity for minimal lighting and phone charging needs, and a lock on the top and side allow for safe storage of personal items. A shelf above the sleeping unit provides ample space for these personal items. In addition, the entire cart can be covered with a simple tarp to protect it from rain water.

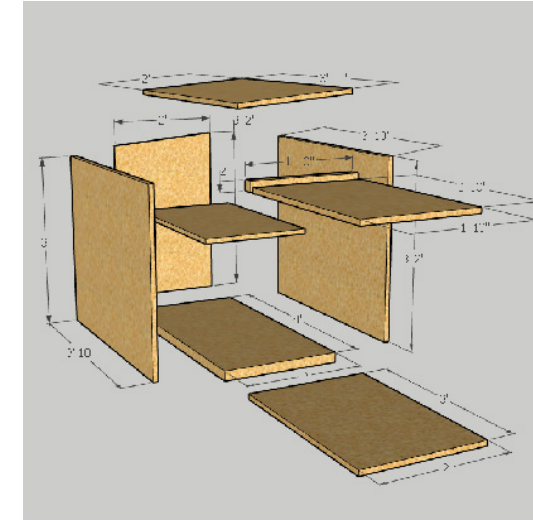


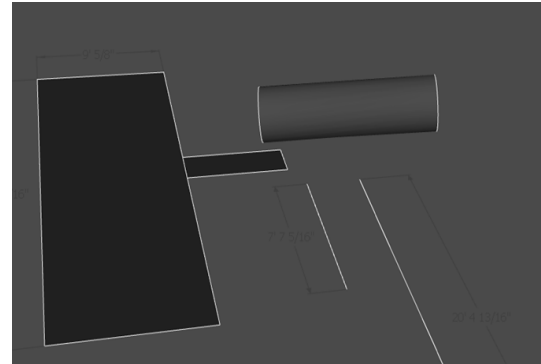
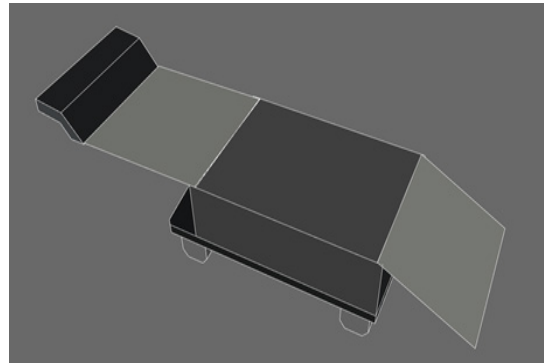
Figure 2.3: This image shows the cart's individual pieces before construction.

- Materials List & Cost
- Pine wood pieces - \$40
  - Screws, locks and hinges - \$20
  - Utility wagon - \$70
  - Insulated bubble roll - \$50
  - Insulated thermal tarp - \$20
  - Tarp for rain protection - \$20
  - Sleeping pad - \$20
  - Sleeping bag - \$20
  - Solar panel - \$100
  - Solar powered generator - \$200

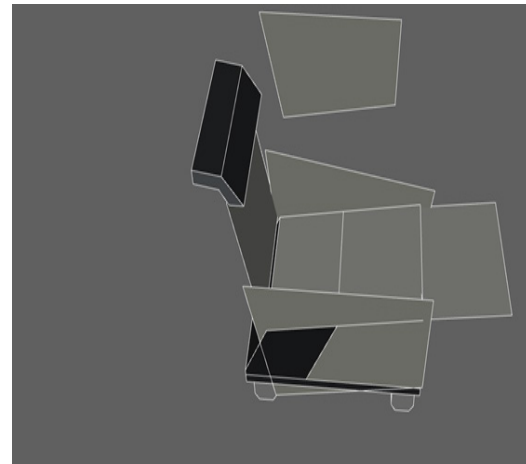
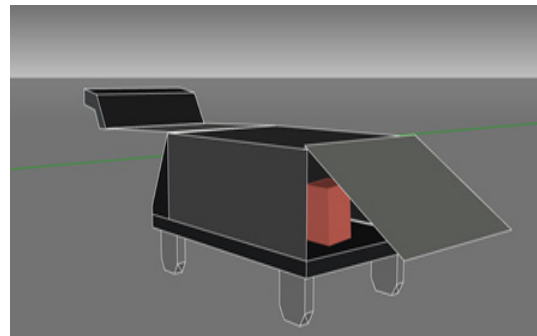
Total Cost - \$570

## Design Team 5: Shopping Cart 3

The "Camper Cart" is a multi-function large dimension cart that can be converted into a comfortable platform for sleeping and moving large objects. The average size a typical shopping cart is 33 in x 20 in x 37 in (LxWxH), but the Camper cart is whopping 5 ft x 2 ft x 2 ft to better accommodate a resting person. Once the Camper Cart has been fully assembled, a large tube that is located beneath the storage compartment of the cart. In this tube, a person can find a large weather-proof tarp and camping poles.



In order to house a person comfortably, the Camper Cart's sides can be lowered by releasing a latch on the side of the cart.



Once all rear latches have been released, all side of the Camper Cart can side down, allowing for more towing capabilities such as moving large payloads of personal things long distances.

## Design Team 5: Shopping Cart 4

Shopping carts are a valuable amenity among homeless individuals due to their versatility, mobility, and the large supply found easily at any big box store. However, the shopping cart lacks in several major ways, like weather protection, safety, and comfort. The design limits some of the negative aspects of street living. It is essentially a retractable tent cot on wheeled drawer cart. It is constructed mostly out of lightweight plastics, with wood for the bed frame and metal for the legs. Remaining light weight was vital to assist the mobility of the user.

A handle allows a way to push the cart. There are four drawers which measure about a foot deep each. A tarp placed over each one provides weather protection.

While compacted, the design measures 3' wide x 3'5" long x 3'2" tall. When folded out, it is 3' wide x 7' long x 4'2" tall. The sleeping compartment is about 2 feet wide and tall, including the mattress.

### Materials & Costs:

- Double sided drawer cart (four 22" metal pegs, four wheels with locking capabilities, four plastic drawers (two 9"\*20" & two 12"\*20", and metal sliders) (\$300-\$450).
- Tent cot (\$170-\$200).
- Wood surface equivalent to two 27"\*25"\*1" and one 10"\*25" (\$40-\$70).
- Hinges for the wood (\$25-\$40).
- Four velcro straps 14"\*1" (\$20-\$30)
- Leg for cot 29" long 21" wide (\$50-\$100)
- Tarp (\$5-\$20).
- 120 inches of heavy duty zipper (\$5-\$20).
- Plastic mattress (\$100-\$150).
- Industrial glue (\$20).

Total cost: \$740-\$1,100

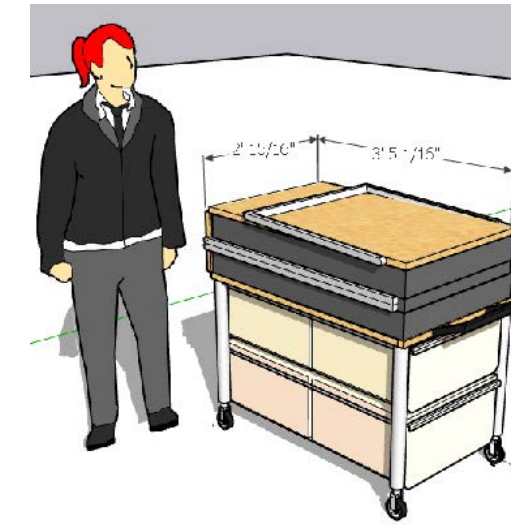


Figure 4.1: This bare bones version shows the drawers and folding logistics more clearly



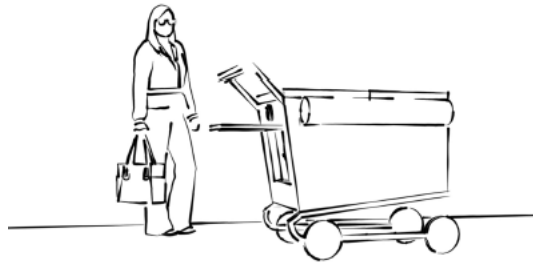
Figure 4.2 highlights the weather protection for the drawers and cot.



Figure 4.3: The final form of the folded out cot. While it is suggested to purchase the tent, it could also be DIY'd. In this image, the tent is just five pieces of trapezoidal tarp strung from two light weight supports with velcro straps. The supports are held up by the velcro, which is simply undone when it is time to fold it.



# Design Team 5: Shopping Cart 5

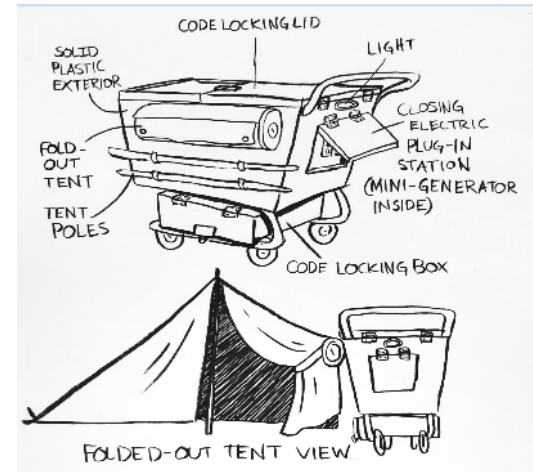


### Materials

- Metal shopping cart frame
- Plastic panels
- Tent materials
- Metal locking box
- Generator and electric connections

This cart was designed for use by individuals experiencing homelessness to provide better mobility, security, shelter and access to power. Someone who might use this cart may prefer not to stay in shelters or use housing services, and would prefer to have the option for mobility.

The cart functions like a retrofitted shopping cart, and would use a standard metal shopping cart frame. The body of the cart would be constructed out of solid plastic panels. Inside the cart, a mini generator would provide light and power. A tent rolls out of the side to provide shelter, and the secure box underneath can be accessed from inside the tent. All openings lock with a code padlock.

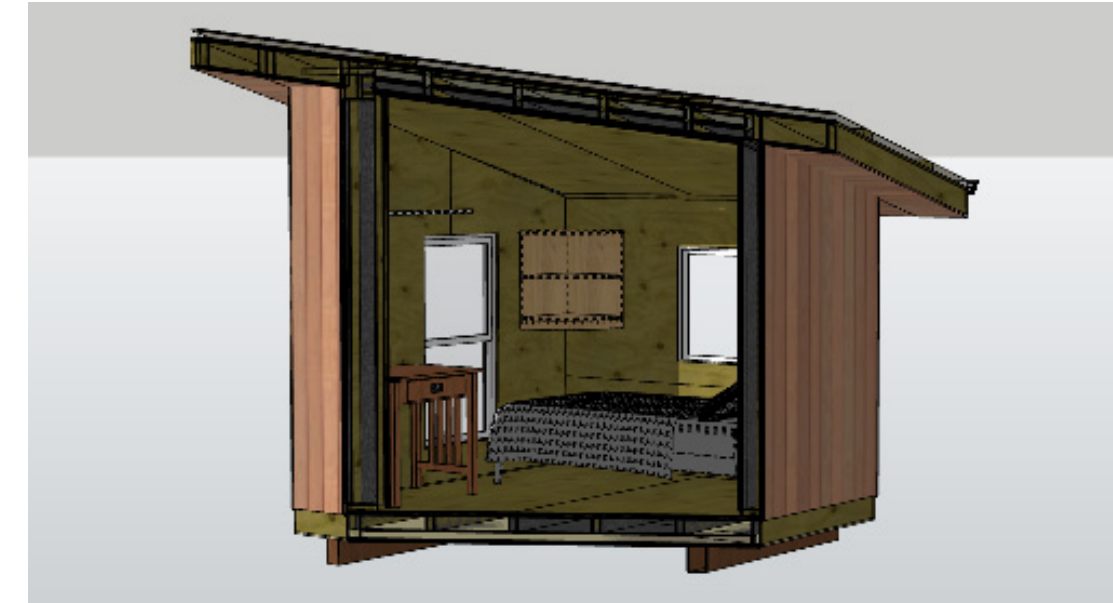


### Construction

1. Screw plastic body to frame and attach lid
2. Attach lockbox to frame
3. Attach tent apparatus
4. Connect generator to electric outlets and light

# Design Team 5: Sleeping Unit 1

The design balances the values of using affordable materials with low embodied carbon as efficiently as possible. The building is based on an 8' x 8' cube with the roof cutting through it at a standard 3/12 pitch. The eave has been extended on the south facing side to block the window from direct summer light according to passive design guidelines. The roof slopes down toward the south allowing rooftop solar panels. Plywood rather than OSB is used on all interior surfaces to avoid excessive and hazardous off gassing but used OSB for exterior sheathing. The shelter is modular and can be constructed in rows which can conserve



Material	Dimmension	Price	Quantity	Cost
Ultra touch denium insulation	4" x 16" x 47"	0	72	0
Cedar siding 6 pc	1" x 6" x 96"	100	10	1000
2x4 stud	2" x 48" x 96"	3	40	120
4x6 skid treated	4" x 6" x 96"	22	2	44
2x6 joist/ floorboard	2" x 6" x 16"	9	20	180
2x6 joist hangers		0.75	20	15
plywood (finish/optional)	.75" x 48" x 96"	38	4	152
ridged foam insulation	2" x 48" x 96"	30	12	360
osb	5" x 48" x 96"	10	15	150
plywood	.5" x 48" x 96"	18	10	180
door	36" x 80"	20	1	20
window	29.75" x 53.25"	180	2	360

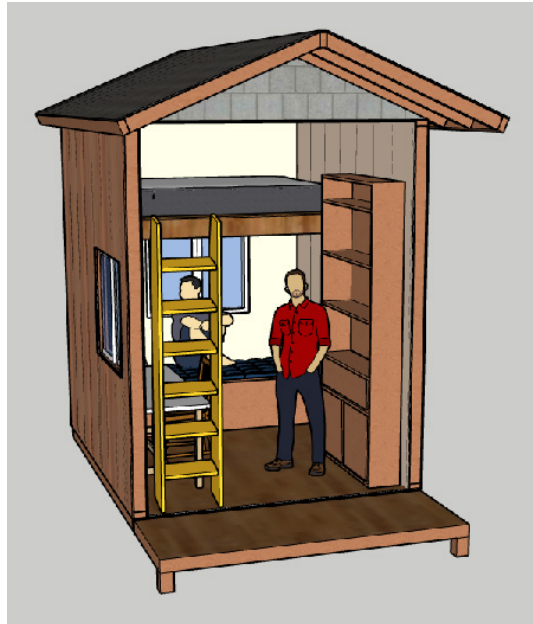


# Design Team 5: Sleeping Unit 2

This sleeping unit is intended to be used by two people experiencing homelessness to live for a period time in a community setting established by the City. The unit features a lofted double bed, desk, wardrobe, storage bench, and a small porch intended to facilitate socialization within the community. To emphasize individuality, the wood exterior of the units can and should be painted by the resident.

This unit is built on a raised foundation that allows for easy transport. It should be constructed with the help of a nonprofit organization with some experience in home construction.

All materials used should be locally sourced, directly from lumber yards and construction stores in the area. Furniture should either be built from scratch or found secondhand.



This unit provides ample room for two people to live comfortably with about 800 square feet of space. The interior is furnished with a desk for doing work or eating a meal. The storage bench at the back of the room provides a decent amount of storage while doubling as a couch or extra bed. A wardrobe can be used to store clothes, books, and other personal items and the top shelf is accessible from the bed for any bedside items needed. The ladder (shown in the stored position in the image above) can be moved to the center of the room when access to the bed is desired. It is easily tucked between the desk and wall when not in use.



### Materials & Cost

#### Construction:

- Framing - \$500
- Siding - \$400-\$500
- Insulation - \$150
- Drywall - \$300
- Roof - \$200
- Windows and Door - \$150

#### Accessories:

- Full size mattress - \$500
- Storage bench - \$75-\$200
- Wardrobe - \$100-\$300
- Desk and Chair - \$130-\$180
- Ladder - \$50
- Electricity - \$300-\$500
- Porch - \$100

**Total Cost - \$2700-\$3800**

The shelter design is a 100% Plastic, which will also for easy assembled and taken down when deemed necessary. Being made mostly of plastic also allows for easy cleaning and a low overall cost as well. Built from industrial grade PVC Sheets and steel bots, this unit is guaranteed to last for many years making it more ecofriendly compared to wooded shelters. This shelter unit's assembly is a breeze, simply arch three PVC sheets on top of two plastic pallets and fasten with steel door hinges and bolt at corners.

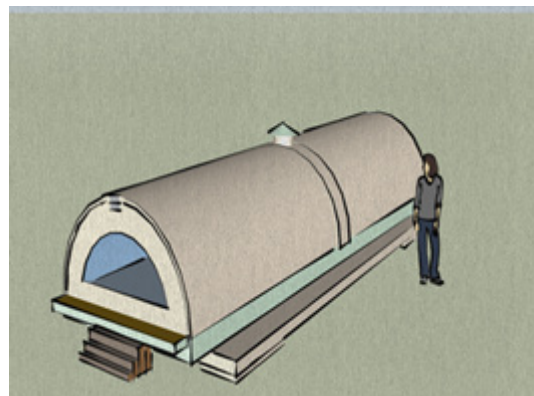


Fig.1 Show the outer Dimenisons of the unit: 16Ft. X 9Ft (L x W)

# Design Team 5: Sleeping Units 3

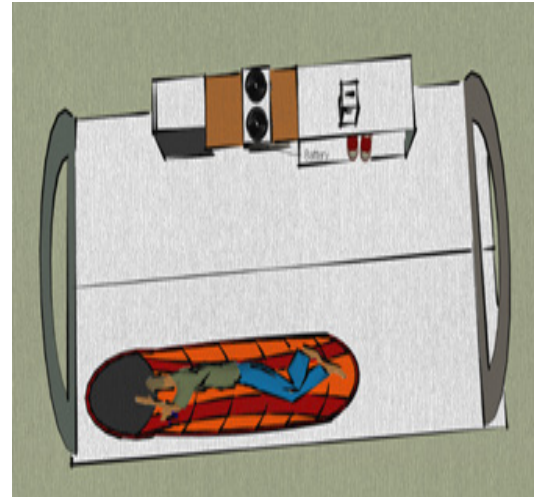


Fig.2 &3 Shows a tenet sleeping in the unit

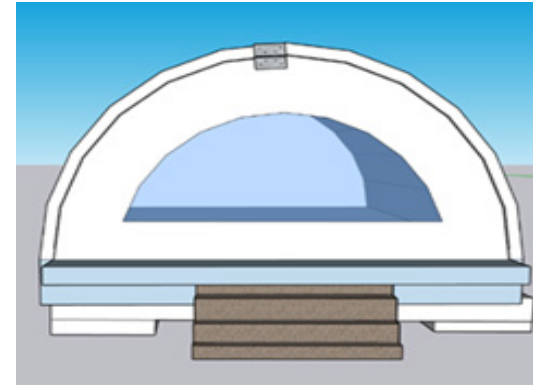
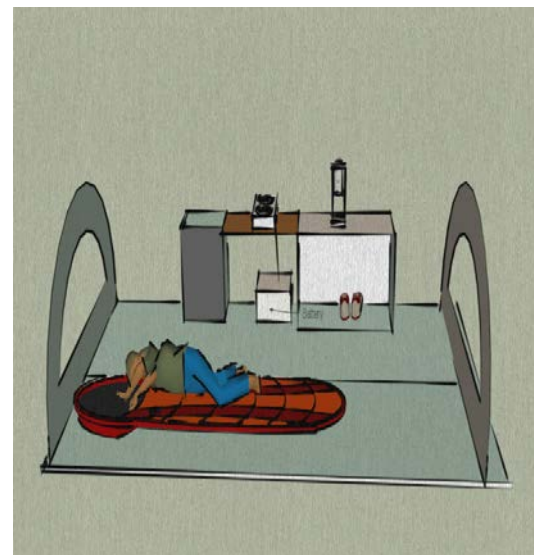


Fig. 4 show the front of the unit dimensions of 9 Ft. x 10 Ft. (W x L)

### Material list:

- 16" x 9 Ft PVC Plastic panels: 5X@ \$103= \$515
- Pre-made Plywood staircase: \$ 105
- 5 x4 half cylinder Clear PVC panel: 2x @ \$25 = \$50
- L.E.D Lamp and sleeping bag= \$40
- Hot Plate= \$20
- Plastic Shelves: \$200
- Bolts and latches: 20@ \$4=\$80
- Solar powered battery=\$1000
- Plastic 4x6 pallets: x2@ \$200= \$400

Total cost: (material + custom cuts=\$600) = \$ 3015





# Design Team 5: Sleeping Unit 4

For this design, the priorities included keeping cost as low as possible and still providing shelter. The housing is minimal and aims to provide just a sleeping area and secured storage for a singular person. The shed is entirely constructed on two pallets for mobilities sake. It would be easy to pick it up and move it when necessary.

The small living space cuts down on cost immensely and also makes construction much more simple. Included in the design is multiple objects to assist living, these are listed at the bottom of the next section.

- Materials and Cost:**
- 2 wood closed-board pallets (\$200)
  - 65"x32" Simple door with window (with hinges & lock) (\$150)
  - Plywood sheets (total \$180)
  - Two 8' x 5'6" x .5" exterior grade
  - Two 4' x 6'6" x .5" exterior grade
  - Two 7'6" x 5'6" x .5"
  - Two 3'6" x 6'6" x .5"
  - Two 8'4" x 5' x .5"
  - Eight 5'6" 2x2's (\$50)
  - 60' squared of sturdy lumber (\$90)
  - 140' of wool insulation (\$200)
  - Two 1' x 2'6" windows (\$350 total)
  - 8'4" x 5' of asphalt shingle roofing (\$40)
  - Nails (\$10)
  - Glue (\$30)
  - 6'2" x 6" x 25" mattress (\$190)
  - Cooler (\$25)
  - Crank battery (\$200)
  - 2 gallons of water (\$5)
  - 5' wall mirror (\$50)
  - Heater/fan (\$30)
  - Black-out rolling curtain (\$20)
  - Gallon of exterior paint of your choice (\$20)

Total Cost: \$1,840

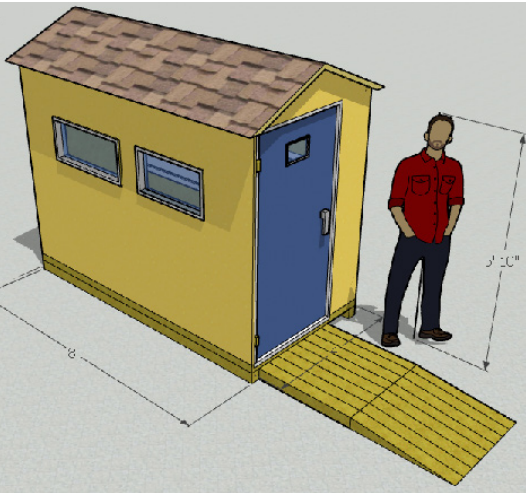


Figure 4.2.1 depicts the exterior of the shed. The dimensions are 4' wide x 8' long x 7' tall at the peak.

Constructed out of simple wooden boards insulated with wool. The exterior should be painted to protect the wood further. Ideally, the color should be chosen by the inhabitant. The roof is asphalt shingles to cut down on costs. There are two windows

The entrance to the shed can include a ramp if necessary. The door needs to be lockable and should include a small window or peephole. There should also be windows in the wall for natural light and also as an alternative exit in case of an emergency.

The biggest advantage to a compact design is it saves on space and is also extremely cheap. In the total given budget of \$7,000, nearly four of these sheds could be built.

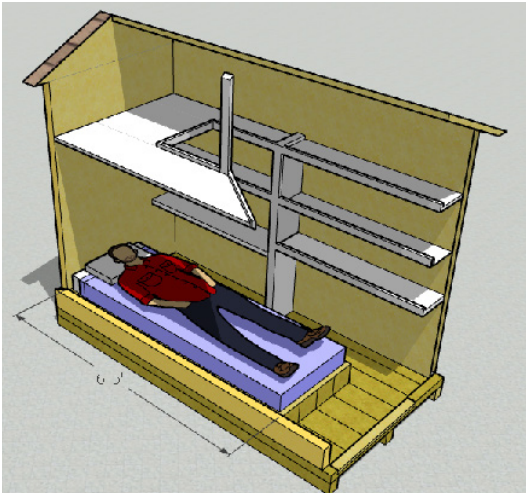


Figure 4.2.1 is the interior of the shed.

The unit includes a maximal amount of shelving along with a desk/shelf duo a next to the head of the bed. The resident can sit on the bed to use the desk. This saves on space while providing an area for working.

- Included in the furniture is some other objects:
- cooler to store food and helps save money by reducing risk of spoilage;
  - A crank battery to produce electricity. It was decided that a solar power would be unhelpful considering the resident would be most likely to use electricity at night;
  - A couple gallons of water for personal use.
  - A 5' wall mirror for grooming;
  - A combo heater and fan for heat control, and;
  - Black-out rolling curtains for privacy.

Due to the small size of the space, many of the necessities for life would need to be found outside.

# Design Team 5: Sleeping Unit 5

**Cost estimation methods and assumptions:**

Construction would be DIY or volunteer labor, no labor costs except electrical work

Wherever possible, materials would be salvaged or secondhand

Low-cost options for fixtures, materials, and furnishings were used for cost estimates

Construction cost estimates based on low-range costs for standard tiny home construction

**Construction steps:**

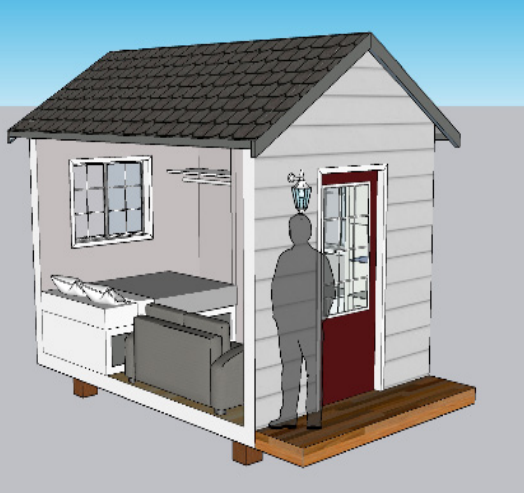
Phase 1: Install pier foundation, build house frame and floor

Phase 2: Construct walls, bed frame, and closet unit; electric and insulation installation

Phase 3: Install windows, door, siding, and roof

Phase 4: Paint interior and exterior, install lighting and finish electrical work

Phase 5: Clean and furnish



**Materials and Costs**

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Construction:</p> <ul style="list-style-type: none"> <li>Sliding windows: \$450</li> <li>Front door: \$250</li> <li>Lumber: \$1,000</li> <li>Asphalt tile roof: \$160 for 107 sq. ft.</li> <li>Engineered click-together flooring: \$95 for 96 sq. ft.</li> <li>Polystyrene panel insulation: \$1,000</li> <li>Wall paneling: \$500</li> <li>Wiring and electrician services: \$1,500</li> <li>Paint: \$100</li> <li>Nails, screws, etc: \$500</li> </ul> | <p>Interior:</p> <ul style="list-style-type: none"> <li>Bed frame with storage space: \$300</li> <li>Mattress (does not require box spring): \$200</li> <li>Desk: \$60</li> <li>Cabinet: \$150</li> <li>Sofa: \$150</li> <li>Desk chair: \$20</li> <li>Side table: \$20</li> <li>Bedlinens, 1 full set: \$90</li> <li>Clothes rail: \$10</li> <li>Hangers: \$4</li> <li>Room divider rail: \$50</li> <li>Divider curtain: \$15</li> <li>Rug: \$30</li> <li>Infrared wall heater: \$80</li> <li>Lighting: \$200</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Total: \$5,555

Final cost: \$6,934





# Design Team 5: Settlement Site Plan: Cornwall Avenue Site

Both residents and city officials have witnessed an increase in the need for temporary housing in Whatcom County, and demand increases more each year. Cities like Bellingham have adopted “housing first” policies that aim to provide more homeless residents with housing. For this assignment we were asked to design a temporary settlement site capable of accommodating 40 sleeping units with access to showers, restrooms, kitchen, social and counseling space. The site is also accessible to transit, public facilities, and services. It is more ideal for most people to find a permanent place of living. After all, the only real solution to homelessness is to give people homes. To start off with, a quick introduction of the parcel is below via satellite image, in figure 6.1

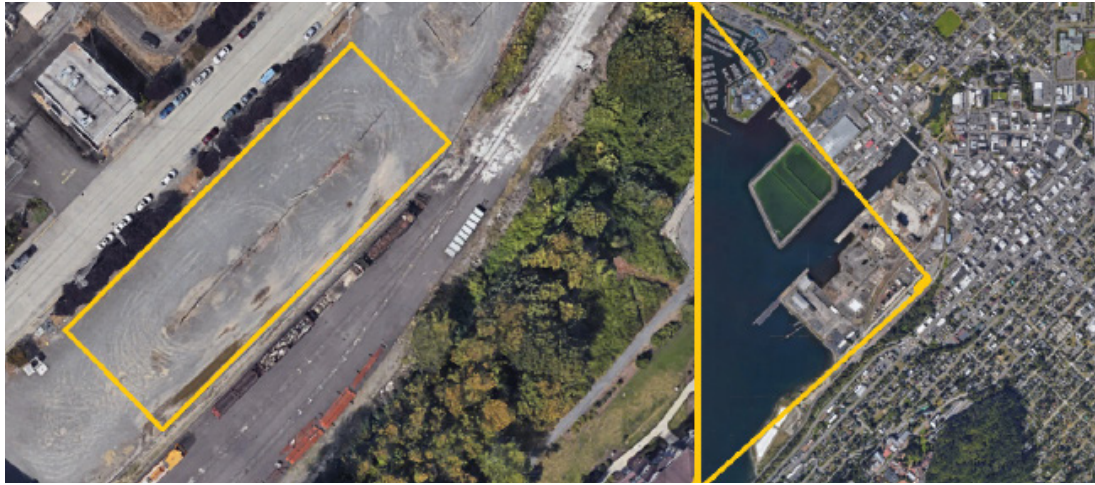
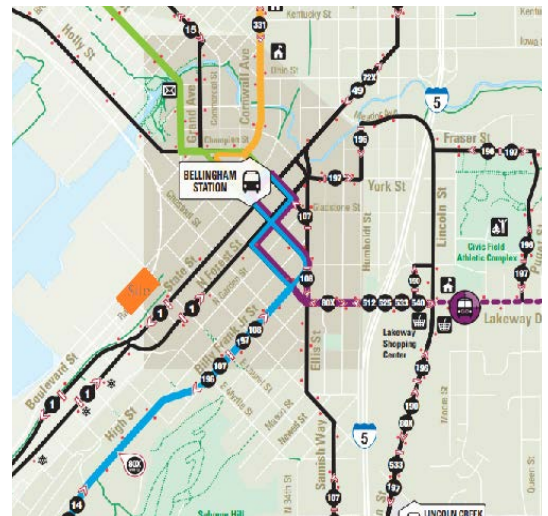


Figure 6.1 The site is located in the industrial waterfront area, near downtown.



**Locational Attributes**  
 The site located at 900 Cornwall Avenue is the focus of the proposed settlement site plan. Sitting less than a quarter-mile from the Bellingham Farmers Market, the lot is part of the city center neighborhood and borders the industrial zone on the waterfront. The site is located close to active train tracks, which could impose environmental stressors on the community such as noise pollution. A positive benefit from this location is that there is likely a lack of competing urban uses which would allow for a more permanent community establishment.

Figure showing transportation access (Fixed Route, n.d.).

The lot’s proximity to downtown Bellingham means guaranteed access to many amenities and public transportation, with a ten-minute walk (0.5 miles) to Bellingham Station. Figure X.X (TRANSIT MAP) depicts nearby transit lines. The lot is also located:

- .7 miles from Unity Care (13 min walk)
- .9 miles to Bellingham Foodbank ( 19 min walk)
- .3 miles to Bellingham Opportunity Council (3 min walk)

# Land Use & Utilities

Figure 6.3 depicts the surrounding land uses for a quick idea of the area. It is in the middle of an industrial area and backs up against a hill. Downtown is situated on the hill right above it, with apartments able to look over the site.

The site measures 42,812 square feet (0.9828 acres) with estimated dimensions of 350’x120’. It is currently owned by the Port of Bellingham and is used as a general parking lot for visitors to the nearby park and adjacent businesses. The lot is covered with gravel and lined with eleven trees on the street side, creating a buffer between the proposed community and traffic. The current zoning classification is Urban Village, which dictates pedestrian-oriented policies like reduced parking requirements and mixed used development.

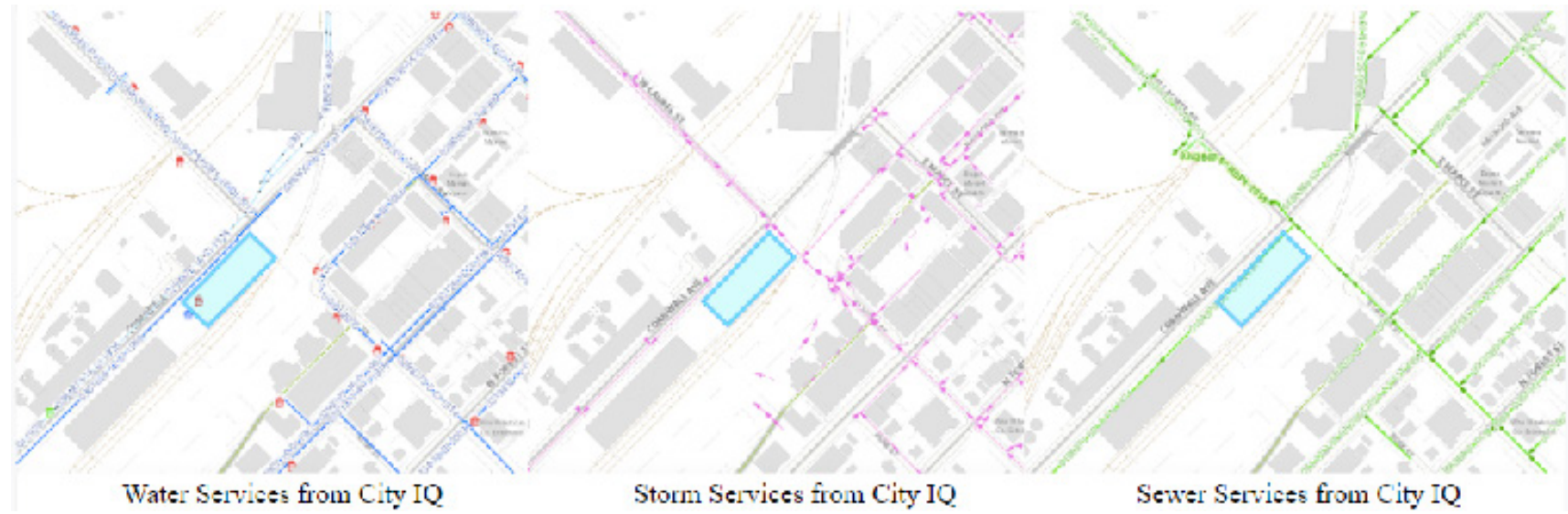
900 Cornwall has direct access to water, storm, and sewer lines.

900 Cornwall Avenue also has direct access to sewer, storm, and water lines. This means there should be no problem providing these necessary resources to the residents and should be relatively inexpensive to install. Figure 6.4 is a visual of various utility proximity and access.

After finally covering the site’s basics, we can move on to the settlement site plan, shown in figure 6.5.



The uses surrounding the site are mostly industrial.





# 900 Cornwall Site Plan

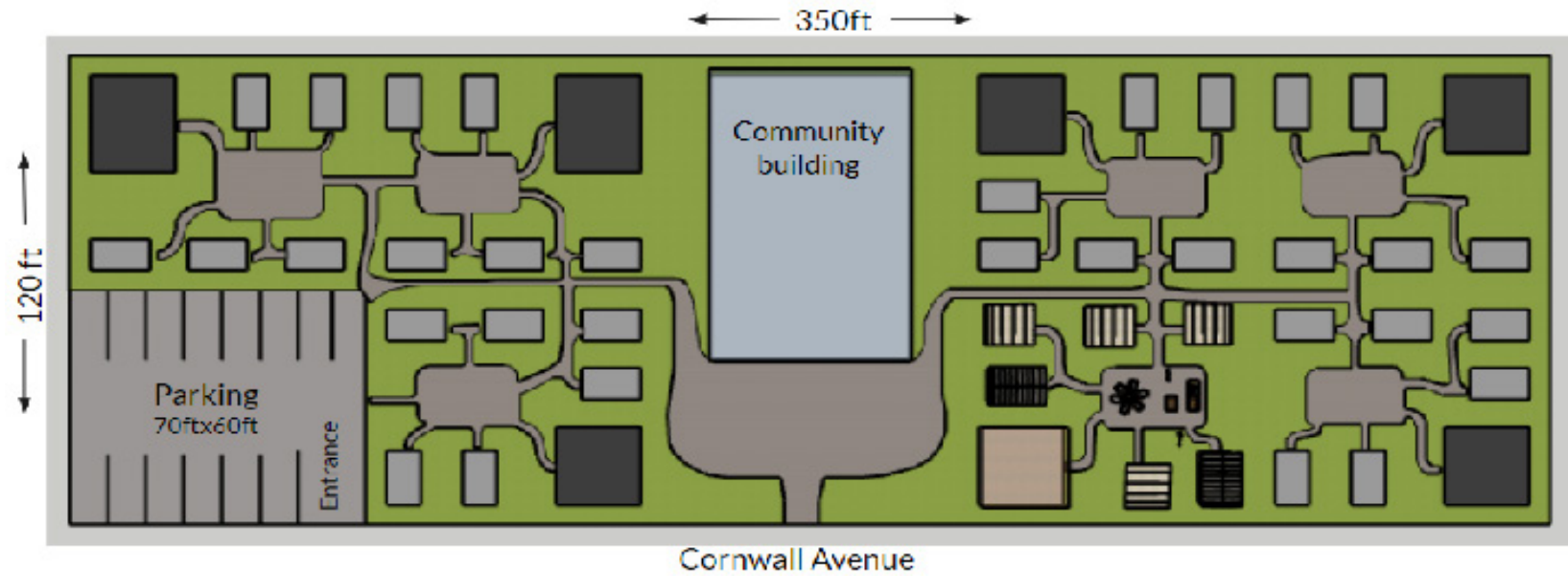


Figure 6.5 depicts the final design for the site plan of 900 Cornwall.

There are seven clusters of five to six sleeping units, which are shown in light gray. In the center of the site are the common facilities building and common outdoor space. Parking access on the north-west side of the lot from Cornwall Avenue provides an entrance while walking paths allow pedestrian movement within the site. Ideally, any of the paving done would be permeable to reduce the risk of flooding.

Each cluster has its own conjoined bathroom and shower facility, shown in dark gray. The space in the center of each cluster is a shared outdoor space that may include gardening space or outdoor lounge space. A labelled diagram of a cluster can be seen in figure 6.6.

Each cluster has 2 double units and four singles. With seven clusters and a total of 39 units, there is a housing capacity of 51 residents. This is with 12 doubles and 27 singles. The capacity can be adjusted by changing the ratio between single and double housing units. The minimum is 40 and the maximum is 80 residents.

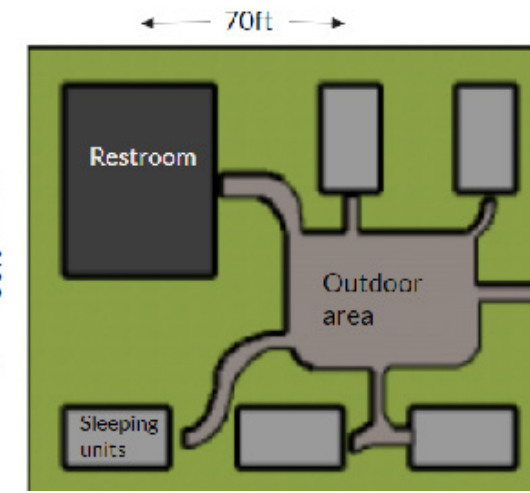


Figure 6.6 A close up of a cluster.

# Community Building

The central community building has two offices, one classroom, three single occupant bathrooms, laundry room, multipurpose room, and large shared kitchen. The whole space is ADA accessible. To save on cost and to increase accessibility the community building is all one story. The multipurpose room is set down one foot lower to divide up the space, with a ramp enabling wheelchair access to the rest of the building. A covered porch looks out across the gardens toward Cornwall Avenue.

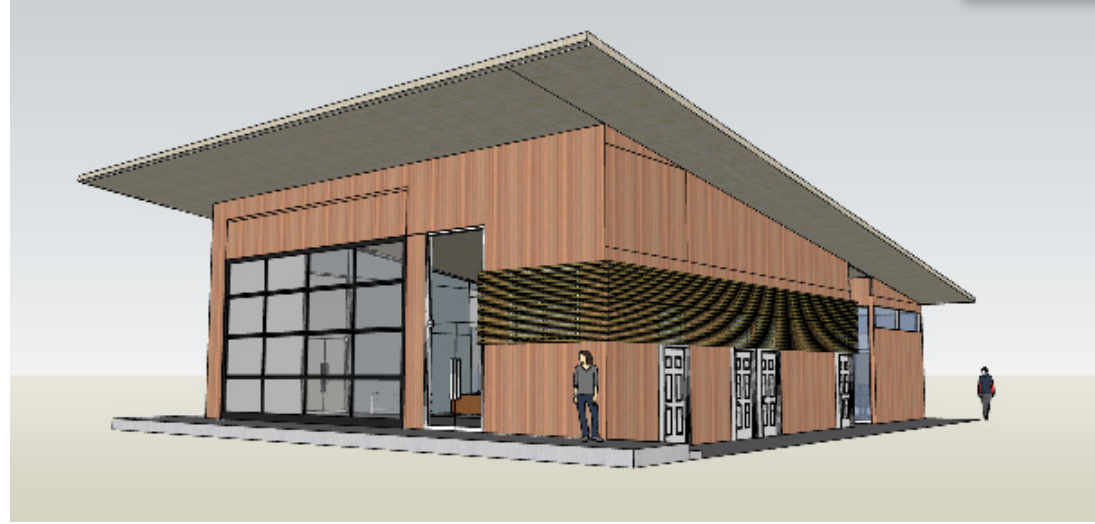
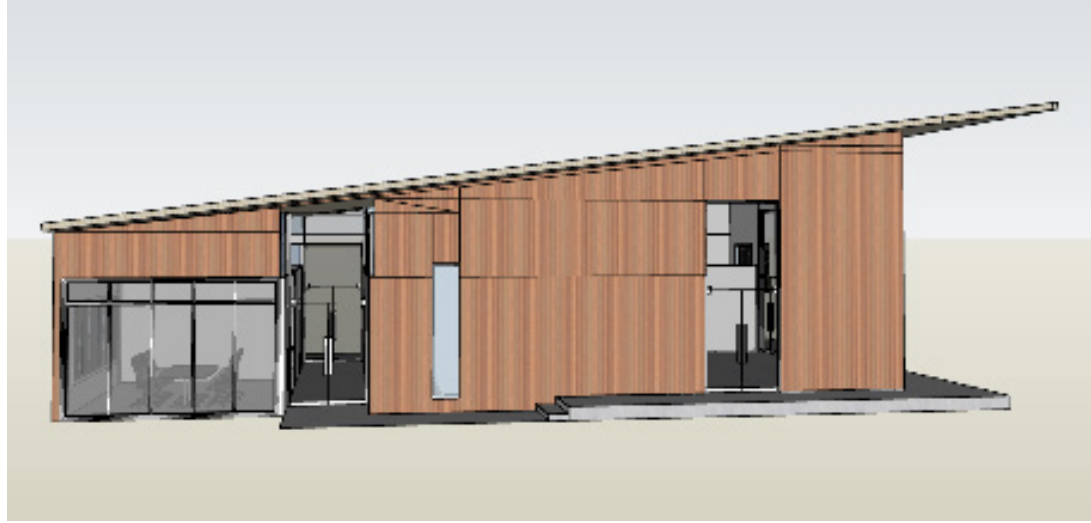


Figure 6.7 depicts the community building exterior and interior floor plan.



The office rooms can be used for social services or a private study area. The classroom can be used as a media lab or conference room as well. The bathrooms are accessible from the outside, all have showers, and are ADA compliant. All greywater would be collected and used as irrigation.



**Sources**

“Fixed Route.” RideWTA, Whatcom Transportation Authority, n.d. [www.ridewta.com/schedules-and-maps/maps/fixd-route](http://www.ridewta.com/schedules-and-maps/maps/fixd-route).

Sergeant, Aeck. “Petals and Imperatives.” Georgia Tech, Georgia Institute of Technology, n.d. [livingbuilding.gatech.edu/petals-and-imperatives](http://livingbuilding.gatech.edu/petals-and-imperatives).

# Metrics of Sustainability

According the Living Building Challenge, there are 7 factors to consider in the quest for sustainable developments. Figure 6.8 depicts this. To connect these design principles with the site plan, they will be analyzed one-by-one:

**Place:** restoring the grass on the site along with encouraging residents to garden via the shared open spaces work towards restoring a balance with nature. Providing green space is especially vital considering the surrounding plains of concrete.

**Water:** since there is not real consideration for water gathering techniques like rain barrels, this petal could use more attention.

**Energy:** the site plan does not include onsite generators so this petal could also use more attention.

**Health & Happiness:** the walkability of this area encourages exercise which is vital for physical fitness. Additionally, the clustered design of the site facilitates social interaction and bonding which is good for mental health.

**Materials:** the smaller housing units save on materials and recycled materials can be substituted for the wood, metal, and furniture found in the units.

**Equity:** this petal is most definitely met because this project is based on providing homes for the homeless. This works towards a more equitable world by giving people who need it a leg up.

**Beauty:** despite the sites’ location in an unattractive industrial zone, the proposal aims for appealing design in both the positioning and design of the housing and facilities.



Figure 6.8 displays the seven principles of sustainable design as described by the living building challenges. They include concerns regarding sociological, environmental, and economic factors (Sergeant, n.d.).