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MINKA Learning Lab

MINKA hardscape Design

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ENGR 491 – Senior Design
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Approved by: _____

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Executive Summary

The Learning Lab for Living Well, also known as the MINKA house, offers an interdisciplinary focus to involve students, faculty, and campus stakeholders in research, health care leadership development, and simulations that address challenges for aging-in-place and health profession career opportunities. In addition, the Learning Lab for Living Well provides all who are in the local community a place to learn about and to adapt home innovations for aging-in-place. Home innovations are designed to integrate smart home technology, health coaching, and learning workshops for a personalized, adaptable approach to aging well. This model of living can be applied locally and can even serve as a global model. In order to showcase these innovations and interdisciplinary approaches, class projects are offered to different majors to create, plan, and execute on the MINKA environment for aging-in-place. For our Senior Design Project, the group focused on the outside living environment of the MINKA. Thus, this is a site design project which includes the hardscape and landscape in the immediate area. Additionally, this project aims to expand the nearby area around Red Mango, located just to the east of the MINKA House. This design will create a more welcoming area where people can relax and enjoy new interactive aspects outside of Red Mango.

ACKNOWLEDGEMENTS

- Jason Hill
  - Dr. Hill allowed us to access the surveying equipment for us to complete a site survey for our project.
- Lisa Fournier
  - Lisa acted as our Project Manager for the GWEP who approved the designs
  - She also gave us other connections and helped describe what the client wants.
- Madeline Menke
  - Madeline was GWEP intern interviewed older citizens to give us an idea on what type of thing they prefer in the garden, landscape, and hardscape.
  - She also helped us stay in contact with Lisa if Lisa was not available.
- Mike Mohr
  - Mike is USI's Architect who helped us with finding the contractor and getting some estimated prices.
  - Mike was also another person who helped us out with the planning and design we needed in order to hire the contractor.
- Adam Tennant
  - Dr. Tennant is our professor for the CE 471 –Design and Planning class.
  - He provides insight, advice, and suggestions during the project.
- Edith Hardcastle
  - Edith is a professor here at USI in the Biology department.
  - She has provided us with a native plant list that we can use throughout our project.

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PROJECT DESCRIPTION

MINKA is a Japanese word that stands for "house of the people." Generally, MINKAs are vernacular houses constructed based on traditional Japanese building styles. This Learning Lab for Living Well takes this sort of design and implements it into an aging in place environment. Such an environment can be expanded to an entire community, either comprised of all similar homes, or intertwined with younger generations as well. The MINKA in particular is located at the University of Southern Indiana's on the North side of campus in between the Education Center and Red Mango. The MINKA house is 600 sq-ft, and the site covers 0.7 acres overall. The goal is to design the hardscape around the MINKA in order to meet the needs of the GWEP (Geriatric Workforce Enhancement Program). The program will be defined in more detail below in the Project Significance section.

Red Mango is a frozen yogurt and smoothie brand that has been on the USI campus since 2012. Currently there is a small gathering area on the outside that covers 0.2 acres. They have been looking for ways to improve activity in this area. We are looking to expand the area to create a more usable, welcoming, and active place in which for people to gather.

PROJECT SIGNIFICANCE AND PURPOSE

Throughout the planning and implementation stages of our project, we have worked with the USI Geriatric Workforce Enhancement Program (GWEP). This program, as it is entitled, focuses on geriatrics, which is a branch of medicine and social care that deals with the health and care of elderly people. Generally, within geriatrics, and especially within USI's GWEP, there is a purposeful focus on holistic care relating to aging in place. Some major factors that pertain to good geriatric care, factors that we designed for and implemented, include healthy and safe exposure to the outdoors, ways to engage their bodies and minds, and simple yet rewarding tasks for them to enjoy. These factors will be outlined further under the project details section, seen below.

This project would be good for the public health because if MINKA Houses such as the one on USI's campus were to be built into a small community, the hardscape and landscape would give the community a nice, bright, and scenic look, unlike a traditional nursing home where all the occupants are subject to all staying in one building. With the use of native plants and trees, the community will benefit from a healthy and symbiotic environment. Also, having access to these landscapes will give the people something to do rather than just sitting in their homes or on their porch. This will give them exercise and enable them to fulfil other interests.

The hardscape and landscape will have to be purpose built with various requirements of aging-in-place in mind. The inhabitants of houses like the MINKA may have various physical or mental health issues, so in order to best serve the inhabitants our site design of the hardscape and landscape will have to incorporate certain detailed design criteria such that the final product can have the best impact on any possible resident. This resulting design for the MINKA House on the USI campus can be used as a model for many different MINKA houses around the United

States. However, certain elements can of course be readily changed depending on religious aspects or cultural views that can be specified by the residents.

OVERVIEW OF PROJECT DETAILS – MINKA

Concerning the hardscape aspect of the design, some safety measures must be implemented in it. For our site design this meant that the hardscape had to have no steps and no pavers on which the resident could trip, no ornamental boulders to minimize risk of injury should a resident fall, and sufficient room for the residents to move around if they were in a wheelchair. The design also accounts for inclement weather conditions by ensuring that the chosen materials will not be slick after being wetted from rain or dew. Additionally, a requirement of the pathway that we proposed to the client (GWEP) was that it naturally led the residents back towards the house. This is due to the fact that many residents may suffer from dementia, causing them to become easily lost or turned around. So, for that reason the pathway is both short and made to lead a person back to the house.

Similarly, the landscape portion of the site has also been designed to minimize the risk of bodily harm and foster interaction. As mentioned above, residents are subject to suffering from dementia and other forgetful ailments, as well as other forms of confusion. Thus, the plants chosen had to be free from pointy or sharp foliage, such as thorns or certain grasses so that they would not be physically harmed further should they fall and so that they would not be poisoned should they confuse any plant as food and ingest any portion of the plants. Lastly in the safety of the plants was the need to make sure that they did not attract harmful insects. Insects such as bees that can sting people are a concern, so we ensured that none of them attracted stinging or biting insects. Instead, some of the plants in the garden and rain garden attract things like butterflies and hummingbirds. In these ways we ensure that their environment has the lowest possible risk of harming residents.

An additional design criterion related to geriatrics is the spatial layout of plants around the walkway. Relating back to accommodating dementia, our project partners (Lisa Fournier and Madeline Menke specifically) mentioned that a key aspect of a geriatric garden is to contain the residents, preventing them from wandering away, yet without making them feel contained. This is achieved, not only by the layout of the walkway, but also by using the plants themselves. The chosen plant species all have various heights and are generally arranged in such a way that the larger fuller plants are towards the back of the garden which surrounds the walkway. Medium height and medium bodied plants are arranged in the middle of the garden space and at the innermost radius of the garden are the smallest plants, nearest the path. Doing this in essence creates a natural barrier to dissuade residents from walking out, and it naturally guides them along the pathway. Related to the garden is a set of planter beds located on the patio deck. While residents are free to plant their own plants in the garden spaces, these beds are provided in the case that a resident cannot bend or kneel down to tend plants at the ground level, thereby providing gardening benefits to anyone despite their condition.

All these measures are taken within the planning of our design so that residents are able to use and enjoy the outdoor space to increase their liveliness and enjoyment while living in the house. A secondary upside to this design is that caretakers can let residents do things on their own without being pressed to constantly watch over them, thereby giving caretakers a much-needed break from time to time.

The attractive economic factor of this project is the hardscape in that since the hardscape includes everything that is stationary, it will not have to be replaced as much as the landscape would. For the landscape, the plants would have to be perennials, which means the plants come back every year. This use of perennials is advantageous from both a maintenance and economic standpoint. The reason why we would have garden beds is for the residents to have their own plants like ornamental or vegetable plants. These plants would be the only thing the residents would have to buy because these are the personal plants that the residents would want for themselves, so the cost for the residents would be relatively low.

OVERVIEW OF PROJECT DETAILS – RED MANGO

The second large aspect of our site design is the Red Mango storefront area which is adjacent to the MINKA. The USI campus Architect, Mike Mohr, showed interest in continuing upgrades to also include the area around Red Mango. He desired plans that outlined a way to beautify the area, make it more inviting, and tie it in with the area around the Minka. After surveying the area via GNSS tools and technology, as detailed below, we noticed that there is a considerable of space around red mango that is not well utilized. Our team proposed that we incorporate three items to draw students in. Two of these are games, cornhole boards and outdoor chess tables. Third is a set of shade structures, these are needed because we determined that the large oak tree nearby is diseased and needs to be removed which will remove a lot of shade space.

In order to implement these interactive items and better utilize the space, we determined that the existing patio must be extended and that the green space around red mango be leveled out. The patio is a decent size but does not allow for expansion due to the existing retaining wall blocking people in. And the grassy potions around the south side of the existing retaining wall and towards the western edge, between the MINKA and Red Mango, are not well utilized either. To remediate these shortfalls, we have decided to demolish the existing retaining wall and extend it out towards the southern sidewalk approximately six feet where it will meet up with a new retaining wall. This new wall will continue westerly around the sidewalk and also up along the drive towards the dumpsters. Doing this will extend the patio for additional sitting space and provide space for chess tables. And the retaining wall will allow two sets of cornhole boards to be placed on level ground.

The landscaping around the retaining wall and throughout the rest of the space will include some of the same plants as the garden around the MINKA walkway. The purpose of this is to visually tie the two spaces together, which was one desire of Mike Mohr, the campus Architect.

EXISTING CONDTIONS

The combined area including that around the Minka house, and the Red Mango exterior is about 0.70 acres. Throughout the area, the elevation varies quite a bit especially around the Minka house due to the original drainage design for the site. The highest elevation is up towards the science center while the lowest elevation is south of site. The greatest change in elevation from highest to lowest is about six feet. The elevations can be seen in the Figure 1. The contours were created by surveying the site first. We got permission from Dr. Hill for using the survey equipment, supplied by the USI Engineering department, to gather survey data of the area and with that data create the site drawing. We first set up the base station on the control point, Dr. Hyde, that is located south of the Business and Engineering Center on USI's campus. From published data on the control point we can know the coordinates and elevation of that point. By using this as a known base station we are able to find accurate distances and elevations across the site by using GNSS, or Global Navigation Satellite System. This system refers to the constellation of satellites providing signals from space to transmit positioning and timing data to the receivers we used down on the ground. While using the survey data, our group was able to get around 500 shots around the site. We took shots of everything within the site to get the most accurate drawing as possible. These shots included ground elevation shots, light poles, manholes, water inlets, electric boxes, trees, an emergency pole, and a sanitary sewer. Other shots include the outlines of the Minka house, sidewalks, and everything around the Red Mango patio. All these shots were then imported into Civil 3D where the contour lines were generated.

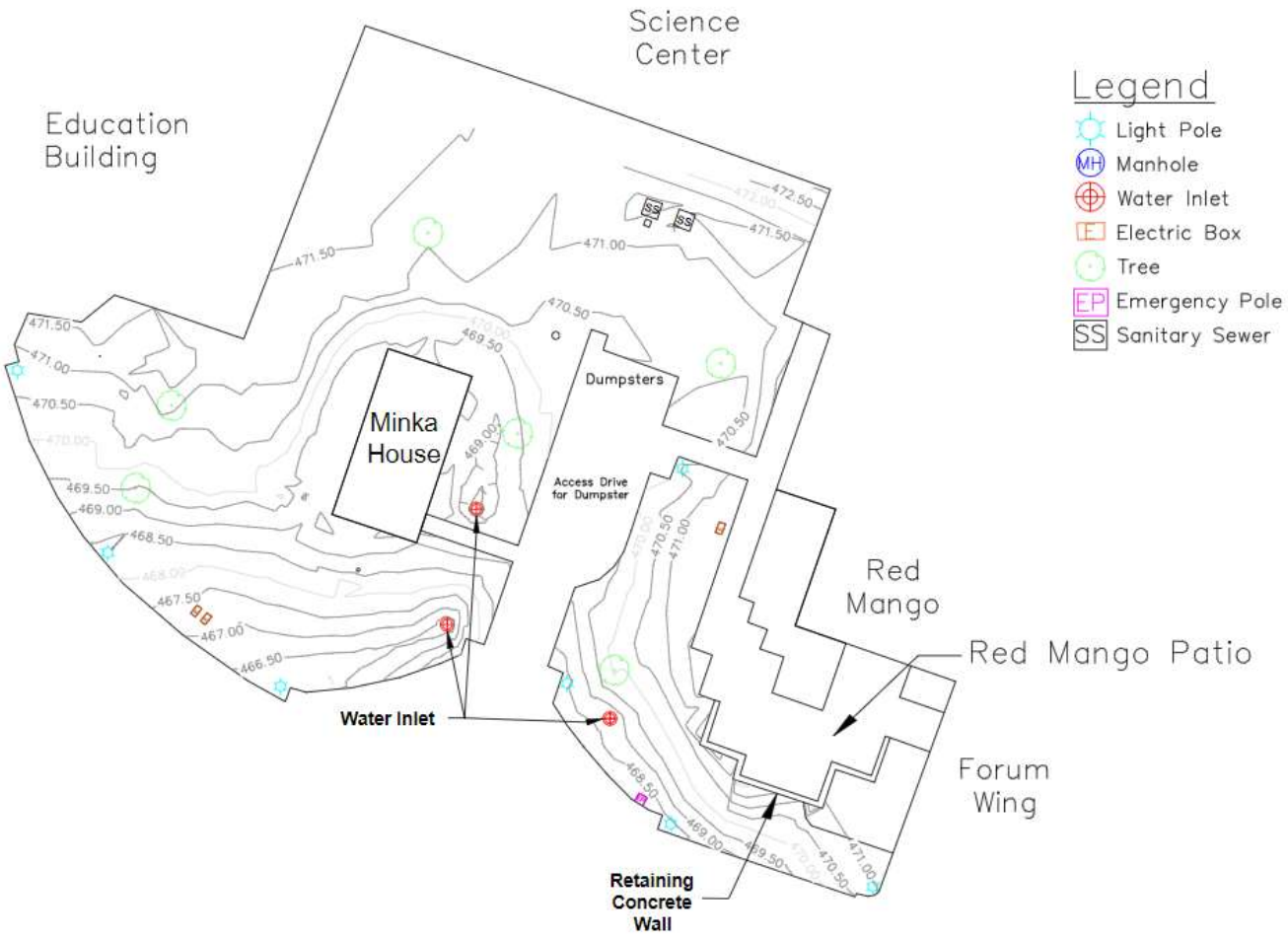


Figure 1: Civil 3D Drawing of Site

PROPOSED PLANS

Looking at the contour map on Figure 1 and looking at it in person, the ground around the Minka house is lower so that the water can properly drain but it does so rather poorly. There is a water inlet southeast of the house to help with site drainage. The north, west, and east side of the Minka can be seen in Figures 2, 3, and 4. As you can see in Figure 2, during a rain fall, this area becomes saturated and has standing water. Also, there is quite a step from the ground up to the porch of the Minka an vice versa. This sudden change in elevation is a hazard to residents. To remove this step and avoid the low wet area, while also incorporating design criteria from the GWEP programs recommendations, an addition to the porch or patio was determined to be the best fit. Not only does this eliminate the falling hazard and the saturated ground, but this would also allow the GWEP people to move around more freely and not be confined to just the house and the porch.

Figure 2: West Side of Minka

Figure 3: North Side of Minka

Figure 4: East Side of Minka

PATIO DESIGN

As alluded to above, in an attempt to alleviate the sudden drop off and low wet area, the group decided to bridge the distance across the low area from the porch to the higher elevated surface with an additional deck, or patio. The patio would be built right next to the existing porch and positioned such that it meets up flush with the surface of the porch. Doing this eliminates difficulties in traversing the space, especially if the inhabitants were in a wheelchair or on crutches, as there would be no obstacle for them to go over to get from one side to the other. This would allow the GWEP people to move around more freely and not be confined to just the house and the existing porch.

During the design process of the patio, we had help from Mike Mohr, the University Architect, who provided us with some notes that contributed to the design and construction of the patio. The patio is a 16' x 13' deck with treated wood framing, 5.5 inches composite wood decking, and 5.5" band board trim at the perimeter. The whole patio sits on nine 1'x 3' deep concrete piers. Since the patio acts like a bridge, there would still be some drainage that come through underneath during a rainfall, so to help with erosion and weed control, a filter fabric topped with #2 stone was installed underneath the patio. The plan view of the patio can be seen in Figure 5.

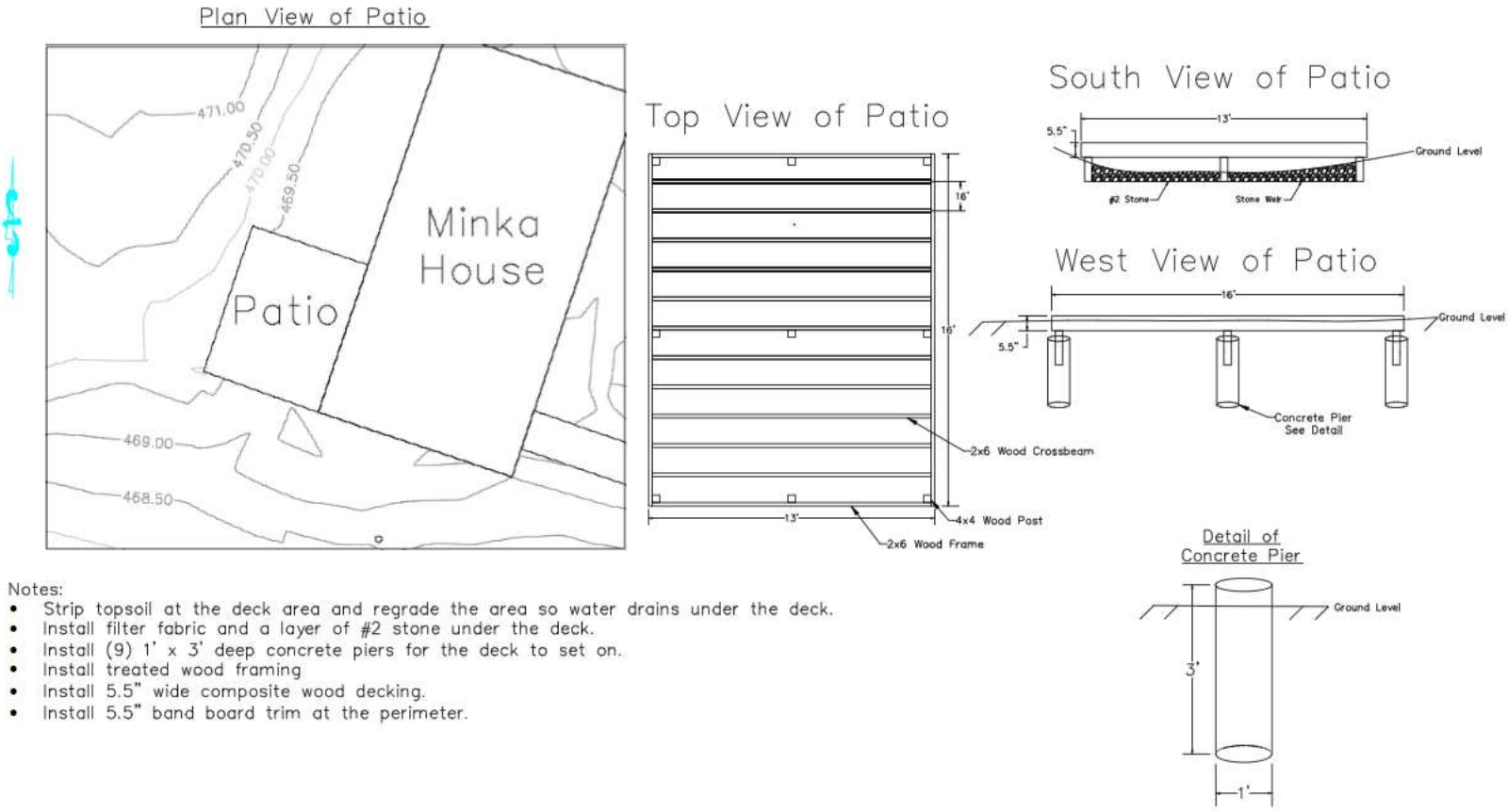


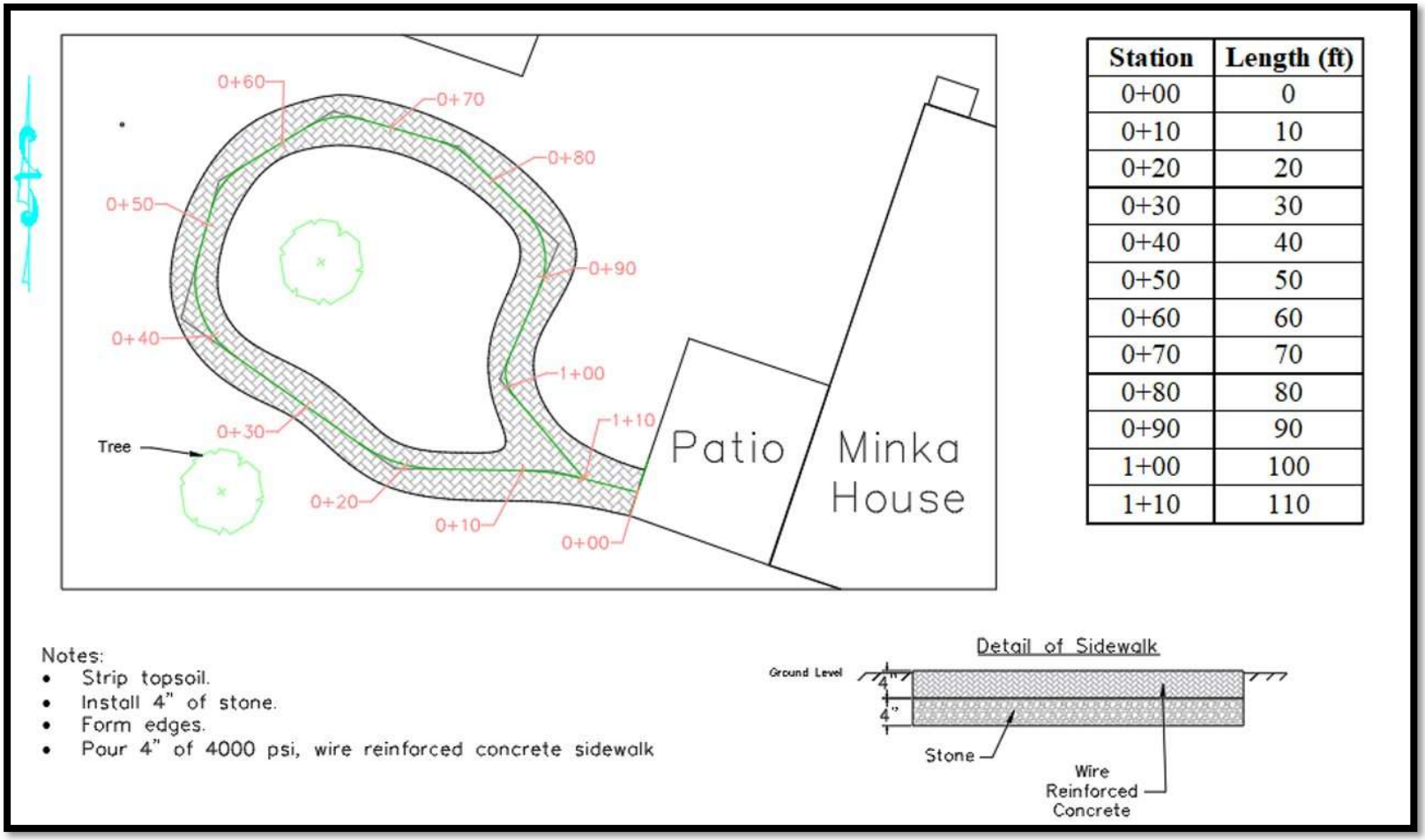
Figure 5: Plan View of Minka Patio

WALKWAY DESIGN

In addition to adding more space like the patio and giving the residents more room to roam, a walkway was added. This goes in line with achieving the geriatric care minded design criteria as mentioned above. We also had help from Mike Mohr on the walkway. The walkway is 110 linear feet that has 4 inches of stone as a base, and it is topped with 4 inches of 4000 psi concrete with wire reinforcement. The walkway is 4 feet wide for wheelchair access. In Section 22 of the ADA Compliance for Sidewalk, Curb Ramps, Blended Transitions, and Pedestrian Facilities, the required minimum clear width of a curb ramp, turning space, or sidewalk, is 4 feet [3].

It must be noted that this walkway, along with the above-mentioned patio, was already implemented as of the summer of 2021. We did this because the funding, made possible by Lisa Fournier of the GWEP, had to be spent by June of 2021. We met with a contractor, presented our design, and had them construct these features ahead of time.

The walkway's main purpose is to allow the residents to view the 1000 square foot garden space that will be mentioned in the next section.



Station	Length (ft)
0+00	0
0+10	10
0+20	20
0+30	30
0+40	40
0+50	50
0+60	60
0+70	70
0+80	80
0+90	90
1+00	100
1+10	110

Figure 6: Plan View of Minka Walkway

WALKWAY LANDSCAPE DESIGN

The landscape around the walkway is a crucial aspect of this project. As previously mentioned above, the focus of designing the landscape is to make sure the plants follow the necessary guidelines given to maintain safety for the residents. First, the plants must be native and surround the pathway all around. This makes sure to keep the path enclosed and not allow the residents to wander outside the path. Next, the plants must be safe and not harmful for the residents. They do not want any plants that could cause harm in case a resident was to fall on, touch, or eat these plants. Finally, make sure there is a wide variety of plants and landscapes that make it interesting and fresh. Listed below in Figure 7 is the detailed drawing of the Walkway Landscape Design that follows all these guidelines.

Five different plants were chosen to be placed along this walkway. Each one has its own advantage and was picked for a specific reason. The goal is to pick plants that attract life and have a good natural color variety. Redbuds are the first plant that was chosen, and they are shown as the purple circles listed below. These trees have pink flowers and serve as good boundaries for the exterior of the walkway. They provide a good amount of structure and foliage. Butterflies, moths, and beetles are also attracted to these, making them perfect for attracting wildlife. Milkweeds are the next plants chosen to be placed and they are shown as blue circles. These plants are special because they are the only plants that monarch caterpillars can feed on and they offer a good orange color as well. Easter Blue stars offer a blue color and attract hummingbirds. This design consists of mainly Eastern Blue stars and offers a great small boundary. Blue False Indigo is a great plant to have included in this design. It is used to improve digestion and increase appetite. It also offers a rich color to add to the variety in this design. These are shown below as darker green circles. The Prairie Dropseed is the final plant incorporated in this design. Prairie Dropseeds are native plants that give a unique grass look. They add good texture and low cover to the landscape and are great for attracting small insects and birds. All five of these plants are native to Indiana and offer great benefits to have in the landscape design. As mentioned by Edith Hardcastle, a USI Biology professor, standard grass lawns are not beneficial for any wildlife and are essentially equal in impact to a parking lot. By incorporating this variety of natural planting, we try to emulate a small biome to encourage natural forms of native life.

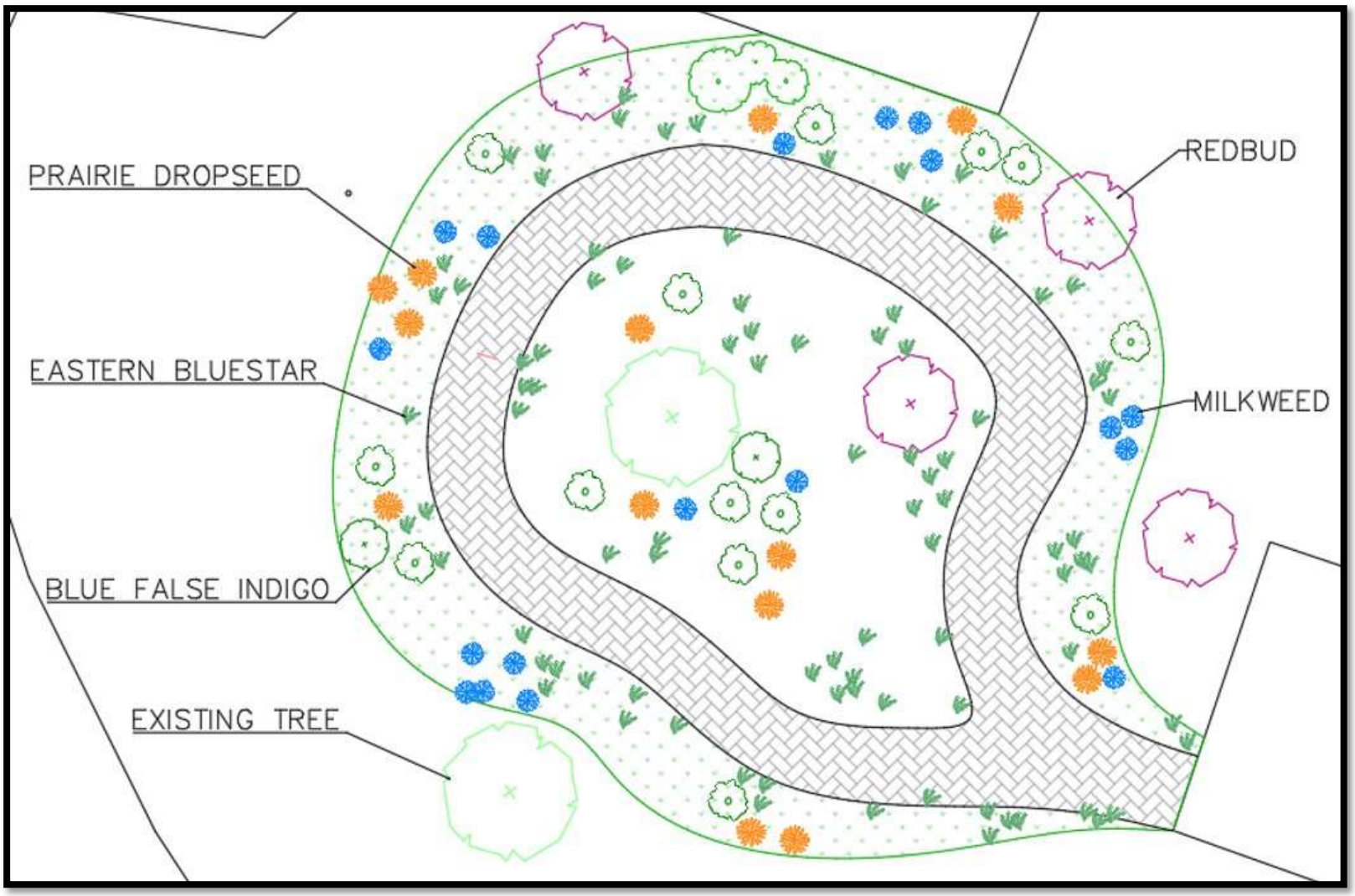


Figure 7: Walkway Landscape Design

UPDATED CONDITIONS

When the project first began in the spring of 2021, our project liaison, Lisa Fournier, and our group met each week to go over the progress, brainstorm ideas, work out plans, and determine what we wanted to see when the project is finished. Lisa informed us that a certain amount of the budget had to be spent by June 30, 2021. Since the patio and walkway were the two biggest aspects and most costly of the project, she thought we should get those accomplished first. Our group and Mike Mohr met with a contractor in late April to see if this was able to be constructed by late June. We showed him the plan sets and talked through some minor site details. A detailed quote was then sent and accepted by the University. The work was completed before the deadline and the quote was included in our overall estimate. These updates can be seen in Figure 8 and 9 below.

Figure 8: Finished Patio Product

Figure 9: Finished Walkway Product

RAIN GARDEN

A rain garden is a storm water management feature. Generally, the purpose of a rain garden is to retain a portion of the initial surface runoff during a rain event. The garden retains and holds water to reduce the peak discharge of the site which alleviates some of the load on the drainage and sewer systems and also serves to provide rudimentary filtration of the water. The water is filtered through the various layers of soil and aggregates in the garden and then permeates into the existing soil, thereby also replenishing the groundwater supply more directly as opposed to being sent to a treatment plant. Designs vary based off desired retention volumes, retention times, and levels of filtration. They can be strictly composed of natural materials or be tailored with things such as multimedia filters or liners. We designed ours to be made of readily accessible and natural materials. A cross section of our design can be seen below in Figure 11.

We proposed the rain garden to achieve two purposes. Firstly, it adds to the calming features of the outdoor area and offers more variety. Residents will enjoy the natural look of the rain gardens and the plants that it has. Secondly, it adds to the sustainability of the MINKA, which is something that we desired to incorporate. This sustainability is twofold, not only does the rain garden serve as a more natural way to alleviate the sites drainage issues, but it also is paired with a rainwater catchment system, as detailed below.

Regarding the technical considerations of the rain garden, we desired to retain the surface runoff from the portions of the site uphill of the Minka (north of the gardens). We predicted that doing so would sufficiently reduce the on-site drainage issues, primarily the pooling of water near the existing porch, and help to alleviate some of the pooling issues on the sidewalk south of the site. In our hydrologic calculations, via the TR-55 method, we determined that the required storage volume necessary to retain the upland runoff was 355.4 cubic feet during a 25-year 1 hour design storm with a rainfall intensity of 2.75 inches per hour. This is much higher than what could be considered a typical storm event with a rainfall of 1.21 inches per hour in the midwestern region [5]. We believe that this is an appropriate storm to design for, especially in conjunction with the constraints of our rainwater catchment system.

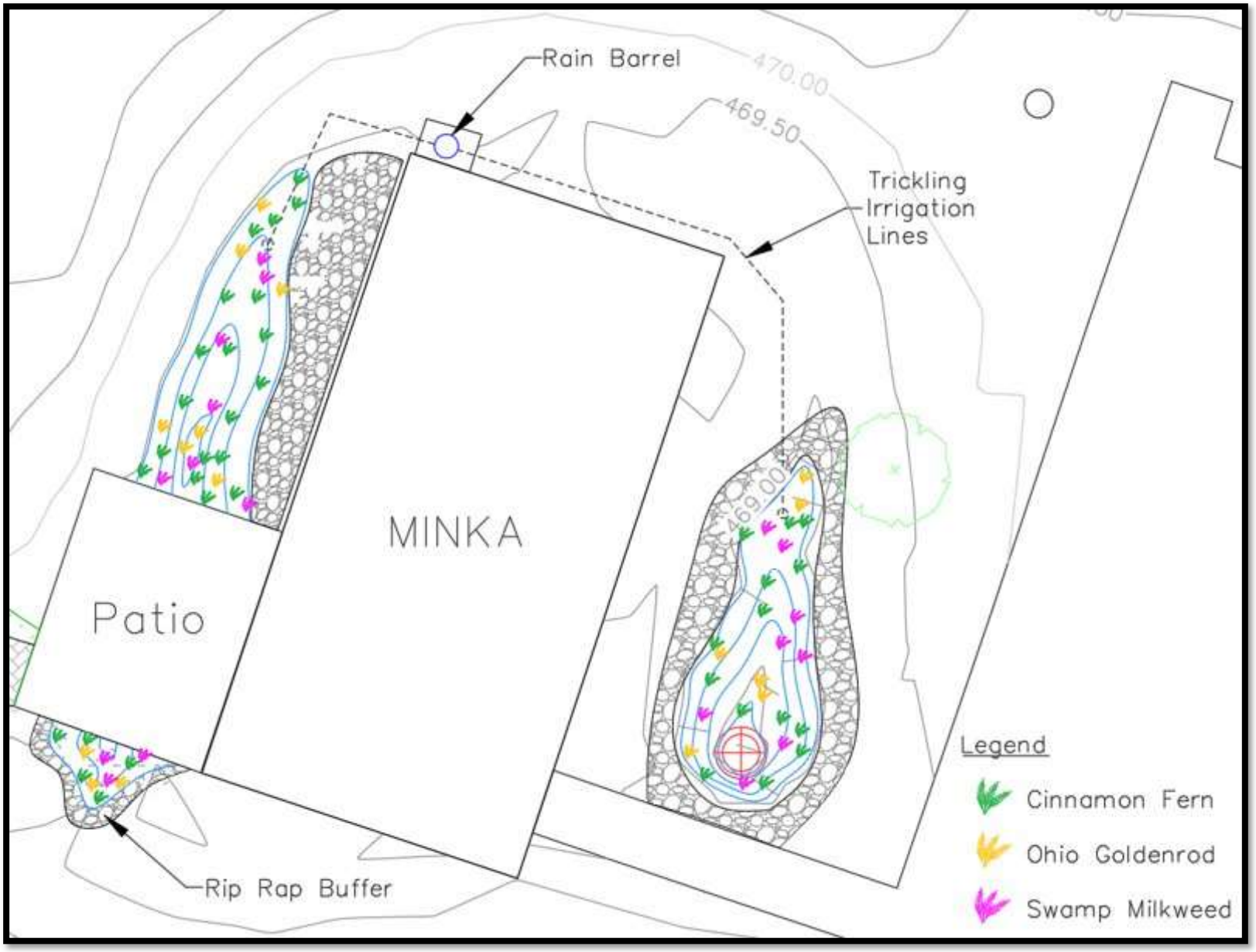


Figure 10: Rain Garden

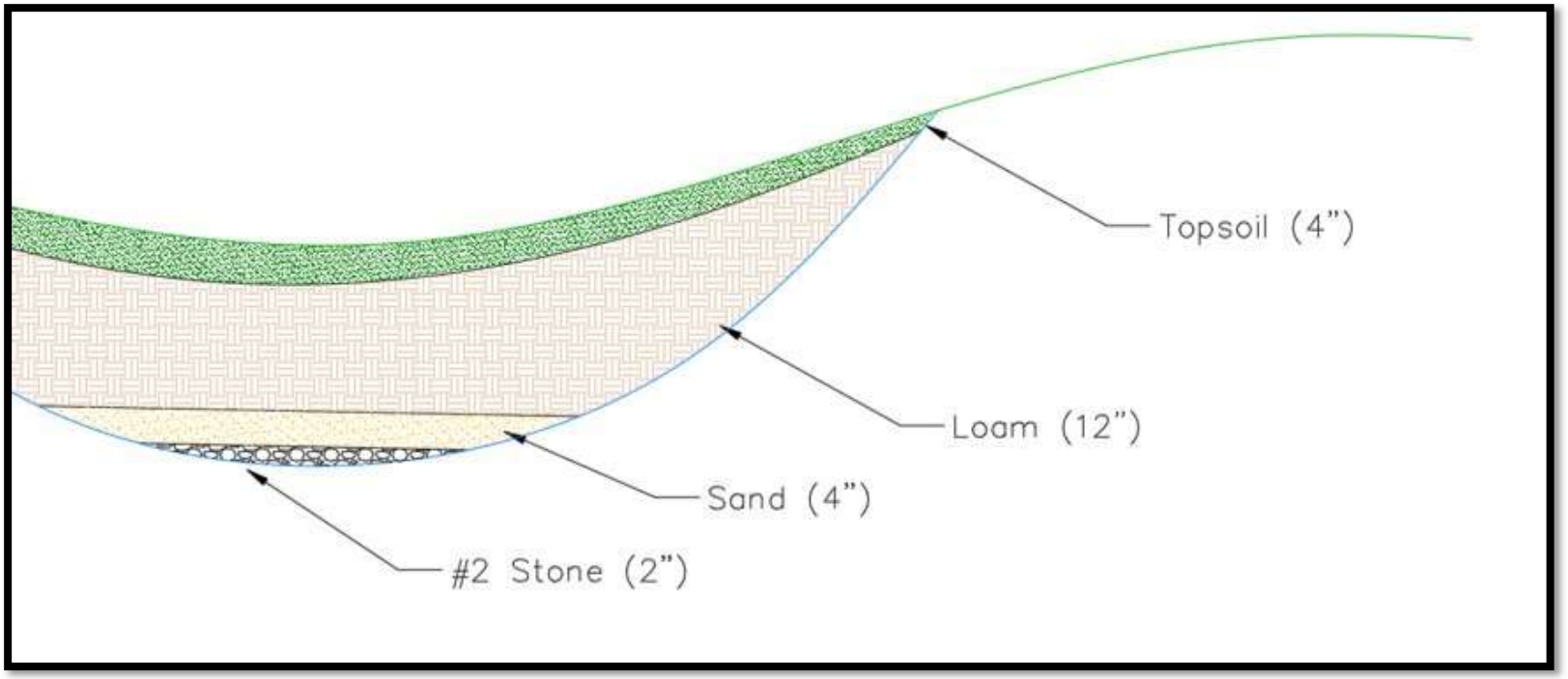


Figure 11: Rain Garden Bed Cross Section

RAINWATER CATCHMENT SYSTEM

The MINKA will employ a rainwater catchment system that will provide a source of water with which to water the plants without using utility supplied water. This will allow the rain gardens to be augmented with stored water during the dry months when there are fewer rainfall events. By harvesting and collecting rainwater we are also able to further the sustainability that we desired in our initial design plan. The portion of the roof that slopes towards the back of the MINKA has been equipped with a new gutter per our recommendations. This allows us to harvest the water that is shed off the roof, thereby partially alleviating the standing water around the MINKA. The catchment area is 525 square foot and will have a runoff volume of 1.79 cubic feet per minute during a 25-year 1 hour rain event. In order to store this rainwater, we used a rain barrel, as seen in Figure 10, that will collect the runoff from the roof, allowing residents to have access to water for watering the gardens. Due to the hydraulics of the rain barrel system, a hose cannot be used as there is not sufficient head pressure to allow for proper flow. Initially, our liaison, Lisa Fournier, requested a hose to be able to water the plants. But due to the lack of head, as mentioned, we recommended a trickling irrigation system. This system has been developed to provide a slow dripping flow of water into the rain gardens to augment them in between rainfall events in summer months. The barrel will have two ¼ - inch PVC pipes, equipped with a valve that can be opened to allow watering of the rain gardens when necessary. One will go to the west side and one to the east side of the MINKA. A 2-inch PVC overflow pipe will also be fitted to

the barrel in the event of rainfalls heavier than the 25-year 1 hour design storm. This overflow will be directed into the easternmost rain garden which surrounds a drain inlet.

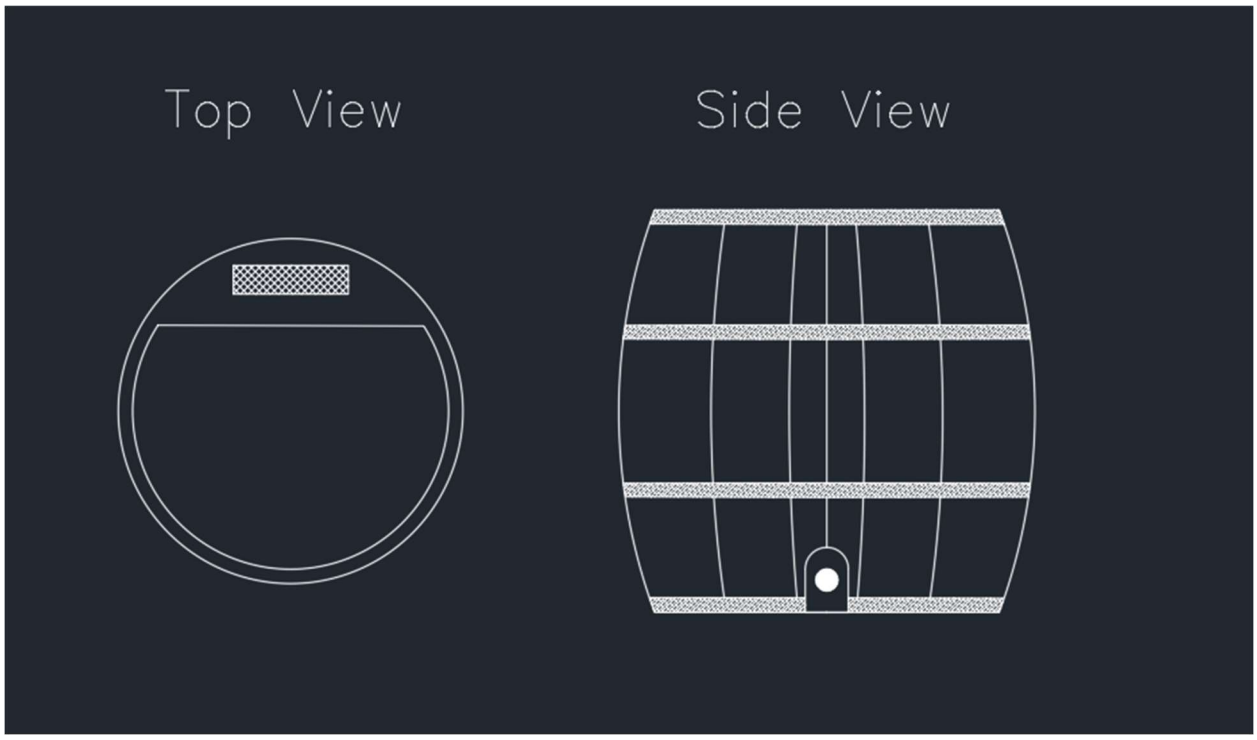


Figure 12: Rain Barrel

RED MANGO EXPANSION

Red Mango is an American frozen yogurt and smoothie brand that is located on USI's campus. They have been looking to expand on their outdoor area to make it more interactive. Currently there is a small patio with tables scattered around it that not many students use. Our plan was to add activities to make the exterior more appealing and interactive by adding cornhole, chess tables, and new shade structures. This aims to increase social interaction on campus and provide additional enjoyable activities. These can be seen in Figures 14,15, and 16. The chess tables and concrete cornholes were provided by Outdoor Creations Inc. and the awnings were provided by ShadeScapes Americas.

The proposed plan for the Red Mango Expansion is to eliminate the existing concrete wall and add a similar concrete retaining wall to the outside of the area next to the existing sidewalk. After the wall is constructed, either dirt or gravel will be added to level off the entire area. Soil will be added for leveling off the grass area and the gravel will be filled in for the expansion of the patio all the way out to the proposed concrete retaining wall. The detail of the concrete retaining wall can be seen in Appendix A2 along with the calculations for overturning, sliding, and bearing capacity.

The two sets of concrete cornholes will need a 10’x4’ space around each cornhole for enough space for players. The two sets will also need to be placed 27’ apart from front to front to apply by the cornhole game rules. The chess tables along with the tables that are already there may be placed wherever on the patio. Then the awnings will need to be placed in an order that covers most of the patio from the sun to allow the students to sit in the shade wherever the tables may be. The whole site plan for the Red Mango can be seen below in Figure 13.

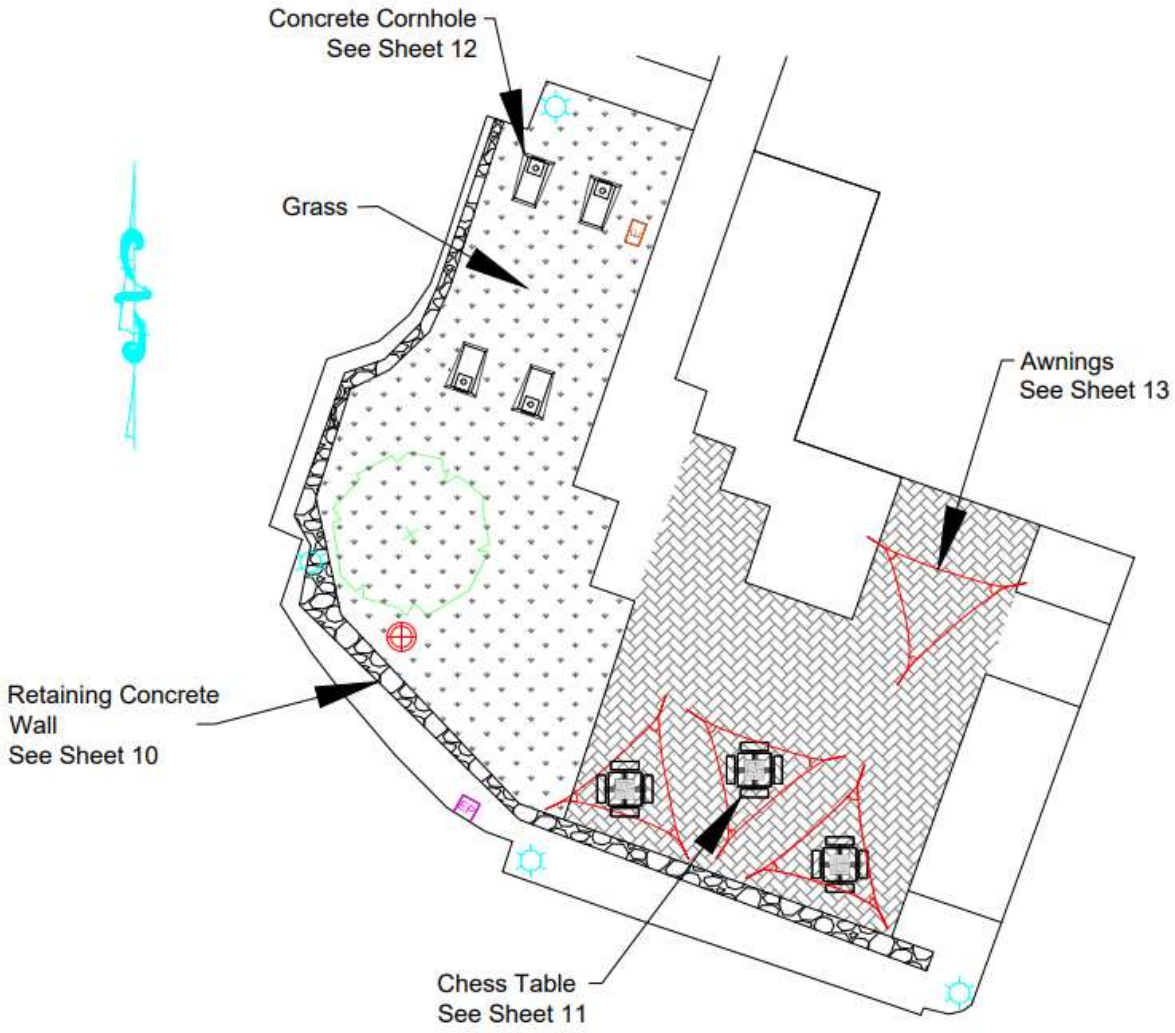


***Figure 13*: Red Mango Expansion**

RED MANGO EXPANSION - AMMENITIES

Figure 14: Red Mango Chess Table

Figure 15: Red Mango Cornhole

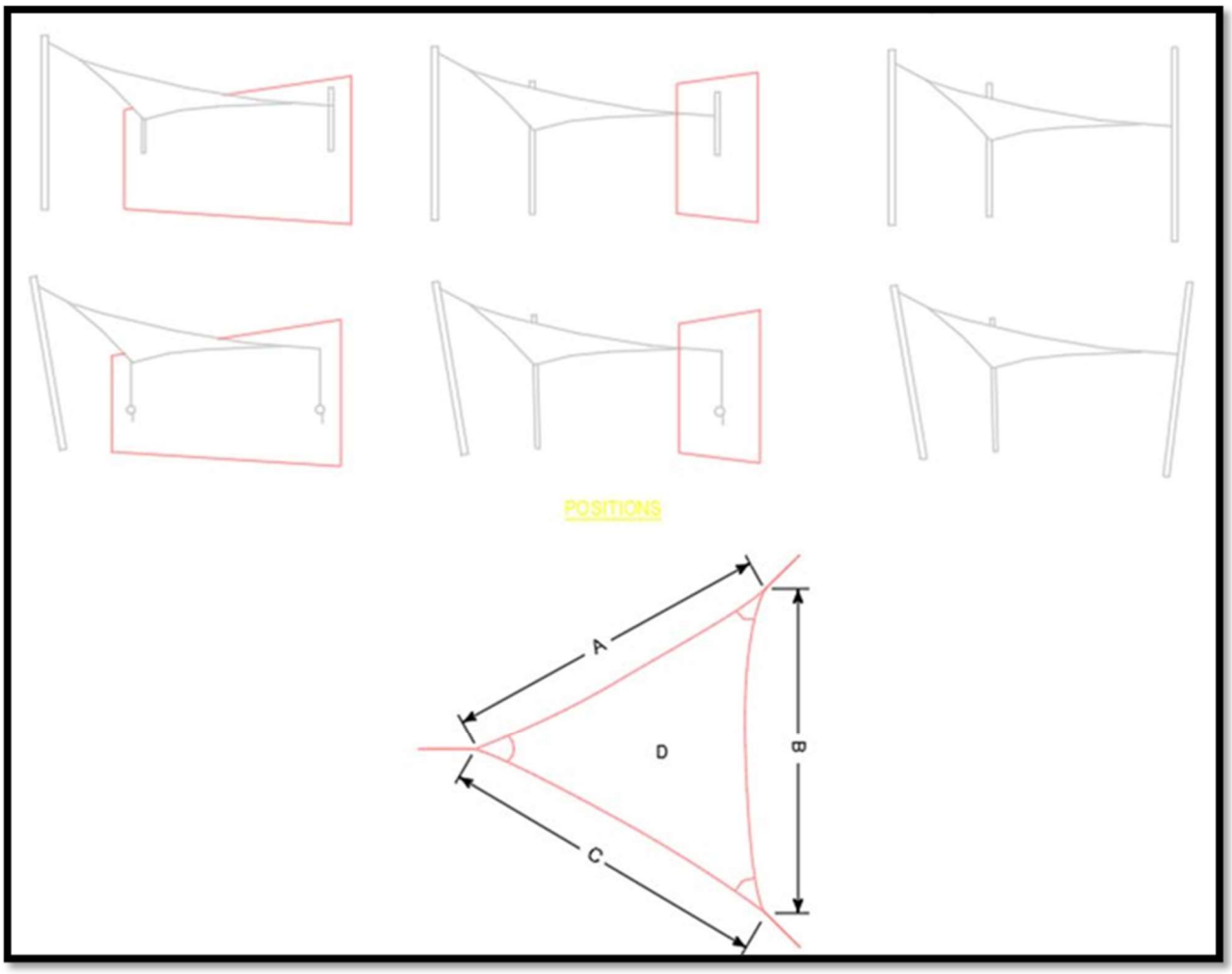


Figure 16: Shade Structures

Detailed Estimate

A detailed estimate includes detailed information on quantities, costs, and rates. Our group was able to create a detailed estimate using two key tools. The first tool was creating a bid schedule which is an itemized list of bid items with a proposed contract amount. Second is a HeavyBid program that is used by construction estimators that allows you to combine labor, equipment, and materials all together to get an accurate estimate.

Listed in Table 2 in Appendix C is the Bid Schedule for this project. A bid schedule is a way to organize the projects bid items to get an estimate on how much the project will cost. Each item is given a number along with a unit price. That unit price is used with the quantities of that item in order to get a total cost for that bid item. Most of the items listed below have a unit of measure (U/M) as a lump sum (LS) which means the pricing includes everything in that bid item. The other ones have a U/M of each (EA). This is where the unit price is multiplied by the

number of products listed in the quantity column. Finally, in the last column is a reference to see where the unit prices came from. These references came from contractors who were kind enough to give us quotes for this project. This bid schedule has 18 items. 17 of the items have a number for price. The Red Mango Expansion has not been bid yet since the contractor has failed to get a bid in the allotted time.

HeavyBid is a construction estimating software that allows you to break down each bid item and add certain activities relating to equipment, labor, and materials. This creates a more detailed estimate for the project. In this program, crews can be made for the project and applied to each bid item. It can calculate how much and how long it will take for the crew to complete the activity. All the items from the bid schedule have been inserted on the left column. Each bid item has an activity information and an activity production which is how they are broken down. Listed below is Figure 16 that shows the overall view and the breakdown of the rain catchment system activity. It is broken into two specific activities. One is materials for the task and the other is the labor. Once all the bid items are updated and complete, it can calculate the total cost of the job and allows for markups and possible changes.

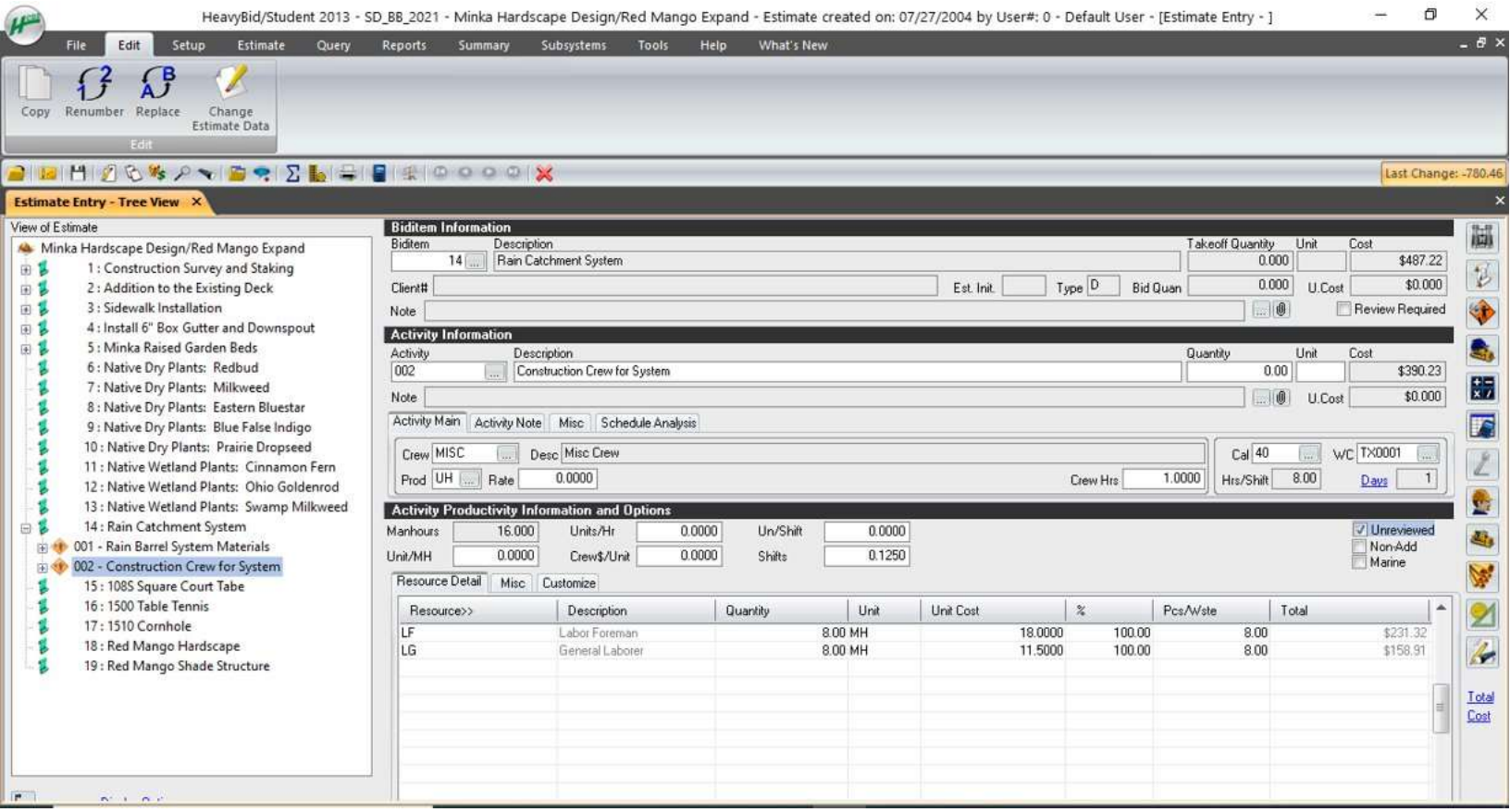


Figure 17: HeavyBid Overview

Figure 17 shown below shows the activity productivity tab where things such as labor, equipment, and materials are broken down. This Figure focuses on the rain catchment system labor. It allows you to put in a specific crew, which in this case is a basic two-man crew working one day for this activity. The program is also able to calculate how much this labor would cost for this specific task based on the laborers title. Different crews can be created for different activities based on what the task may be.

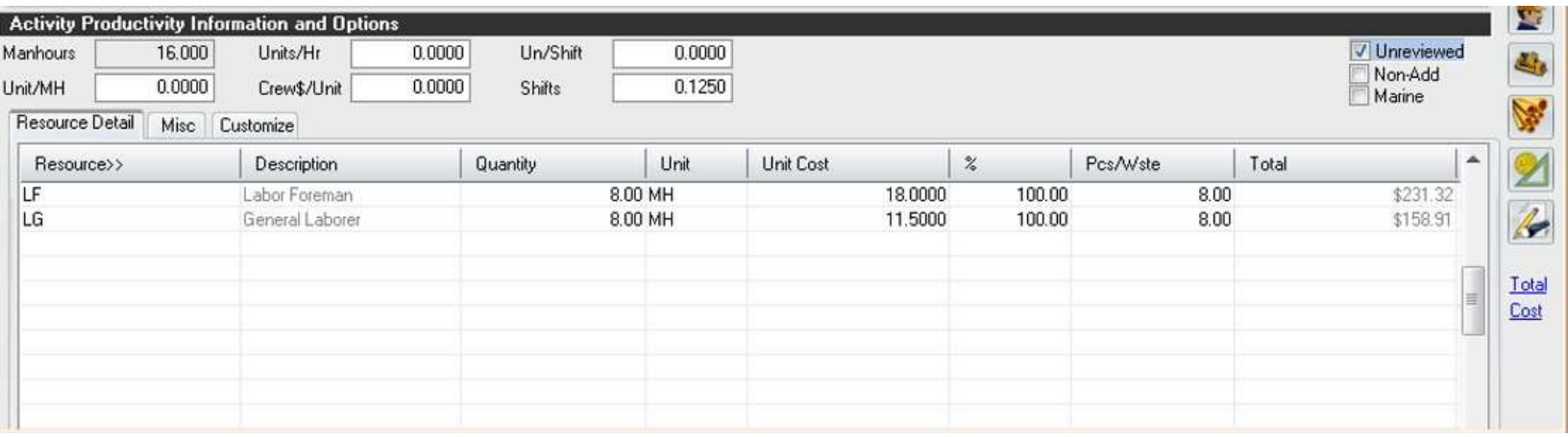


Figure 18: Activity Productivity

Finally, Figure 18 shows the activity and bid item information. The activity information is where the crew we created is summed up together to get a total cost. In this case it came out to be $390.23. This cost is then added to the material cost of the rain barrel and allows us to get a total cost for the whole bid item. The total cost for the rain catchment system which includes all labor and materials comes out to be $487.22. Keep in mind that this is an estimate so everything will not be perfect. The total cost has not yet been determined since the contractor for the Red Mango Hardscape did not send a quote within the required time frame.

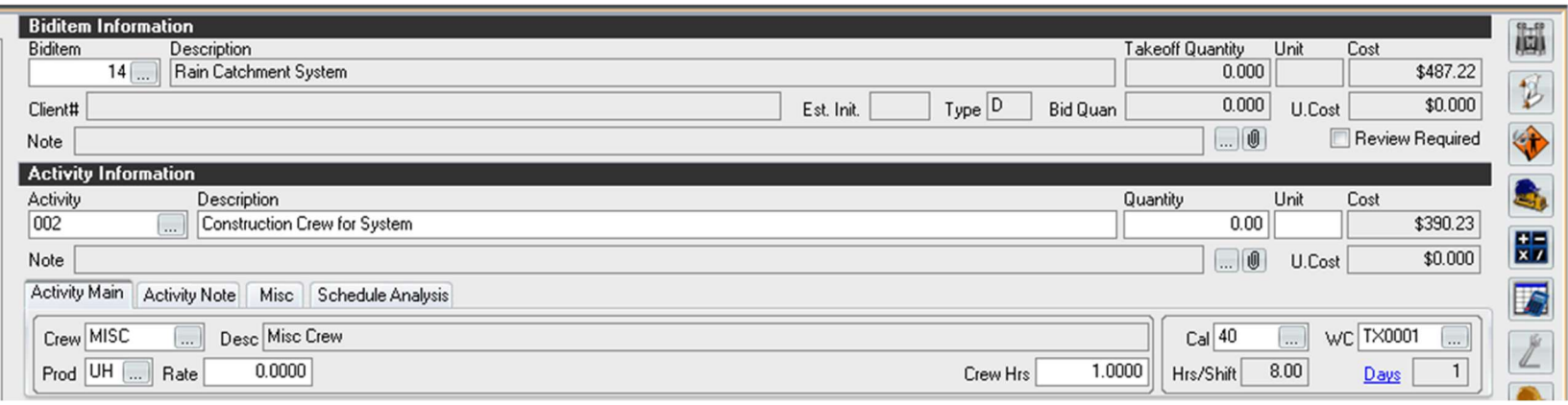


Figure 19: Activity and Bid Item Information

REFERENCES

[1] Das, Braja M., and N. Sivakugan. *Fundamentals of Geotechnical Engineering*. Cengage Learning, 2017.

[2] Houghtalen, Robert J., et al. *Fundamentals of Hydraulic Engineering Systems*. Pearson, 2017.

[3] *Section 22 –Ada Compliance for Sidewalk, Curb Ramps ...* https://www.in.gov/dot/div/contracts/standards/GIFE/SECTION%2022.pdf.

[4] "Home." *RTS Home Accents*, https://www.rtshomeaccents.com/

[5] US Department of Commerce. *NOAA Atlas 14*, US Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, 7 Nov. 2005, https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html.

APPENDIX

Appendix A: Design factors

Appendix B: Calculations

Appendix C: Preliminary Project Schedule

Appendix D: Bill of Materials

Appendix E: Complete Plan Set

APPENDIX A

Design Factor	Page number, or reason not applicable
Public health safety, and welfare	Pg. 2 (Executive Summary); Pg. 6-7
Global	Pg. 2 (Executive Summary); Pg. 5
Cultural	N/A
Social	Pg. 5; Pg. 7; Pg. 19
Environmental	Pg. 16-18
Economic	Pg. 7
Professional Standards	Pg. 12

Table 1: Design Factors Considered

APPENDIX B

1.) [2] HYDRO

Manning's Equation:

$$Q = \frac{1.489}{n} \cdot AR^{2/3} \cdot S^{1/2}$$

Where:

Q = Flow Rate (cfs)

A = Cross – Sectional Area (sq.ft)

R = Hydraulic Radius (ft)

S = Slope

n = Surface Roughness Coefficient

Rational Method:

$$Q = CiA$$

Where:

Q= Flow Rate (cfs)

C= Runoff Coefficient

I= Rainfall Intensity (inches per hour)

A= Watershed Area (Acres)

TR-55 Method:

$$Vr = 53.33Q(Am)$$

$$\boldsymbol{Vs = Vr * (\frac{Vs}{Vi})}$$

Where:

Vr = Runoff Volume (acre-ft)

Q = Runoff (inches)

Am = Drainage Area (miles^2)

53.33 = Conversion factor from in-mi^2

Vs = Storage volume required (acre-ft)

1.A)

Design trickling irrigation lines to empty 35 gallons of stored water in one day:

Find Q…

$$\frac{35GAL}{1DAY} \cdot \frac{1DAY}{24HR} \cdot \frac{1HR}{60min} \cdot \frac{1min}{60sec} \cdot \frac{1Ft^3}{7.48GAL} = 5.42E^{-5}$$

Q = 0.0000542 cfs

Solve Manning's Equation for diameter:

$$0.0000542 \frac{Ft^3}{S} = \frac{1.489}{n} * A * R^{\frac{2}{3}} * S^{1/2}$$

Where:

n = 0.01

A = $\pi * r^2$

R = $\frac{A}{P}$ (will assume pipe flows half full)

S = $\frac{Ft}{Ft}$

Substituting in above equations, values measured on site, and researched values:

$$0.0000542\frac{Ft^3}{S} = \frac{1.489}{0.01} * \pi r^2 * (\frac{\pi r^2}{2\pi r/2})^{\frac{2}{3}} * (\frac{0.07}{27})^{1/2}$$

Reducing equation and solving for the radius eventually yields:

$$3.0E^{-9} = (r^2)^{3/2} * r$$

$$3.0E^{-9} = r^4$$

$$r = \ 0.00765'$$

$$r = 0.0918"$$

Thus,

$$\boldsymbol{Dia = 0.18"}$$

Using the closest nominal pipe size, we choose to use a ¼ - inch PVC pipe.

1.B)

Design a single overflow pipe where the outflow at least meets or even exceeds the inflow from the gutter, utilizing the same assumptions and flow profile:

From Rational Method:

Roof outflow, inflow to barrel = $0.0298\frac{Ft^3}{S}$

$$0.0298\frac{Ft^3}{S} = \frac{1.489}{0.01} * \pi r^2 * (\frac{\pi r^2}{2\pi r/2})^{\frac{2}{3}} * (\frac{0.07}{27})^{1/2}$$

$$3.3867E^{-5} = r^4$$

$$r = 0.915"$$

$$\boldsymbol{Dia = 1.83"}$$

Similarly, we shall choose the nearest nominal size of 2 inches for the overflow pipe to at least have the same outflow as the inflow from the gutter

1.C)

Design the rain garden to have an adequate storage volume:

$$\boldsymbol{Vr = 53.33Q(Am)}$$

Where:

Am=0.000556 from survey data

Q = 2.75 $\frac{inches}{hour}$ from previous determinations

$$Vr = 53.33 * (2.75) * (0.000556)$$

$$Vr = 0.08159\ acre - ft$$

$$Vr = 3554.37\ Ft^3$$

$$\boldsymbol{Vs = Vr * (\frac{Vs}{Vi})}$$

Where:

$\frac{Vs}{Vi}$ =0.1 from TR-55 Manual Figure (6-1)

$$Vs = 3554.37 * 0.1$$

$$\boldsymbol{Vs = 355.43\ Ft^3}$$

2.) [1] RETAINING WALL

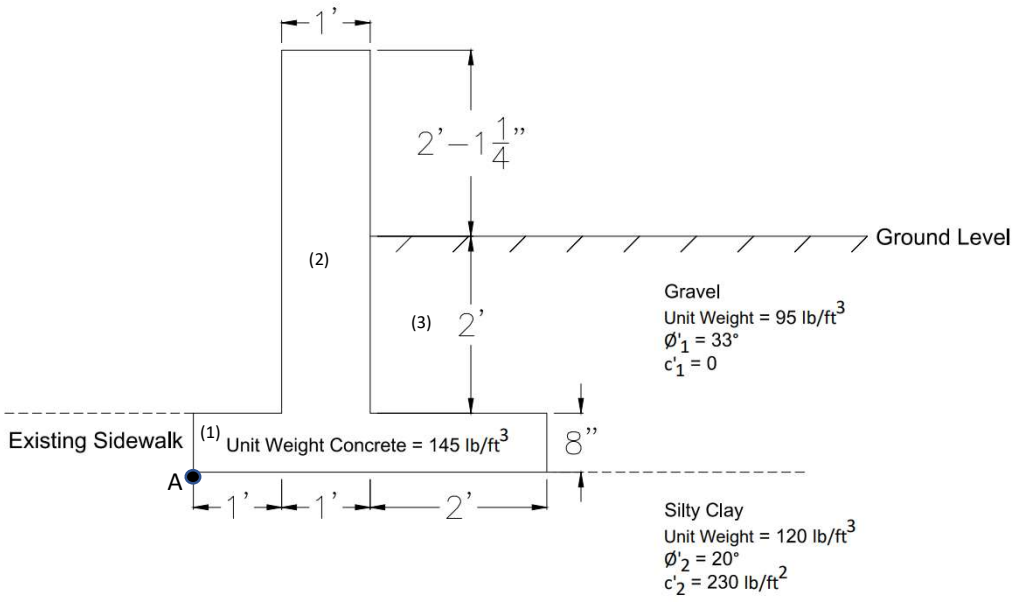


Figure 15: Detail of Concrete Retaining Wall

$$H' = \frac{25.25"}{12"} + 2' + \frac{8"}{12"} = 4.77'$$

$$P_a = \frac{1}{2}\gamma H'^2 K_a = \frac{1}{2} * 95 * (4.77)^2 * 0.295 = 318.83\ lb/ft$$

$$K_a = tan^2\left(45 - \frac{\emptyset_1'}{2}\right) = tan^2\left(45 - \frac{33°}{2}\right) = 0.295$$

$$P_v = P_a sin\alpha = 318.83 \sin(0) = 0\ lb/ft$$

$$P_h = P_a cos\alpha = 318.83 \cos(0) = 318.83\ lb/ft$$

Resisting Moment

Section	Area (ft^2)	Weight/Unit Length (lb/ft)	Moment Arm from Point A (ft)	Moment (lb-ft/ft)
(1)	$4' * \frac{8"}{12"} = 2.67$	$145 * 2.67 = 387.15$	2	$387.15 * 2 = 774.3$
(2)	$2' * \frac{25.25"}{12"} = 4.10$	$145 * 4.10 = 594.5$	1.5	$594.5 * 1.5 = 891.75$

(3)	$2'x2' = 4$	$145 * 4 = 380$	3	$380 * 3 = 1140$
		$P_v = 0$	$\Sigma = 6.5$	0
		$\Sigma V = 1361.65$		$\Sigma M_R = 2806.05$

Overturning

$$M_o = P_h\left(\frac{H'}{3}\right) = 318.83\left(\frac{4.77}{3}\right) = 506.94\ lb - ft/ft$$

$$FS = \frac{\Sigma M_R}{M_o} = \frac{2806.05}{506.94} = 5.54 > 2\ \text{ü}$$

Sliding

$$FS = \frac{(\sum V)\tan(k_1\emptyset_1') + Bk_2c_2' + P_p}{P_a cos\alpha} = \frac{(1361.65)\tan\left(\frac{2}{3} * 33°\right) + (4 * \frac{2}{3} * 230) + 0}{318.83\cos(0)} = 3.65 > 1.5\ \text{ü}$$

$$k_1 = k_2 = \frac{2}{3}$$

Bearing Capacity

$$M_{net} = \Sigma M_R - \Sigma M_o$$

$$\overline{CE} = \bar{x} = \frac{M_{net}}{\Sigma V}$$

$$e = \frac{B}{2} - \frac{\Sigma M_R - \Sigma M_o}{\Sigma V} = \frac{4}{2} - \frac{2806.05 - 158.83}{1361.65} = 0.056 < \frac{B}{6} = 0.666\ ft$$

$$q_{toe} = \frac{\Sigma V}{B}\left(1 + \frac{6e}{B}\right) = \frac{1361.65}{4}\left(1 + \frac{6(0.056)}{4}\right) = 369\frac{lb}{ft^3}$$

$$q_{heel} = \frac{\Sigma V}{B}\left(1 - \frac{6e}{B}\right) = \frac{1361.65}{4}\left(1 - \frac{6(0.056)}{4}\right) = 311.82\frac{lb}{ft^3}$$

$$q_u = c_2'N_cF_{cd}F_{ci} + qN_qF_{qd}F_{qi} + \frac{1}{2}\gamma_2B'N_\gamma F_{\gamma d}F_{\gamma i} \qquad \emptyset_2' = 20°, N_c = 14.83$$

$$q = \gamma_2 D = 120(0) = 0\ lb/ft^2 \qquad N_q = 6.4, N_\gamma = 5.39$$

$$B' = B - 2e = 4 - 2(0.056) = 3.888\ ft$$

$$F_{qd} = 1 + 2tan\emptyset_2'(1 - sin\emptyset_2')^2\left(\frac{D}{B}\right) = 1 + 2\tan(20)(1 - \sin(20))^2\left(\frac{0}{4}\right) = 1$$

$$F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c tan\emptyset_2'} = 1 - \frac{1 - 1}{14.83\tan(20)} = 1$$

$$F_{\gamma d} = 1$$

$$F_{ci} = F_{qi} = (1 - \frac{\psi}{90})^2 = (1 - \frac{13.18°}{90°})^2 = 0.73$$

$$\psi = tan^{-1}\left(\frac{P_a cos\alpha}{\Sigma V}\right) = tan^{-1}\left(\frac{318.83\cos(0)}{1361.65}\right) = 13.18°$$

$$F_{\gamma i} = (1 - \frac{\psi}{\phi_2'})^2 = (1 - \frac{13.18°}{20°})^2 = 0.12$$

$$q_u = 230(14.83)(1)(0.73) + 0(6.4)(1)(0.91) + \frac{1}{2}(120)(3.888)(5.39)(1)(0.12) = 2640.84\ lb/ft^2$$

$$FS = \frac{q_u}{q_{toe}} = \frac{2640.84}{369} = 7.16\ \text{ü}$$

APPENDIX C

Task	Due Date
Initial Survey	May. 1
Initial Meeting with Lisa and Mike	May. 5
Patio Design Completed	May. 14
Walkway Design Completed	May. 21
Initial Design Presentation (Lisa, Mike, Edith's Class)	May. 24
Design Implemented	Jun. 30
Final Survey	Oct. 1
List of Drawings Review	Oct. 4
Drawings Completed	Oct. 29
Draft Report Review	Oct. 29
Tables and Figures Completed	Nov. 3
Quantity of Measures Completed	Nov. 3
First draft of a full written report	Nov. 10
First draft of poster due	Nov. 12
Design Presentation Review Complete	Nov. 17
Draft Report to Advisor	Nov. 17
Final Presentation Day	Dec. 3
Final version of poster due	Dec. 9
Final Report, to Advisor, shared drive	Dec. 10
Final Report submitted to SOAR	Dec. 17

Table 2: Preliminary Schedule

APPENDIX D

ITEM	DESCRIPTION	U/M	Quantity	Unit Price	Amount	REFERENCE
Bid Items						
1	CONSTRUCTION SURVEY AND STAKING	LS	ALL	$ 600.00	$600	University Achitect
2	ADDITION TO THE EXISTING DECK	LS	ALL	$ 10,310.00	$ 10,310.00	University Achitect
3	SIDEWALK INSTALLATION	LS	ALL	$ 7,240.00	$ 7,240.00	University Achitect
4	INSTALL 6" BOX GUTTER AND DOWNSPOUT	LS	ALL	$ 620.00	$ 620.00	University Achitect
5	MINKA RAISED GARDEN BEDS	LS	2	$ 80.21	$ 160.42	University Achitect
6	NATIVE DRY PLANTS: REDBUD	EA	4	$ 214.51	$ 858.04	Fast Growing Trees
7	NATIVE DRY PLANTS: MILKWEED	EA	18	$ 22.29	$ 401.22	Spring Hill Nurseries
8	NATIVE DRY PLANTS: EASTERN BLUESTAR	EA	88	$ 18.99	$ 1,671.12	Grims Garden
9	NATIVE DRY PLANTS: BLUE FALSE INDIGO	EA	19	$ 38.00	$ 722.00	Garden Centerpoint
10	NATIVE DRY PLANTS: PRAIRIE DROPSEED	EA	15	$ 19.99	$ 299.85	Grims Garden
11	NATIVE WETLAND PLANTS: CINNAMON FERN	EA	37	$ 16.49	$ 610.13	Gips Garden Store
12	NATIVE WETLAND PLANTS: OHIO GOLDENROD	EA	16	$ 20.95	$ 335.20	Burpee Gardening
13	NATIVE WETLAND PLANTS: SWAMP MILKWEED	EA	18	$ 21.95	$ 395.10	Garden Goods Direct
14	RAIN CATCHMENT SYSTEM	LS	1	$ 96.99	$ 96.99	RTS Home Access
15	108S SQUARE COURT TABLE	LS	3	$ 1,159.00	$ 3,477.00	Outdoor Creations
16	1510 CORNHOLE	LS	2	$ 1,134.00	$ 2,268.00	Outdoor Creations
17	RED MANGO HARDSCAPE EXPANSION	LS	ALL	Contractor Quote		
18	SHADE STRUCTURE	EA	4	$ 3,200.00	$ 12,800.00	Shadescapes
	Total, Bid Items:				$ 42,865.07	

Table 3: Bid Schedule

APPENDIX E

University of Southern Indiana
Engineering Department
8600 University Blvd
Evansville, IN 47712

Project Proposal Plans for

Minka Geriatrics Site Design & Red Mango Expansion

INDEX

West Side Minka | East Side Minka | Red Mango

PROJECT SITE

Design By:
No. 1 Trevor Meier — DATE — INITIALS
No. 2 Daniel Moss — DATE — INITIALS
No. 3 Brayden Bultman — DATE — INITIALS

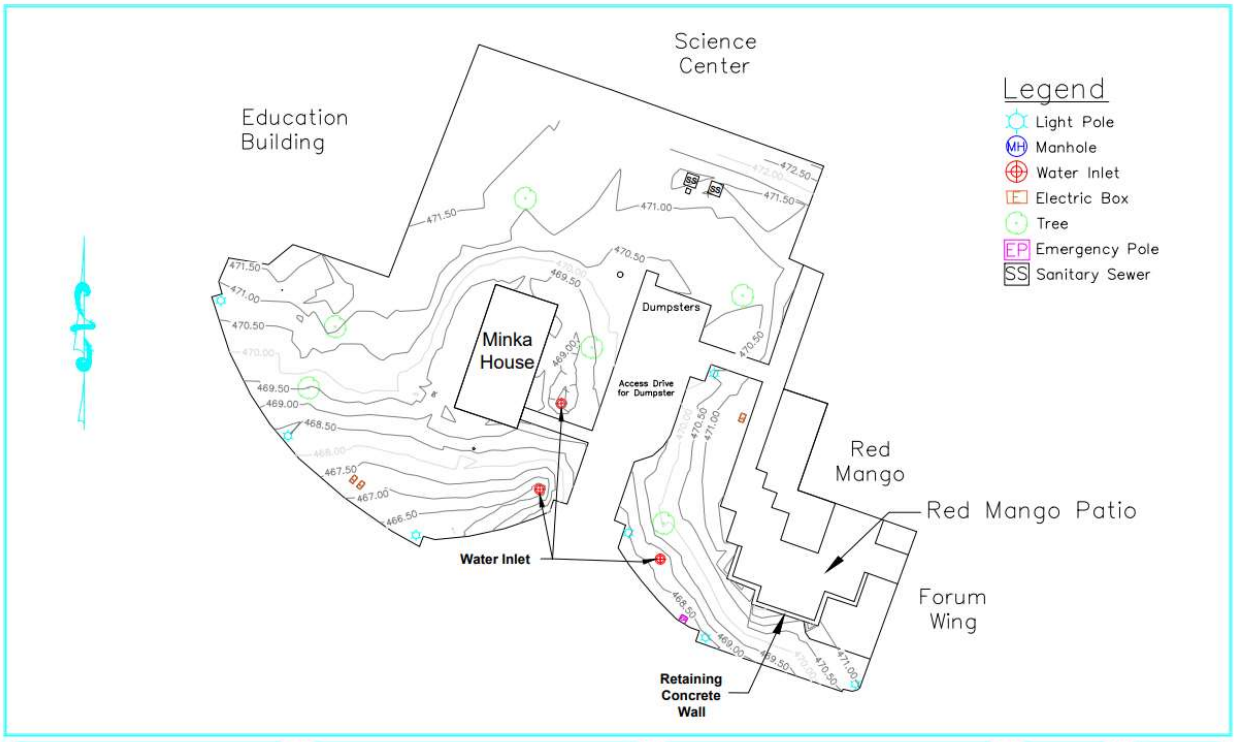
Reviewed By: Adam Tennant — DATE — INITIALS
Approved By: Adam Tennant — DATE — INITIALS

PROJECT NAME: Minka Geriatrics Site Design & Red Mango Expansion
REVISION DATE: 12/8/2021
NTS
DRAWING NO.: STD_900-01
SHEET 1 OF 13

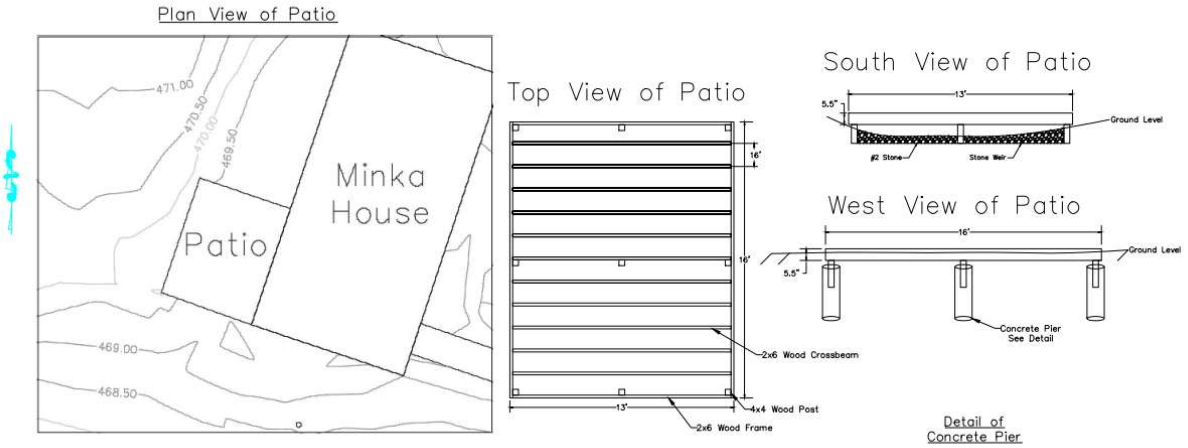
DESCRIPTION	U/M	QUANTITY	UNIT PRICE	AMOUNT
CONSTRUCTION SURVEY AND STAKING	LS	ALL	$ 600.00	$ 600.00
ADDITION TO EXISTING DECK	LS	ALL	$ 10310.00	$ 10310.00
SIDEWALK INSTALLATION	LS	ALL	$ 7240.00	$ 7240.00
INSTALL 6" BOX GUTTER AND DOWNSPOUT	LS	ALL	$ 620.00	$ 620.00
MINKA RAISED GARDEN BEDS	LS	2	$ 80.21	$ 160.42
NATIVE DRY PLANTS: REDBUD	EA	4	$ 214.51	$ 858.04
NATIVE DRY PLANTS: MILKWEED	EA	18	$ 22.29	$ 401.22
NATIVE DRY PLANTS: EASTERN BLUESTAR	EA	88	$ 18.99	$ 1671.12
NATIVE DRY PLANTS: BLUE FALSE INDIGO	EA	19	$ 38.00	$ 722.00
NATIVE DRY PLANTS: PRAIRIE DROPSEED	EA	15	$ 19.99	$ 299.85
NATIVE WETLAND PLANTS: CINNAMON FERN	EA	37	$ 16.49	$ 610.13
NATIVE WETLAND PLANTS: OHIO GOLDENROD	EA	16	$ 20.95	$ 335.20
NATIVE WETLAND PLANTS: SWAMP MILKWEED	EA	18	$ 21.95	$ 395.10
RAIN CATCHMENT SYSTEM	LS	1	$ 96.99	$ 96.99
108S SQUARE COURT TABLE	LS	3	$ 1159.00	$ 3477.00
1510 CORNHOLE	LS	2	$ 1134.00	$ 2268.00
RED MANGO HARDSCAPE EXPANSION	LS	ALL	CONTRACTOR QUOTE	
SHADE STRUCTURE	EA	4	$ 3200.00	$ 12800.00

University of Southern Indiana
Engineering Department
Senior Design Project

PROJECT NAME & LOCATION: Minka Geriatrics Site Design & Red Mango Expansion
DRAWING NAME: Quantity of Measures
REVISION DATE: 12/8/2021
NTS
DRAWING NO.: STD_911-30-01
SHEET 2 OF 13

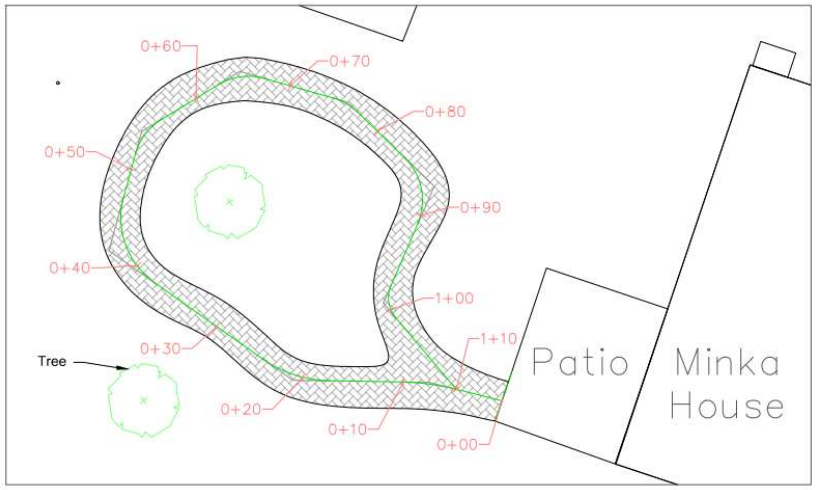


University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Existing Conditions**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **3** OF **13**



Notes:
- Strip topsoil at the deck area and regrade the area so water drains under the deck.
- Install filter fabric and a layer of #2 stone under the deck.
- Install (9) 1' x 3' deep concrete piers for the deck to set on.
- Install treated wood framing
- Install 5.5" wide composite wood decking.
- Install 5.5" band board trim at the perimeter.

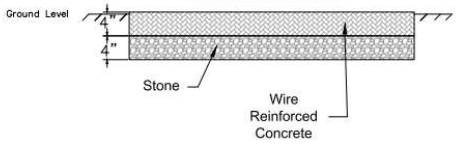
University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Minka Patio**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **4** OF **13**



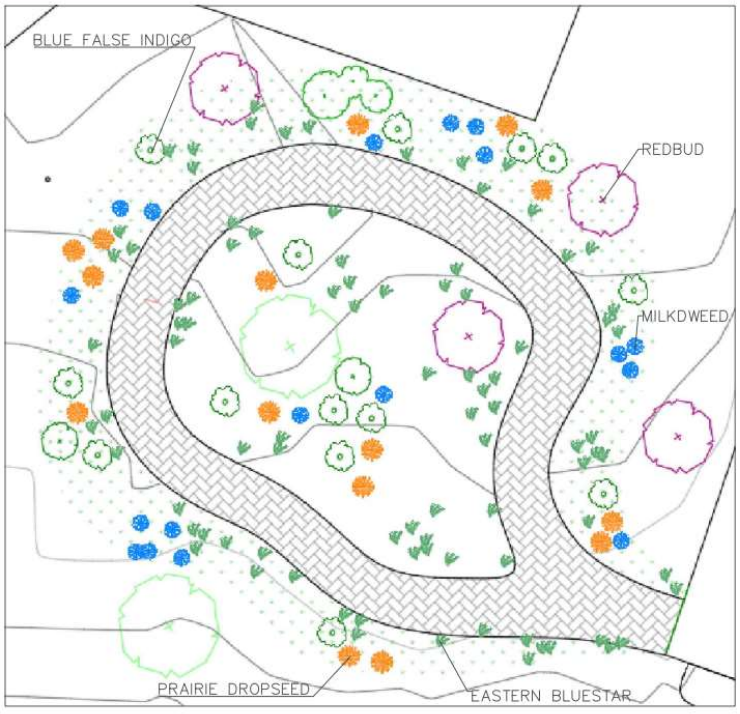
Station	Length (ft)
0+00	0
0+10	10
0+20	20
0+30	30
0+40	40
0+50	50
0+60	60
0+70	70
0+80	80
0+90	90
1+00	100
1+10	110

Notes:
- Strip topsoil.
- Install 4" of stone.
- Form edges.
- Pour 4" of 4000 psi, wire reinforced concrete sidewalk

Detail of Sidewalk

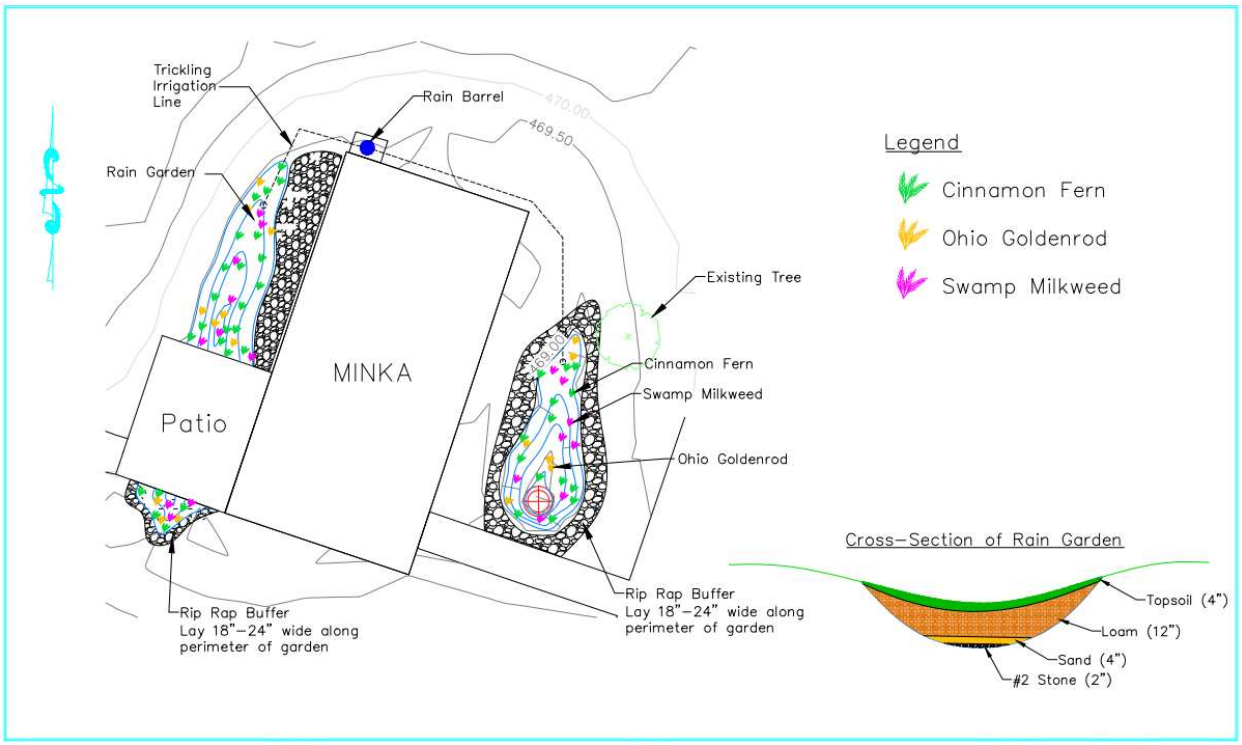


University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Minka Walkway Alignment**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **5** OF **13**

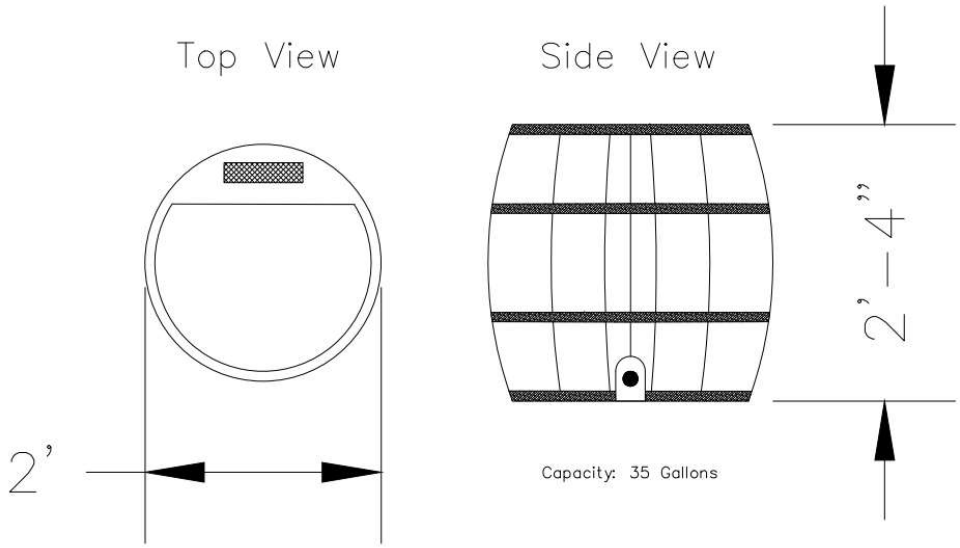


Legend
- REDBUD
- MILKWEED
- EASTERN BLUESTAR
- BLUE FALSE INDIGO
- PRAIRIE DROPSEED

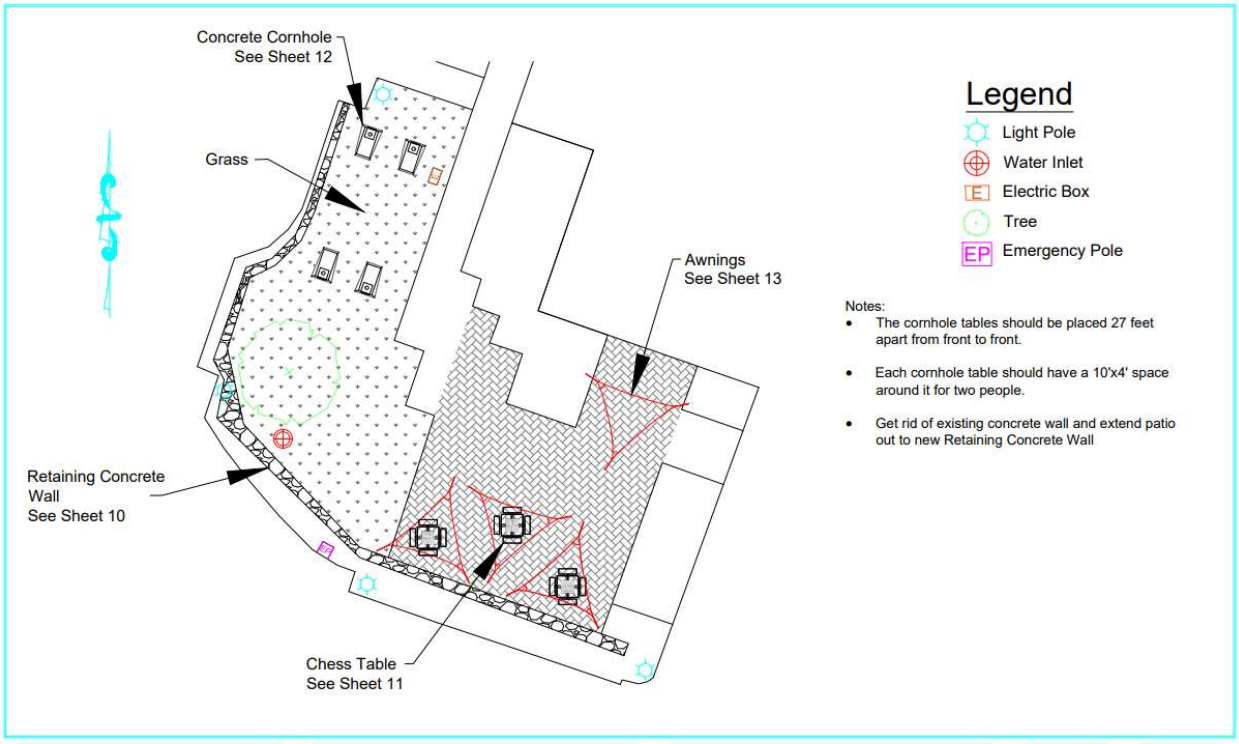
University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Walkway Landscape** **Planting Plan**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **6** OF **13**



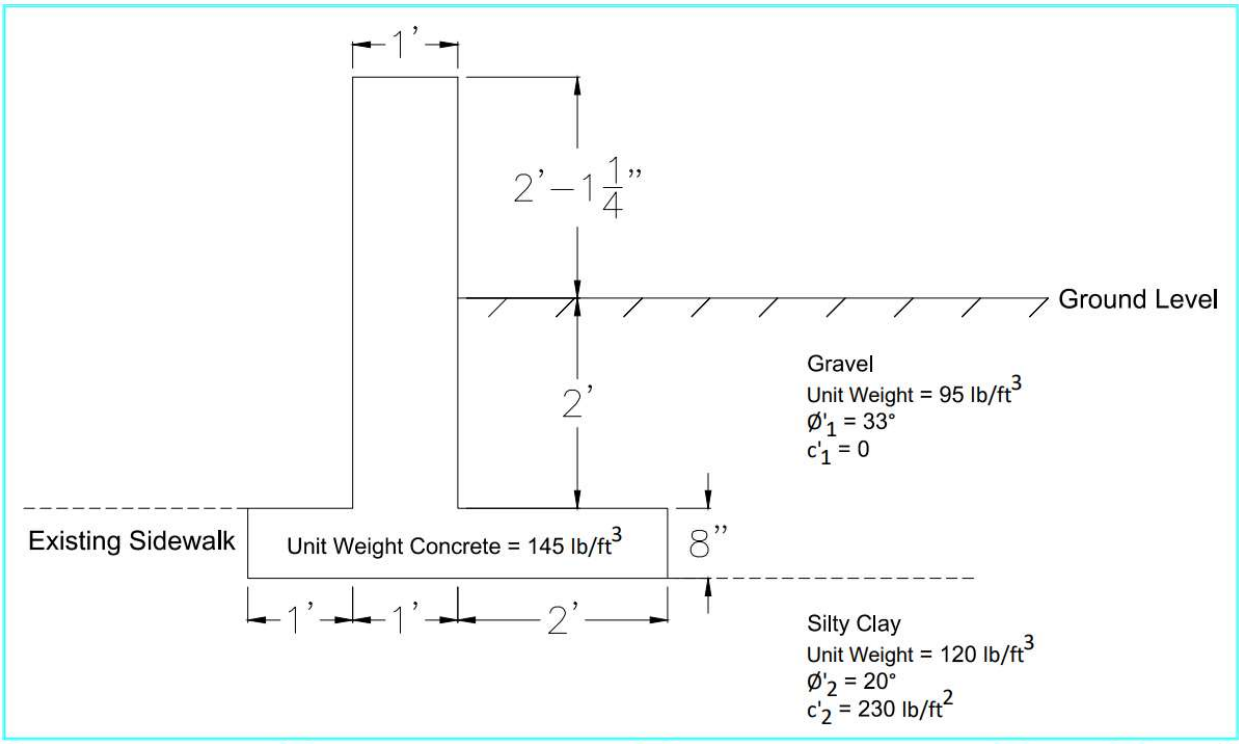
University of Southern Indiana Engineering Department	PROJECT NAME & LOCATION	DRAWING NAME	REVISION DATE	DRAWING NO.
Senior Design Project	Minka Geriatrics Site Design & Red Mango Expansion	Rain Garden	12/8/2021	STD_911-30-01
			NTS	SHEET 7 OF 13



University of Southern Indiana Engineering Department	PROJECT NAME & LOCATION	DRAWING NAME	REVISION DATE	DRAWING NO.
Senior Design Project	Minka Geriatrics Site Design & Red Mango Expansion	Rain Barrel	12/8/2021	STD_911-30-01
			NTS	SHEET 8 OF 13

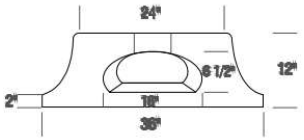


University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Red Mango Expansion**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **9** OF **13**

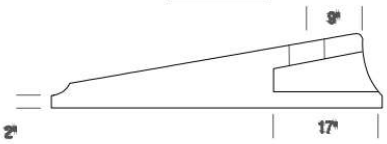


University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Detail of Concrete Retaining Wall**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **10** OF **13**

BACK ELEVATION

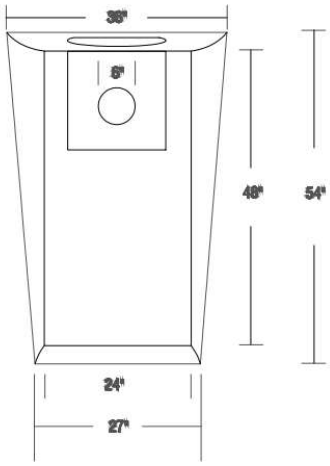


SIDE ELEVATION



NOTES:
1. Concrete mix design to include a mixture of Portland Cement, water, coarse and fine aggregates, pure mineral oxide coloring agents (when applicable) to yield a minimum compressive strength of 5000 psi.
2. Final product shall be reinforced with #4 and #5 rebar grid.
3. Product is cast in 1-piece with no assembly required.
4. Hairline cracks may develop over time. These are not structural failures, but inherent characteristics of the material itself.
5. Air pockets are a common occurrence in precast products. The frequency and size of air pockets are variable and to be expected, especially on vertical surfaces.
6. Concrete corners and edges will chip if not handled according to guidelines. Patch kits are available but may or may not blend and can be variable.
7. There is a level of care and maintenance associated with your product and is the responsibility of the end user. Choosing the right sealer can help minimize those costs.

PLAN

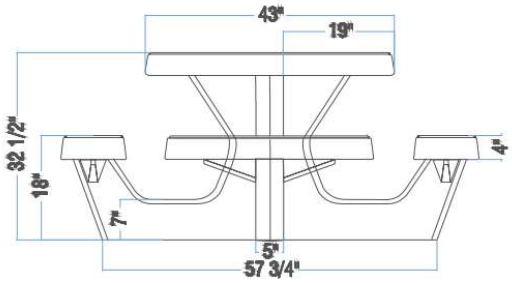


WEIGHT: 950 LBS ea.

Provided By: Outdoor Creations Inc

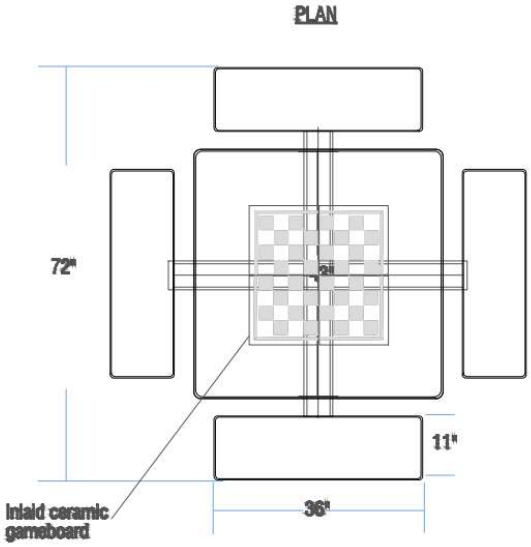
University of Southern Indiana Engineering Department Senior Design Project	PROJECT NAME & LOCATION Minka Geriatrics Site Design & Red Mango Expansion	DRAWING NAME Detail of Amenities Concrete Cornhole	REVISION DATE 12/8/2021 NTS	DRAWING NO. STD_911-30-01 SHEET 12 OF 13

SIDE ELEVATION



NOTES:
1. Concrete mix design to include a mixture of Portland Cement, water, coarse and fine aggregates, pure mineral oxide coloring agents (when applicable) to yield a minimum compressive strength of 5000 psi.
2. Final product shall be reinforced with #4 and #5 rebar grid.
3. Product is cast in 1-piece with no assembly required.
4. Hairline cracks may develop over time. These are not structural failures, but inherent characteristics of the material itself.
5. Air pockets are a common occurrence in precast products. The frequency and size of air pockets are variable and to be expected, especially on vertical surfaces.
6. Concrete corners and edges will chip if not handled according to guidelines. Patch kits are available but may or may not blend and can be variable.
7. There is a level of care and maintenance associated with your product and is the responsibility of the end user. Choosing the right sealer can help minimize those costs.

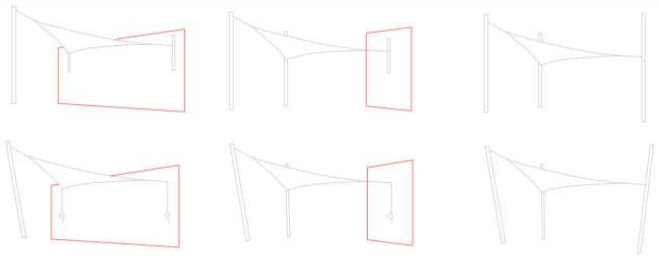
PLAN



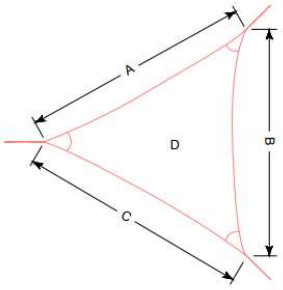
WEIGHT: 2000 LBS

Provided By: Outdoor Creations Inc

University of Southern Indiana Engineering Department Senior Design Project	PROJECT NAME & LOCATION Minka Geriatrics Site Design & Red Mango Expansion	DRAWING NAME Detail of Amenities Concrete Chess Tables	REVISION DATE 12/8/2021 NTS	DRAWING NO. STD_911-30-01 SHEET 11 OF 13



POSITIONS



TOP VIEW

	A	B	C	D
INGENUA	cm / ft	cm / ft	cm / ft	m² / ft²
T40	400 / 13' 1"	400 / 13' 1"	400 / 13' 1"	6.1 / 66'
T50	500 / 16' 5"	500 / 16' 5"	500 / 16' 5"	9.8 / 104'

NOTES:
1. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
2. ALL IMPERIAL DIMENSIONS ARE METRIC CONVERSIONS AND HAVE BEEN ROUNDED TO THE NEAREST 1". IF EXACT DIMENSIONS ARE REQUIRED, SEE THE UMBROSA METRIC DIMENSIONS.
3. DO NOT SCALE DRAWING.
4. THIS DRAWING IS INTENDED FOR USE BY ARCHITECTS, ENGINEERS, CONTRACTORS, CONSULTANTS AND DESIGN PROFESSIONALS FOR PLANNING PURPOSES ONLY. THIS DRAWING MAY NOT BE USED FOR CONSTRUCTION.
5. ALL INFORMATION CONTAINED HEREIN WAS CURRENT AT THE TIME OF DEVELOPMENT BUT MUST BE REVIEWED AND APPROVED BY THE PRODUCT MANUFACTURER TO BE CONSIDERED ACCURATE.
6. CONTRACTOR'S NOTE: FOR PRODUCT AND COMPANY INFORMATION VISIT www.CADdetails.com/info AND ENTER REFERENCE NUMBER 4822-025.

University of Southern Indiana Engineering Department **Senior Design Project**	PROJECT NAME & LOCATION **Minka Geriatrics Site Design & Red Mango Expansion**	DRAWING NAME **Detail of Amenities** **Awnings**	REVISION DATE **12/8/2021** **NTS**	DRAWING NO. **STD_911-30-01** SHEET **13** OF **13**