Hartman Arboretum and Food Forest

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1.0 Abstract

The purpose of this project is to explore more sustainable agricultural methods. It was inspired by the 12 principles of permaculture. Permaculture is a land management technique that focuses on creating small communities of plants. In these communities, the plants coexist in a harmonious way, just like natural occurring plant groupings. These groupings are called guilds and the implementation of them eliminates the need for tilling, fertilizers, and pesticides. When many guilds are placed close to each other, that area can be called a food forest. This method of growing food is important because current agricultural methods are causing major problems to the global water supply and soil quality. The site chosen for this project is a small portion of 25-acre facility by the name of Hartman Arboretum. It is a local non-profit organization dedicated to the preservation of trees and native habitats for wildlife. The location hopes to implement more sustainable land management practices in the future, making them an ideal partner for this work. The deliverables for this project include the following design elements; a 1000 square foot post-frame structure, rainwater harvesting and storage design, and a guild planting plan for a food forest.

2.0 Introduction

The scope of this project involves a design proposal for Hartman Arboretum in Evansville Indiana. The Arboretum, as seen in Figure 1, is a local green space dedicated to the education and preservation of rare species and horticultural practices. The proposal includes the design of a 1000 square foot post-frame structure with large classroom and seed storage vault, a rainwater harvesting and storage system and a planting plan (guilds) for a food forest and a cost estimate for the project. The structure was designed to accommodate rain barrels to collect roof runoff to supply water to the building's interior. The excess runoff from the barrels is designed to flow into a rainwater garden on the south side of the proposed building. The planting plan is designed to be implemented at the base of the 30 existing nut trees on the property. Guilds will be planted at the base of each, transforming the area into a food forest. This will increase the yield of that area without the usage of any further resources and help the arboretum move in a more sustainable direction with their land management practices.

Figure 1: Memorial Garden at Hartman Arboretum

3.0 Background Information

The following section contains information pertaining to the site location and design choices made by the team for this project. Specifics about the site and why it was chosen will be covered, as well as the 3 major contributing aspects of the project which are permaculture, structural analysis, and hydrology.

3.1 Hartman Arboretum

Hartman Arboretum was founded in 2001 as a non-profit wildlife sanctuary and arboretum. It is owned by Jean Hartman and co-operated with her son Brian Hartman. The site is a level 1 accredited arboretum. This means several things; the site is governed by a body that develops a master plan for the future of the arboretum, the site has 25+ varieties of trees that they cultivate and maintain, the site has employees/volunteers who care for the facilities and the site is open the community at a minimum of 1 time per year in the form of a community event. This site does about 5-6 community events per year and the employees are provided through a partnership with SWIMGA (Southwestern Indiana Master Gardener Association). The site currently has several designated garden areas (see Figure 2) with interest in incorporating more sustainable land management practices in the future.

Figure 2: Map of site provided by industrial liaisons

3.2 Permaculture

Permaculture is a combination of the two words: permanent agriculture. Its main goal is to encourage a holistic approach to growing food. This is achieved with less work and creates more yield. It does this by utilizing harmonious relationships between plants and their surrounding environment. In nature, plants group tightly together in layers with many species coexisting in symbiotic relationships. In these groupings, plants can share the resources of sun, water, and soil. The diversity in these “guilds” allows for a natural balance of pests and microbiome health in the soil. For this project, all the above-mentioned factors culminated into nut-tree guilds. I close example to the nut guild can be below in figure 3. The 12 principles of permaculture are as follows: 1. Observe and interact, 2. Catch and store energy, 3. Obtain and yield, 4. Apply self-regulation, 5. Use on site materials, 6. Produce no waste, 7. Design from patterns to details, 8. Integrate rather than segregate, 9. Use slow and small solutions, 10. Value diversity, 11. Use the edges and 12. Respond creatively to change. The team focused on principles 1,2,3,8,10 and 11. Those were most applicable to scope of the project.

3.3 Why Permaculture?

Traditional agriculture methods of monocropping and row gardening require heavy use of pesticides and fertilizers. Excessive nutrients from these products gather in runoff and get carried to nearby water sources. These nutrients lower oxygen levels in the water allowing algae growth. This algae growth consumes more oxygen in the water and ultimately lowers the oxygen levels so much that it makes it toxic to marine life. This leads to toxic algae blooms, as seen in figure 3, where large areas of water have become uninhabitable for marine life. Excessive nutrients also pollute ground water and drinking water and are difficult or impossible to remove with treatment. Traditional agriculture methods also lead to increased soil degradation. This occurs when topsoil is disturbed from deforestation and tilling and allows easier erosion from rain and wind. Monocropping also disrupts nutrient balance in soil by creating a deficit of some and an excess of others. Meaning the heavy use of fertilizers and pesticides leads to more unstable soil moisture and increased runoff. Monocropping also causes increased Carbon dioxide levels by releasing sequestered carbon when soil is tilled, or land is cleared. It also leads to higher use of fossil fuels to operate farm equipment and to transport foods greater distances. All of these negative side effects can be eliminated with the implementation of permaculture methods.


Figure 3: 6,700 square miles of toxic algae bloom in the Gulf of Mexico

Figure 4: An example of an established fruit tree guild

3.3 Post Frame Structure

The post frame structure's size is twenty-seven feet wide by forty feet long. The size was chosen because it will meet the minimum size requirements for Leed certification and provide enough useful space for the arboretum and its various events. The structure is a multipurpose building. The building includes a one hundred square foot seed vault, and the rest of the building is an open floor plan. This can be used for educational events as well as storage. The framing plan includes an overhead door and a walk door for easy access. The structure's design is based upon common construction practices for post frame buildings. Figure four which is below depicts what the building will look like when constructed. The figure shows the access doors as well as the aesthetic wainscot along the bottom of the building's walls.

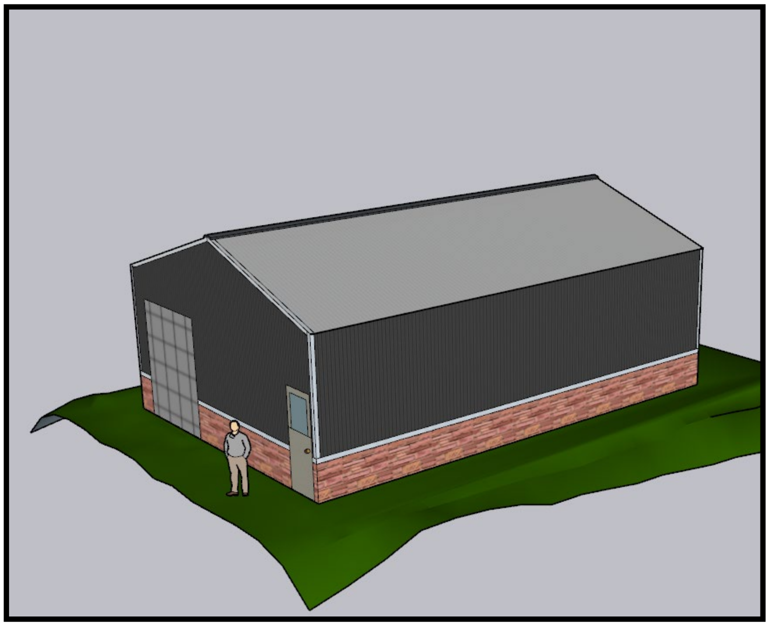

Figure 5 (Architectural Representation of Structure)

3.4 Hydrologic Conditions

The hydrologic characteristics of the proposed building are critical for optimizing the rainwater collection system. With a roof area totaling approximately 1,000 ft^2, there exists a substantial surface area capable of contributing to the rain barrels positioned at each corner of the structure. Moreover, the roof material, specified as corrugated sheet metal, offers excellent runoff potential due to its designed slope and low friction factor. These material attributes facilitate rapid and efficient water runoff, ensuring the rain barrels can swiftly collect water.

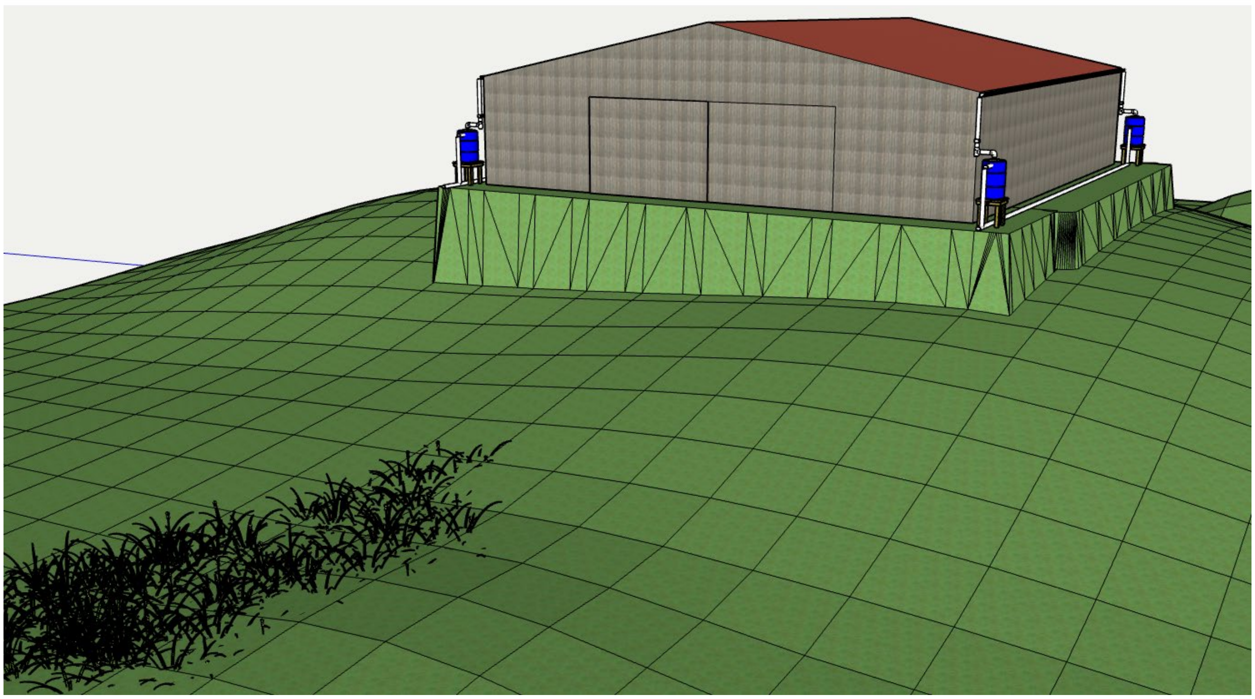

Figure 6 (Architectural Depiction of Structure and Rain Barrel System)

4.0 Design and Analysis

4.1 Existing Site Conditions

The space selected for the site is located on the north side of Evansville, IN (as seen in figure 5). The 25-acre arboretum is home to many species of trees and shrubs, a variety of wildlife and flowers as well as a few small gardens. Our industrial liaisons were happy to allow us access to the site for recognizance work as well as thorough information about the current site condition and needs. The site was visually inspected by the team and then surveyed to create a topographic map. This map provided the team with a model of the existing conditions of the site. From there, design could begin.

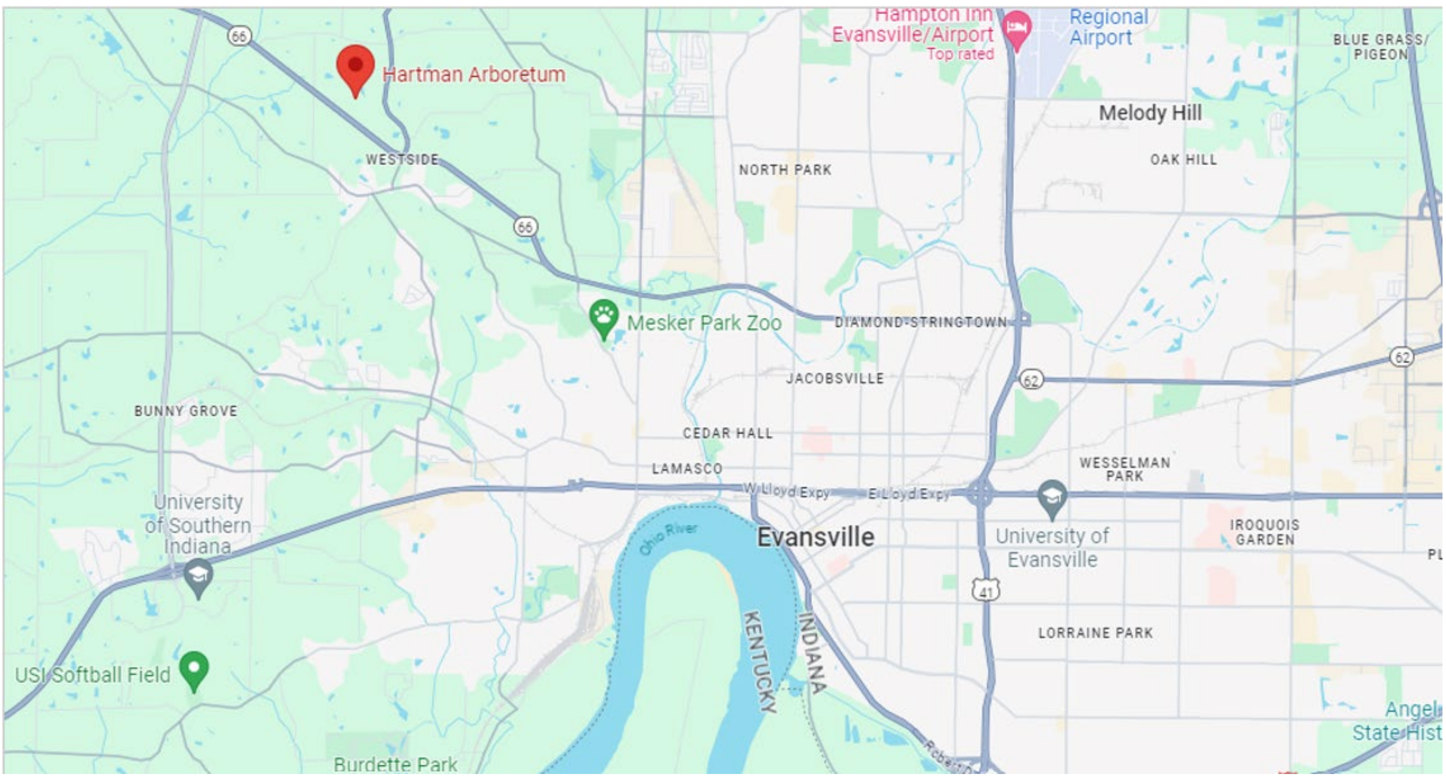

Figure 7: Map with location of Hartman Arboretum

4.2 Visual Inspection and Surveying

Visual inspection of the site was crucial to the success of the project's design. The industrial liaison and owner Jean Hartman facilitated a tour of the property where the team gained valuable insight into the current function and issues of the site. While walking around, the different zones were observed as seen in figure 6, as well as some minor erosion issues found, and a potential location for the building. The property contains a few small lakes that collect rainwater runoff and are then piped throughout the gardens to allow a closed loop system for water distribution. The building was also designed in the same way to be cohesive with the arboretum's goals. Strategic resource usage is a valued aspect at Hartman Arboretum and in goals of permaculture as well. Once the initial inspection was complete, the team returned later to gather the necessary surveying information for the creation of a topographic map. This map (as seen in figure 6) allowed for informed design decisions to be made.

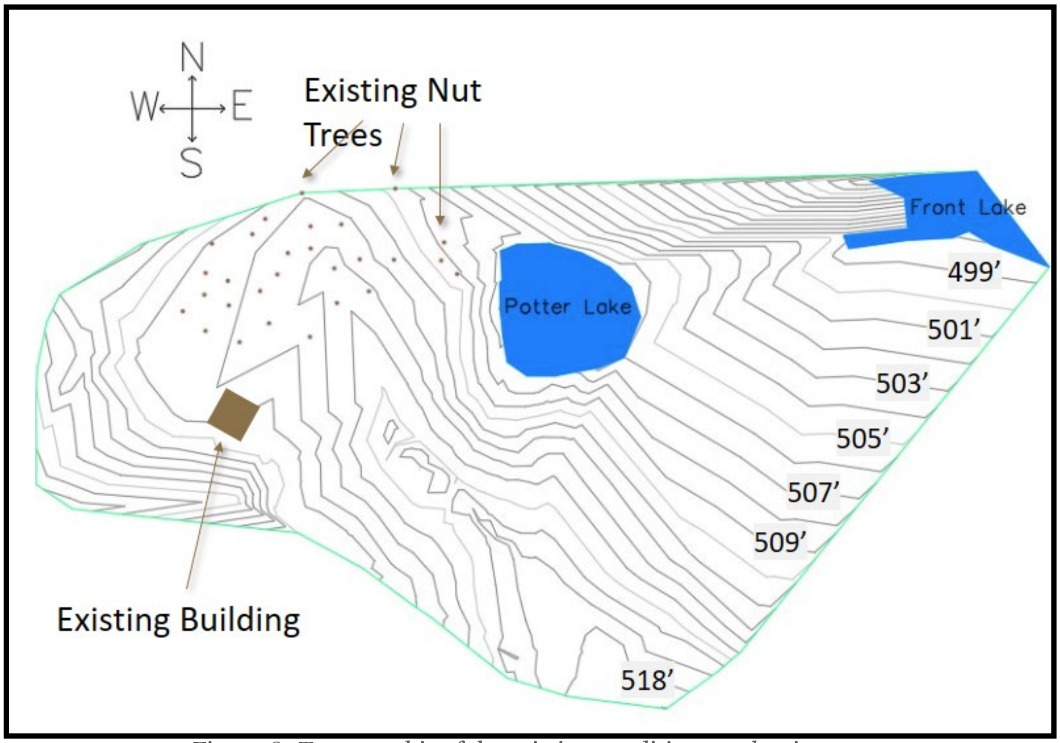

Figure 8: Topographic of the existing conditions at the site

4.3 Guild Planting Plan

With the existing conditions observed, the team could begin designing how exactly to implement permaculture practices at the site. During visual inspection, it was observed that the site had 30 established nut trees. This was a great starting point for the design of further yield. By utilizing the materials already on the site (the nut trees) and the permaculture principles 8,10, and 11, the team was able to design a planting plan (as seen in figure 8). This plan utilized guilds, as previously mentioned and seen in figure 3, to fill the empty space at the base of the nut trees. Guilds with a large nut tree at the center have 8 layers. Each layer fills a specific need to ensure an overall symbiotic environment.

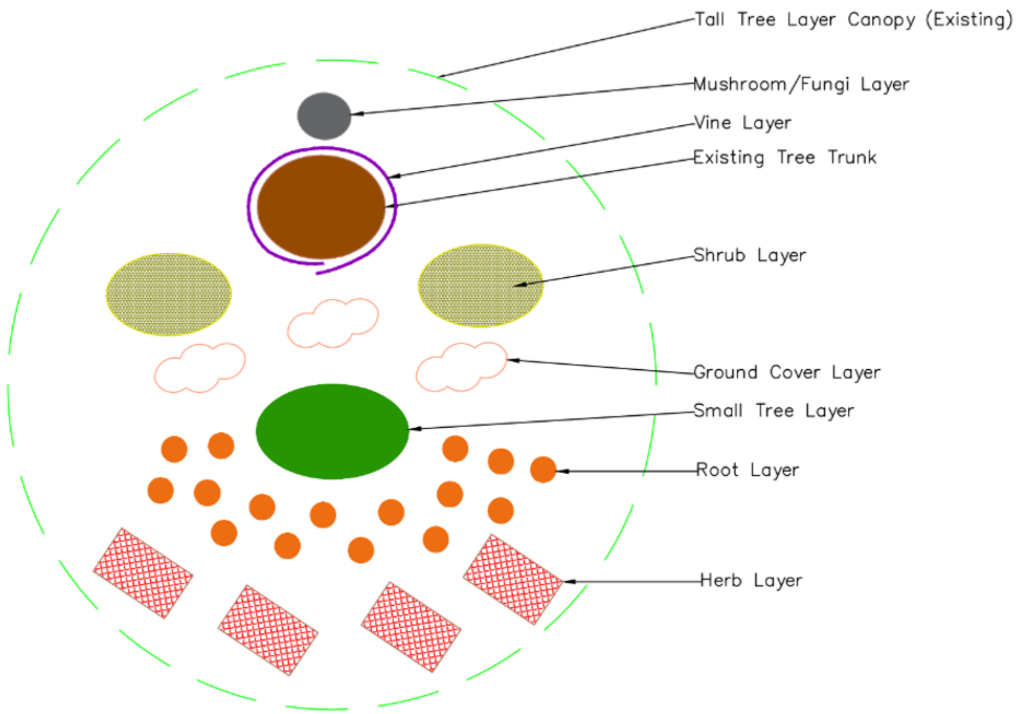

Figure 9: 8 layer guild planting plan

4.4 Species Selection

There are many species options for each layer and a full list can be seen below in Table 1. Native Indiana species and perennials were preferred choices from the table below. This was to sustain habitats for native animal species and encourage the future self-sufficiency of the guild. The layers of the guild are determined by plant size and location in reference to the sun. Ideally the tallest layer, the nut tree layer, is located at the center of the guild, with smaller plants spreading out around it depending on the light requirements of the species. This layer includes any nut tree 20 feet or taller. The back side of the tree, the south side, is reserved for the mushroom layer because of the specific environmental needs of fungi. The fungi play an essential role in the success of the guild and overall food forest. They convert dead and organic matter into nutrients the rest of the plants can consume. The next layer in descending order from north to south from the trunk of the nut tree is the vine layer. The vine layer utilizes the vertical space often left unused in common agricultural practices. The existing nut tree acts as a trellis for this layer. This adds to the increased yield of the guild without the need for any additional materials. The next layer moving further south is the shrub layer. This layer acts as a living mulch, covering the soil to protect it from the harsh temperatures of the sun in the hottest months and helping it to retain moisture for longer. When a soil retains moisture for longer, the guild requires less irrigation. The layer planted in front of that is the ground cover layer. This layer also acts as a living mulch and fills the low-lying space at the bottom of the other plants. This area is often neglected for use in growing. Placing low growing plants ensures all the soil is covered. Covered soil benefits all the surrounding species for the reasons mentioned above. The next layer after the ground cover layer is the small tree layer. This consists of any semi-dwarf rootstock variety of fruit trees. These types of trees only grow as high as 12'-20'. This size ensures the lower plants are not completely in shade and that the nut tree and fruit tree are not in competition with each other over available resources. The last and furthest south layer is the herb layer. This layer also acts as a living mulch layer. There is a large amount of redundancy built into the system for water conservation because this is one of the main ways to ensure success of the food forest while embodying sustainable use of resources. The herb layer also acts as a natural pesticide and fertilizer. Many species of beneficial insects are drawn to and feed off the flowers of the herb plants. These beneficial insects eat detrimental insects while pollinating the surrounding plants.

Table 1: Species options for 8 layers of planting plan

Tall Tree	Mushroom	Vine	Shrub	Ground Cover	Small Tree	Root	Herb	Flowers (Herb)
Korean Pine	Oyster	Beans	Currants	Cranberries	Dwarf Apples	Burdock	Basil	Cosmos
Oak	Shiitake	Melons	Highbush Blueberry	Creeping Blueberries	Dwarf Cherries	Carrots	Chives	Flowering Tabacco
Walnut	King Stropharia	Cucumbers	Elderberry	Kinnikinnick	Dwarf Figs	Dock	Dill	Gloriosa
Non-Dwarf Apple		Squash	Huckleberry	Salal	Dwarf Peaches	Parsnip	Fennel	Daisy
Non-Dwarf Cherries		Tomatoes	Goumi	Strawberries	Dwarf Plum	Alfalfa	Lavendar	Marigold
Non-Dwarf Figs		Peas	Gooseberry	Wintergreen	Dwarf Persimmon	Yarrow	Oregano	Mexican Sunflower
Non-Dwarf Peaches		Nasturtiums	Sea Buckthorn	Mint		Garden Sedge	Parsley	Saliva
Non-Dwarf Plum		Blackberry	Serviceberry	Creeping Thyme		Little Bluestem	Thyme	Sunflowers
Non-Dwarf Persimmon		Chayote	Hazel nuts	Nasturtiums		Northern Sea Oats		Zinnia
		Grapes	Filberts	Rosemary		Prairie Dropseed		Agastache
		Kiwi				Switch Grass		Amosonia
		Mashua						Aster
		Chinese Yams						Black-eyed Susan
		Passionfruit						Blanket Flower
		American Groundnut						Boltonia
								Columbine
								Coneflower

5.0 Proposed Site Conditions

Proposed site conditions include the post-frame building, planting guilds and rain barrels.

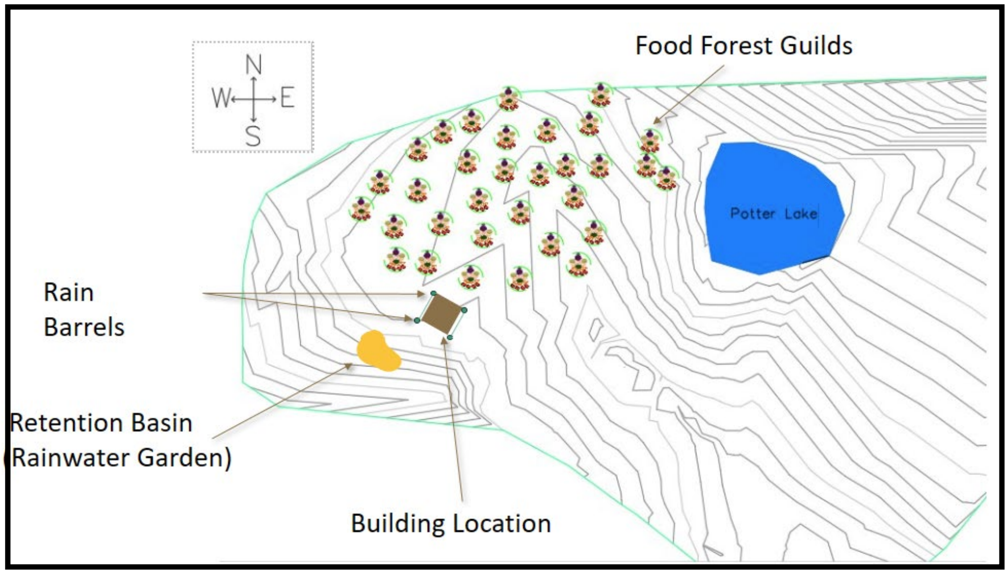

Figure 10 (Proposed Conditions)

5.1 Structure Analysis and Design

The analysis began at the top of the structure with the loading applied to the trusses. This was then used to inform the rest of the design. The appropriate girders and posts were then determined. Next, the footings were analyzed. The design was based on typical construction practices for post frame buildings. This provided a good starting point for member selection. A Risa model of various components was created to analyze the design. After this, design checks were performed to ensure that the design was sufficient. Once this was completed, various drawings and models were created.

5.1.2 Truss Analysis

The style of truss chosen for this project was the Howe style truss. This style of truss was chosen because it is quite common and readily available. The truss has an overall span of twenty-seven feet. ASCE (American Society of Civil Engineers) 7-16 was used to determine the appropriate loads. The National Design Spec (NDS 18) was used to design the wooden members. The figure below depicts these loads being applied to the truss. It should be noted that the truss was examined for shear, moment, bearing, and buckling stresses. The axial force diagram shown in figure 11 shows the forces in each of the truss members. The max force is 2.4 kips in member one. The shear and moment diagrams are shown in figures twelve and thirteen respectively.

Table 2 (Truss Loading)

Loading		
Material	**Dead Load (psf)**	**Live Load (psf)**
Corrugated Metal	2.5	NA
Spray Foam	0.2	NA
Purlins	4.0	NA
Snow Load	NA	15
Construction Load	NA	20

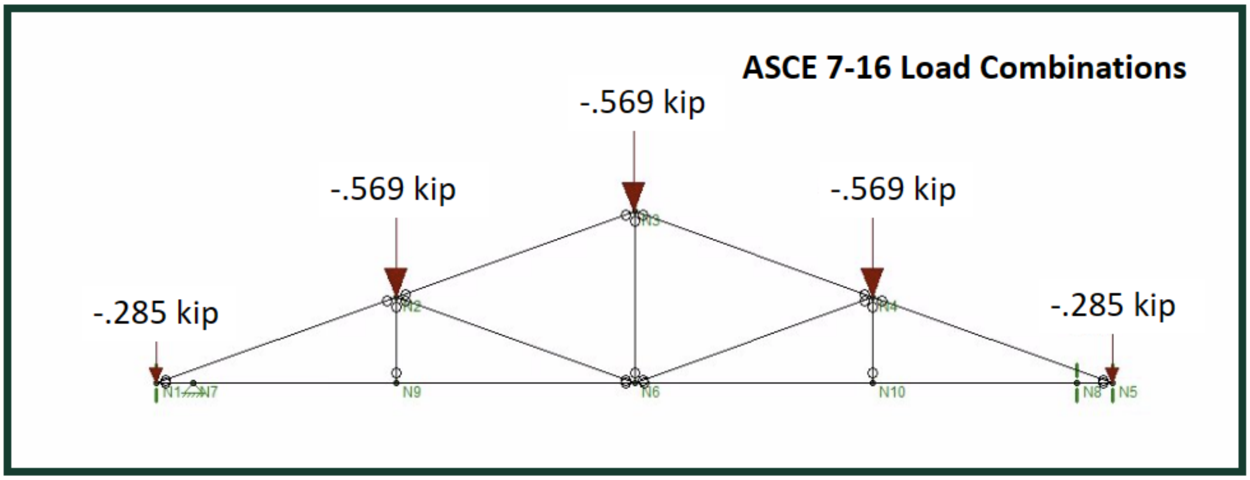

Figure 11 (Truss Free Body Diagram)

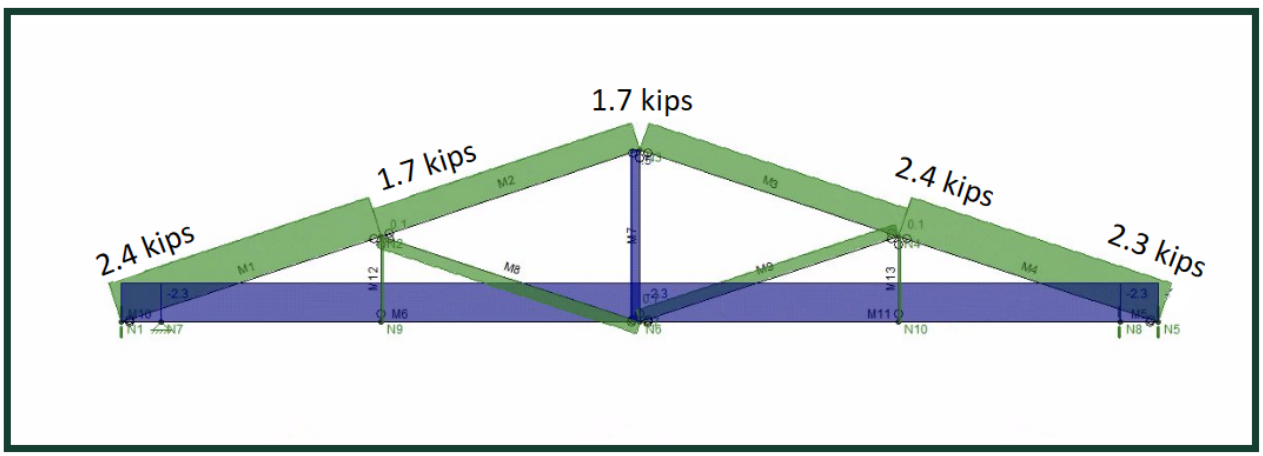

Figure 12 (Axial Force Diagram)

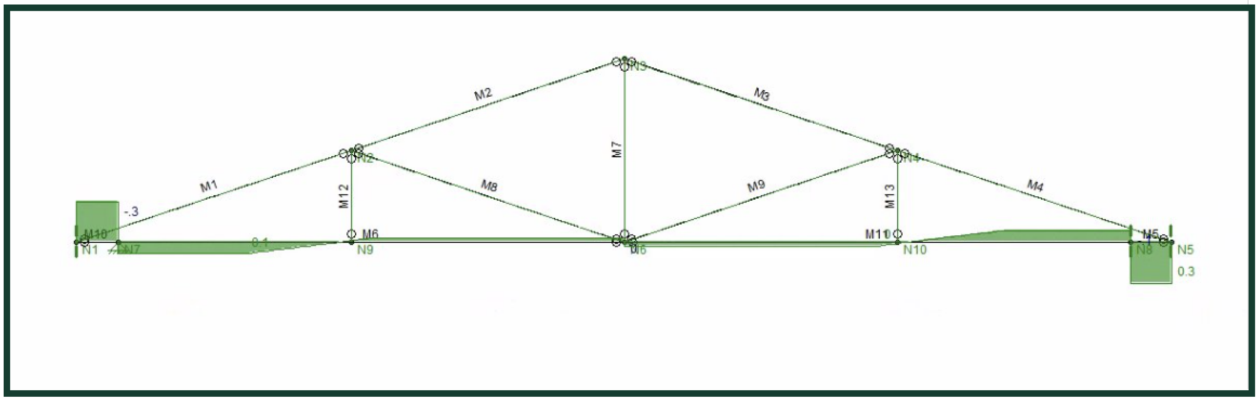

Figure 13 (Shear Diagram)

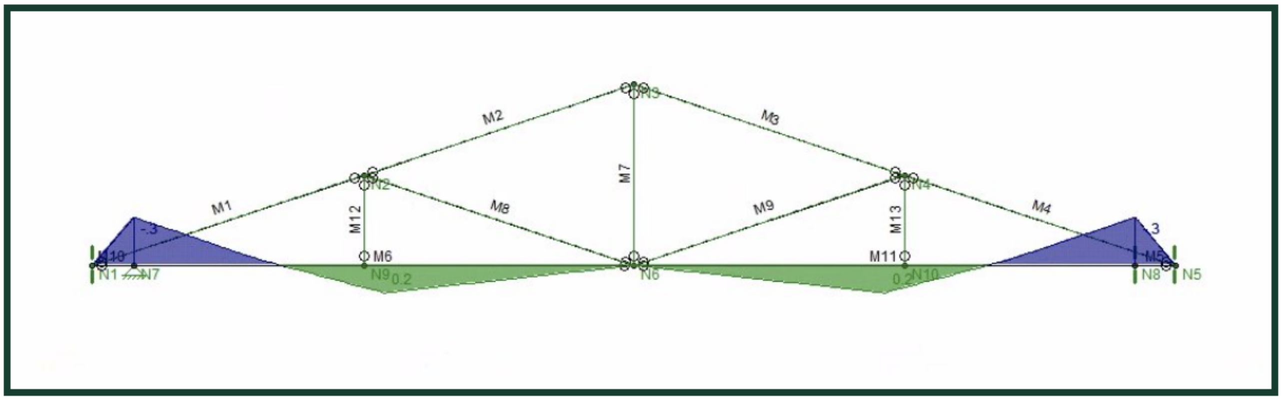

Figure 14 (Moment Diagram)

5.1.3 Truss Design

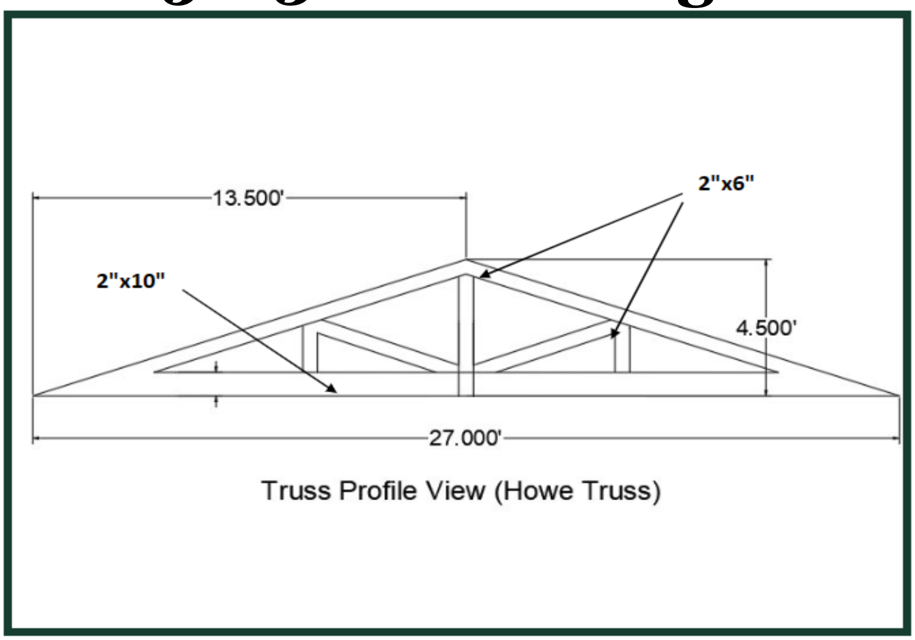

Figure 15 (Howe Truss Design)

5.1.4 Girder and Post Analysis

The Girder and post analysis was done using the loads from the truss design. The loads applied to the girders from the trusses were used to inform the design. These loads were modeled as a distributed load across the girder within Risa. This distributed load can be seen in both figure fifteen and sixteen. The design checks can be seen in table three. NDS 18 code was then used to verify that the two by twelve girders were sufficient and that the posts were sufficient to resist buckling. It should be noted that the post was modeled as being unbraced along the entire length, while in actuality the two by four wall girts would provide some bracing. Also, if the girders were not notched into the post, a smaller post size could have been used. This type of connection was used since it is typically how the connection is made. More analysis would be needed to determine a different connection design to allow for a smaller post.

Table 3 (Girder Design Checks)

Girder Design Check		
	Bending	Shear
Strength (psi)	1250	175
Stress (psi)	950	169

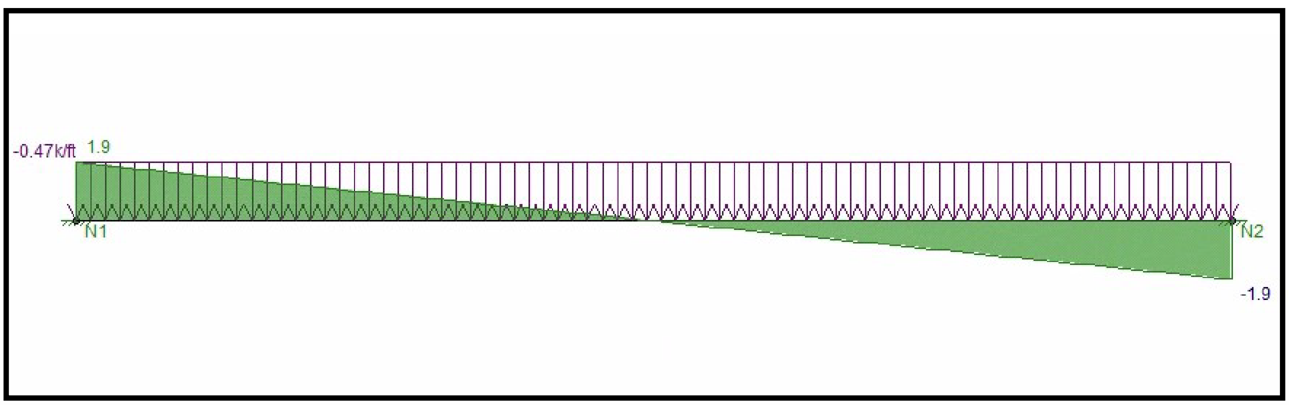

Figure 16 (Girder Shear Diagram)

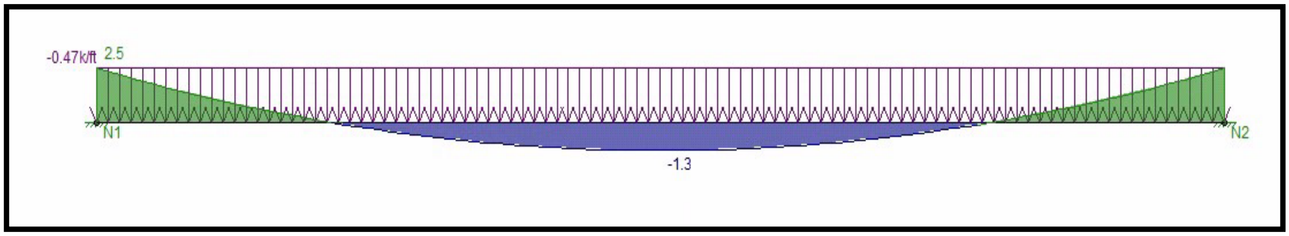

Figure 17 (Girder Moment Diagram)

Table 4 (Post Buckling Analysis)

Post Buckling Analysis	
le (in)	96
Fc' (psi)	746
Fmax (lb)	22596
P (lb)	5700
fc' (psi)	189

5.1.5 Girder and Post Design

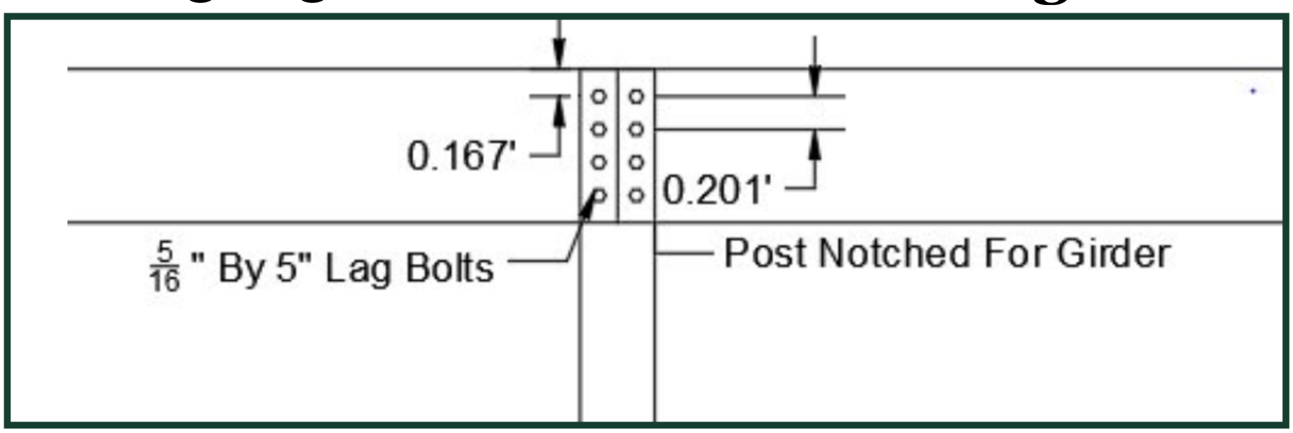

Figure 18 (Post Girder Connection)

5.1.6 Footing Analysis

The footing for the structure consists of circular pier footings. The footings were designed for typical construction. The footings pass the bearing capacity requirements for the soil located on the site. This was done using the soil survey data gathered by the web soil survey. Typical construction utilizes twenty-four-inch diameter footings. For this reason, twenty-four-inch diameter footings were chosen. This size of footing passes the bearing capacity requirement. The results for this analysis are shown in table five below.

Table 5 (Footing Analysis)

Footing Analysis	
P (lb)	5700
Ap (ft^2)	3.14
Bearing Stress(psf)	1816
Bearing Capacity (psf)	2000

5.1.7 Post and Footing Design

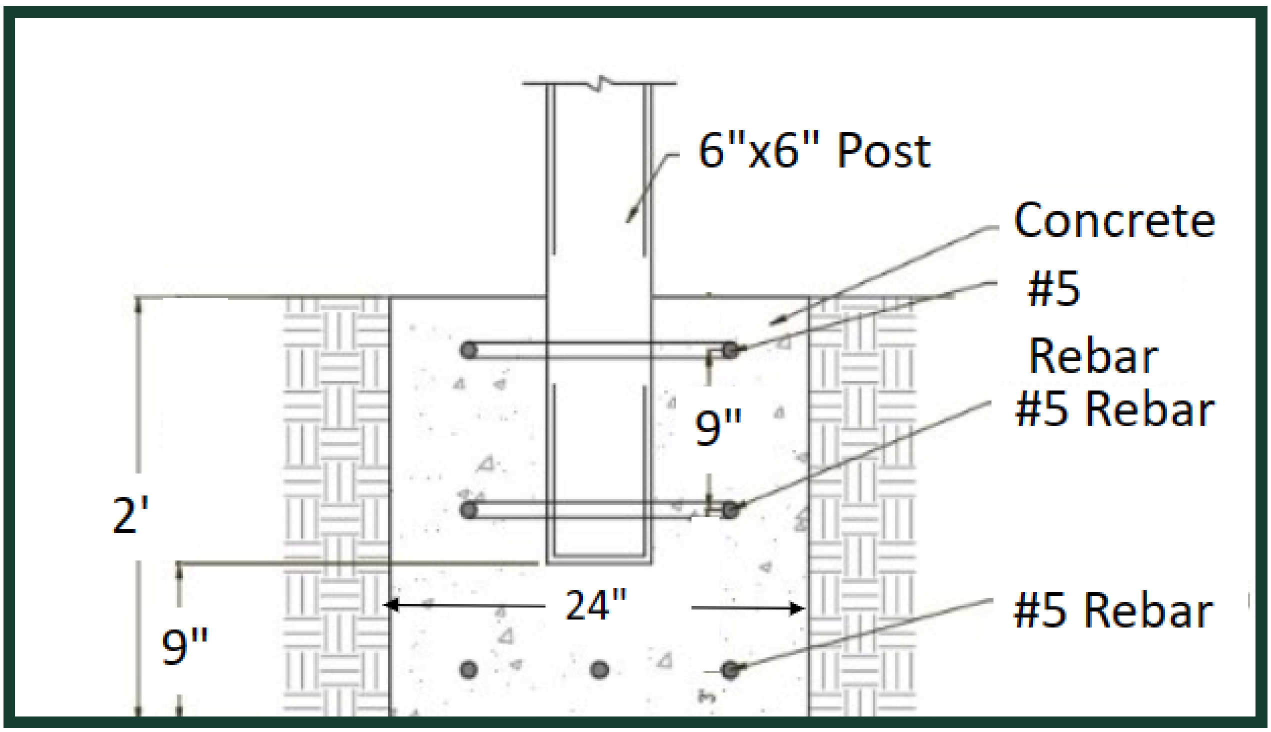

Figure 19 (Post Footing Connection)

5.1.8 Framing Plan

The model in figure nineteen shows the overall framing plan for the structure. This includes all framing members including all trusses, purlins, posts, girders, and the floor slab. The framing plan also includes the framing for the overhead door and walk door. Each of these components is called out in the framing plan below.

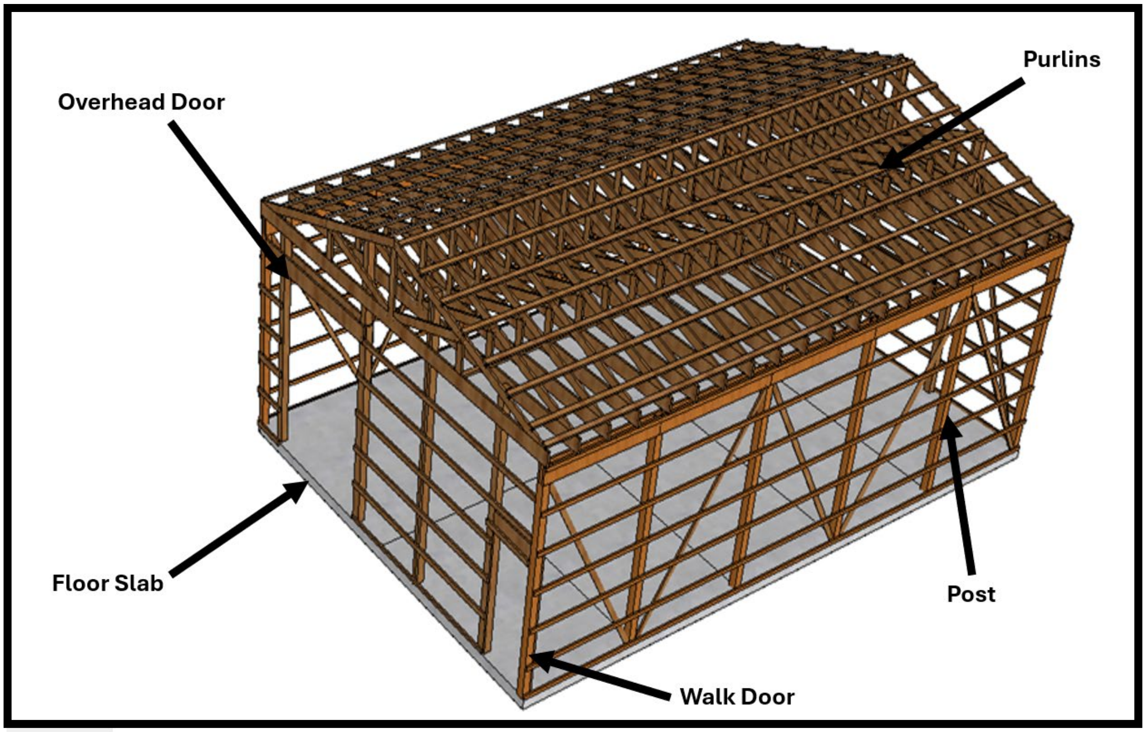

Figure 20 (Framing Plan)

5.2 Soil Analysis

Shown below is the Soil Map of the Hartman Arboretum site. Depicted in the red outline is the watershed area in question and under analysis for the Hydrology portion of this report. This soil map visually shows the different soil types within the outlined area in question (the Hartman site). For the red outlined portion, HoB2, Hosmer Silt Loam, is the main soil type we are working with for this portion of the site. This soil type is broken down and analyzed in figure fourteen below.

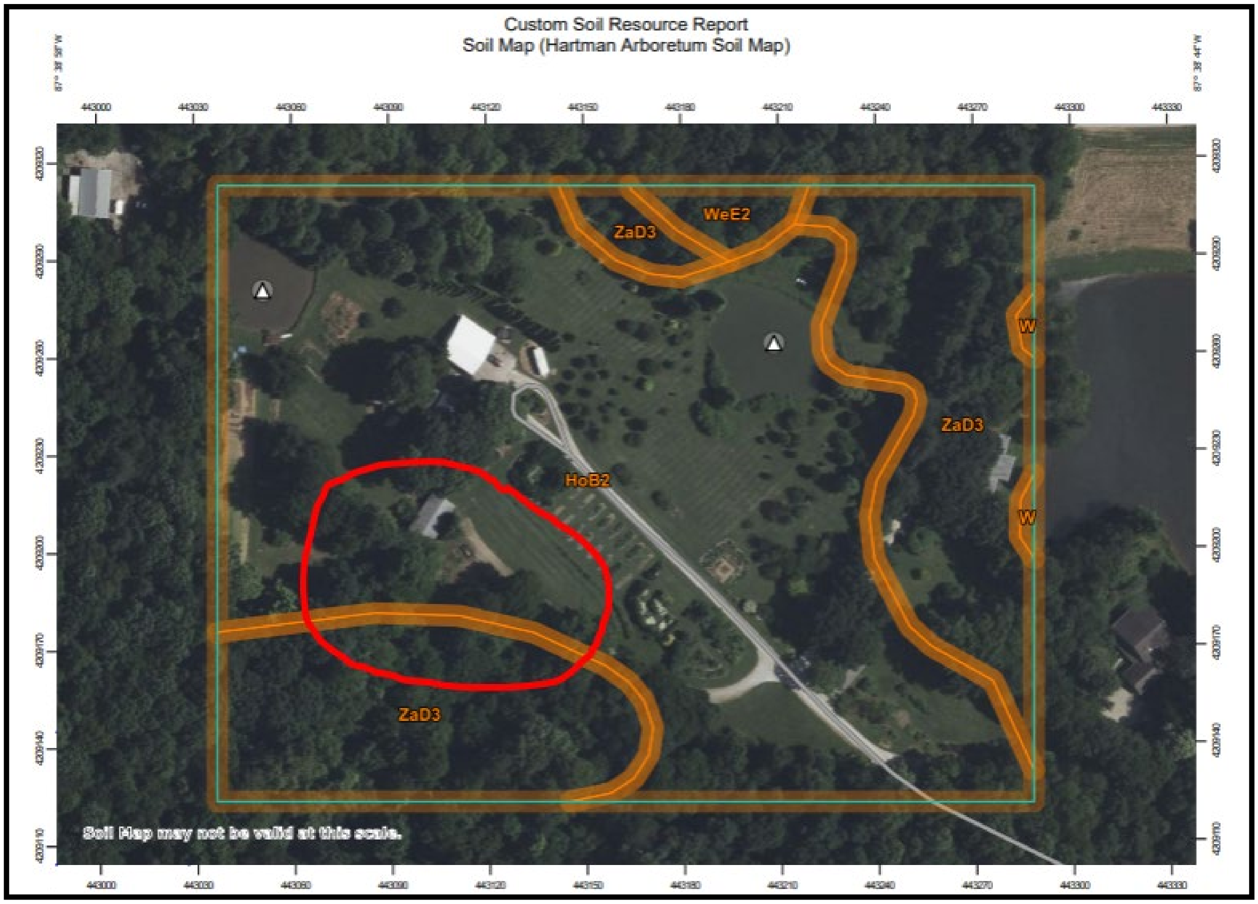

Figure 21 (Soil Map)

Interpretive groups

- *Land capability classification (irrigated):* None specified
- *Land capability classification (nonirrigated):* 2e
- *Hydrologic Soil Group:* C/D
- *Ecological site:* F115XA004IL - Fragic Upland
- *Hydric soil rating:* No

Figure 22 (Hydrologic Soil Group)

5.3 Hydrologic Analysis

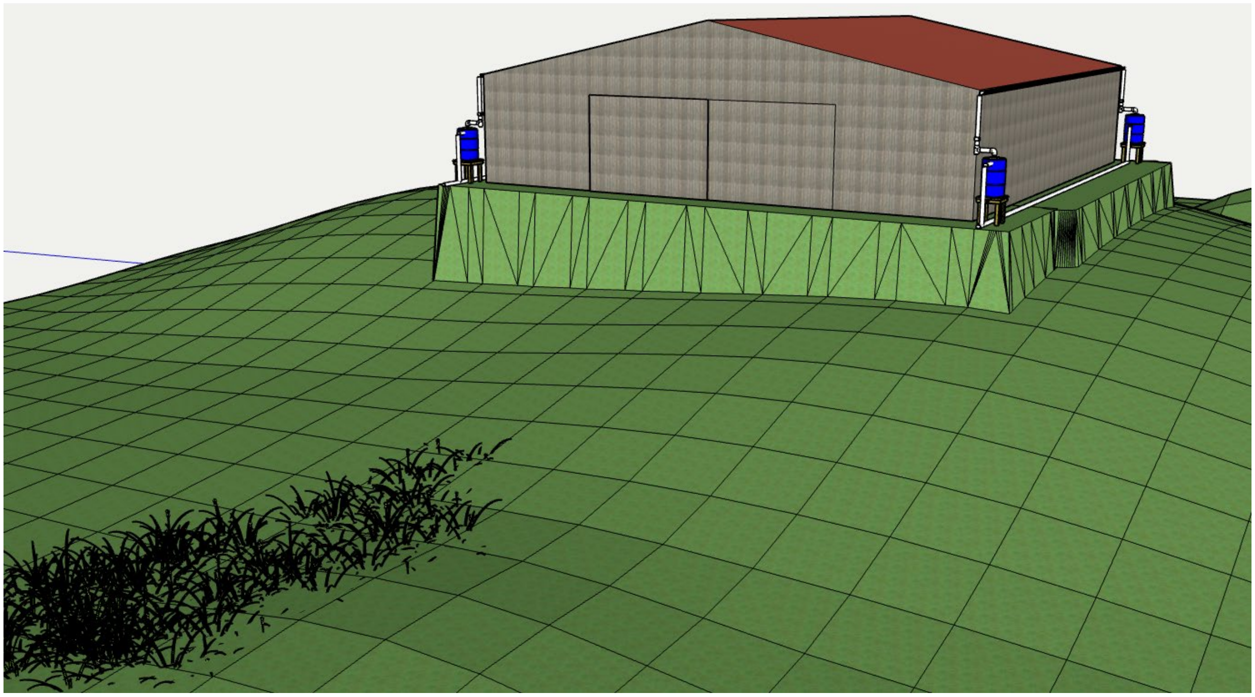

Figure 23 (Proposed Structure with Rain Barrel Collection System)

For the Hydrologic portion of this project, we came up with two goals. The first goal was to produce a water collection system that could collect the runoff rainwater from the roof of the proposed structure to be used for the closed system of the structure. The second goal was to produce an overflow structure for any excess rainwater not collected by the rainwater collection system. These two goals work together to produce a viable working water collection and overflow system for the proposed structure on the site.

5.3.1 Rainfall Data

Table 6 (Rainfall Data)

Max (Wet)	2009	September	5.17
Min (Dry)	1963	August	2.47
Avg	2005	January	2.96

Shown above is the rainfall collection data provided by Dr. Hill. This rainfall data began with data for each year from 1950 to 2013. Through this data, the Max (wet) year, Min (dry) year, and Avg year were calculated. These years consisted of 2009 being the highest rainfall year, 1963 being the lowest rainfall year in inches, and 2005 being the average rainfall year in inches.

Next, highlighted in green is the rainfall in inches of the average month of rainfall in each of the 3 years listed. To find this, the total rainfall in inches of each year was totaled. This value was then divided by the number of months in the year (12) and finally the month that was closest to that average was found and used as the average month in each year. These months were September of 2009, August of 1963 and January of 2005. These values are used later to calculate the Runoff.

5.3.2 Rain Barrel Calculation

When brainstorming a water collection system many ideas came to mind. Of these ideas, rain-barrels became the natural choice as they are durable, easy to fix, and can hold a substantial amount of water. When coming up with the design and implementation of the rain-barrels we hit a few snags along the way. At first, we attempted to calculate how many rain-barrels we would need to capture all the rainfall for even a one-year storm event. This quickly got out of hand with approximately 15 55-gal rain-barrels needed. This quickly became unachievable.

Eventually, with the help of Dr. Hill, we narrowed down a smaller rain-barrel collection system with an overflow collection system. The smaller rain-barrel system included 4 55-gal functional rain-barrels connected with a gutter system and overflow piping to a rain garden retention system. These 4 rain-barrels are to be on each corner of the proposed structure and connected to the gutters of the proposed structure as shown below in figure 23.

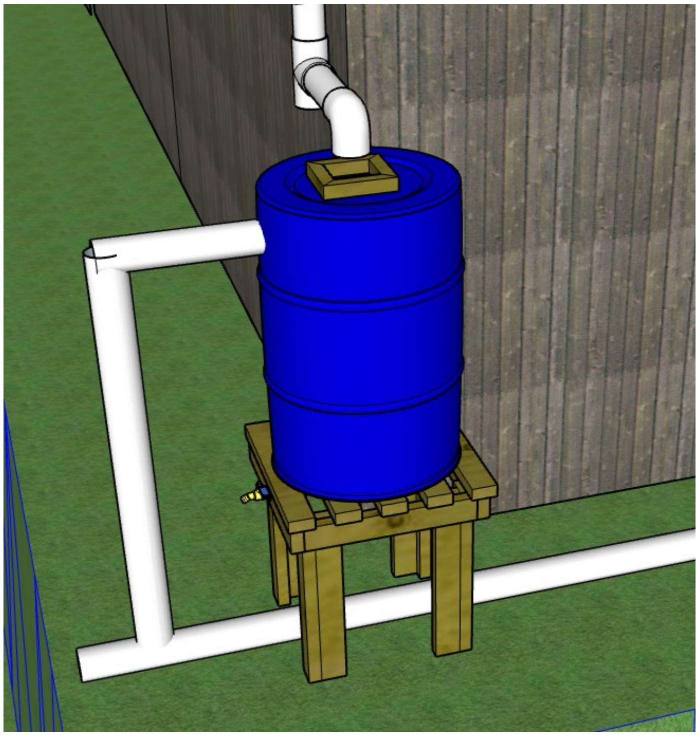

Figure 24 (Rain Barrel)

Each of the 4 rain-barrels consists of 4” gutter piping connecting from the roof gutters and eventually down to an overflow pipe. These pipes are standard 4” PVC Sewer and Drainage pipes. With the 4 55-gal rain-barrels, the maximum storage capacity in gallons comes out to be 220 gallons of water storage. With the implementation of the proposed structure there comes a closed system. A closed structure system is a system in which there is no electricity and no pumping water supply. With this system a certain amount of water is needed to maintain all the needs within the structure. Shown below is the calculation for this system.

Table 7 (Rain Barrel Calculation)

# of Rain Barrels (55-gal barrels)	Water Usage (gal/day)	Maximum Storage Capacity (gal)
4	15	220

For this closed system, the approximate amount of water used per day comes out to be about 15 gallons per day. This amount stems from how much water would be used to wash hands when working with soil, watering small plants within the structure, and for any additional unintended uses. When we have a full water storage of 220 gallons and we use approximately 15 gallons per day, the closed system can survive without a rainfall even for about 2 weeks and this is not a likely event for this area of Indiana where we receive about 120 rainy days a year. Figure 24 depicts a typical rain barrel.

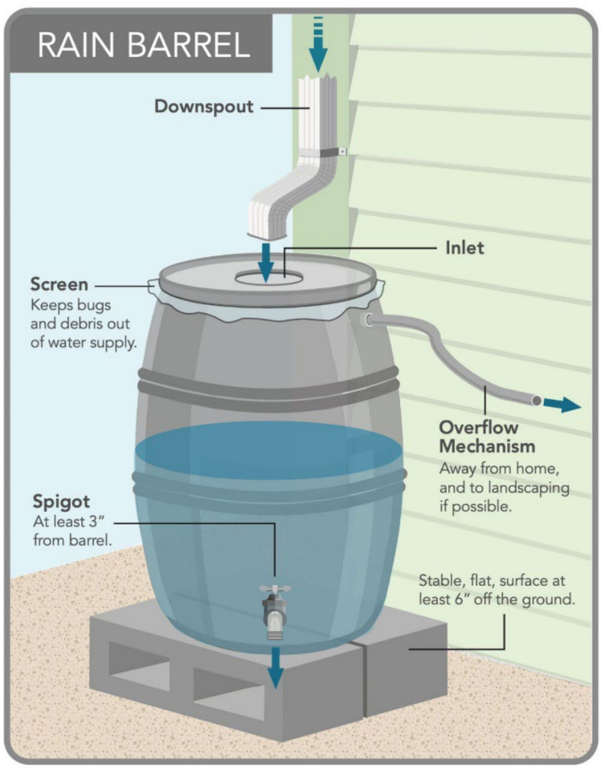

Figure 25 (Rain Barrel Depiction)

5.3.3 Rainfall Runoff Calculation

When calculating the amount of runoff for a structure a few key variables are needed. The first variable needed is the roof area of the structure. In this case, the roof area is 1,080 ft^2. The next key variable is the rainfall in inches for each of the years. Now these values shown below are the amount of rainfall in inches for an average month in each year. Using the rainfall in inches and the roof area we can calculate the runoff volume in ft^3. To calculate this, we first must convert the rainfall from inches to ft. To do this I simply divided the value by 12. Then we must multiply the rainfall in ft by the roof area. Thus, the Runoff Volume calculated in ft^3. Next, we must convert this runoff from ft^3 to gallons because our rain barrels are measured in 55-gallon drums. These calculations are depicted in table 8 below.

Table 8 (Runoff Calculation)

Rainfall in September (inches)	Structure Roof Area (ft^2)	Runoff Volume (ft^3)	Runoff Volume (gal)
5.17	1080	465	3480
Rainfall in August (inches)	Structure Roof Area (ft^2)	Runoff Volume (ft^3)	Runoff Volume (gal)
2.47	1080	222	1663
Rainfall in January (inches)	Structure Roof Area (ft^2)	Runoff Volume (ft^3)	Runoff Volume (gal)
2.96	1080	266	1993

5.3.4 Excess Rainfall Calculation

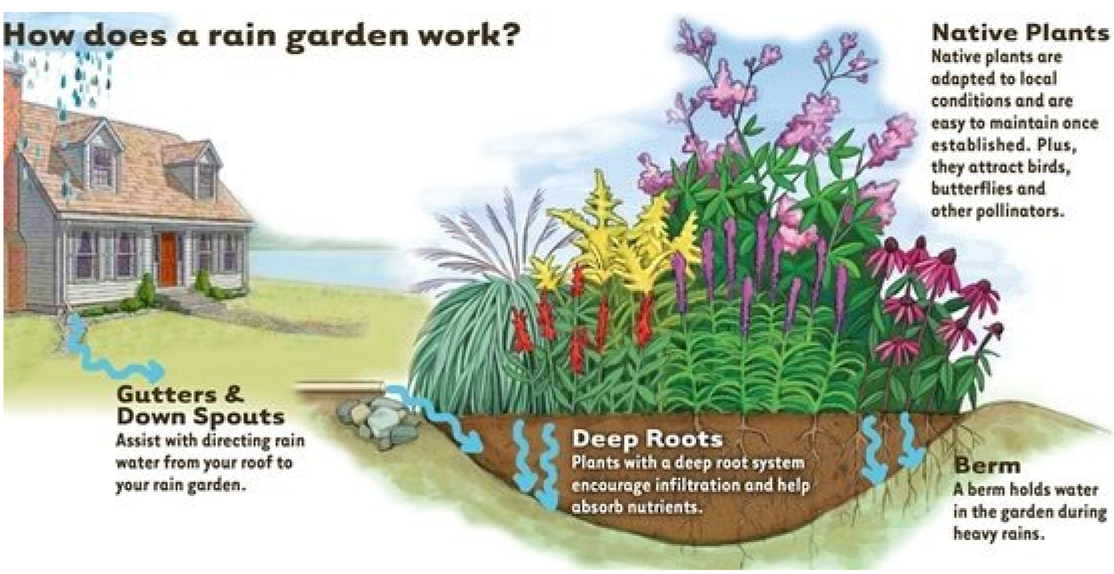

Figure 26 (Rain Garden Depiction)

For the overflow of the rain-barrel system we decided to use a rain garden like the rain garden above in Figure 26. A rain garden is a collection system composed of a specific soil mixture of sand, organic material, and topsoil. This mixture allows for great retention of water. A rain garden needs to be sized to the appropriate volume to retain any overflow excess rainfall. For this rain garden, we must know how much rainfall excess there is. To find this, we used the excess rainfall from the largest rainfall month of September of the wet year. Using the wet year, we can size the rain garden for the largest rainfall year and have plenty of space for a smaller year rainfall. To find this we converted the excess rainfall from the wet year to a volume in cubic ft. Now that the excess is in cubic ft, we can size a rain garden in cubic ft.

Here we have an excess water runoff of 405 cubic ft. To size the rain garden, we simply took the square root of the excess runoff to get approximately 20 ft. Now we know that the rain garden must be approximately 20 ft long and 20 ft wide with a depth of 1 ft.

Table 9 (Water Usage)

Excess Water Runoff (ft^3)	Minimum size of Rain Garden with 1 ft depth
405	20x20x1 ft

Now that the size of the rain garden is found we need to find the mixture of soil needed for excellent drainage and seepage for the excess runoff. To do this we needed to break down the 1 ft depth of the garden. Breaking this down, we found that a rain garden consists of approximately 30% organic material, 40% loamy topsoil, and 30% sand. Calculating how many inches in depth each material is going to be is easily obtained by multiplying each percentage by 12 inches. Thus, we have how many inches of each material we need for the rain garden soil mixture.

Table 10 (Rain Garden Soil)

Rain Garden	
30% organic material	3.6 inches
40% loamy topsoil	4.8 inches
30% sand	3.6 inches

6.0 Cost Estimate

The estimate for the arboretum was created using heavy-bid software. The crew concept was utilized to create the estimate. Each bid item includes the cost of labor and materials. As shown in table eight, the most expensive construction cost is the foundation construction. The next most expensive item is the roof installation. These two items both involve significant labor and material costs. Some of the work could be performed by volunteers from organizations such as the master gardener's association. This could reduce some of the planting and landscaping costs included in the estimate. The estimate also includes a profit markup of twenty percent. This is a typical markup percentage for this type of construction. The total cost is also highlighted in the table.

Table 11 (Estimate Summary)

Bid Item	Cost
Existing Structure Demolition	$ 10,755
Surveying	$ 2,558
Building Pad Construction	$ 17,789
Foundation Excavation	$ 10,305
Foundation Construction	$ 19,260
Framing	$ 11,986
Roof Installation	$ 18,738
Building Sheathing Install	$ 14,417
Water Resources Work	$ 8,960
Pond Restoration	$ 1,399
Sign Installation	$ 5,399
Planting	$ 10,900
Final Grade and Site Cleanup	$ 1,080
Markup (20%)	$ 26,710
Total	$ 160,260

7.0 Conclusion

The proposal presented throughout this report would greatly enhance Hartman Arboretum and help them to implement more sustainable land management practices in the future. It will also help facilitate awareness of the harm current agricultural practices are having on the environment today and how to mitigate that harm in the future. Food production is a very commercialized industry and has removed the connection people have with nature and the important role it plays in our lives. Growing food and beautifying the earth can happen simultaneously. These values are at the core of Hartman Arboretum's beliefs are the team is happy to work with them to further implement them at their site. These enhancements would also likely increase the number of visitors and the number of learning activities available at the site as well as and increase the quality of life and the quality of food for the surrounding community.

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9.0 Appendix

HoB2—Hosmer silt loam, 2 to 5 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2x06n
Elevation: 330 to 850 feet
Mean annual precipitation: 38 to 48 inches
Mean annual air temperature: 52 to 59 degrees F
Frost-free period: 170 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Hosmer, eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hosmer, Eroded

Setting

Landform: Loess hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess over gritty loess

Typical profile

Ap - 0 to 7 inches: silt loam
Bt - 7 to 29 inches: silt loam
Btx - 29 to 65 inches: silt loam
2Bt - 65 to 79 inches: silt loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: 17 to 33 inches to fragipan
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: F115XA004IL - Fragic Upland
Hydric soil rating: No

Appendix N: ABET Outcome 2, Design Factor Considerations

ABET Outcome 2 states "*An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health safety, and welfare, as well as global, cultural, social, environmental, and economic factors.*"

ABET also requires that design projects reference appropriate professional standards, such as IEEE, ATSM, etc.

For each of the factors in Table N.1, indicate the page number(s) of your report where the item is addressed, or provide a statement regarding why the factor is not applicable for this project.

Table N.1, Design Factors Considered

Design Factor	Page number, or reason not applicable
Public health safety, and welfare	Public health will need to be a consideration throughout the entire process. This is important to the project's success. The public's health will be considered every step of the way.
Global	The appropriate safety procedures and guidelines shall be followed throughout the design and construction process. This will be enforced by ethical engineering practices and sound ethical judgement by the project managers.
Cultural	This project will provide a global standard for new seed banks. This is something needed worldwide to provide global redundancy.
Social	This seed bank will need to provide cultural value for many years. This will be especially important to the culture surrounding Evansville and will provide a great educational purpose for the community.
Environmental	This new center will provide social value to Evansville. Anybody in the community will be granted the opportunity to learn about the center and the educational opportunities that it would offer.
Economic	The environmental impact of this project will be great as well. This center will provide green management of stormwater and efficient use of the space provided. This will have a positive impact on the ecosystem on and around the property.
Ethical & Professional	The seed bank would have a significant impact on the economy. This would be an attraction for people to visit and to gain a better understanding of how society can better implement green practices into construction and urban areas.

Reference for Standards	ADA