LAKOTA Food Sovereignty Project
Fall Design Review
November 22nd , 2019

EPICS PURDUE

Three Universities Partner Together for One Vision

PURDUE UNIVERSITY

SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

OGLALA LAKOTA COLLEGE

LAKOTA Food Sovereignty Project

This work is the combined effort by students from Purdue, SDSMT and OLC

EPICS PURDUE

Project Partner ~ Oglala Lakota College

He Sapa

Pine Ridge Reservation

Community Partner Information

Food Desert: An area where either a substantial number or share of residents has low access to a supermarket or large grocery store (USDA).

- 80% limited access to grocery stores
- 95% of food from off-reservation sources
- Food cost 10% higher

Funding Partners for our vision

Ford College Community Challenge

Ford

SOUTH DAKOTA COMMUNITY FOUNDATION

GROWING FOR GOOD FOR 30 YEARS

AIHEC

EPICS PURDUE

Small House

Purdue Small House Team Members

Jonah Adler
First Year Engineering

Elijah Marcum
First Year Engineering

Samantha Bijonowski
Civil Engineering

Rasik Mennow
First Year Engineering

Small House Project

Purpose: To help provide affordable and sustainable housing

Our Task: To recommend a foundation design

EPICS / PURDUE

Overview

- Asked to design a pier and beam foundation
  - Looked into 4 different types
- Developed a CAD file for the house
  - Currently have 2 of the 4 foundations modeled
- Calculated the dead load
- At the mid-semester, shifted focus from sustainability to focus more on foundation
- Our deliverable this semester: A first recommendation on the foundation

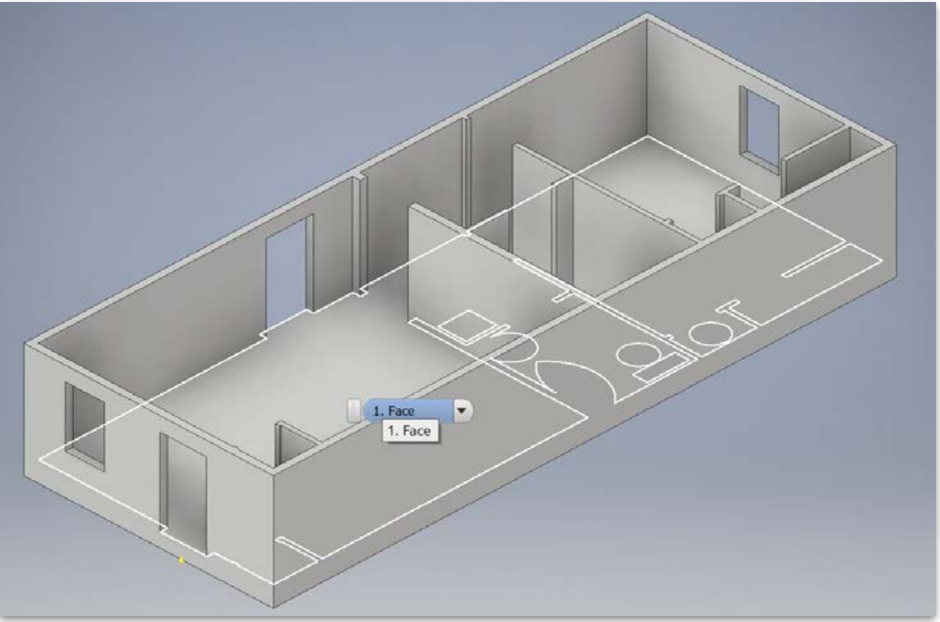
Overall Timeline

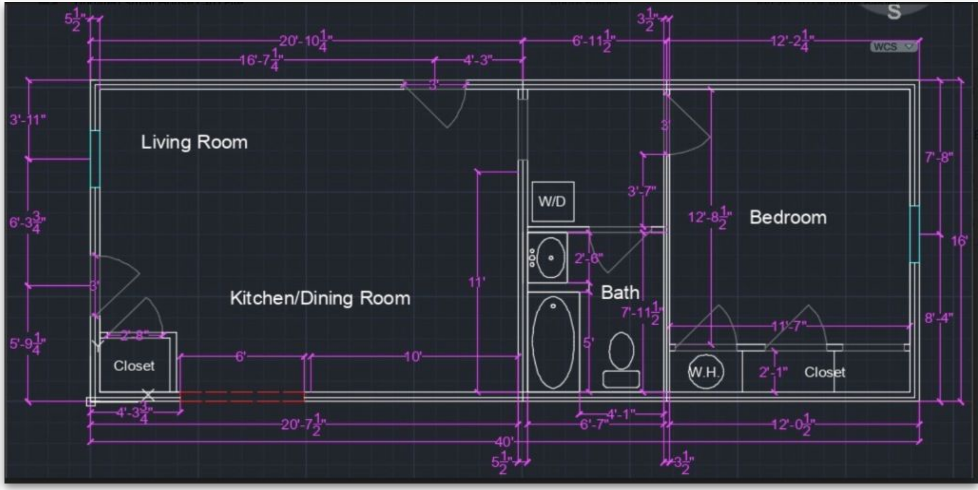
- Construction difficult during winter months, depends on foundation type

2019-2020 Small House Schedule	
Oct	
Nov	Make a Foundation Recommendation
Dec	
Jan	
Feb	Final Design
Mar	Begin Construction (Depends on Foundation)
Apr	
May	Finish construction
Jun	Family moves in

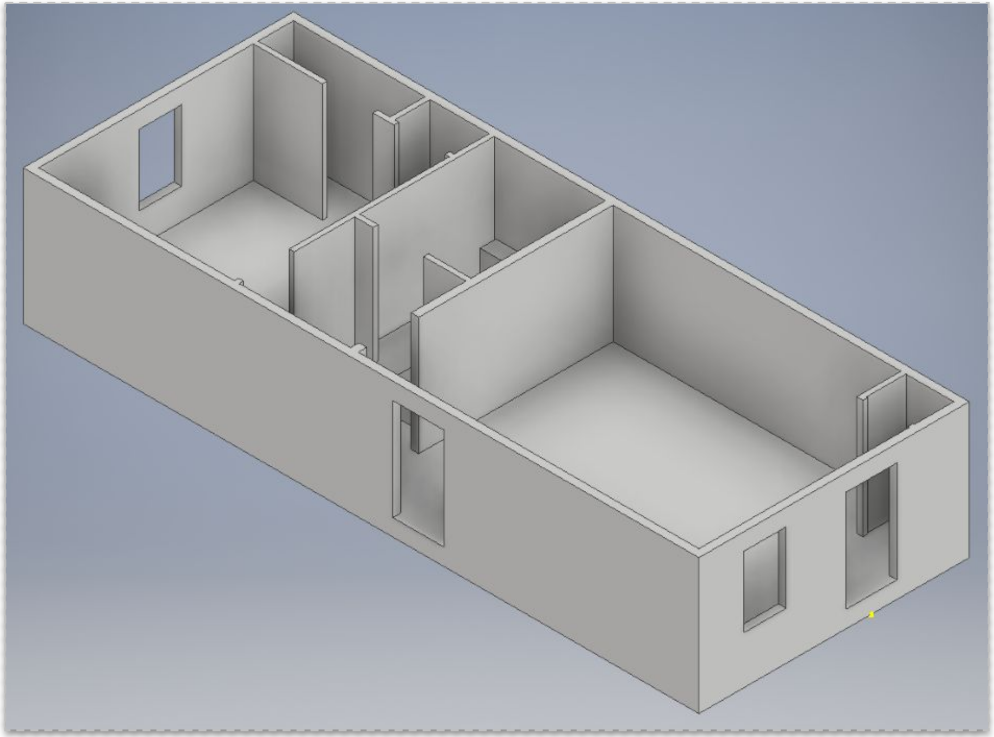
EPICS PURDUE

House and Foundation





House and Foundation

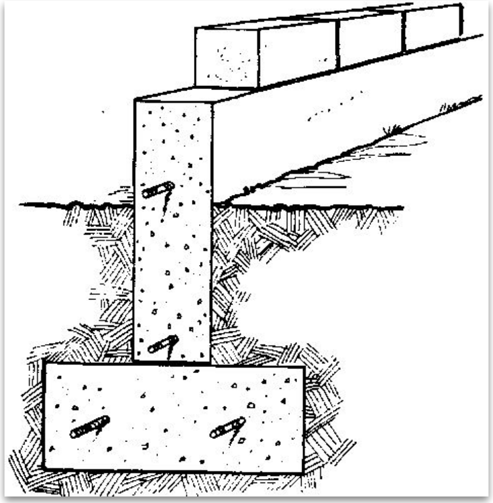


Dead Load

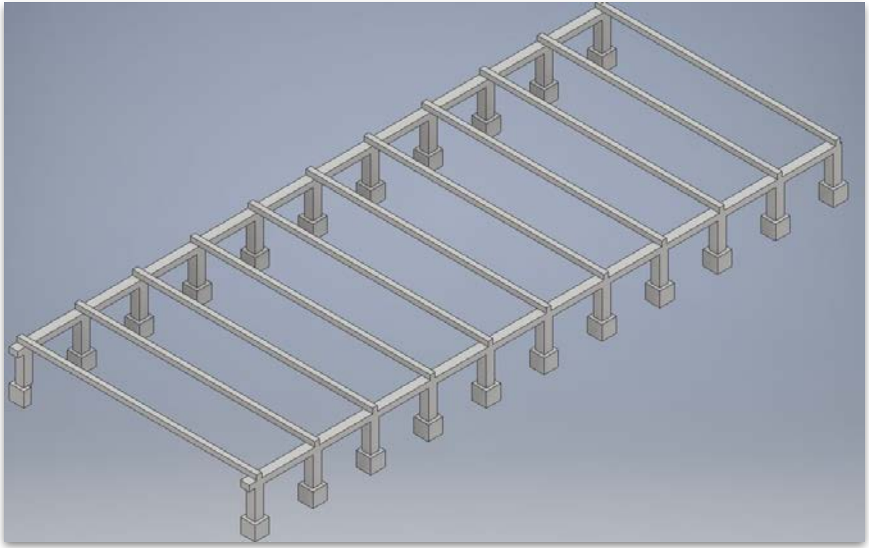
Type:	Material:	Unit Weight (lb	Quantity (count	Total Weight (lb)
Wall	Drywall (5/8") exterior	2.2	896	1971.2
	Drywall (1/2") interior	1.6	512	819.2
	Stud 2x6 (8 feet long)	26	118	3068
	Siding	0.2	108	21.6
	Plates 2x6 (8 feet long)	26	14	364
	Insulation (16") sheets	30.2	104	3140.8
Floor	Joist and Band: (2x10) 10'	55	37	2035
	Flooring: 7/16" 4'x8' OSB	47	20	940
	Vinyl Flooring: (sq yd)	2.29	72	164.88
Roof/Ceiling	Drywall (sqft)	2.2	640	1408
	Insulation (9") (sqft)	1.05	640	672
	purlin 2x4 (2' o.c.)	21	20	420
	MTL panel (sqft)	1.49	800	1192
	Trusses 16x4 (2' o.c.)	51	20	1020
			Total Weight	**17236.68**
			Safety Factor	**25855.02**

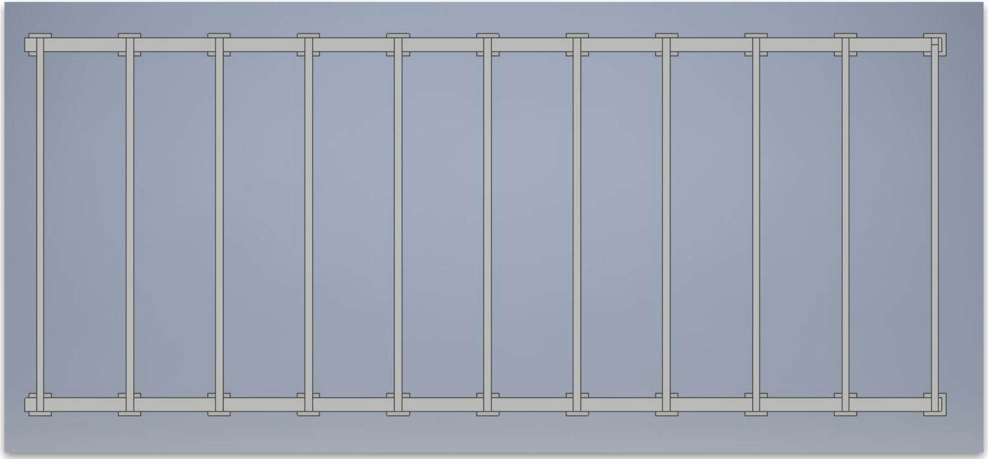
Foundation Options

- Slab
- Continuous Footers
- Pier and Beam
- Helical Piers

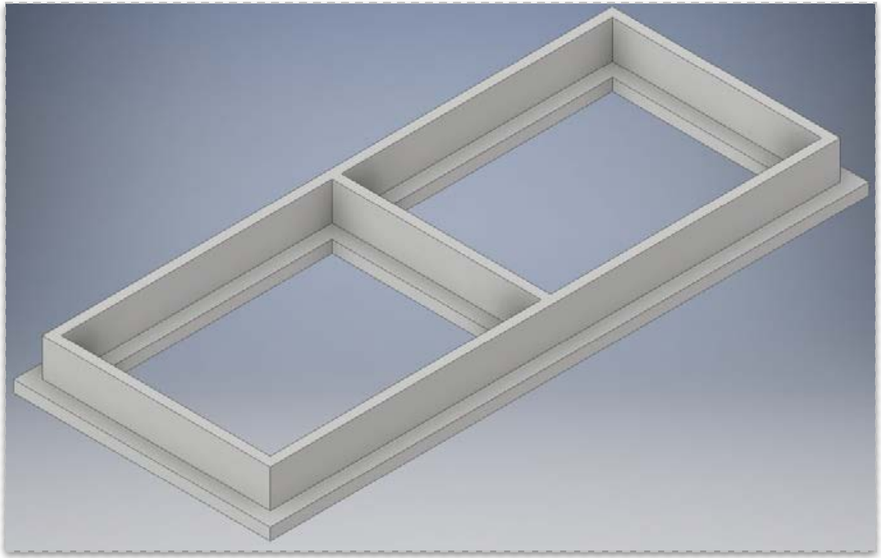


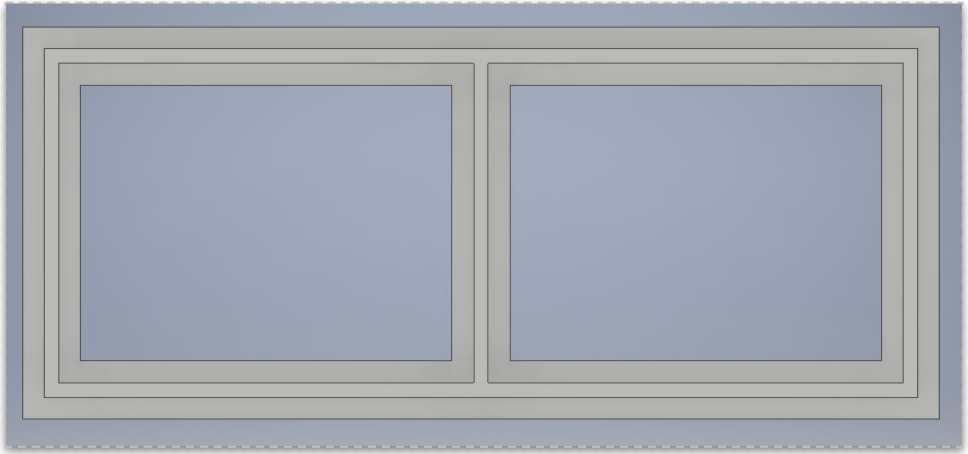
Pier and Beam Foundation



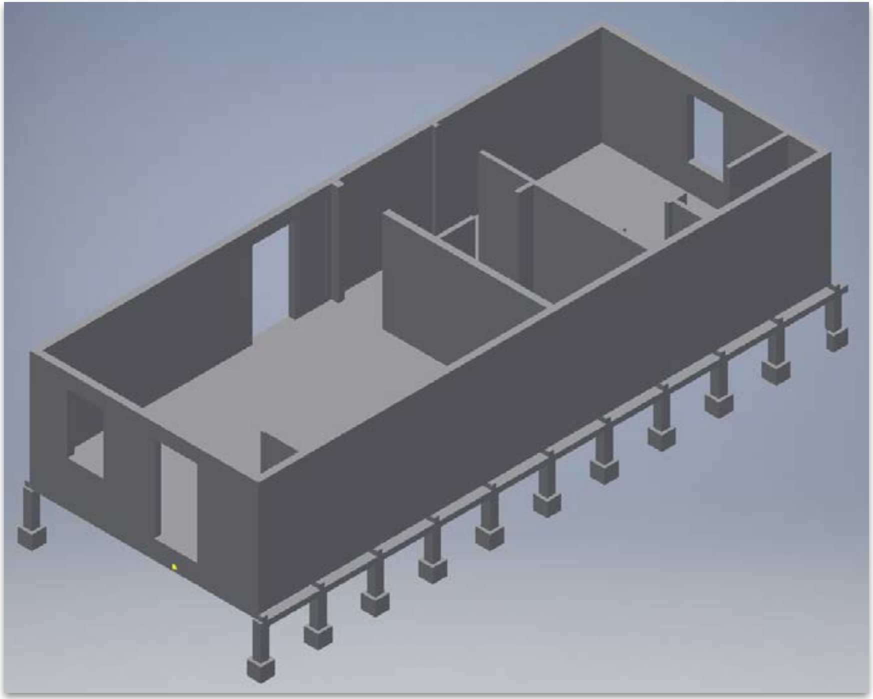


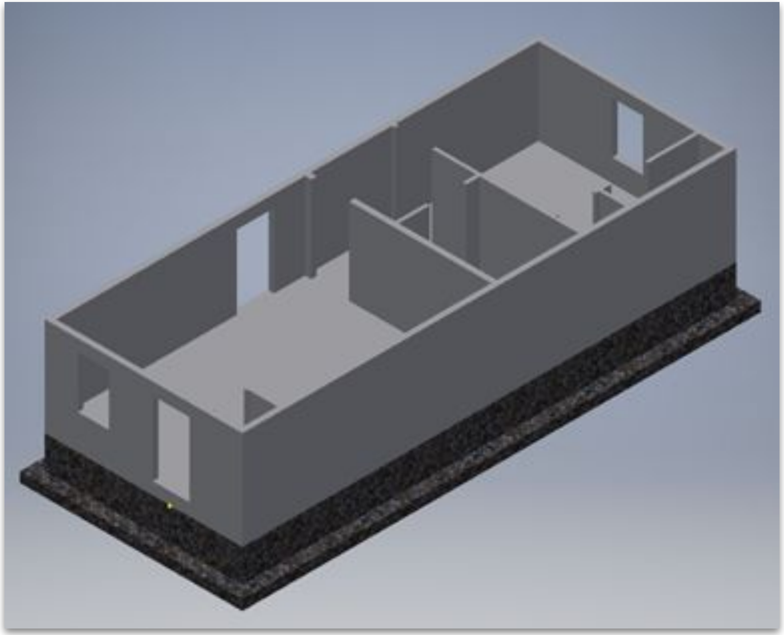
Continuous Foundation





House, Foundation Options





Foundation Decision

	Slab	Continuous Footers	Pier and Beam	Helical Piers
Overall Low Cost	☐	☐	☑	☑
Low Cost Maintenance	☐	☐	☑	☑
Infrequent Maintenance	☑	☑	☐	☐
No Specialized Equipment	☑	☐	☑	☐
Easy Construction	☑	☐	☑	☑
No Expertise Required	☑	☐	☑	☐
Suited to Cold Weather	☑	☑	☐	☑
	5	2	5	4

Setbacks and Solutions

- Lack of expertise among team members
  - Paul Leidig, EPICS TA and structural engineer
- Still waiting on soil test results
  - Emails out to necessary parties
- Vague original blueprints
  - Smart estimations/Brandon Fulk

Next Steps

- After we receive the soil data, make a final recommendation
- Find a contractor in South Dakota who can help design the foundation
- Take steps to increase sustainability for this project
- Go to South Dakota to visit the sites for the houses

Questions?

Greenhouse

Purdue Greenhouse Team Members

Shiying Chen
Agricultural Engineering

Katie Johnson
Aerospace Engineering

Elijah Klein
First Year Engineering

Derick Ford
Transdisciplinary Studies in Technology

Purdue Greenhouse Team Members

<u>Megan Reger</u>
First Year Engineering

<u>Jacob Lundgren</u>
Civil Engineering

<u>Malcolm MacDonell</u>
First Year Engineering

Overview

- Past Semesters' Work
- Greenhouse Kit Overview
- Lighting
- Heating
- Plant and Growing Information
- Automation and Back-up Power
- Next Steps

Past Semesters

Year 1

- Greenhouse on OLC campus
- General Greenhouse Function and Design
- Energy Conservation Methods
- Ford Blue Oval Network Grant

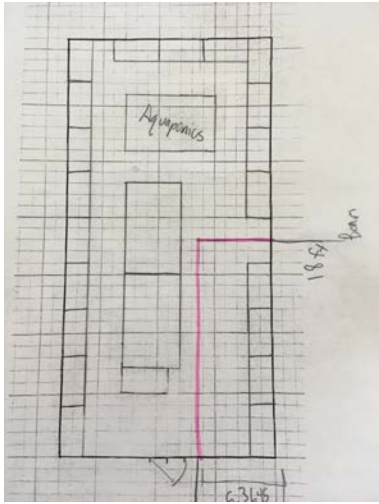
Year 2

- AIHEC Grant & Community Foundation Grant
- CEM Senior Design Collaboration
  - Technical calculations and Specifications
  - Determined best possible kits
- Began Greenhouse Interior Design and Layout
- Trip to Rapid City and OLC campus

The Greenhouse

Location: Oglala Lakota College Rapid City Campus

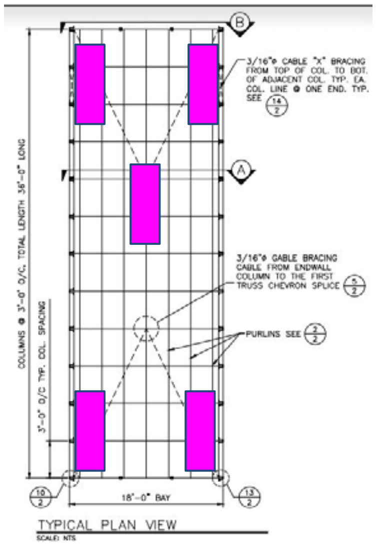
248 ft^2 of table grow space
40 ft^2 available for aquaponics
Possible curtain sectioning

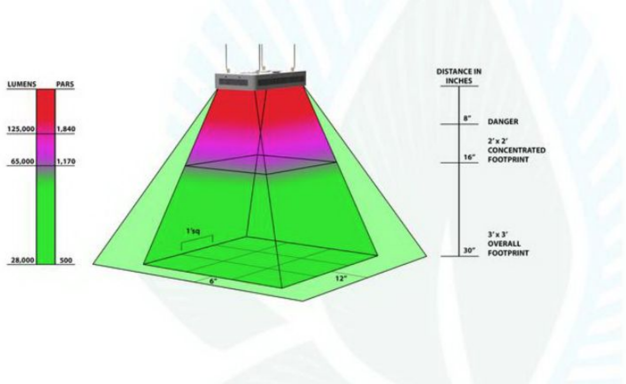


18x36x10 feet

Lighting Plan

SOLAR SYSTEM 550 PROGRAMMABLE SPECTRUM LED LIGHT X5





2,750 watts over 360 sq ft

COST:
Int: $899 (includes adv. controller) x 5 = $4,495
Op: NLT $10.78¢/**kWh X 6 hrs = $ 53.35**
(monthly) **NMT**$10.78¢/**kWh x 24 hrs= $ 213.40**

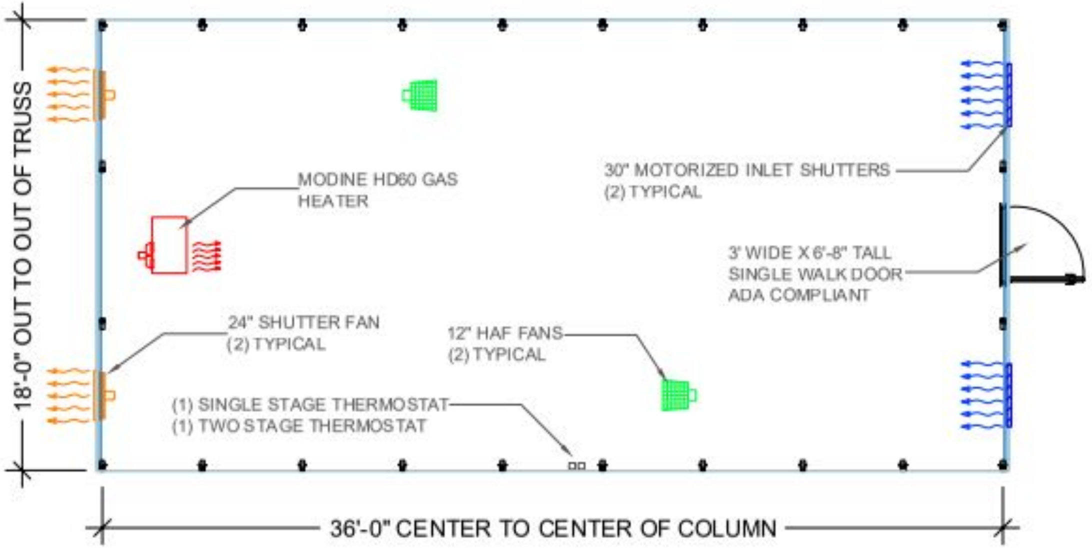
*Corner lights will receive a 12 degree inboard cant and and a 5 degree medial cant. This spectrum overlap will put us well within the 30 lumens/sq ft threshold to supplement growth

*provides 9,385 BTU heat hrs

EPICS PURDUE

Heating

- 6mm twin wall polycarbonate:
- Surface area: 1449 ft^2
- Temperature difference max: 80 degrees
- BTU requirement: 70711-71406
- GHM Kit Modine heater is 48000 output



(Electrical plan)

(Thermostat for the Heater)

Heating

- Greenhouse Megastore Modine Heater options:

Item NO.	Input	Output BTUH	Vent Size	Motor HP	Airflow CFM Range	Air Temp Rise Range
HDC60	60,000	48,000	4"	1/4	635 - 1100	40-70
HDC75	75,000	60,000	4"	1/3	795 - 1390	40-70
HDC100	100,000	80,000	4"	1/2	1060 - 1850	40-70
HDC125	125,000	100,000	4"	1/2	1240 - 2050	45-75

- HDC 100 output: 80,000 btu now being delivered

Cold Stratification

- Cold stratification is the process that a seed goes through in order to germinate
- It mimics the process that seeds go through in nature of going through winter before spring
- Occurs at 34-41 degrees
- Out of our list of plants we would need to do it for sage, currant, lavender, buffaloberry and sweetgrass
- They need a cold moist period(about 60 days)After the cold stratification process it can be brought out into the same temperature as the rest of the greenhouse
- One of the recommended ways to do this is by putting it in a fridge
  - 27 inch mini fridge - $119 Best Buy (there's one in Rapid City)

Zoning

Plant list:

- Consist of berry shrubs (>50%), basic food and traditional plants
- Selected from list given by OLC and our recommendation
- Similar growing period and temperature

sage

Zoning determination:

- One separate area for aquaponics
- Separate into 5 zones, rank by water requirement
  - ❖ Zone 1 - Cold stratification area
  - ❖ Zone 2 - Drought area
  - ❖ Zone 3 - Less wet area
  - ❖ Zone 4 - Normal wetness area
  - ❖ Zone 5 - Most wet area
- 2-3 plants per zone

currant

tomato

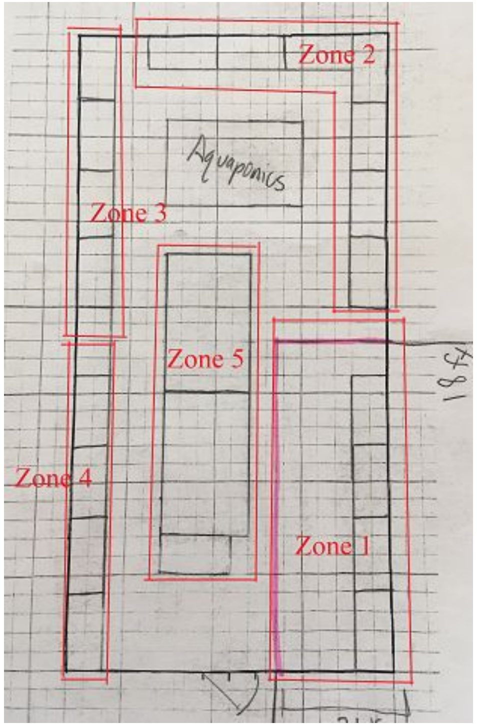
Zoning cont.

Plant	Water Requirement	Temperature Range	Grow Period	Zone
Lavender	1/2 - 1" per week	68-86°F Need stratification	Plant in March, harvest in June - Sept	**1 (Cold) for stratification, later in zone 3 (Less wet area)**
Sweet Grass	1-1.5" per week	60 - 75°F Need stratification	Plant in Feb, harvest in late June - early July	**1 (Cold) for stratification, later in zone 4 (Normal wetness area)**
Buffaloberry	1/4" per week	-63 - 83°F Need stratification	Plant in March, harvest in June - Sept	**1 (Cold) for stratification, later in zone 2 (Drought area)**
Currant	1/3" per week	-40 - 90°F Need stratification	Plant in March, harvest in second May - June	**1 (Cold) for stratification, later in zone 2 (Drought area)**
Sage	1/2 - 1" per week	65-75°F Need stratification	Plant in April, harvest in anytime second year	**1 (Cold) for stratification, later in zone 3 (Less wet area)**

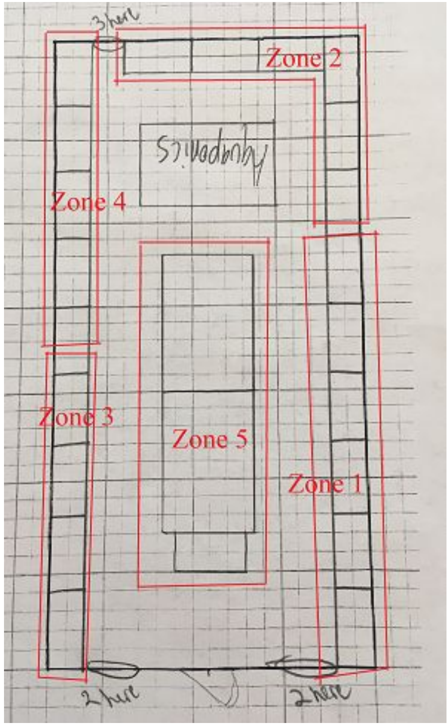
Zoning cont.

Plant	Water requirement per week	Temperature range (° F)	Grow period	Zone
Tomato	½ - 1”	65 - 85	Plant in April, harvest in July - Sept	**3 (Less wet area)**
Cabbage	1 - 1.5”	60 - 65	Plant in April, harvest June or August - Oct	**4 (Normal wetness area)**
Kale	1 - 1.5”	60 - 65	Plant in April, harvest June or August - Oct	**4 (Normal wetness area)**
Wild Licorice	1”	68 - 77	Plant in March, harvest July - October	**4 (Normal wetness area)**
Strawberry	1 - 2”	60 - 80	Plant in March, harvest in second May	**5 (Most wet area)**
Raspberry	1 - 2”	70 - 75	Plant in March, harvest in second June - August	**5 (Most wet area)**
Mint	1 - 2”	55 - 75	Plant anytime before August, harvest anytime after 3 months	**5 (Most wet area)**

Curtain Sectioning



Option 1: Curtain in Northeast corner

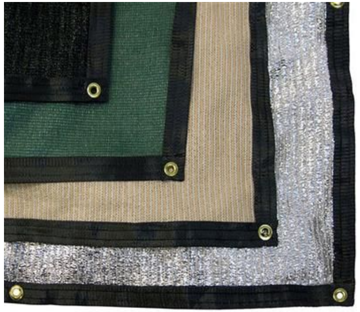


Option 2: No curtain

Curtain Sectioning Options

- Suggested by Nathan Deppe and Jason Tennant
- Talked to greenhouse megastore and they do not offer anything that would suit our needs
- We weren't able to find any models in other greenhouses
- We found physical partitions and shade cloths overhead
- We are working on a proof of concept, half scale insulation wall that would utilize concrete blankets (as suggested by Brandon) or a different insulating material
- Door/opening could be done magnetically as pictured

Concrete Blanket



Shade Cloth

Magnet Door

Insulated Fabric

Cold Curtain Prototype

Aquaponics

Fish - Plants - Bacteria**

*also crawfish make a great addition

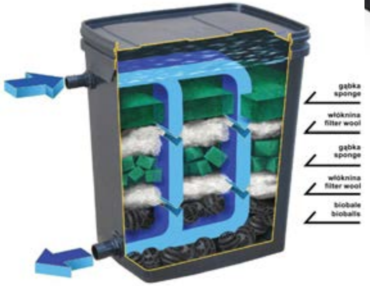
require biofilter.The **four common types of biofilters are:

- Rotating biological contactors
- Expandable media filters
- Fluidized bed filters
- Packed tower, or trickle, filters

<u>5 Components:</u>

Plant Bed
Fish Tank
Settling Basin (for solid waste)
Bio-Filter (for nitrification)
Water Pumps

——-> ←——-



Western Dakota Tech

We have a prospective partnership with Western Dakota Technical Institute; they've received acknowledgement from the National Science Foundation for their aquaponics designs and operations

EPICS / PURDUE

Interior Automation

- Irrigation Automation
  - We decided on the II RI Smart Controller
  - Runs off of one CR123 battery, should last a minimum of three years
  - Bluetooth/app connection to set up water schedules remotely
- Light Automation
  - Teckin Mini Smart Outlet wifi plug
  - App can be used to control each light remotely
- Heating Automation
  - The heat system has a thermostat to maintain an internal temperature of the greenhouse for the plants during winter

II RI Irrigation Smart Controller

Teckin Mini Smart Outlet

Backup Power

The issue: Every once in a while the greenhouse might lose power. Depending on the weather, this could cause a temperature drop in the greenhouse which would be harmful to the plants.

One solution: Having a small backup generator

- Would only need to power the heater
- Would be able to run as long as it has fuel
- Would not be able to automatically kick in during a power outage
- Would need to be put outside of the greenhouse during use

Something to be looking into: Battery Backup

Next Steps

On site

- Lay foundation
- Lay gravel
- Construction
- Install interior
- Begin planting

Purdue

- Thermal curtain
- Creating partnership with Western Dakota Tech
- Supplementary power
- Ordering interior components
- User Manual
- Lakota Food Sovereignty Coalition Summit

Questions?