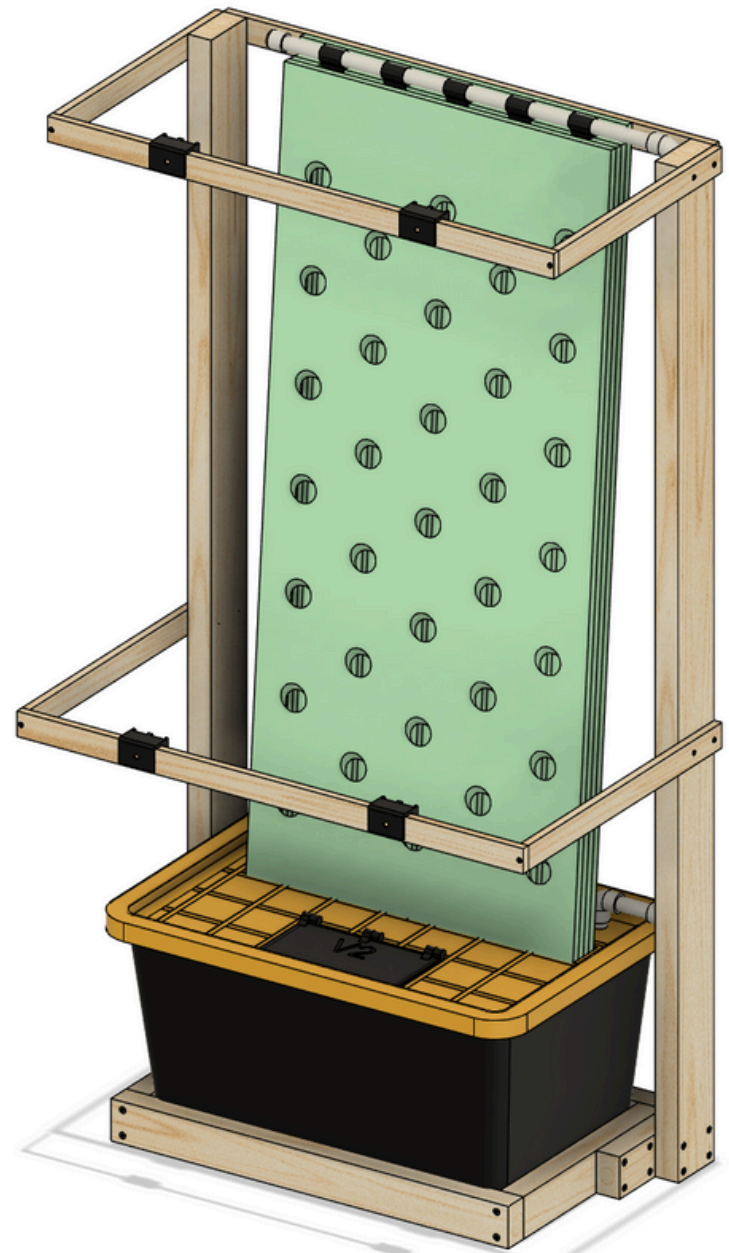


# BUILDING PLANS:

## VERTICAL GARDEN HYDROPONIC SYSTEM



**Controlled Environment  
Agriculture Lab**

*College of Agricultural &  
Environmental Sciences*

**UNIVERSITY OF GEORGIA**

This packet contains detailed instructions for building your own residential hydroponic vertical gardening system.

Prepared for REEU Summer Research Program 2024 by Nathan Finnell



# Materials and Tools List

## Introduction

These directions are designed to be followed alongside the “Vertical Garden Hydroponic System” building plans. Ensure that you have read the complete tools and materials list before beginning this project. The estimated building time is approximately three hours using power tools, plus a 5-hour break to allow full-curing of the adhesive before use.

## Materials Master List

1. (1) [sheet of 4'x8'x1/2" Kingspan foam board](#) (\$19.97)
2. (1) [bottle Gorilla Glue white](#) (2 oz or larger) (\$6.00)
3. (6) [5/16" x 3" course-thread bolt](#) (\$0.43)
4. (12) [3/8" x 1 1/2" washers](#) (\$0.29)
5. (1) [17-gallon tote with lid Project Source Commander Brand](#) (\$10.98)
6. (2) [2 x 4 x 10](#) (\$5.48)
7. (28) [2 1/2" wood screws](#) (\$7.98)
8. (14) [1 1/2" wood screws](#) (\$6.98)
9. (2) [1 x 2 x 8](#) (\$3.42)
10. (2) [Monios 4ft Lights](#) (\$24.90):
11. (1) [#6-32 X 1/2" machine screw](#) (\$2.98)
12. (1) [1/2" x 10' PVC pipe](#) (\$4.71)
13. (3) [90 degree PVC elbow](#) (\$0.70)
14. (1) [Active Aqua pump 400 GPH](#) (\$30.91)
15. (1) [PVC to pump adapter](#) (\$0.76)
16. (5) [3D printed nozzles](#)
17. (2) Monois light 3d-printed light mount



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**Tools Master List**

1. Razor blade or knife with a blade length of at least 1.5 inches (4 cm)
2. Yard or meter stick
3. Permanent marker or pen
4. Clear Gorilla Glue (or another waterproof, foam-compatible adhesive)
5. Tape measure
6. Electric or hand drill
  - a. 1½” bit (preferably hole-saw style)
  - b. 7/8” bit
  - c. 5/16” or 3/8” drill bit
7. Jig Saw or similar cutting method
8. Bubble level
9. Drill with a screw bit or screwdriver
10. Saw (in order of preference): Circular, bandsaw, jigsaw, handsaw.
11. PVC cutter or saw.
12. PVC cement
13. (optional) Sandpaper to improve the finish



# Order of Construction and Directions

## Water and Plant Walls

The construction of the vertical garden system will start with manufacturing the foam water wall and plant wall. The water wall refers to the **rear** foam surface with channels that the water adheres to and flows down. The plant wall refers to the removable **front** component with an array of holes that support the plants in the water channels.

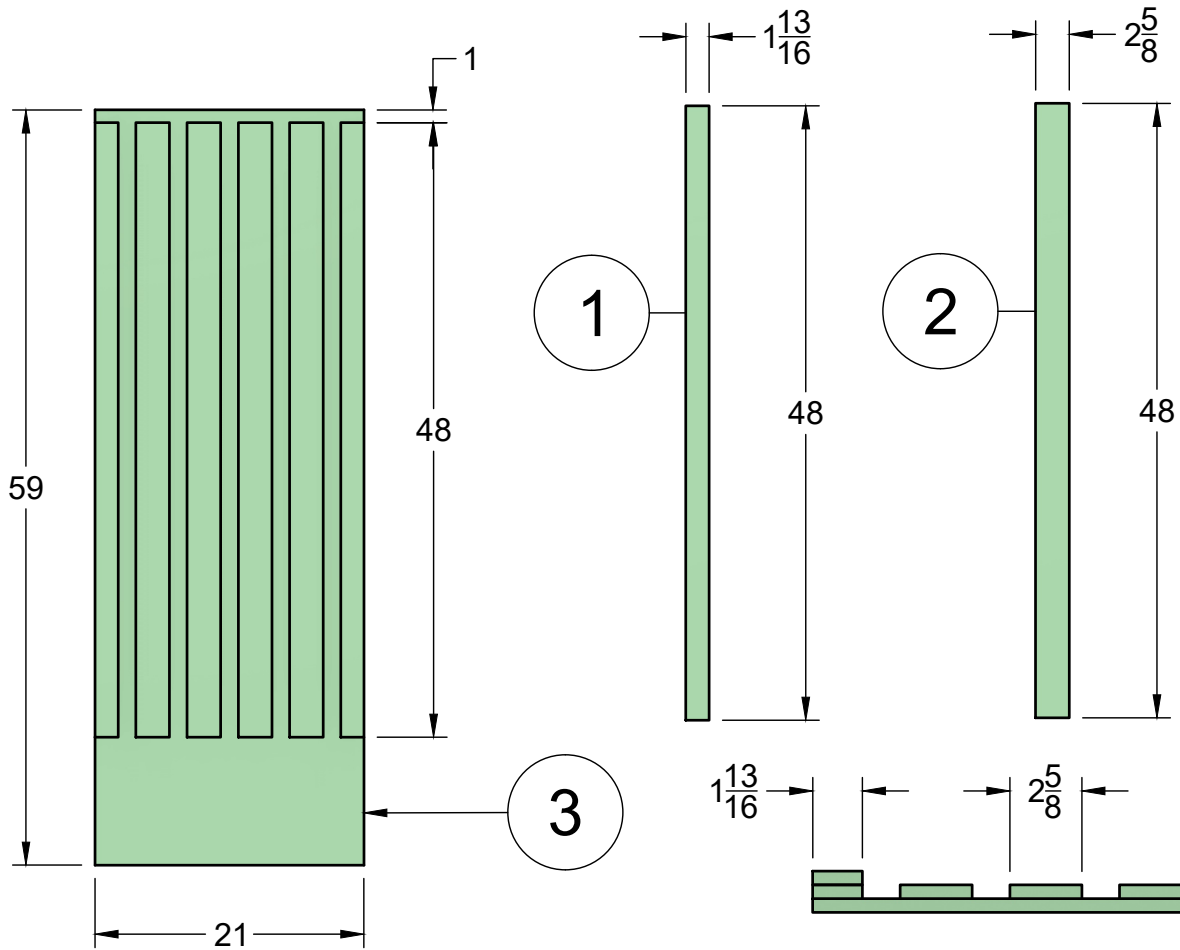
Manufacturing of Water and Plant walls will require:

1. Razor Blade or knife with a blade length of at least 1.5 inches (4 cm)
2. Yard or meter stick to measure with and cut against
3. Permanent marker or pen
4. Clear Gorilla Glue (or another waterproof, foam-compatible adhesive)
5. A tape measure
6. Electric or hand drill
  - a. 1½” bit (preferably hole-saw style)
  - b. ⅞” bit
  - c. 5/16” or ⅜” drill bit

Materials:

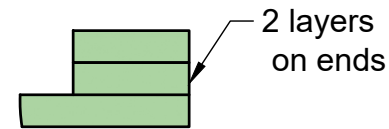
1. (1) [sheet of 4’x8’x½” Kingspan foam board](#) (\$19.97)
2. (1) [bottle Gorilla Glue white](#) (2 oz or larger) (\$6.00)
3. (6) [5/16” x 3” course-thread bolt](#) (\$0.43)
4. (12) [3/8” x 1 ½” washers](#) (\$0.29)

**SubTotal: \$31.13**

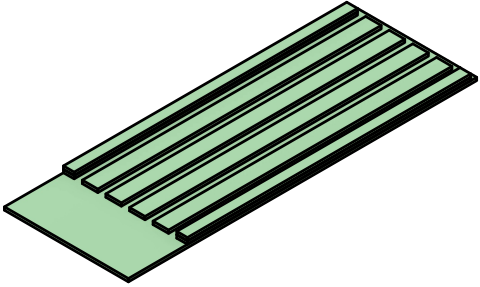


PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	BACK WALL (59 X 21)
2	4	OUTER WALL (NARROW)
3	4	INNER WALL (WIDE)

Foam components are cut using a razor blade with a yardstick as guide. Attach foam components using an S-shaped pattern of "White Gorilla Glue" adhesive listed in construction materials. Stack books and other heavy items on top of components while glue dries to ensure a water-tight seal.



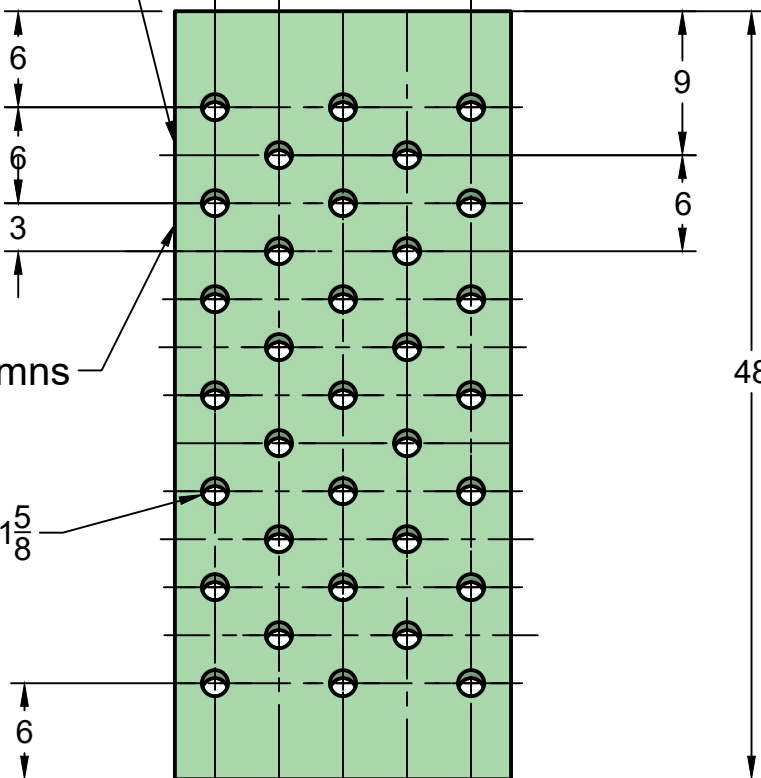
DETAIL A  
SCALE 1:3

	PROJECT HydroPonics Summer 2024			
	TITLE Water Wall			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A			
DRAWN	nathan finnell	7/1/2024	SCALE N/A	WEIGHT
			SHEET 1/1	

Vertical Spacing of Holes is 6"

2.5 16 2.5

4



3" Offset Between Columns

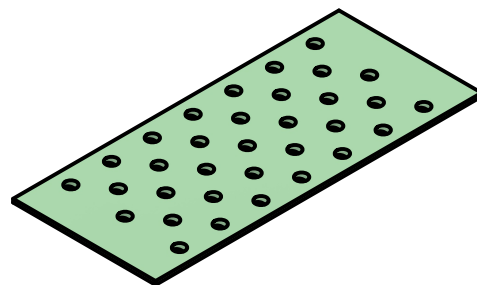
1  $\frac{5}{8}$ " hole-saw style  
drill bit recommended

$\varnothing 1\frac{5}{8}$

Angled Drill Path

45°

First cut the 21" x 48" sheet. Draw the intersecting lines and mark the center of each hole before beginning the drilling process. If unable to reliably drill a 45 degree hole path, use a quick square or other 45 degree tool as a support for the drill.



PROJECT

HydroPonics Summer 2024

TITLE

Plant Wall

APPROVED

CHECKED

DRAWN

Nathan Finnell

6/27/2024

SIZE

A

CODE

DWG NO

REV

SCALE 1:8

WEIGHT

SHEET 1/1



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## Reservoir

After the foam pieces are manufactured, modifications to the plastic lid must be made for the wall assembly to create an effective seal and drain into the reservoir. Two rectangular holes must be cut at the rear of the lid for the wall assembly and filling lid. Then, a hole will be drilled for the PVC plumbing to pass through on its way to the top of the system.

Manufacturing of the modified lid will require:

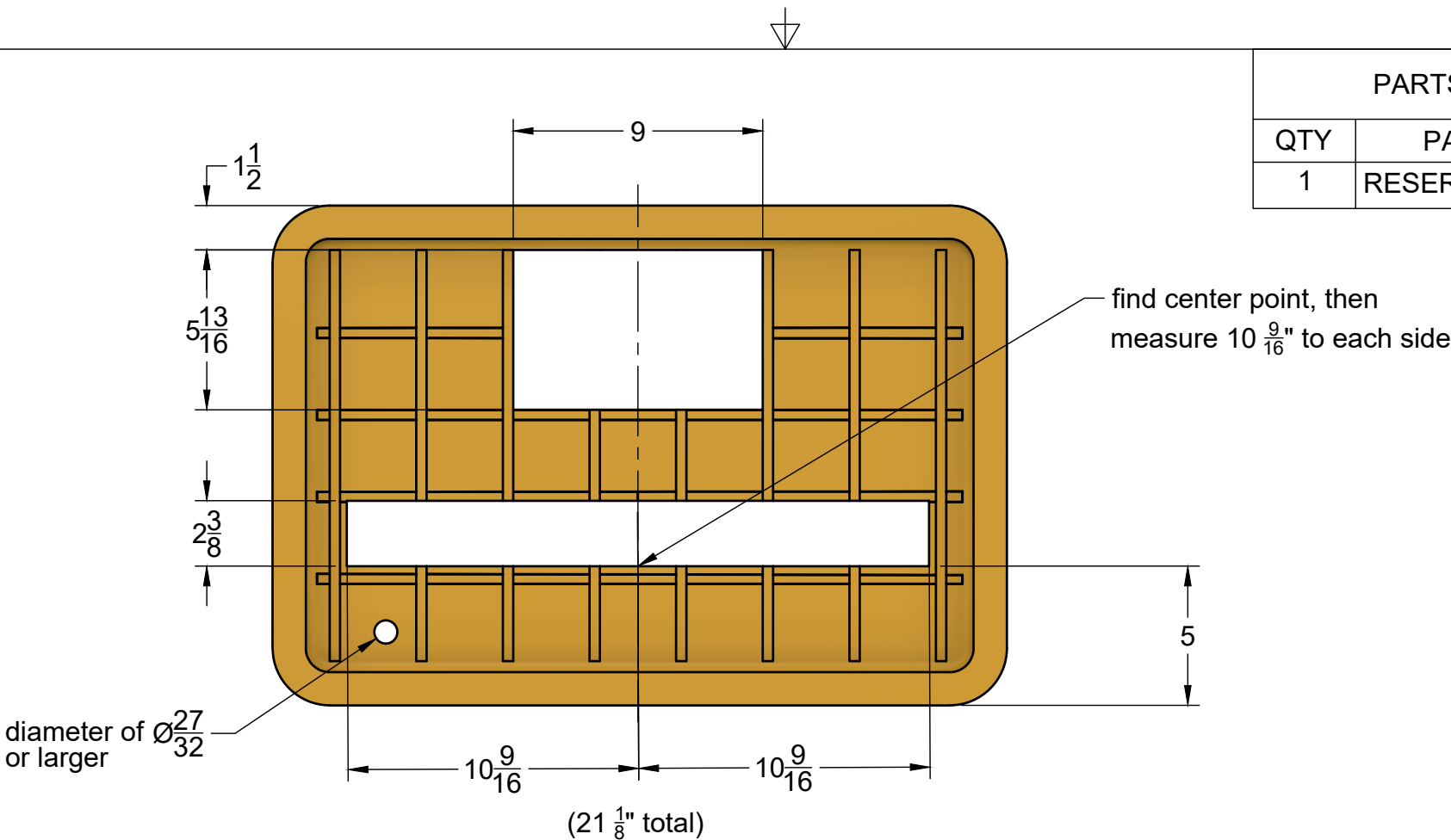
7. Marker or pen
8. Tape measure or yardstick
9. Jig Saw or other cutting method
10. Drill bit larger than the jig-saw blade
11. Power or hand drill

Materials:

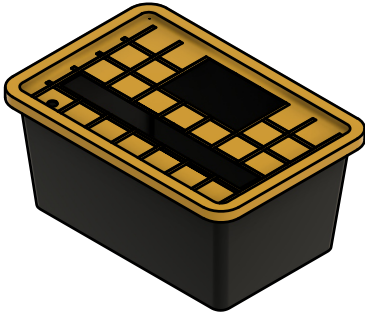
1. (1) [17-gallon tote with lid Project Source Commander Brand](#) (\$10.98)

**SubTotal: \$10.98**

PARTS LIST	
QTY	PART NAME
1	RESERVOIR LID



Measure and trace the cut lines with a marker, then make cuts using a jigsaw or other cutting method. For jigsaw: Begin by pre-drilling a hole for the blade to fit within the cut zone, then continue cutting the outlined rectangle. Finally, drill a hole for the PVC pipe from the pump to pass through.



PROJECT			
HydroPonics Summer 2024			
TITLE			
Reservoir Lid Modification			
APPROVED		SIZE	REV
CHECKED		A	
DRAWN	nathan finnell	7/15/2024	
SCALE 1:16		WEIGHT	SHEET 1/1



## Frame and Lighting Array

The frame and lighting array of the vertical garden assembly provide a support structure for the water wall assembly, LED-array, and secure the reservoir in place. It will be constructed in two parts, the first is made of structural 2 x 4 lumber, and the second from 1 x 2. The lumber selected for this frame design should be accessible at any hardware or home improvement store.

First, follow the “Frame” sheet and cut all necessary components for assembly. Then, turn to the assembly page, drill holes, and install screws as indicated on the screw placement sheet. Then, move on to building the lighting array on the next page.

Manufacturing of the Frame will require:

12. Marker or pen
13. Tape measure or yardstick
14. Level
15. Drill or screwdriver
  - a. Matching drill-bit for screws
16. Saw, in order of preference: Circular, bandsaw, jigsaw, handsaw.
17. (optional) Sandpaper to improve the finish

Materials:

1. (2) [2 x 4 x 10](#) (\$5.48)
2. (28) [2 ½” screws](#) (\$7.98)
3. (14) [1 ½” screws](#) (\$6.98)

**SubTotal: \$25.92**



## Frame and Lighting Array

The lighting array utilizes a 6-piece frame made from 1 x 2 lumber to support the two Monios (or other brand) LED lights. The position of the lights is critical to achieving equal distribution of light for all 33 plants, so extra care must be taken in aligning the lights to the positions indicated in the plans.

First, cut the indicated quantity of each item to the correct lengths using the “Lighting Array” page. Use a marker to measure the bottom (longer) arms to a position 34 inches from the top of the frame as shown in the dimensions. Check that the arms are level with a bubble level, then drill pilot holes for each screw, and finally assemble the frame side arms. Once the top and bottom arms are complete, find the front pieces, align them with the side arms, drill pilot holes, and insert screws to complete the lighting array.

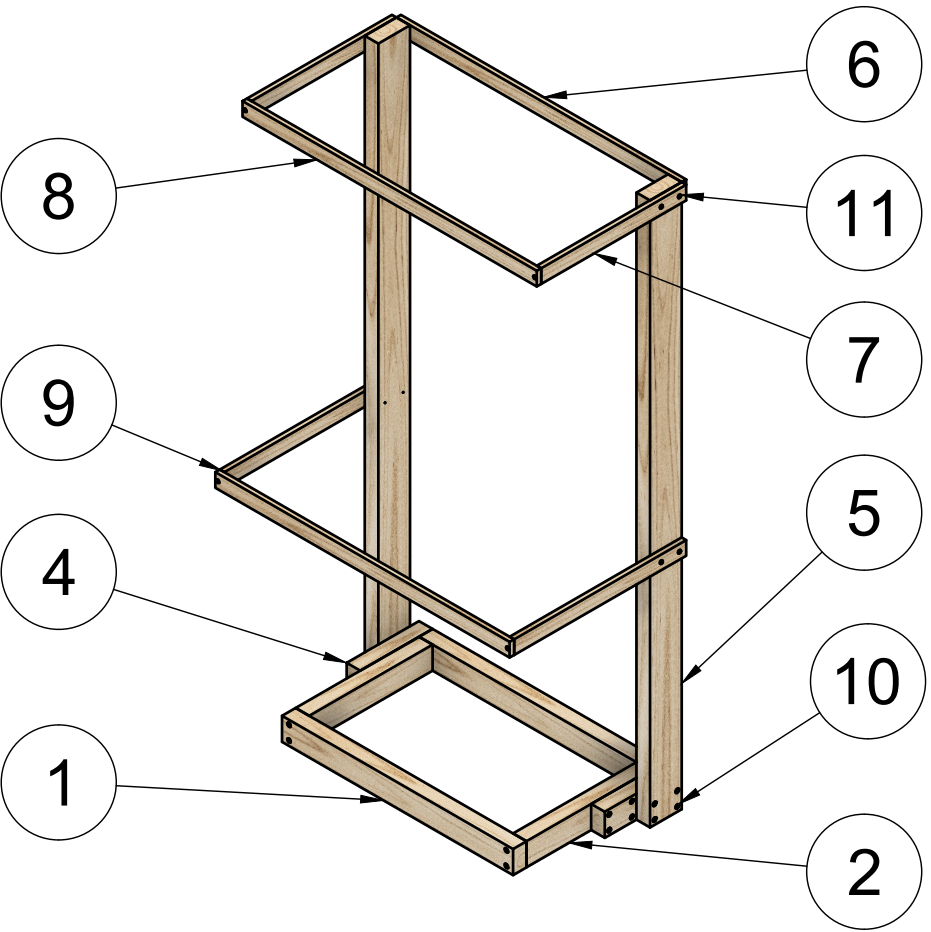
Manufacturing of the Light Array will require:

18. Marker or pen
19. Tape measure or yardstick
20. Level
21. Electric or hand drill
22. Phillips-head screwdriver or drill bit
23. Saw (to cut 1 x 2)
24. Bubble level

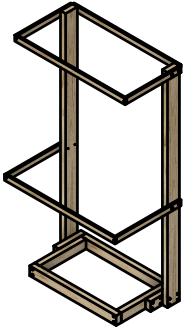
Materials:

1. (2) [1 x 2 x 8](#) (\$3.42)
2. (2) [Monios 4ft Lights](#) (\$24.90)
3. (1) [#6-32 X ½” machine screw](#) (\$2.98)
4. (2) Monois light 3d-printed light mount

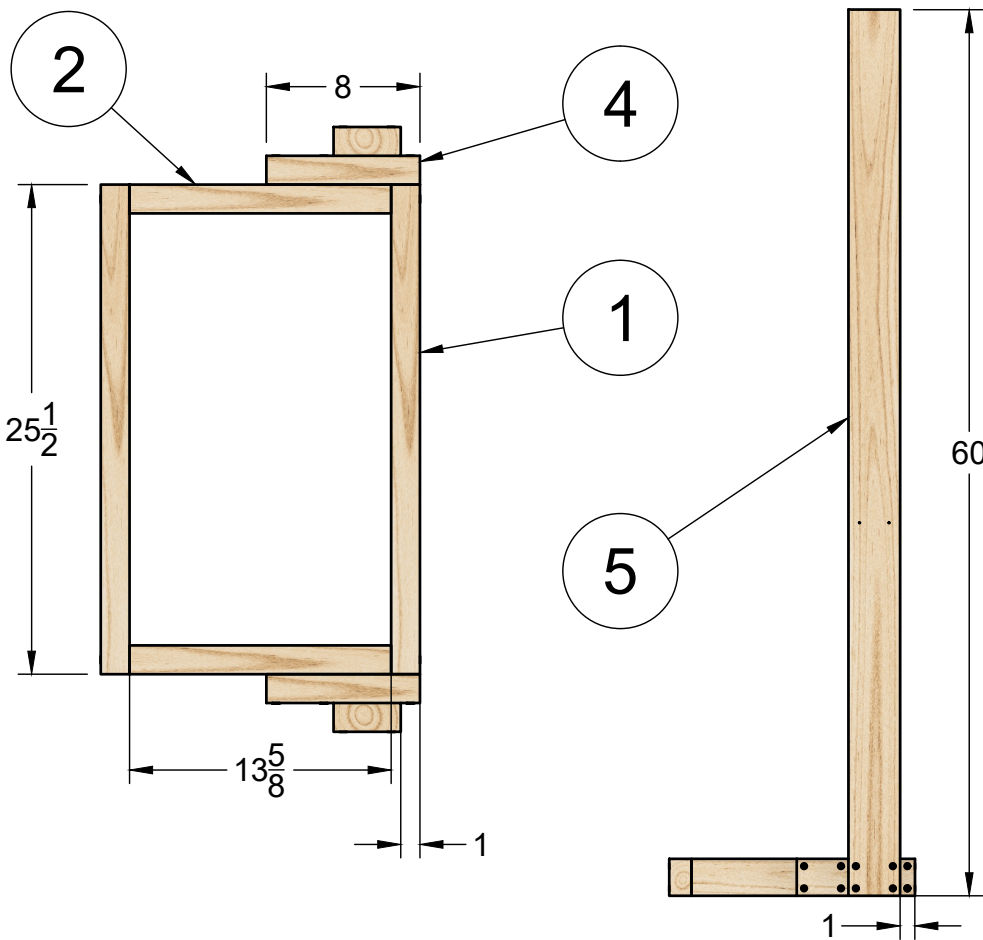
**SubTotal: \$59.62**



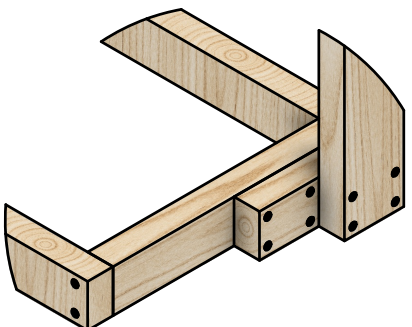
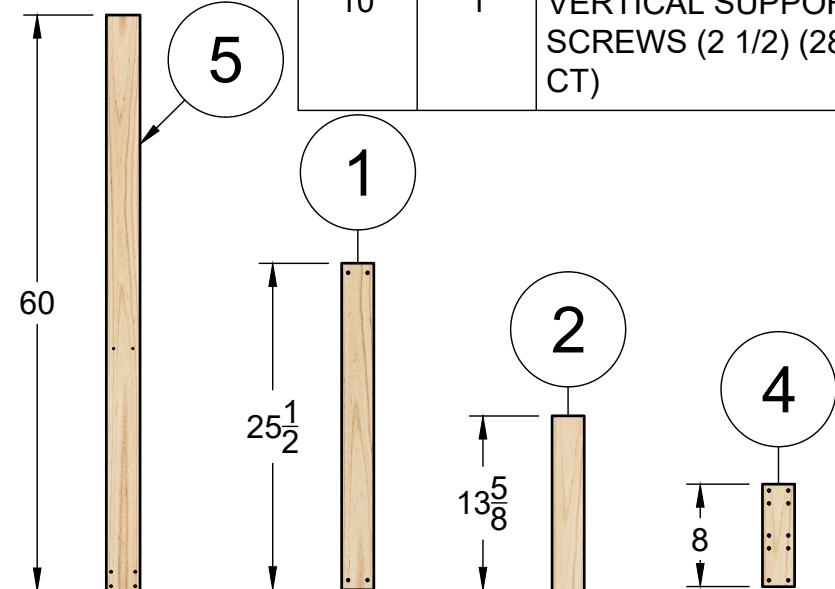
PARTS LIST		
ITEM	QTY	PART NUMBER
1	2	LENGTH FOUNDATION 2X4
2	2	WIDTH FOUNDATION 2X4
4	2	VERTICAL SUPPORT
5	2	VERTICAL ARM
6	1	REAR WALL SUPPORT ARM 1X2
7	2	TOP LIGHT SIDE ARM 1X2
8	2	LIGHT ARM FRONT 1X2
9	2	BOTTOM LIGHT SIDE ARM 1X2
10	1	VERTICAL SUPPORT SCREWS (2 1/2) (28 CT)
11	1	LIGHTING ARRAY SCREWS (1 1/2) (14 CT)



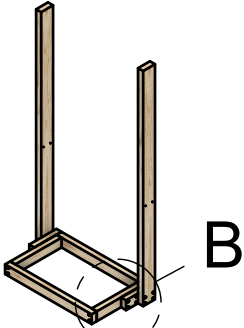
PROJECT			
HydroPonics Summer 2024			
TITLE			
Hydrowall Frame			
APPROVED	SIZE	CODE	DWG NO
CHECKED	A		
DRAWN	Nathan Finnell	7/2/2024	SCALE 1:15
		WEIGHT	SHEET 1/6

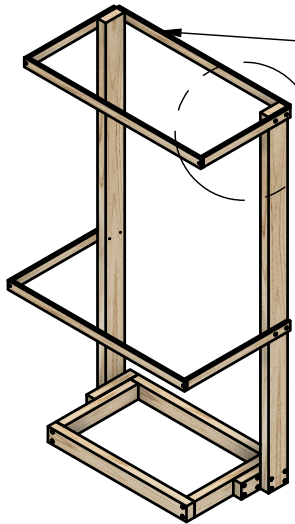


PARTS LIST		
ITEM	QTY	PART NUMBER
1	2	LENGTH FOUNDATION 2X4
2	2	WIDTH FOUNDATION 2X4
4	2	VERTICAL SUPPORT
5	2	VERTICAL ARM
10	1	VERTICAL SUPPORT SCREWS (2 1/2) (28 CT)



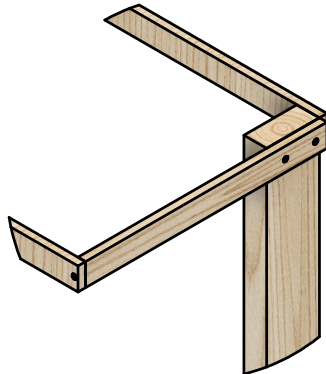
DETAIL B  
SCALE 1:8

	PROJECT HydroPonics Summer 2024			
	TITLE Hydrowall Foundation			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A			
DRAWN	Nathan Finnell	7/2/2024	SCALE 1:10	WEIGHT
			SHEET 5/6	

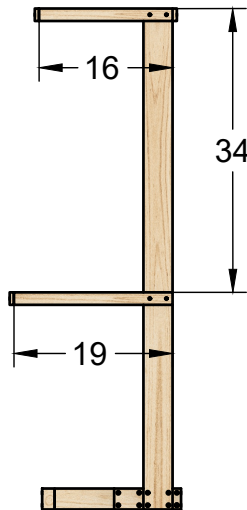


6

A

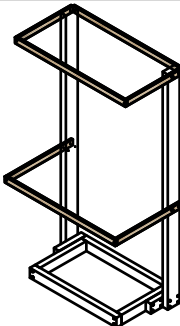
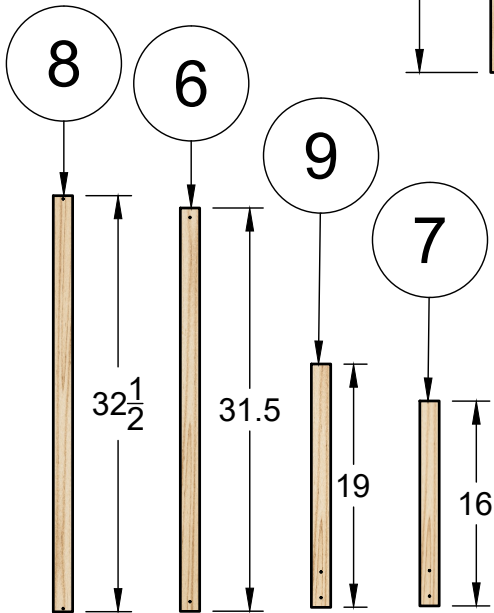
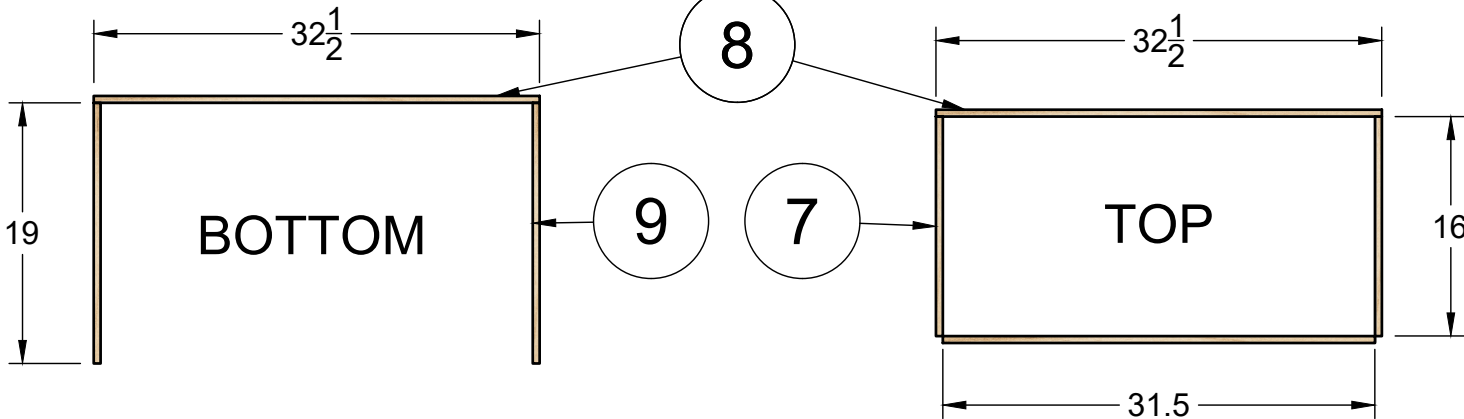


DETAIL A  
SCALE 1:9

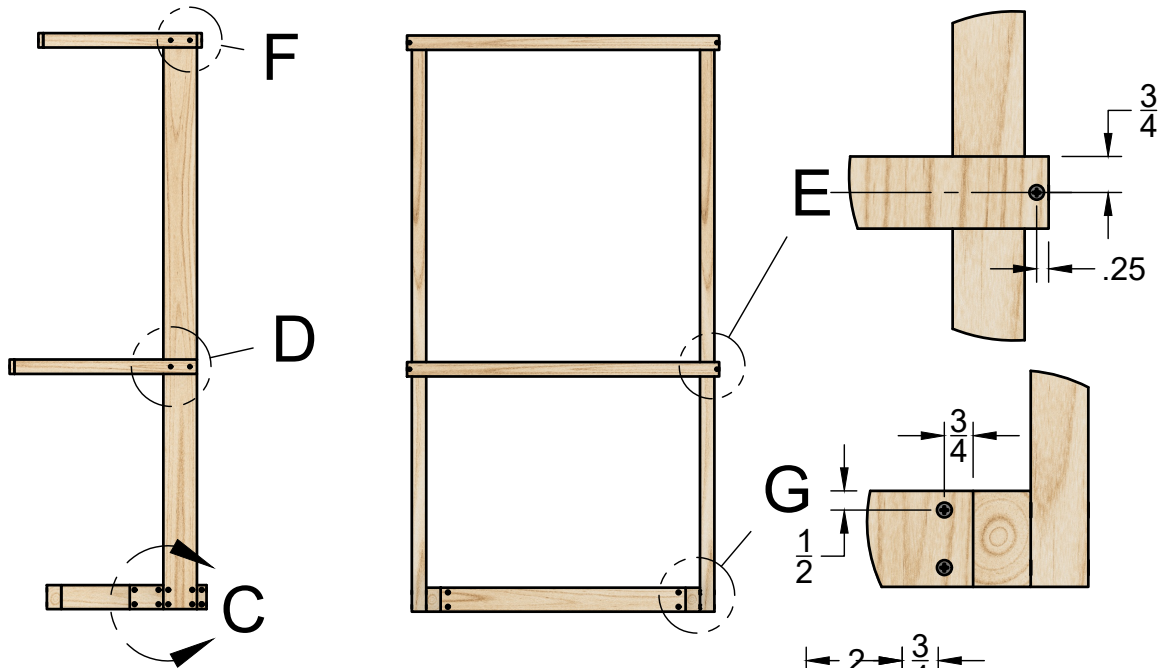


PARTS LIST

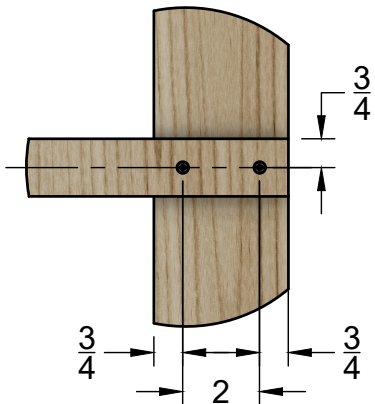
ITEM	QTY	PART NUMBER
6	1	REAR WALL SUPPORT ARM 1X2
7	2	TOP LIGHT SIDE ARM 1X2
8	2	LIGHT ARM FRONT 1X2
9	2	BOTTOM LIGHT SIDE ARM 1X2



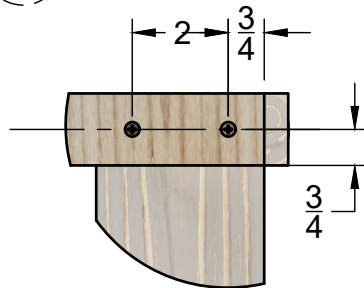
PROJECT HydroPonics Summer 2024			
TITLE Hydrowall Lighting Fixture Frame			
APPROVED	SIZE A	CODE	DWG NO
CHECKED			REV
DRAWN Nathan Finnell 7/2/2024	SCALE 1:15	WEIGHT	SHEET 6/6



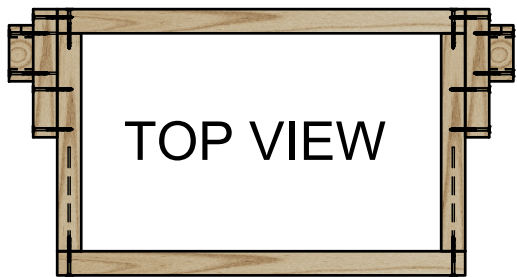
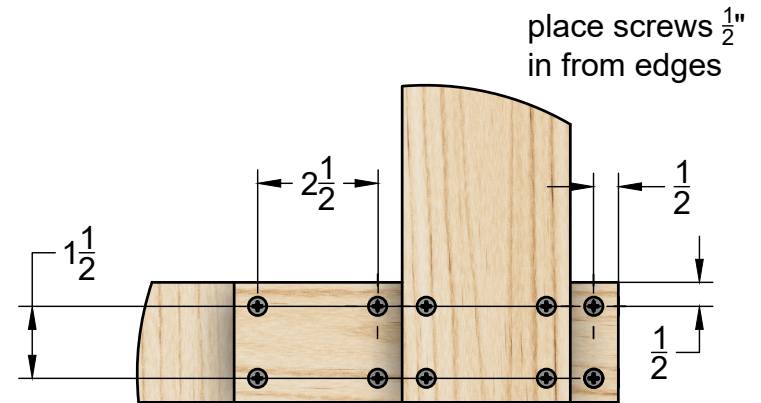
HARDWARE LIST		
APPLICATION	SCREW TYPE	QUANTITY
Bottom Frame Screws (long)	2 1/2" wood screw	28
Lighting Fixture Screws (short)	1 1/2" wood screw	14
All holes are predrilled with a 1/16" drill bit to prevent cracking. Screws are torqued until the head is flush with the wood surface.		

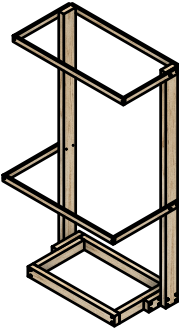


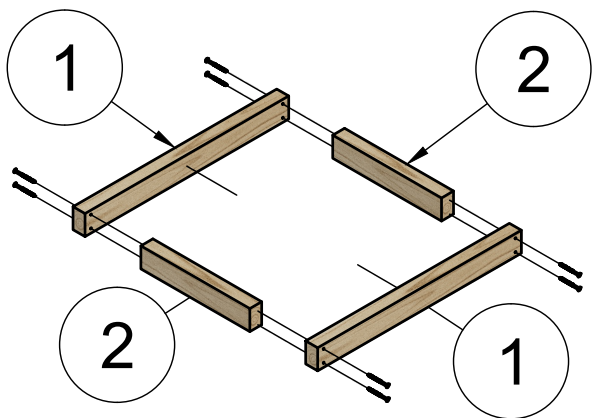
DETAIL D



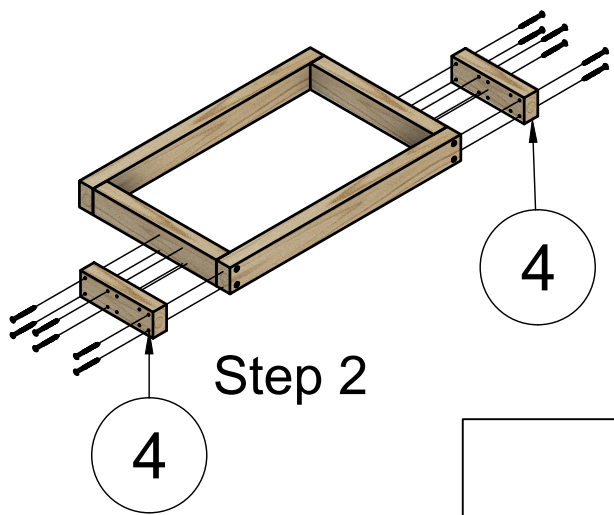
DETAIL F



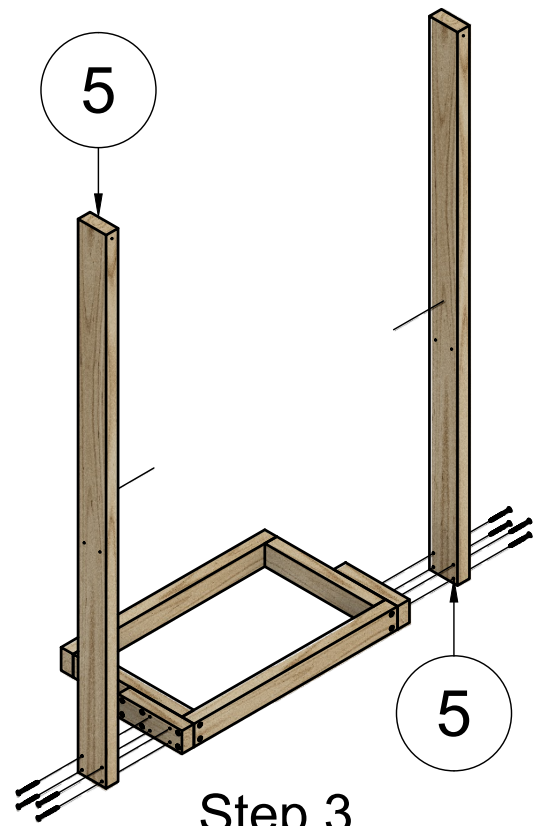
	PROJECT			
	HydroPonics Summer 2024			
	TITLE			
	Frame Screw Placement			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A			
DRAWN	Nathan Finnell	7/2/2024	SCALE 1:20	WEIGHT
			SHEET 4/6	



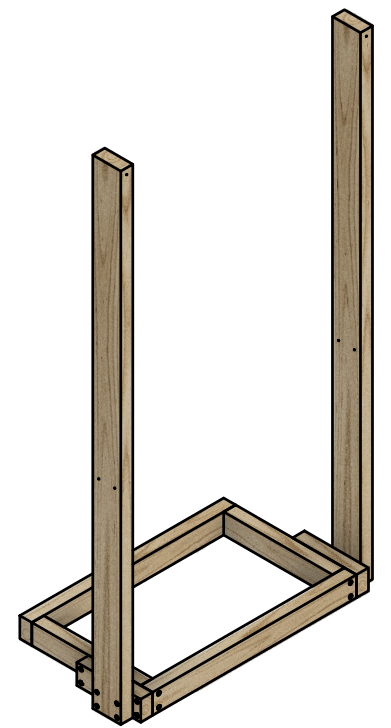
Step 1



Step 2

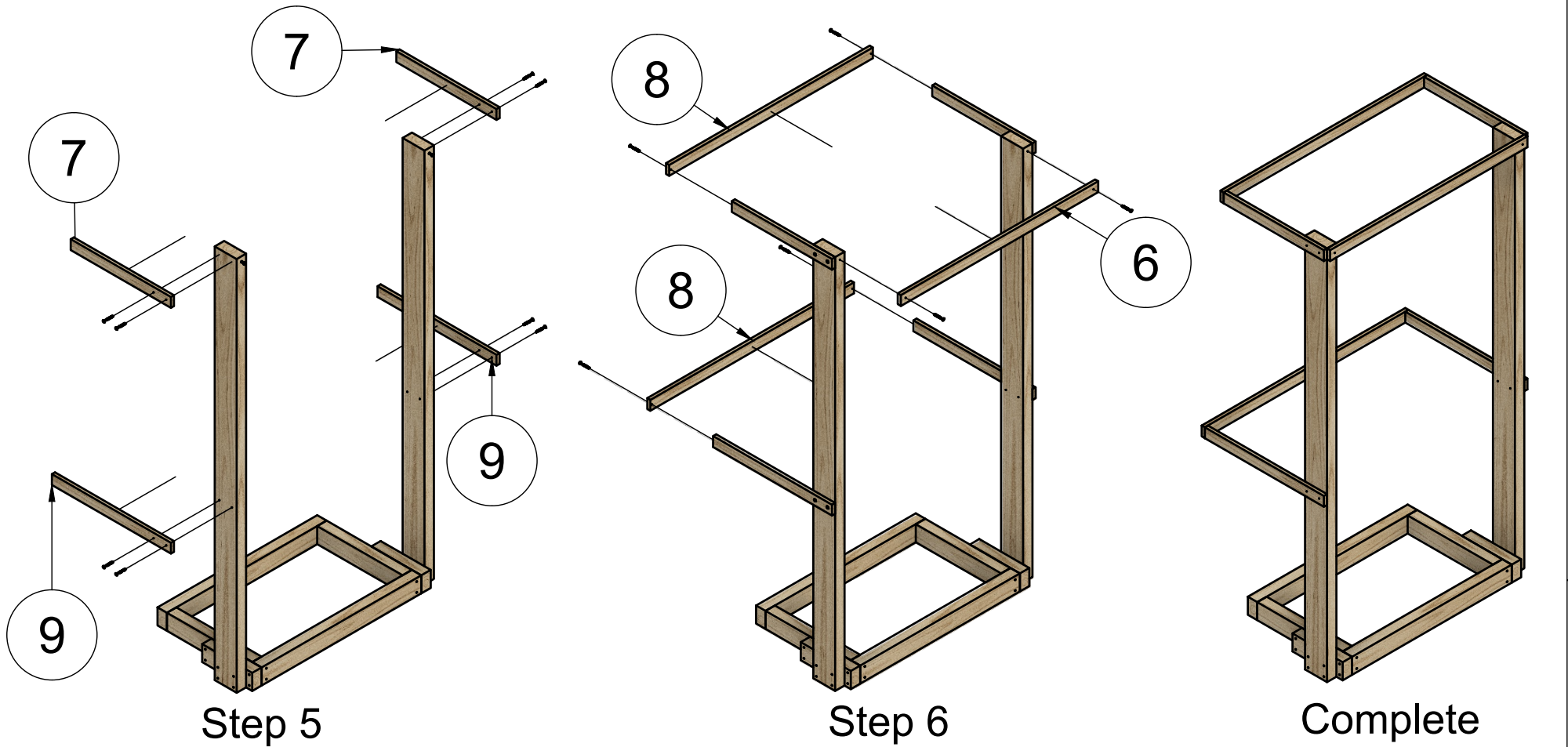


Step 3



Step 4

		PROJECT HydroPonics Summer 2024			
		TITLE Hydrowall Foundation Assembly Steps			
APPROVED		SIZE	CODE	DWG NO	REV
CHECKED		A			
DRAWN	Nathan Finnell	7/2/2024	SCALE 1:15	WEIGHT	SHEET 2/6



		PROJECT			
		HydroPonics Summer 2024			
		TITLE			
		Hydrowall Light Frame Assembly Steps			
APPROVED		SIZE	CODE	DWG NO	REV
CHECKED		A			
DRAWN	Nathan Finnell	7/2/2024	SCALE 1:16	WEIGHT	SHEET 3/6



## Plumbing

The plumbing setup consists of 4 lengths of ½” PVC pipe connected by 3 elbows and a cap. The PVC irrigation pipe runs along the top of the water wall and has an array of 5 evenly-spaced irrigation holes. 3D-printed nozzles cover the holes and guide the water down the channels ensuring consistent adhesion. This leads to an even distribution of nutrient-solution for every plant.

Manufacturing of the Plumbing will require:

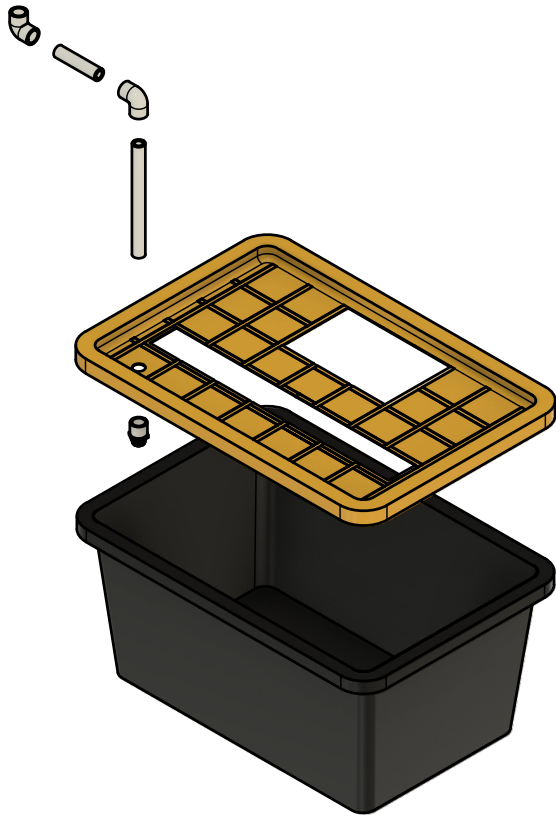
1. Drill
2. ⅜” bit
3. Permanent Marker or pen
4. Tape measure or yardstick
5. PVC cutter or saw.
6. PVC cement
7. Hand File/Sandpaper

Materials:

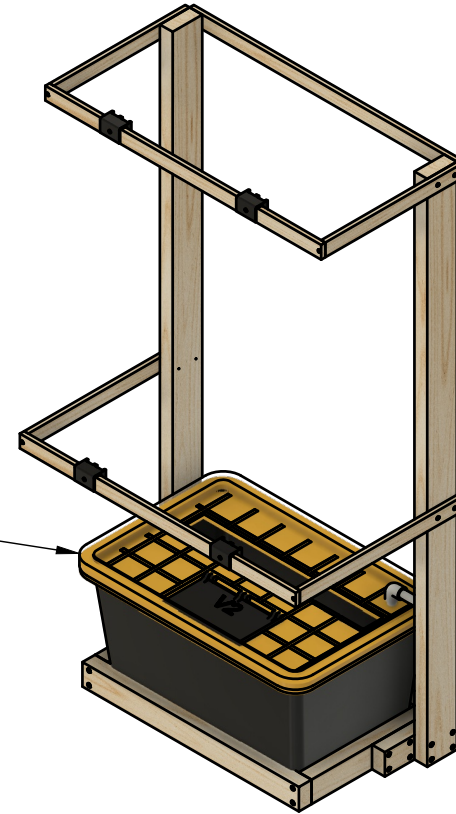
1. (1) ½” x [10’ PVC pipe](#) (\$4.71)
2. (3) [60 degree PVC elbow](#) (\$0.70)
3. (1) [Active Aqua pump 400 GPH](#) (\$30.91)
4. (5) 3D printed nozzles
5. (1) [PVC to pump adapter](#) (\$0.76)

**SubTotal: \$38.48**

**Grand Total: \$166.13**

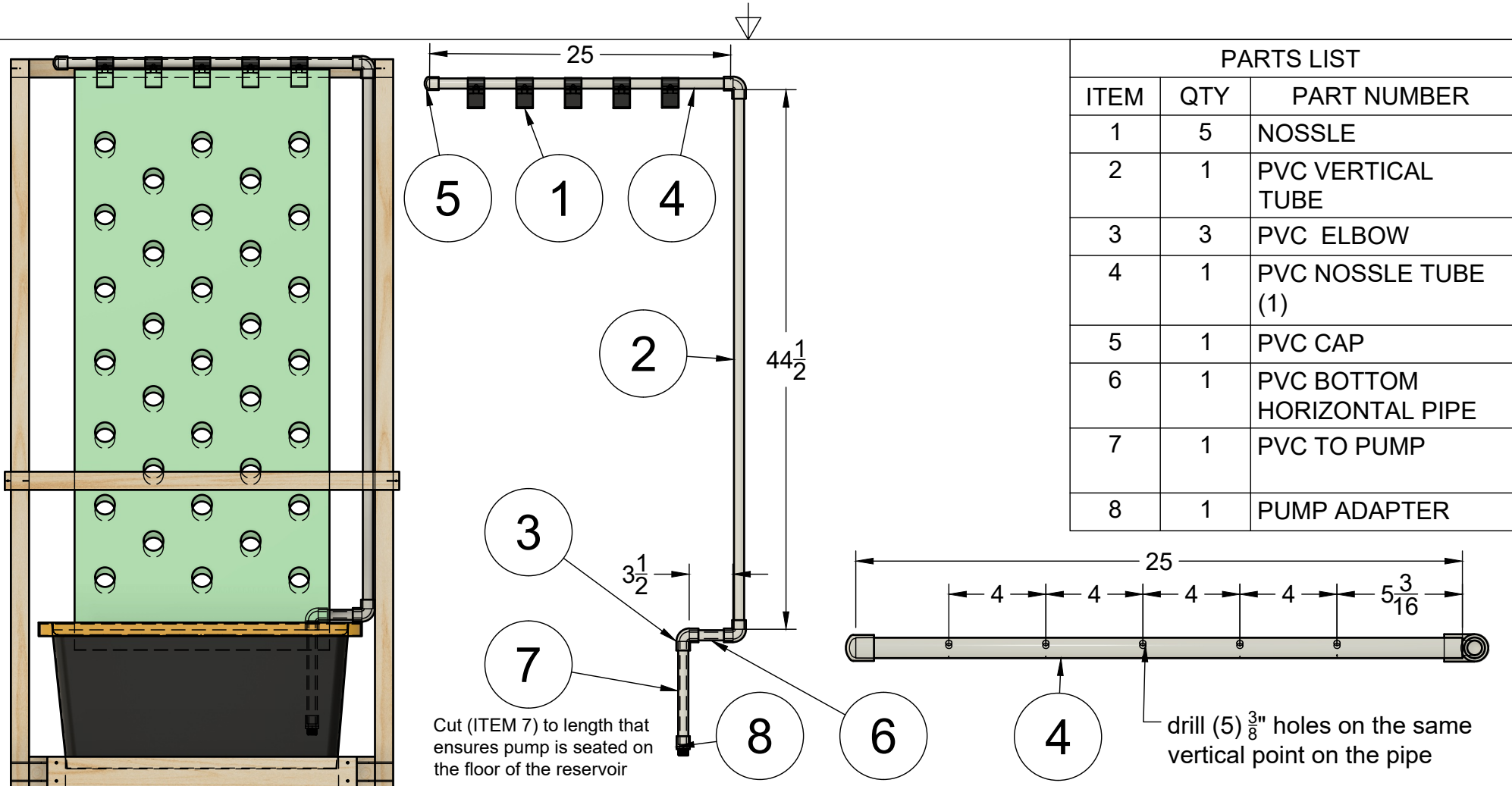


Assemble the lower plumbing system and thread the adapter to the pump. Insert lower pipe through the lid, and close the reservoir.



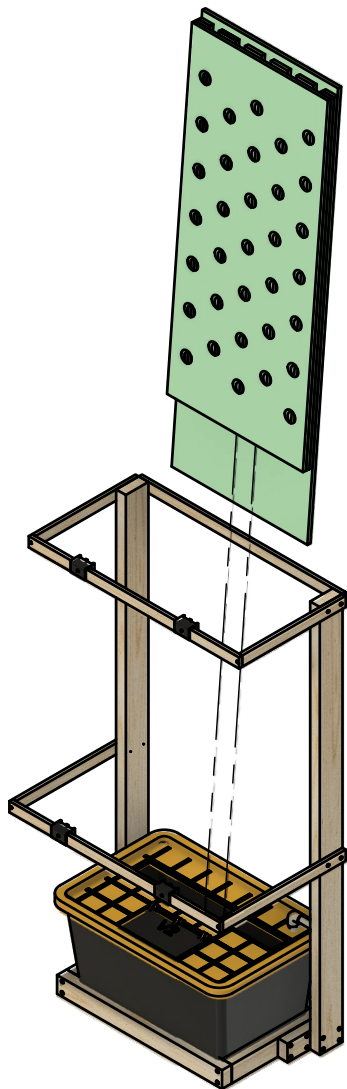
Insert the reservoir and plumbing assembly into the rectangular foundation. Press down firmly to seat the reservoir to its proper fitment.

		PROJECT			
		HydroPonics Summer 2024			
		TITLE			
		Vertical Garden Complete Assembly			
APPROVED		SIZE	CODE	DWG NO	REV
CHECKED		A			
DRAWN	nathan finnell	7/17/2024	SCALE 1:16	WEIGHT	SHEET 2/3

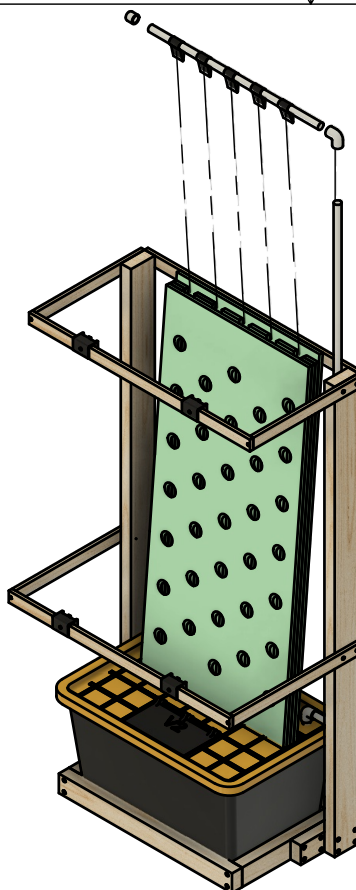


PARTS LIST		
ITEM	QTY	PART NUMBER
1	5	NOSSLE
2	1	PVC VERTICAL TUBE
3	3	PVC ELBOW
4	1	PVC NOSSLE TUBE (1)
5	1	PVC CAP
6	1	PVC BOTTOM HORIZONTAL PIPE
7	1	PVC TO PUMP
8	1	PUMP ADAPTER

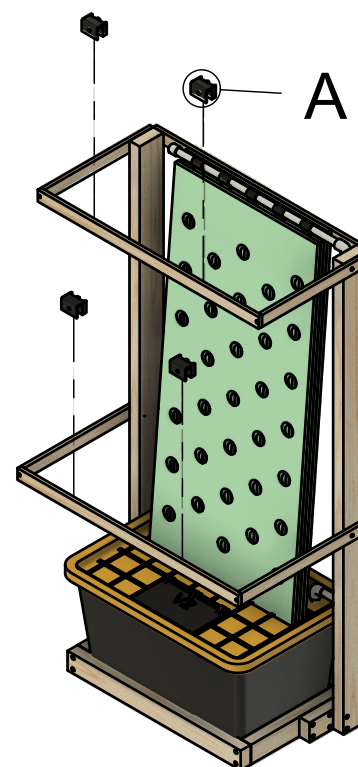
		PROJECT		
		HydroPonics Summer 2024		
		TITLE		
		Plumbing Assembly		
APPROVED		SIZE	CODE	DWG NO
CHECKED		A		
DRAWN	nathan finnell	7/12/2024	SCALE 1:15	WEIGHT
			SHEET 1/1	



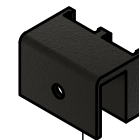
Insert the wall assembly through the top of the frame until it is seated on the bottom of the reservoir.



Assemble the vertical PVC pipe, upper elbow, and nozzle tube. Vertically insert each of the 5 nozzles into its respective channel, then slide nozzle tube into elbow.

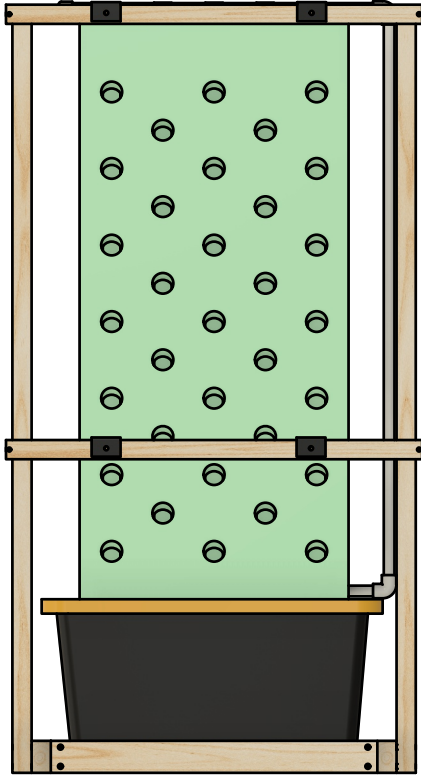


Place the (Monios T5) light hangers in their respective positions on the lighting frame. Note proper orientation in DETAIL A.

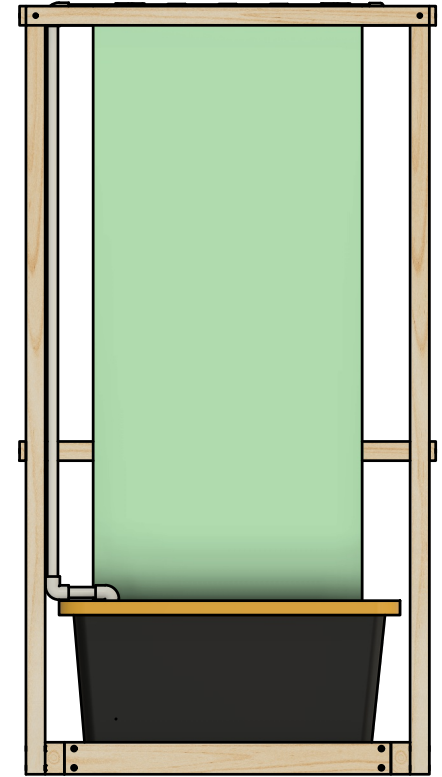
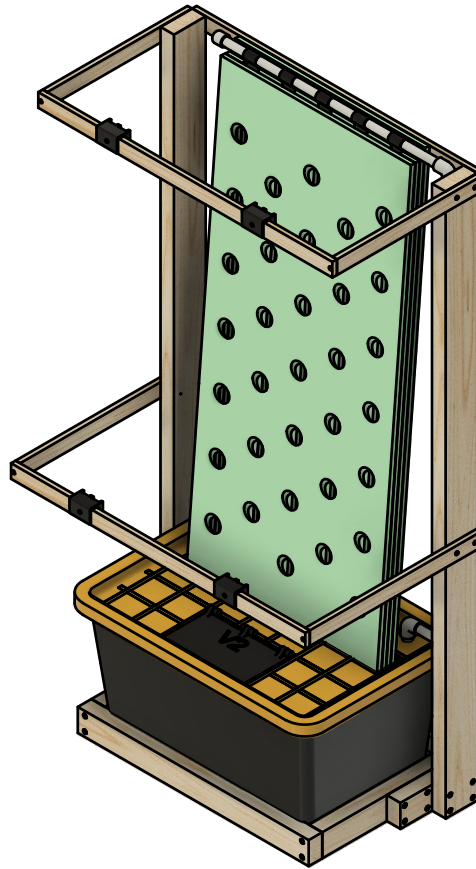


DETAIL A  
SCALE 1:4

					PROJECT			
					HydroPonics Summer 2024			
					TITLE			
					Vertical Garden Complete Assembly			
APPROVED		SIZE		CODE	DWG NO		REV	
CHECKED		A						
DRAWN	nathan finnell	7/17/2024	SCALE 1:20		WEIGHT		SHEET 3/3	



FRONT



BACK

		PROJECT		
		HydroPonics Summer 2024		
		TITLE		
		Vertical Garden Complete Assembly		
APPROVED		SIZE	CODE	DWG NO
CHECKED		A		
DRAWN	nathan finnell	7/17/2024	SCALE 1:13	WEIGHT
				SHEET 1/3



### Nutrient Solution

The nutrient solution consists of Jack's 15-5-20 fertilizer at a nitrogen concentration of 120 ppm. There is approximately 1 ounce (30g) of Jack's 15-5-20 mixed with 10 gallons (approx 37 liters) of water to achieve this concentration. A kilogram of [Jack's 15-5-20](#) may be purchased for (\$26.50).

### Using the Vertical Garden System

Once the assembly is completed, fill the reservoir with 10 gallons of water and add 30 grams of Jack's 15-5-20 fertilizer to complete the nutrient solution. Ensure that all plumbing connections are tight, all nozzles are in place, and plug in the pump to start the flow of water down the channels. Place and press net cups in each hole in the plant wall, ensuring that they are touching the nutrient solution film. Make sure to maintain the nutrient solution levels of your system, as letting the reservoir run dry can cause damage to both the plants and the pump. After fixing any issues with leakage, choose a substrate (rock wool or coco coir are recommended), sprout your plants, insert them into the net cups, turn on the lights, and begin your journey with vertical gardening.