

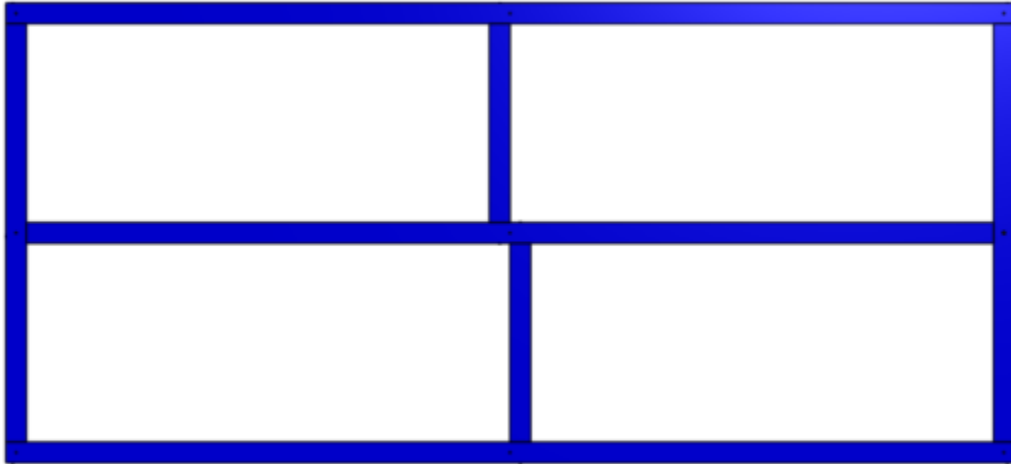
Instruction Manual

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Support Structure and Plant Bed Build

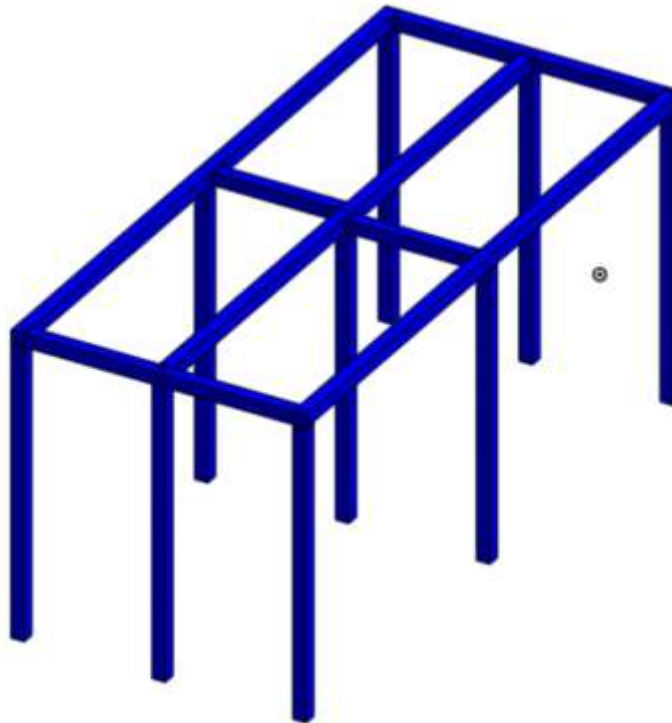
*Note: Screen captures from CAD used for photos not taken during assembly

1. From 2"x2" boards, cut to following lengths:
2x 2.2m (Front / Rear), 2x 0.910m (Left / Right), 1x 2.110m (Middle Horizontal), and 2x 0.433m (Middle Vertical). Screw these boards together in the orientation shown below (the lengthwise edge of each Middle Vertical Board aligns with the centerline of the Middle Horizontal board):



You have now completed the Plant Bed Base.

2. From the remaining 2"x2" boards, cut 9x 1.0m (support legs). Screw each leg to the Plant Bed Base so that the finished assembly looks like this:

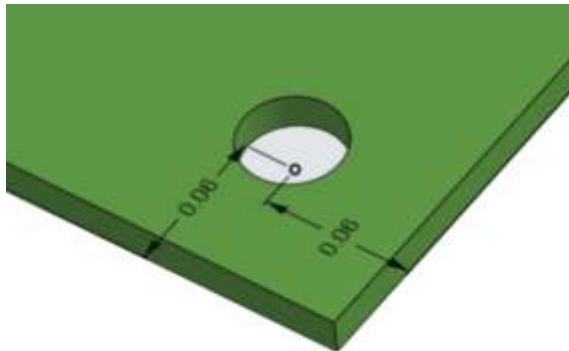


- From 1"x6" boards cut to the following lengths:
1x 2.2m (Rear Deflection Board), 3x 1.0m (Side and Middle Deflection Boards), and 3x 0.3 (Front Deflection Board). Assemble with screws to the existing Plant Bed Base as shown below:



These boards help to keep the support legs more rigid.

- On the plywood board, create a hole near a corner (0.06m from each edge) with a diameter of 0.040m. The result should look like this:



Screw the plywood board to the existing Plant Bed Base so that it is centered symmetrically. The result should look like below:



Note: This image doesn't show the plywood screwed to the Plant Bed Base (gaps can be seen); only the location of assembly.

5. From the 1"x6" boards cut the following lengths:
2x 2.4m (Front and Rear Side Walls), 2x 1.162m (Left and Right Side Walls). Screw these boards together as shown in the image below to create the Sidewall Assembly:



6. On the Front Sidewall board, holes will need to be cut for overflow drains. 2, 0.035m diameter holes (slightly larger than PVC pipe) centered .025m from the top edge of Front Side Wall will be added, each 0.5m from left or right edges of the Front Side Wall. Once holes are drilled, a PVC pipe of roughly 0.08m can be added to each hole and a PVC elbow added to the outside of the hole. Use PVC glue to permanently attach the two pieces. Sealant is then added to the inner and outer crevices to prevent leaks and hold the drain in place. The completed build of one of the overflow drains is shown below:



Note: This image shows two overflow drains at same location; in recommended design one will be above each fish tank. Also, the additional piece of wood attached to the side wall was used to hold up the grow lights, which were only needed for indoor testing and are not a part of the final design. Finally, recommended sealant will not be black in color as shown in the image.

7. The Sidewall assembly can now be aligned with the plywood board and screwed in place. These side walls and the plywood board create an area called the "Plant Bed" where the plant rafts will float while they grow. The assembled result can be seen below:



Now brackets can be added to the corners to reinforce the plant bed. An example is shown below:



8. The 10'x12' tarp can now be unfolded and lined on the inside of the plant bed (will be taught once plant bed is filled with water. A hole should be cut in the tarp that is the same size as the hole in the plywood and directly above it (this will be sealed later with a through-wall pipe fitting).
9. Create equidistant holes in foam boards to allow for seedling to sit in, but not fall through foam boards (we used .025m diameter holes, however it will vary depending on amount of starting material used for each seedling. A completed foam board is shown below:



Hand Pump Build

Plunger:

1. Cut a 1.1" diameter hole in the top of the 1 ¼" PVC Cap with a lathe or hole drill.
2. Etch a 0.06" deep groove around a ¾" PVC Cap. This can be done with a lathe or a table saw.
3. Seat an O-ring [#] in the groove. It stick out 0.1" or less.
4. Glue a 26" length of ¾" PVC and two 5" length pieces of ¾" PVC to a ¾" Tee connector as shown below.



5. Slide [cap with hole] onto the plunger. It should be free to move.
6. Then slide an O-ring [#]
7. Glue ¾" cap to end of plunger as shown above.
8. Leave to dry.

Outer Shaft:

1. Glue 24" length of 1 ¼" PVC to a 1 ¼" PVC Straight Coupling.
2. Glue a 1.25" x 3/4" PVC Reducer Bushing into the other end of the coupling.
3. Glue and thread a ¾" PVC Close Riser into the bushing.
4. Glue and thread a ¾" PVC Threaded Tee onto the riser as shown in the image below.



The Base:

1. Mark direction of water flow on the check valves.
2. Glue and thread a 3/4" Socket Female x NPT Male Connector into one of the open ends of the threaded tee.
3. Glue 3" long piece of ¾" PVC into the connector.
4. Glue the check valve on so that the flow is directed into the pump.
5. Repeat steps 2-3 on the remaining open end of the threaded tee connector.
6. Glue the second check valve so that the flow is directed away from the pump.
7. Double check that the check valves are arranged so the water is pulled in one side and expelled through the other.
8. Leave to Dry.



Final Assembly:

1. Wet the end of the plunger to lubricate the o-ring.
2. Insert plunger into outer shaft.
3. If fit is too tight, deepen the groove for the o-ring.
4. Once fit is verified, glue the cap with the hole in it that is free moving on the plunger to the top of the outer shaft.
5. Use two pieces of the extra [1" x 1"] wood to make the pump level with the filter.
6. Screw any scrap wood between the pieces of wood to provide a place to put your foot while pumping.
7. Attach to the pump with brackets as shown above.

Filter Build

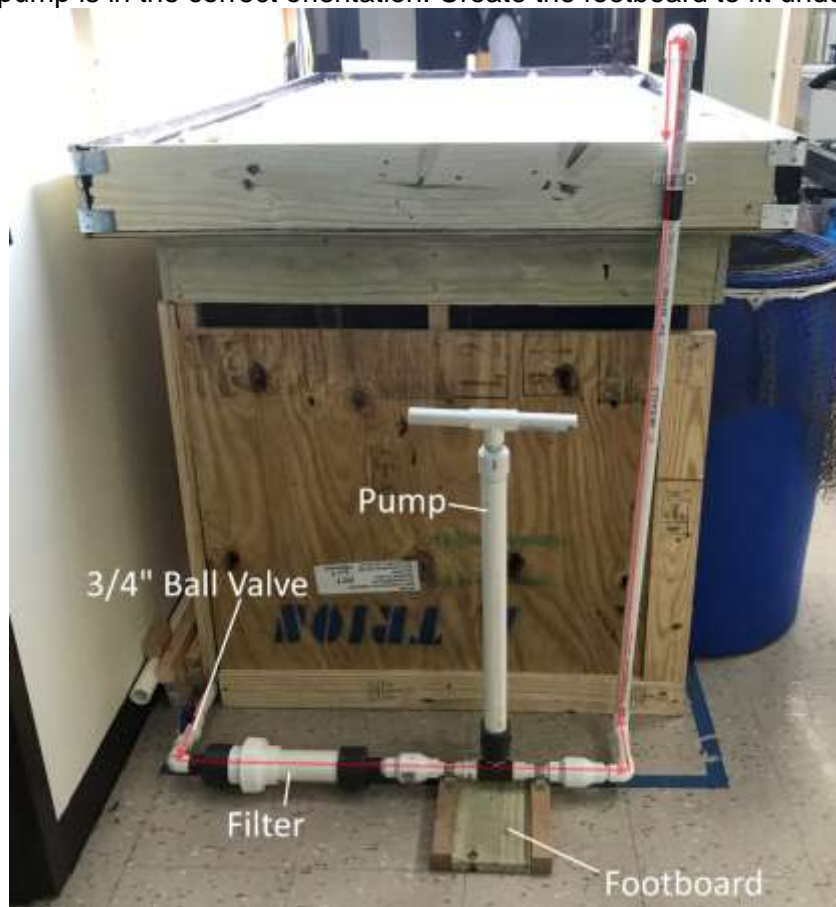
1. Using an 8" section of the 2" PVC connect one end to a 3/4" to 2" reducing coupler and connect the other end to one side of the 2" threaded slip coupler.
2. On the other end of the 2" threaded slip coupler attach another piece of 2" PVC. This second piece of PVC should be short because it just needs to connect the 2" threaded slip coupler to the second 3/4" to 2" reducing coupler.
3. Cut filter foam to into 3 2" circles and stack the discs
4. Take a large washer and loop a zip tie around it.
5. Thread the zip tie through the foam filter stack
6. Place the filter in so that the washer side is closer to the hand pump and the top of the zip tie is near the filter opening.





PVC Piping Build

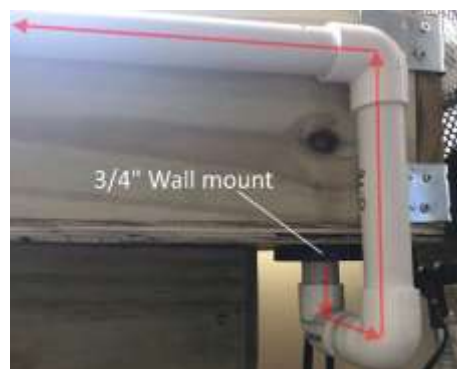
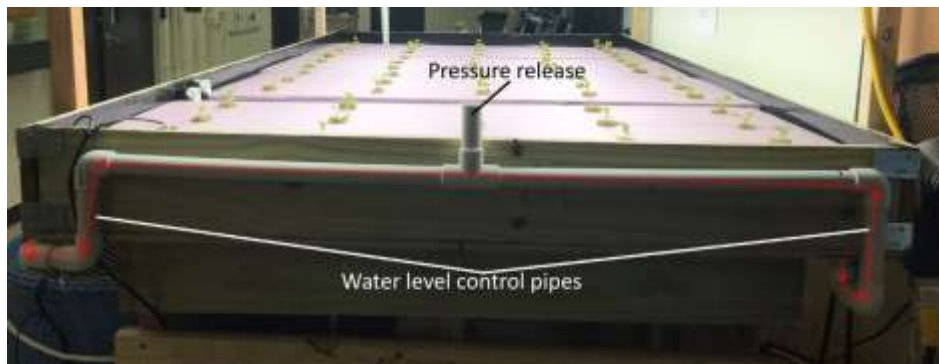
Create the following piping system out of $\frac{3}{4}$ " PVC to bring water from the fish tanks to the plant bed. The pipes that draw from the fish tanks should reach almost to the bottom of the tanks. Make sure the pump is in the correct orientation. Create the footboard to fit under the pump.

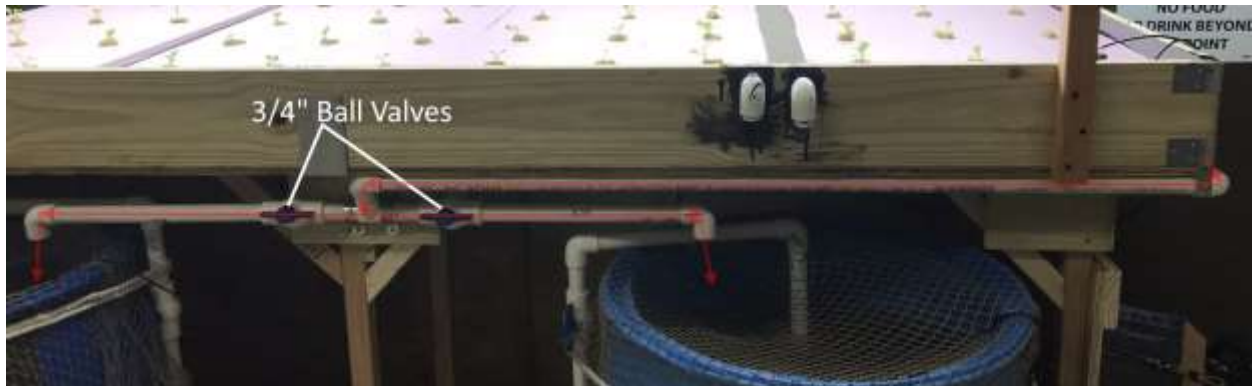




Create the following piping system out of $\frac{3}{4}$ " PVC to let water drain from the plant bed back down to the fish tanks.

The wall mount is put through the bottom panel of the plant bed. The pipes labeled "water level control" are used to determine the height of water in the plant bed needed before draining occurs. Cut these to a length such that there is about 4" of water in the plant bed before it starts draining. The pressure release tube ensures that a siphon is not formed in the drain. Make it long enough that water does not splash out when draining.





Mount both piping systems to the structure so that the pump expels water into the opposite corner of the plant bed that the drain system takes water from. Attach using piping brackets wherever necessary. 1-1/16" ID brackets can be used in places where the pipe is flush with the wall. 1-5/16" ID brackets can be used in places where a connector is flush with the wall.

Sensor System Assembly

1. Place pH, Oxygen and one temperature sensor in one of the barrels
2. Place a temperature sensor in the other barrel
3. Place Turbidity sensor and one temperature sensor in the plant bed
4. Plug in sensors into their corresponding ports on the side of the sensor enclosure.
5. Mount solar panels facing straight up if in Colombia or at 40° facing south if in the US.
6. Plug in solar panels into solar port on side of sensor enclosure
7. To use the bluetooth functionality, you must first initially pair with the device before it can be initially used. To do this, power on the system by moving the toggle switch to the on position, going to settings on your phone, select the HC-06 device and enter the pairing code of either 0000 or 1234. Note: this step only needs to be done once.

Beginning of Cycle Tasks

1. Fill tanks with water and fish.
 - a. Start with 10-15 fry
 - b. The total mass of the fish should not exceed 20lbs per barrel
2. Fill the plant bed with water until it starts to drain
3. Put the seedling foam with the starting plants into the holes in the rafts. The roots/foam should be underwater.
4. Float the rafts in the plant bed.

Recommended Fish Maintenance Tasks

Morning

1. Pump system for 15-20 minutes.
2. Clean the filter (see Filter Maintenance).
3. Remove 5 gallons of water from each fish tank.
4. Add 5 gallons of fresh water to each fish tank.
5. Feed the fish.
6. Check parameters using sensor system.

Evening

1. Pump system for 15-20 minutes.
2. Clean the filter (see Filter Maintenance).
3. Feed the fish.
4. Check parameters using sensor system.

How to Pump the System

- When using the hand pump, stand on the wooden base for leverage.
- Keep watch of water levels in the plant bed and in the fish tanks.
- Pumping for 15-20 minute intervals will cycle half the water in the system
- There is no one method for cycling the water. Find what works best for you.

Suggested Method 1:

1. Turn off the drain pipe valve leading to one tank.
2. Turn off the pump pipe valve from the other tank.
3. In this method, the water pulls from one tank and drains into the other.
4. Once the water level in one tank gets too low or too high, switch valves into the opposite configuration.

Suggested Method 2:

1. Start with all valves open.
2. Adjust valves as needed to maintain a somewhat equal water level in both fish tanks.

Filter Maintenance

1. Pull off submerged sections of pipe in the fish tanks from the pipe to the drain. It should be pulling air, not water.
2. Pump until only air is going through.
3. Shut off valve next to filter.
4. Unscrew threaded coupling.
5. Pull filter material out.
6. Clean filter by running water through it in the opposite direction.
7. Put filter back in the PVC.
8. Screw on threaded coupling.
9. Open valve next to filter.
10. Reattached submerged sections of the piping.

Sensor System Use

The sensor system will display and record sensor values when the power is on. To view the values, there are several methods to choose.

1. Open the lid and press either the 'Up' or 'Down' buttons to illuminate the display. Pressing these buttons again will cycle through all of the parameters including the current time.
2. Connect a phone, using Bluetooth, to the system and use the Android app to view the parameters. To do this, tap "Select BT module" button in the app and choose the correct IP address from the list. The parameters should update with current values on the front page.
3. Remove the MicroSD card and connect it to a computer. Open the Excel spreadsheet "AquaponicsCSVtoGraphTemplate.xltm" located on the MicroSD. Save the template with a new name and import the data from the sensor system by pressing the 'Import Data' button. The values will be loaded in and the spreadsheet will form graphs of the data to view.

To remove power from the system, the silver Power switch will remove both Solar and Battery power. The Green Status light will turn off and the power sources can be safely disconnected.

If the system is ever in an unknown state or is functioning not as expected, pressing the red Reset button will reset the system. If the issue is not remedied after pressing the reset button, cycling the power switch should fix the issue.

The battery is equipped with over discharge protection. In the event that the solar panels are not able to provide enough power and the battery runs out, it will automatically remove power to the system before it draws too much charge. This is expected behavior. Make sure to place the solar panels so that they are facing the sun as directly as possible. The system will power on again when the power from the sun is great enough. This should also charge the battery as well.

End of Cycle Tasks

1. To harvest plants, remove them from the seedling foam.
2. To harvest fish, remove fish from barrel with net.

Troubleshooting

- If pump is not working properly, clean the filter.
- If air is coming through the pump when it shouldn't be, check all PVC couplings are fully on.