



# GI Node (Height-Adjustable) with Pressure Transducer & Soil Moisture Sensor

Learn how to assemble a height adjustable GI node with a pressure transducer and soil moisture sensor.

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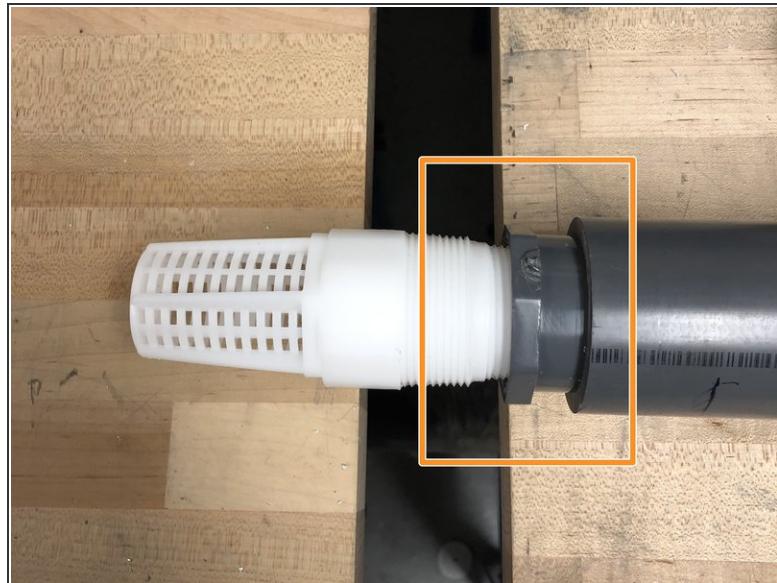


## PARTS:

- Enclosure (1)
- Steel Plate (1)
- Enclosure-to-steel plate screws (4)
- Enclosure-to-steel plate nuts (4)
- Solar Panel (1)
- Cable Glands(for solar wire) (1)
- Lock (1)
- Microcontroller (1)
- Jumpers (6)
- Enclosure-to-board screws (4)
- Cellular Modem (1)
- 8GB SD card (1)
- Twilio SIM card (1)
- Antenna (1)
- GPS Unit (1)
- Velcro (1)
- 3.7 V Li-ion Battery (1)
- 4-Wire Terminal Block Plug 2.54 mm (1)
- 5-Wire Terminal Block Plug 3.5 mm (4)
- 2-Wire Terminal Block Plug 3.5 mm (1)
- 150  $\Omega$  1% resistor (1)
- 12 V Step-up voltage regulator (1)
- Soil Moisture Sensor (1)
- Pressure Transducer (1)
- Hydrophobic Vent Cap (1)
- Thick-Wall Unthreaded PVC Water Pipe( 5ft l, 2 in w) (1)
- Thick-Wall Unthreaded PVC Water Pipe (5ft l, 1.5in w) (1)
- Cut-to-Size Suction Strainer with Backflow-Prevention Valve(Foot Valve) (1)
- Rigid PVC Conduit 1-1/2 Trade Size Female x 1-1/2 NPSM Male Adapter (1)
- Thick-Wall PVC Pipe Fitting Bushing Adapter, 1-1/2 Socket Male x 1-1/4 NPT Female (1)
- Steel Locknut (1)
- O-Ring (1)
- Pipe Lubricant (1)
- Hose Clamps 46-70mm (1)
- Cool seal 22-18 Butt Splice (3)



## Step 1 — Inserting the Foot Valve and Pipe Bushing



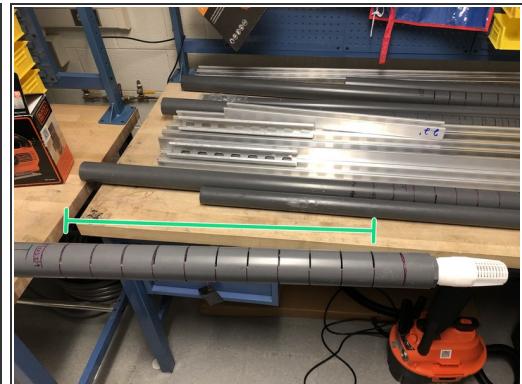
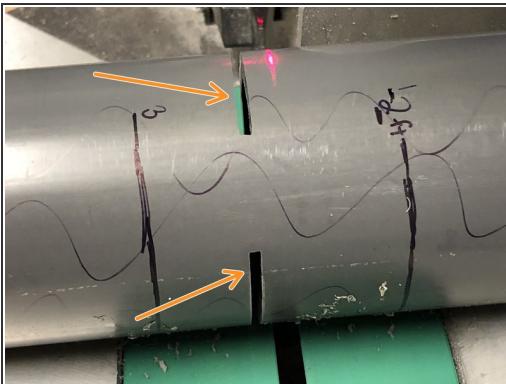
- Obtain a foot valve, remove the internal spring and recycle it. Trim it by sawing off to leave the 1.25 inch and 1.5 inch sections (allowing it to screw into the pipe bushing).
- Screw the foot valve into the pipe bushing and then insert it into the 2-in pipe.

## Step 2 — Marking the Pipes



- On the 2-inch pipe, make a line 1.75 inch from the bottom (to make space for the pipe bushing). Then make a line 2.5 ft from the bottom of the foot valve for the soil moisture sensor hole.
- From the 1.75 inch line, mark lines 2 inches apart until you reach the 2.5 ft mark.

## Step 3 — Making the Pipe Slits on the 2-inch Pipe



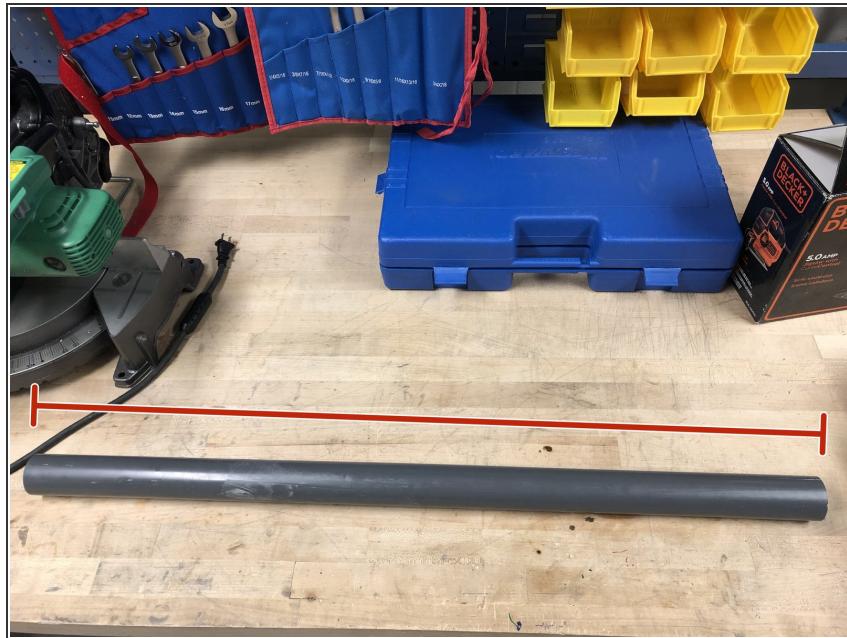
**⚠** **Tips:** Wear face mask and safety glasses while cutting the PVC pipe.

- Using the table saw, cut the 2-inch pipe all the way through at the designated mark.
- Using the table saw, cut slits on both sides of the pipe at each mark above the 1.75 inch line until you reach the 2.5 ft line.
- Leave at least an inch of space between the top and bottom halves of each slit to ensure the pipe stability.

**(i)** Use the table saw laser to help position the slits evenly.

- The slits should look like this.

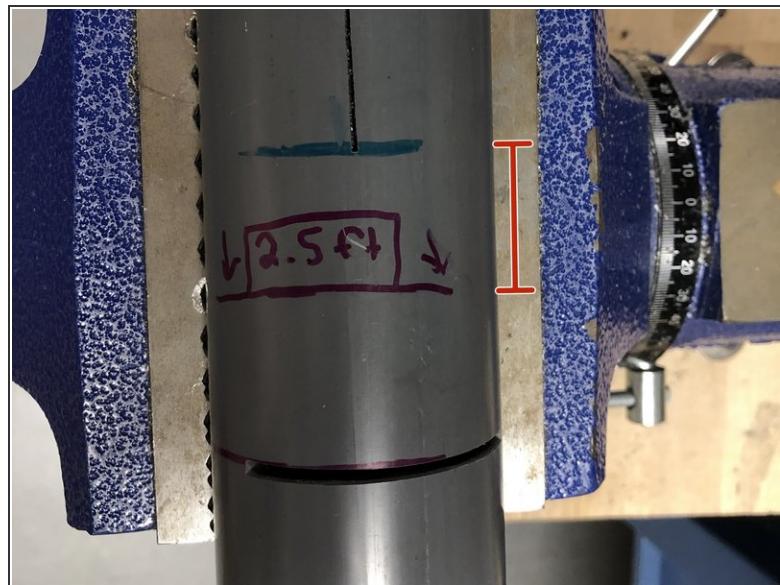
## Step 4 — Preparing the 1.5 inch Pipe for Connection



- Using the table saw, cut the 1.5-inch pipe to be 35 inches long.

- i* If you do not want the GI node to be height adjustable, cut the 1.5 inch pipe to be about 6 inches. It will only be used to connect the 2-inch pipe to the node.

## Step 5 — Preparing the 2-inch Pipe for Connection



- Ask the machine shop to make a lengthwise slit on either side of the 2-inch pipe from the end without the pipe bushing to about 1 inch above the 2.5 foot mark (this 1 inch gap is shown in the 2nd image). These slits will make it easier to slide the 1.5 in pipe in and out.

## Step 6 — Coating the Pipes with Lubricant



- Obtain the pipe lubricant.
- Use a paper towel or rag to coat the outside of the 1.5-inch pipe in a light layer of the lubricant.
- Coat the inside of the 2-inch pipe only in the section with the two long, lengthwise slits(as this is the section the 1.5-inch pipe will fit into).

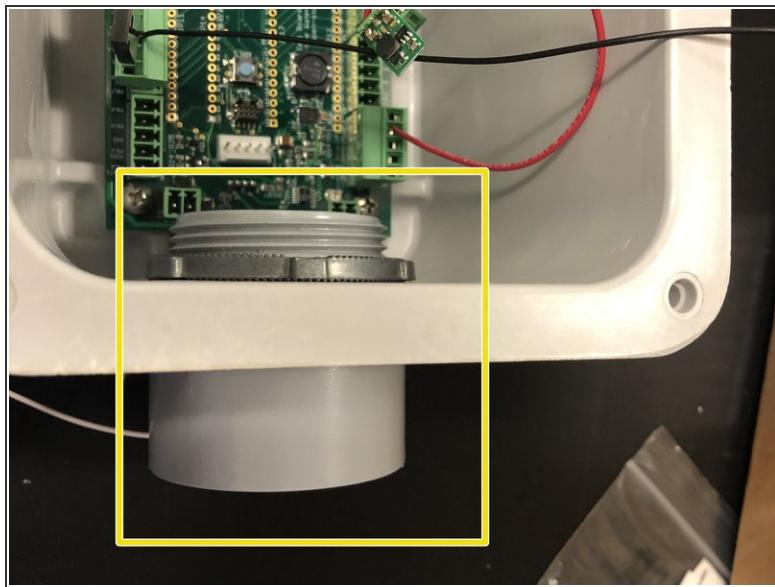
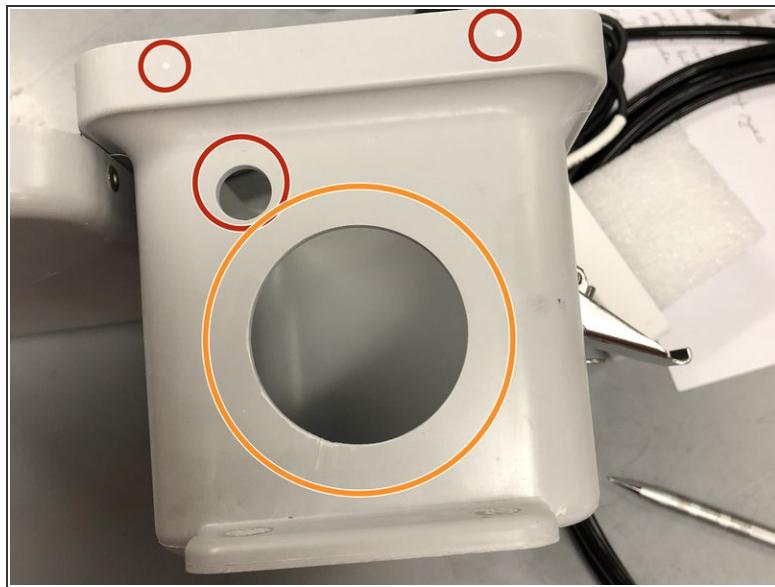
 Make sure to wash your hands after handling pipe lubricant.

## Step 7 — Inserting the 1.5 inch Pipe



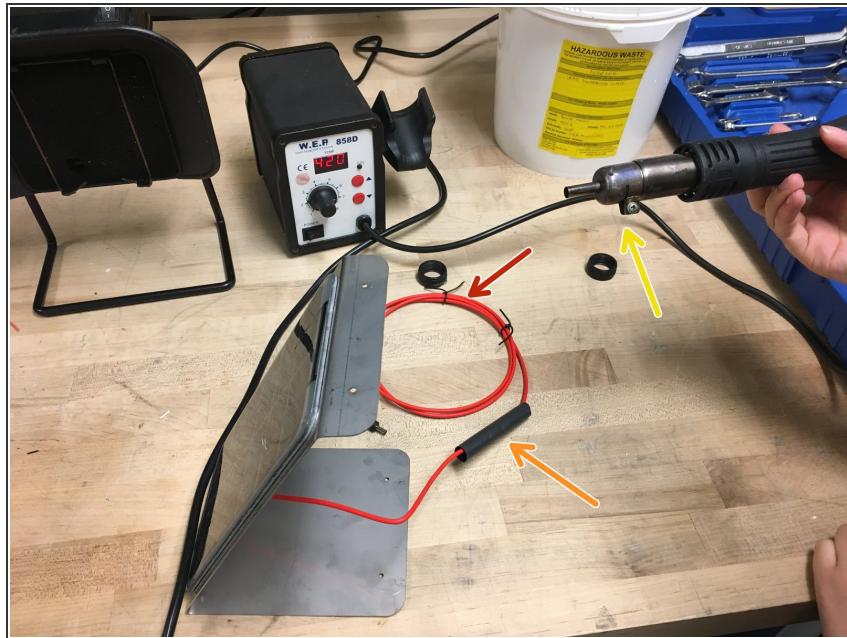
- Slide the 1.5-inch pipe(coated on outside with lubricant) as far in as needed into the 2-inch pipe(coated on inside).
- Use a hose clamp to secure the two pipes together at this desired height.

## Step 8 — Obtain Enclosure



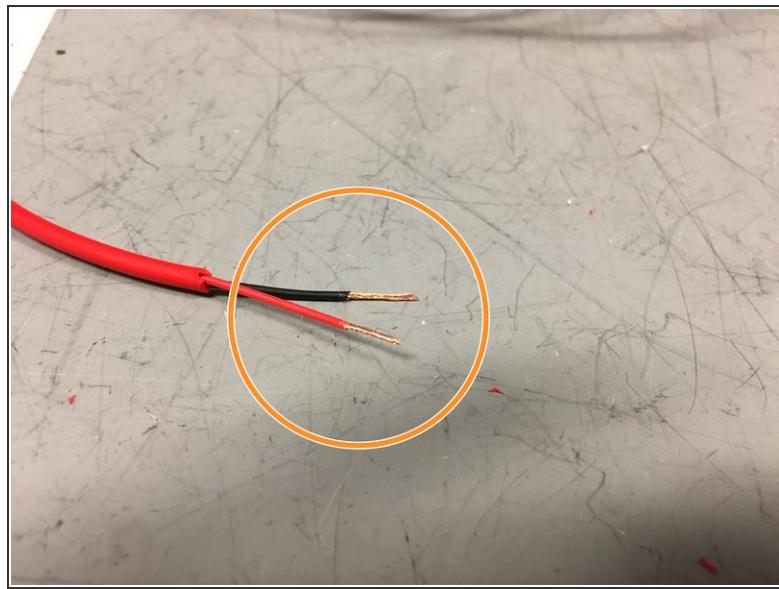
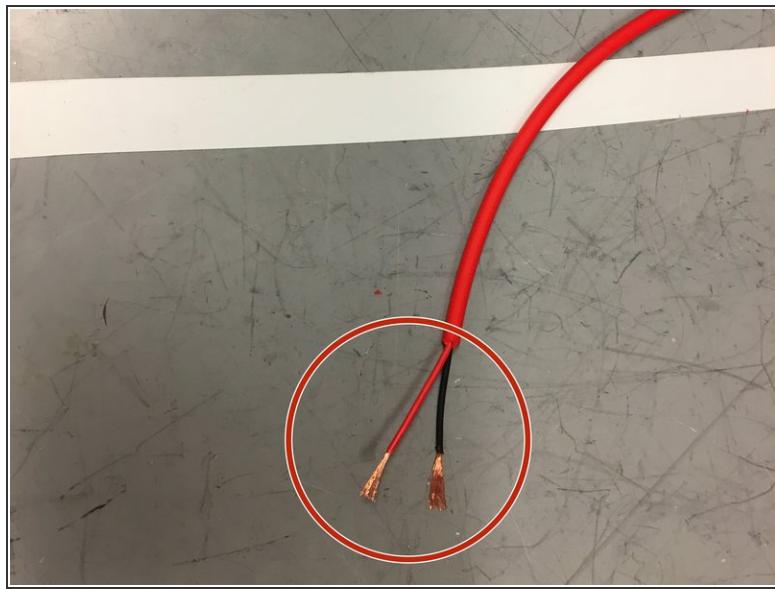
- The enclosure should have the standard node holes for the solar gland and solar panel attachment.
- The large hole is a 2-inch diameter hole. This is larger than the standard node enclosure. The machine shop will cut these holes.
- Insert the pipe fitting with the water resistant o ring on the outside, screwing on the metal ring on the inside.

## Step 9 — Extending the Solar Panel Wire



- Obtain the solar panel extension cable.
- Cover the connection between the solar panel wire and the extension cable with the heat-shrink tubing.
- Then, use a heat gun to shrink the tubing, creating a water-tight seal around the connection.

## Step 10 — Preparing Solar Panel Wire



- Trim the solar panel extension wire so there is approximately 20 inches of wire from the connection point.
- Strip the wires as shown.
- Twist the ends of the wires.

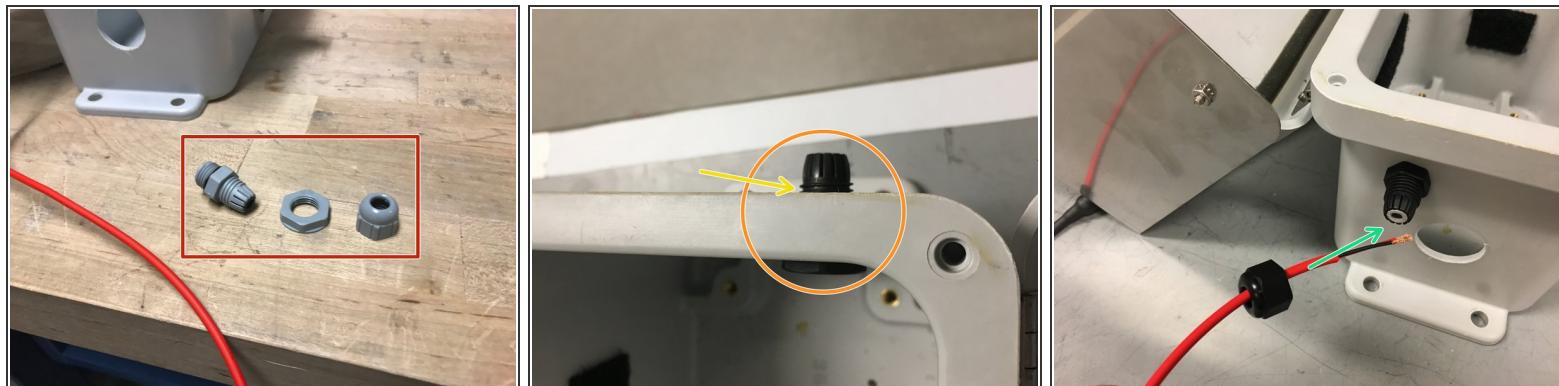
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## Step 11 — Attaching the Solar Panel



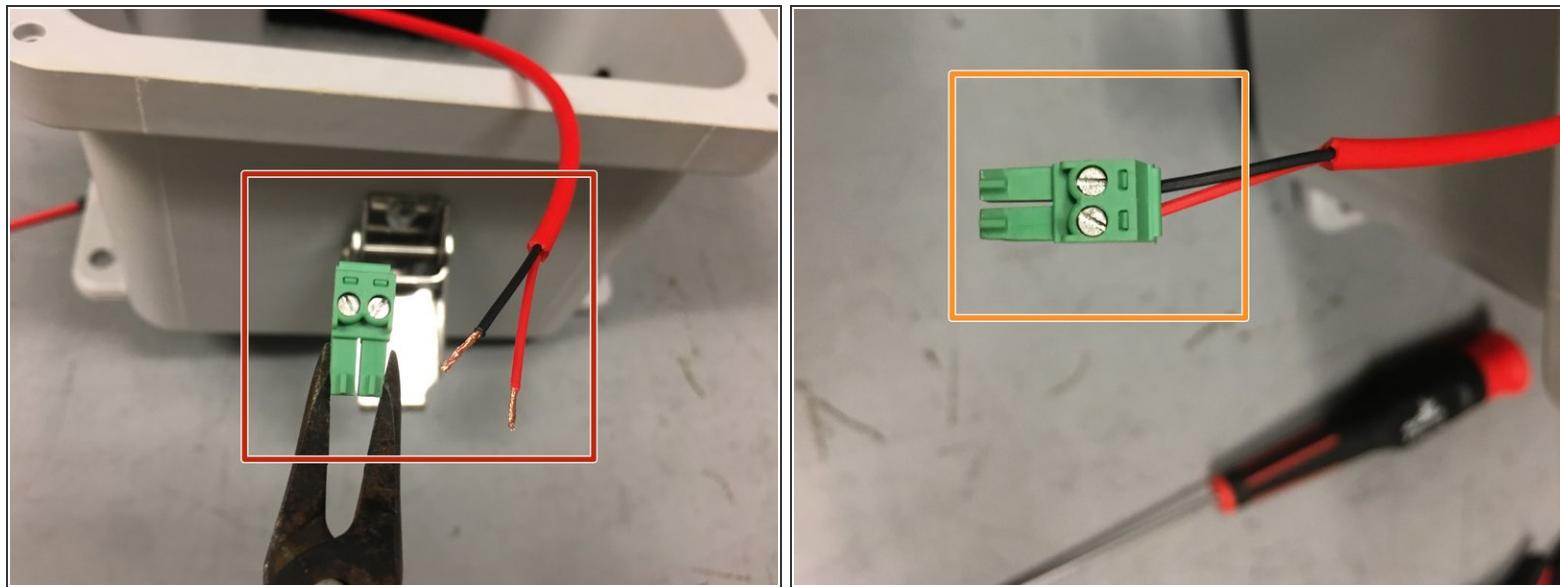
- Attach the solar panel onto the metal plate.
- Using screws and a screw driver, screw the solar panel into these holes. Now that the solar panel is attached to the metal plate, attach the metal plate onto the lid of the enclosure.
- Note: the tall side of the metal plate should be on the same side of the enclosure as the holes for the ultrasonic sensor and cable glands.
- The screws and nuts should be screwed in this matter in the holes on the sides of the box lid (meaning the nut is on the outside).

## Step 12 — Solar Panel Wire pt 1



- Obtain a cable gland.
- Screw the cable gland into the wall of the enclosure, through the small hole, as shown.
- Place an o-ring between the cable gland and outer-wall of the enclosure.
- Insert the solar panel extension wire into the cable gland as shown, leaving approximately 8 inches of wire inside the enclosure.

## Step 13 — Solar Panel Wire pt 2



- Obtain a plugable header and ensure the ends of the wires are twisted.
- Screw the wires into the plugable header as shown in the picture.

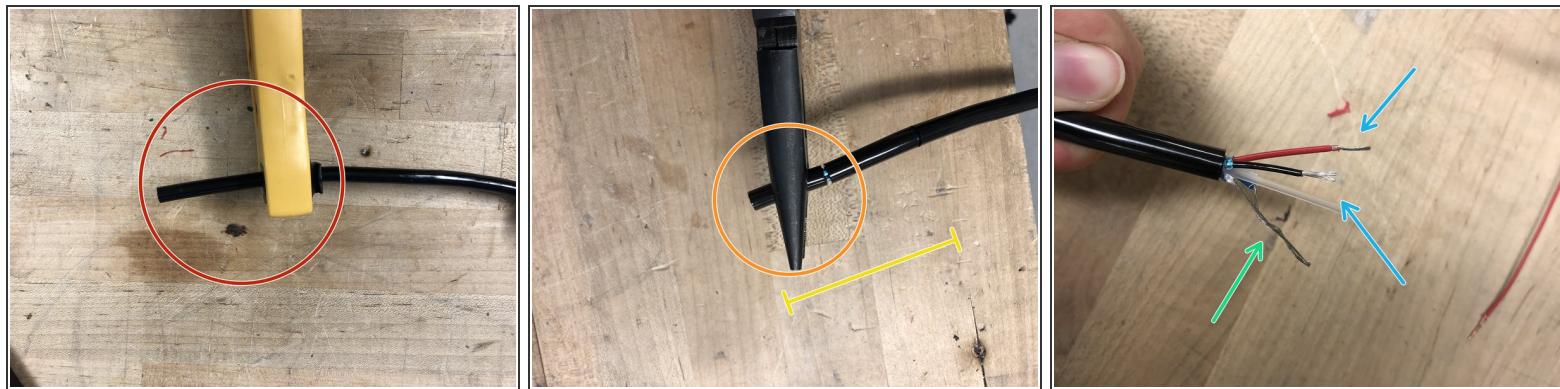
*(i)* Note: hand tight is just right.

## Step 14 — Trimming Pressure Transducer



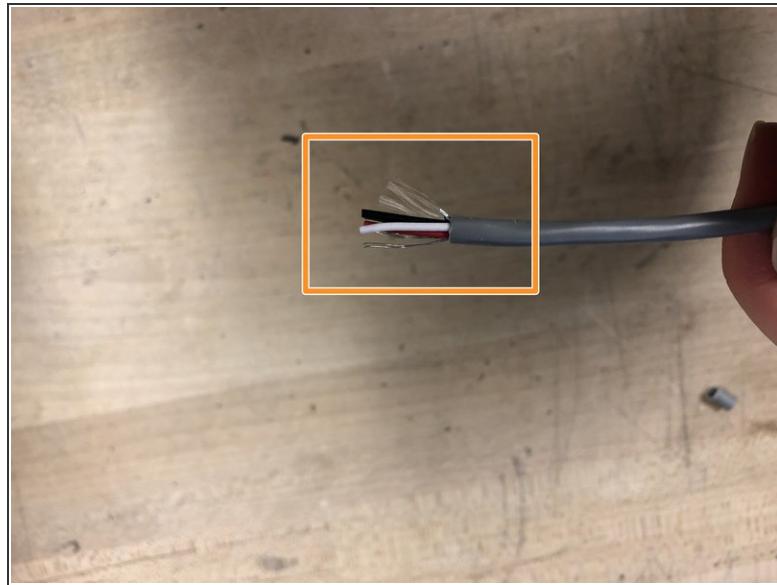
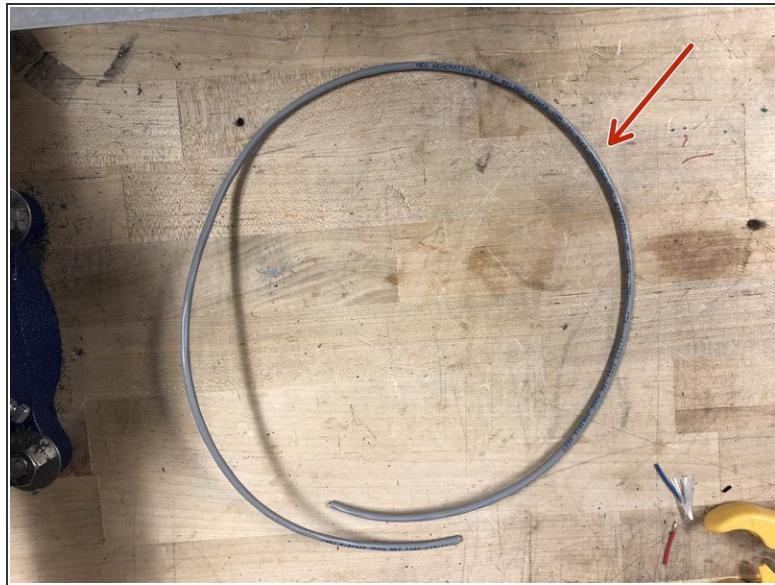
- Obtain the pressure transducer for measuring infiltration.
- Use coax cable cutters to cut the thick black outer cable at 75 inches from the end of the grey cylinder.
- Use wire cutters to cut through the inner wires.

## Step 15 — Stripping Pressure Transducer Wires



- Use the coax cable cutters to remove about 3 inches of the thick black covering.
- ⚠ Be careful not to break or cut the other wires (the silver wire is especially fragile)!
- Use pliers to twist/pty off the black cable (doing it in two segments may help, for a total of about 3 inches (the yellow marker)).
- The blue wire and plastic strips can be cut off.
- Fold the silver wire over on itself and twist it to make it less fragile.
- Use wire cutters to cut the red and black wires to be about the same length as the now-folded silver wire, and use wire strippers to strip about 1/2 inch off of the black and red wires.

## Step 16 — Obtaining Wires to Lengthen Pressure Transducer



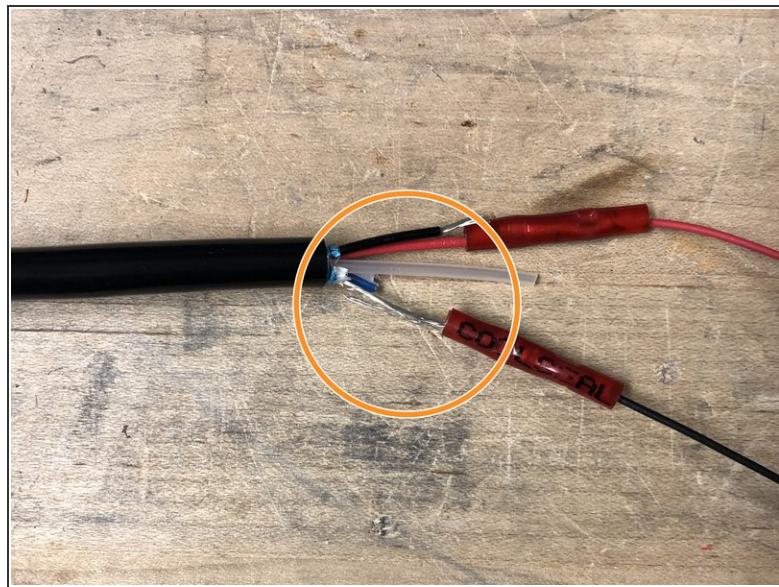
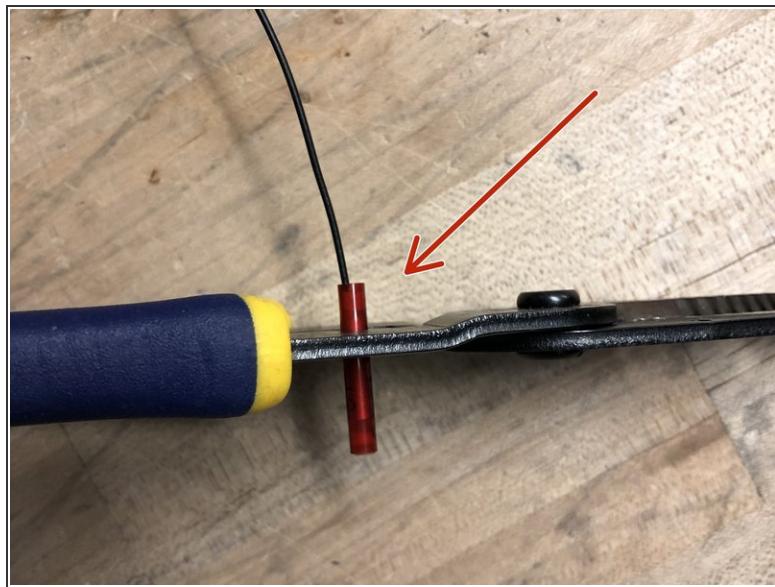
- Cut 32 inches of grey 22-gauge 4 conductor stranded wire. (This one has red, white, black, and green wires inside).  
*(i)* If you are not making an adjustable GI node, this only needs to be about 10 inches!
- Use wire strippers to take off about 2 inches of the grey outer cable to make it easier to pull out the red wire, black wire, and white wire. The rest can we recycled.

## Step 17 — Stripping the Three Free Wires



- There may not be wire strippers that work for thinner wires, so you can solder off the plastic coating on the outside of the wires as a way of stripping them.
- Peel away the excess plastic so the ends look clean, with about a 1/2 an inch of each end of each of the three wires exposed (the black wire is shown as an example; the same should be done to the red and white wires).

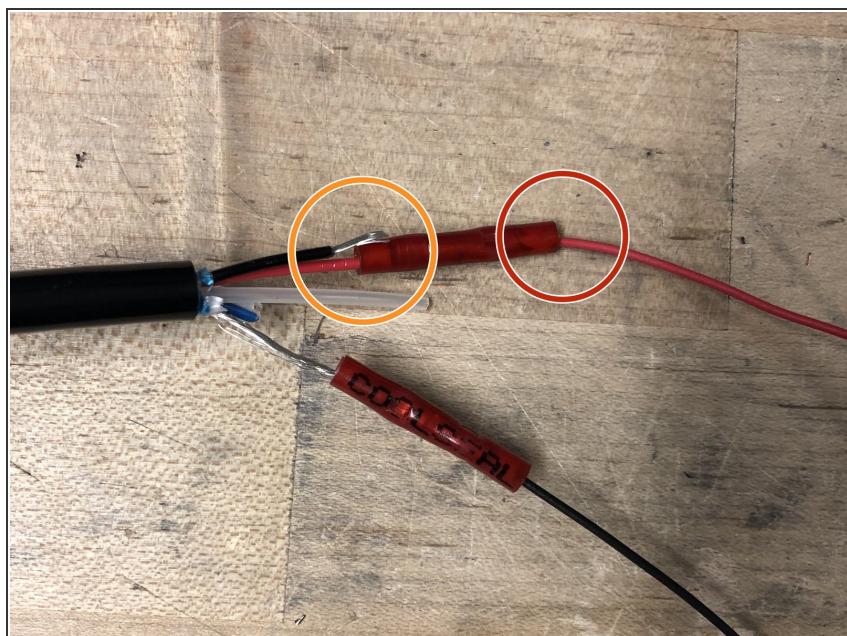
## Step 18 — Adding Black Wire to the Pressure Transducer



- Insert one end of the 22 gauge black wire into a butt splice and crimp it to lock it inside.
- Insert the silver wire from the pressure transducer into the other end of the butt splice and crimp it, connecting the two.

*ⓘ Give it a little tug to ensure secure connection.*

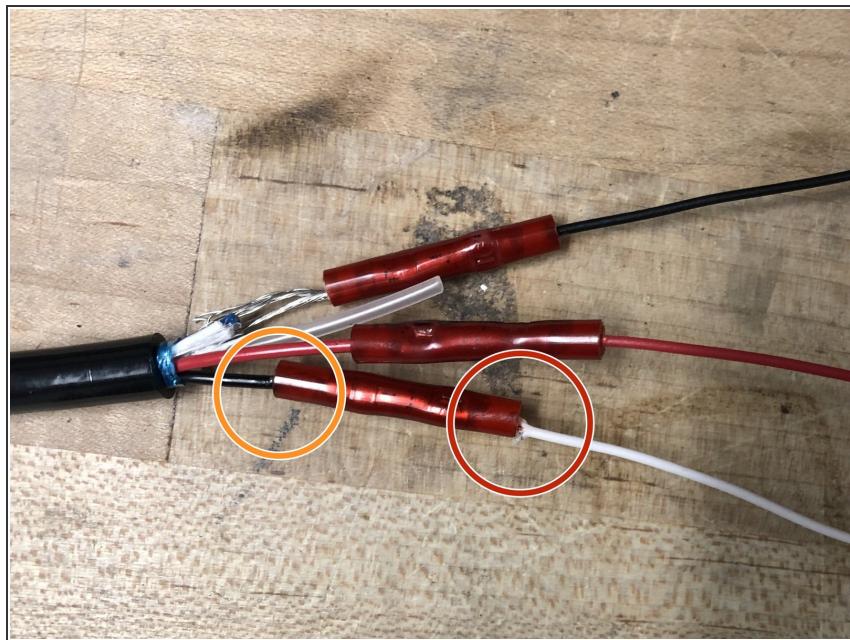
## Step 19 — Adding Red Wire to the Pressure Transducer



- Insert one end of the 22 gauge red wire into a butt splice and crimp it to lock it inside.
- Insert the red wire from the pressure transducer into the other end of the butt splice and crimp it, connecting the two.

*ⓘ Give it a little tug to ensure secure connection.*

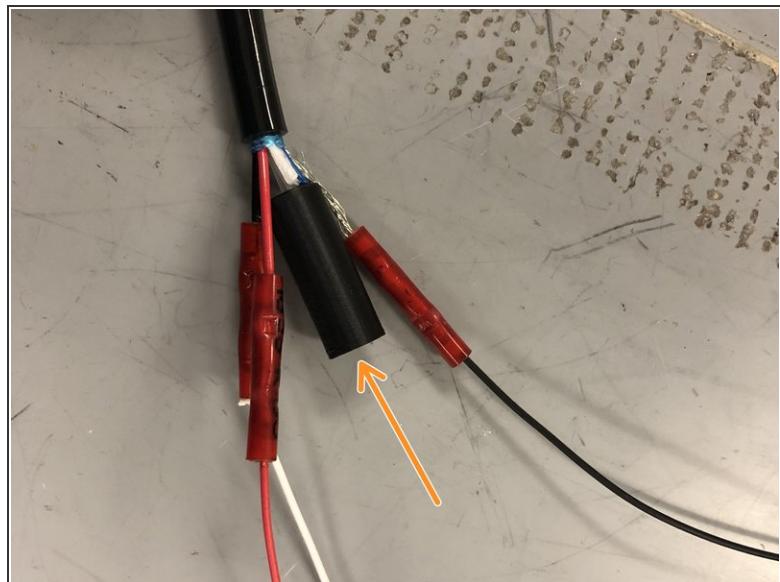
## Step 20 — Adding White Wire to Pressure Transducer



- Insert one end of the 22 gauge white wire into a butt splice and crimp it to lock it inside.
- Insert the black wire from the pressure transducer into the other end of the butt splice and crimp it, connecting the two.

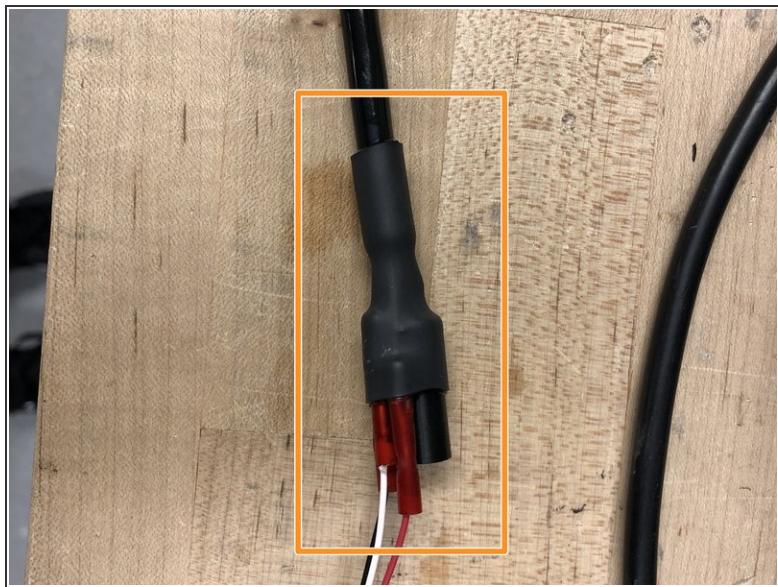
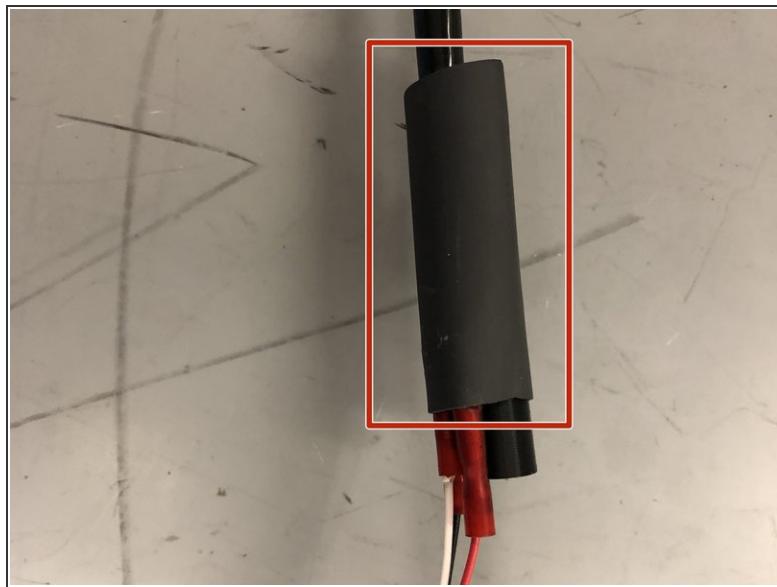
*i* Give it a little tug to ensure secure connection.

## Step 21 — Clear Tube Vent Cap



- Obtain a hydrophobic vent cap.
- Put the cap onto the clear tube, pushing it as far down as it can go.

## Step 22 — Heat Shrinking



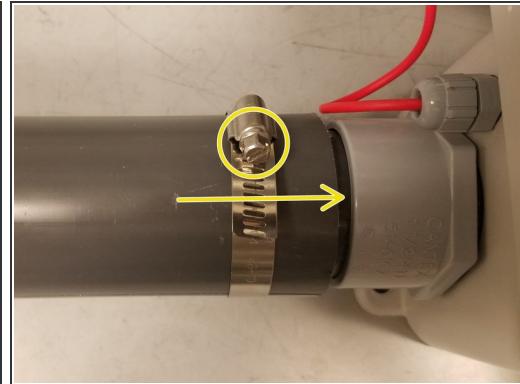
- Obtain a section of heat shrink tubing, and slide it onto the section where the pressure transducer wires are now connected to the 32 inch (or 10 inch) wires. This will be used to stabilize the connection and protect the more fragile silver wire.
- It may be a little difficult to get the tubing over all three butt splices and the hydrophobic cap, but it should end up fitting snugly.
- Heat shrink the material around the connection point, starting from one end and slowly moving around in circles, moving towards the other end until it looks like this.

## Step 23 — Soil Moisture Sensor



- Obtain the soil moisture sensor
- *i* If making an non-height adjustable GI node, you can cut the wire to be only 75 inches long so you have less excess wire in the node enclosure!

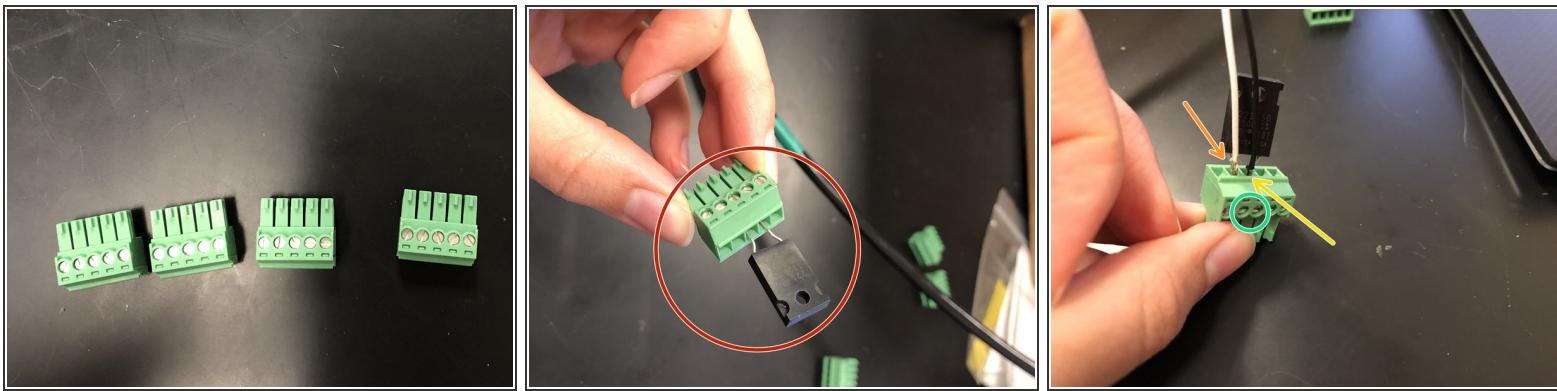
## Step 24 — Attach the pipes and sensors



- Thread the soil moisture sensor through the hole in the 2-in pipe.
- Thread the pressure transducer wire into the pipe. Make sure the end of the transducer sits at the bottom of the foot valve.
- Attach the 1.5" pipe into the node pipe fitting and tighten the hose clamp at the desired node height.

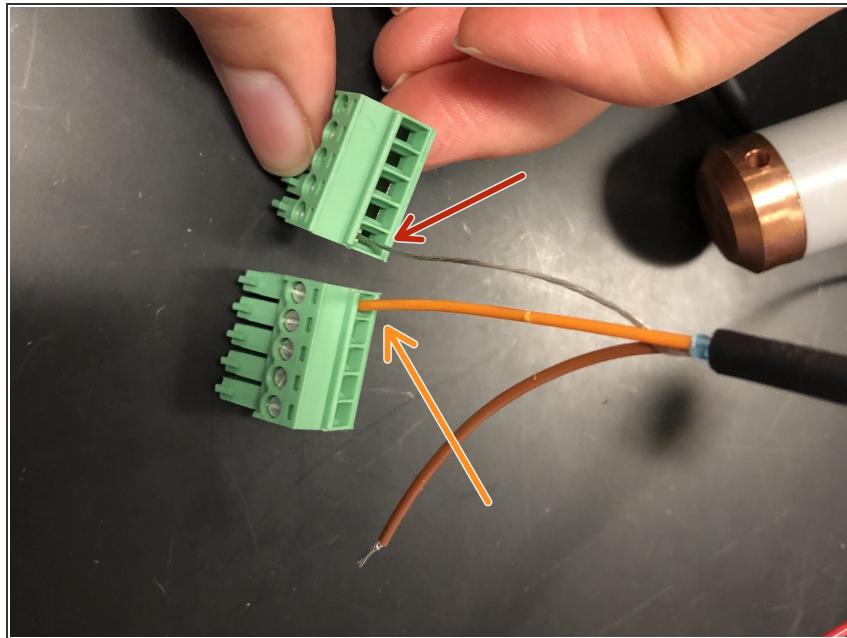
*i* The sensor wires should be inside the node now!

## Step 25 — Terminal Block #1



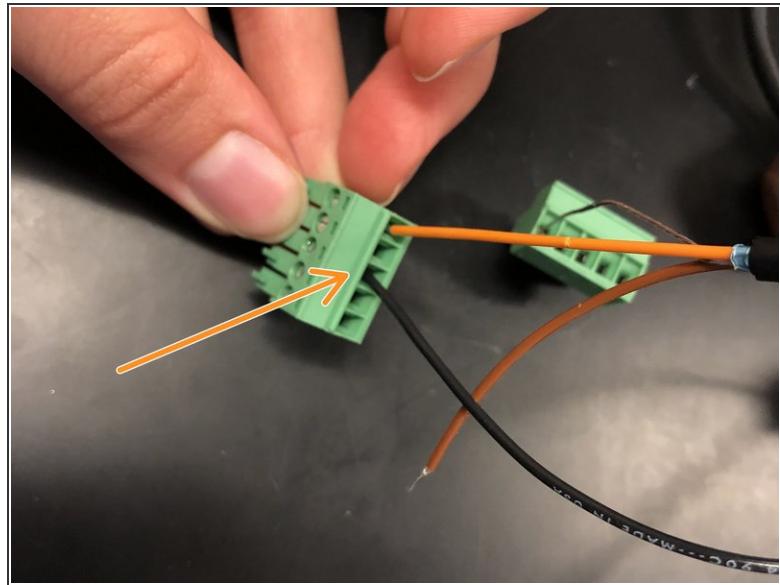
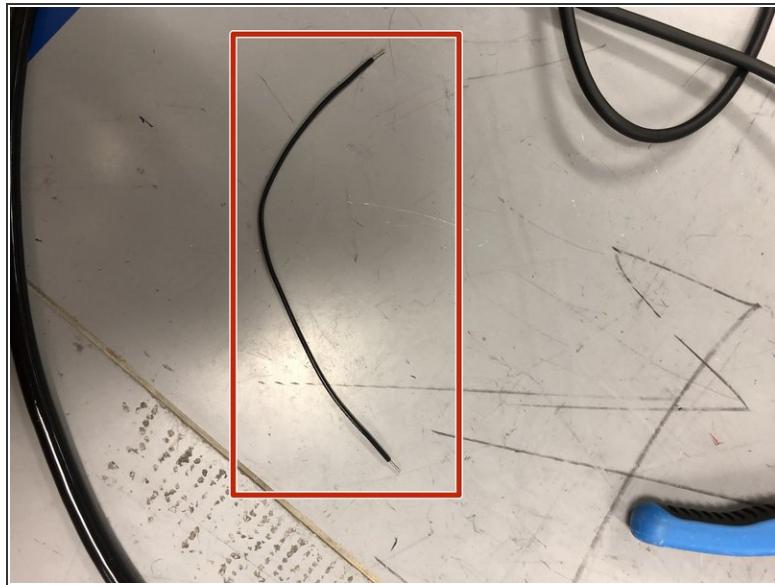
- Obtain four 5-position pluggable header blocks for connecting the sensors to the Open-Storm board.
- *(i)* Terminal block #1 is for the pressure transducer.
- *(i)* Images are shown connecting the terminal blocks outside of the node to make it easier to follow. But these steps should be completed inside the node.
- Insert a 150-Ohm resistor into terminal block #1 as shown.
- Insert the white data wire from the pressure transducer into the second slot (with one of the resistor prongs).
- Insert the black ground wire from the pressure transducer into the third slot (with the other resistor prong).
- Use a screwdriver to screw the wires and resistor into place.
- *(i)* Note: Hand tight is just right.

## Step 26 — Terminal Blocks #2 and #3



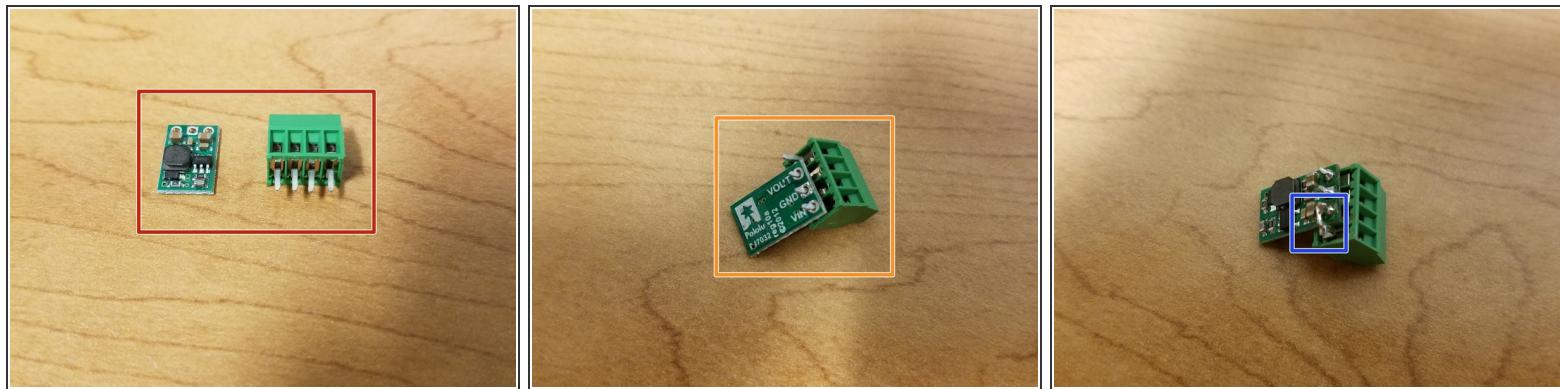
- ⓘ Terminal blocks #2 and #3 are for the soil moisture sensor.
- ⓘ Images are shown connecting the terminal blocks outside of the node to make it easier to follow. But these steps should be completed inside the node.
- Screw in the silver ground wire into the 5th slot of terminal block #2.
- Screw in the orange data wire into the first slot of terminal block #3.

## Step 27 — Terminal Block #3, continued



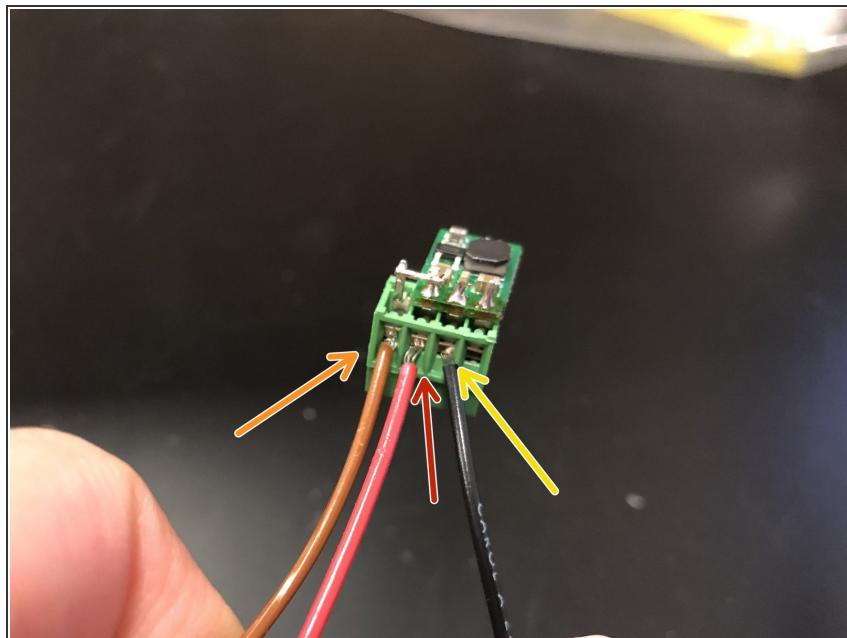
- ⓘ Images are shown connecting the terminal blocks outside of the node to make it easier to follow. But these steps should be completed inside the node.
- Cut 6 inches of 24 gauge black wire and strip both ends.
- Screw one end of it into the third slot of terminal block #3.

## Step 28 — Terminal Block #4



- Obtain a 4-wire terminal block and Pololu 12V step-up voltage regulator.
- Attach the voltage regulator to terminal block #4. Make sure the "v-out" has an extra terminal next to it. You will need to connect two wires to "v-out" later. Then solder them together.
- Next solder a small wire to connect the two terminals of "v-out".

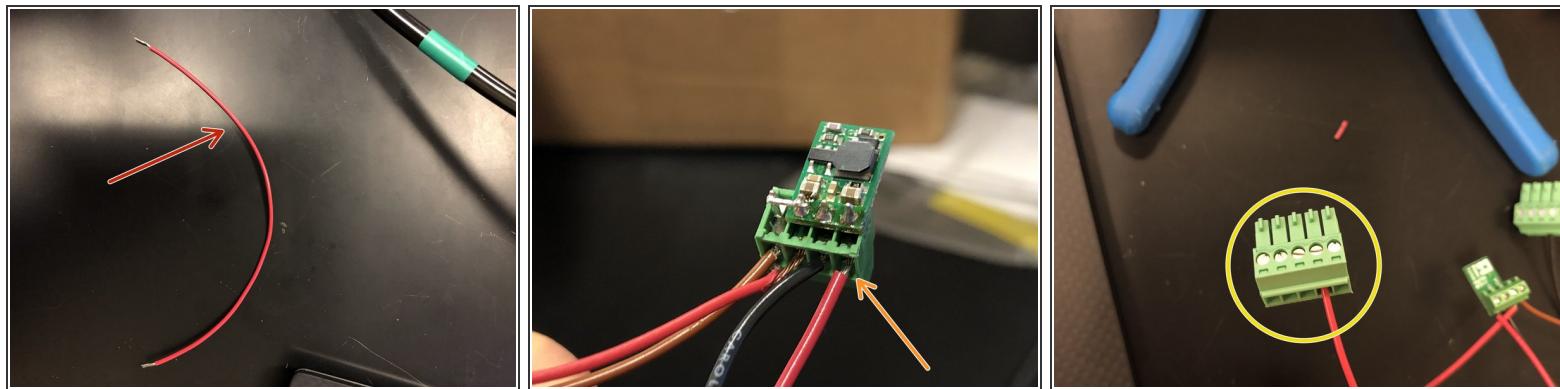
## Step 29 — Terminal Block #4 continued



*i* Images are shown connecting the terminal blocks outside of the node to make it easier to follow. But these steps should be completed inside the node.

- Screw in the red power wire from the pressure transducer into the second slot (VOUT) as shown.
- Screw in the brown power wire from the soil moisture sensor in the first slot (VOUT-2).
- Screw the other end of the 6-inch black wire into the third slot (GND) as shown.

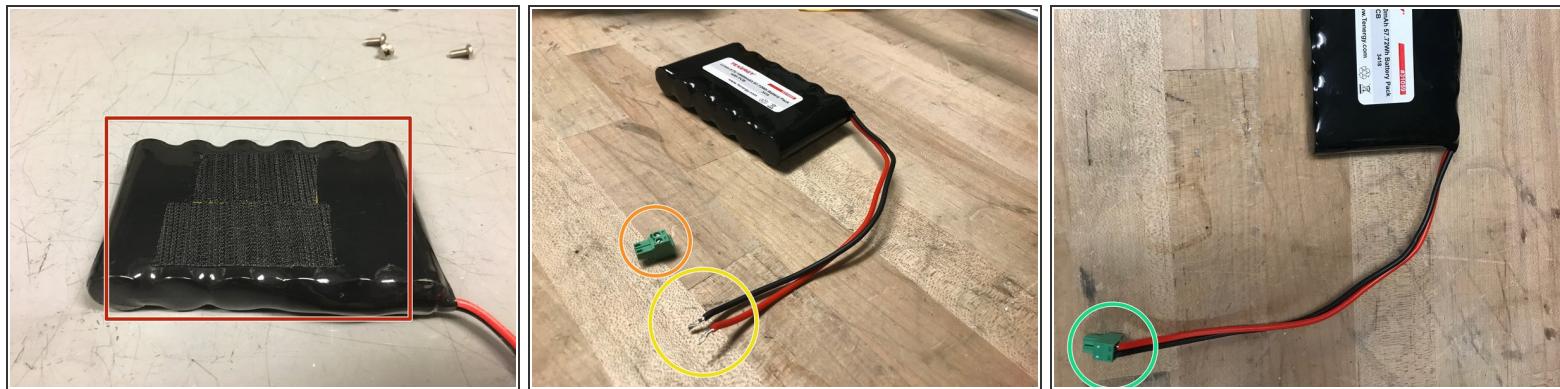
## Step 30 — Terminal Blocks #4 and #5



ⓘ Images are shown connecting the terminal blocks outside of the node to make it easier to follow. But these steps should be completed inside the node.

- Obtain 6 inches of 24-gauge red wire and strip both ends.
- Screw one end of this wire into the fourth slot(VIN) in terminal block #4.
- Screw in the other end into the fourth slot in terminal block #5.

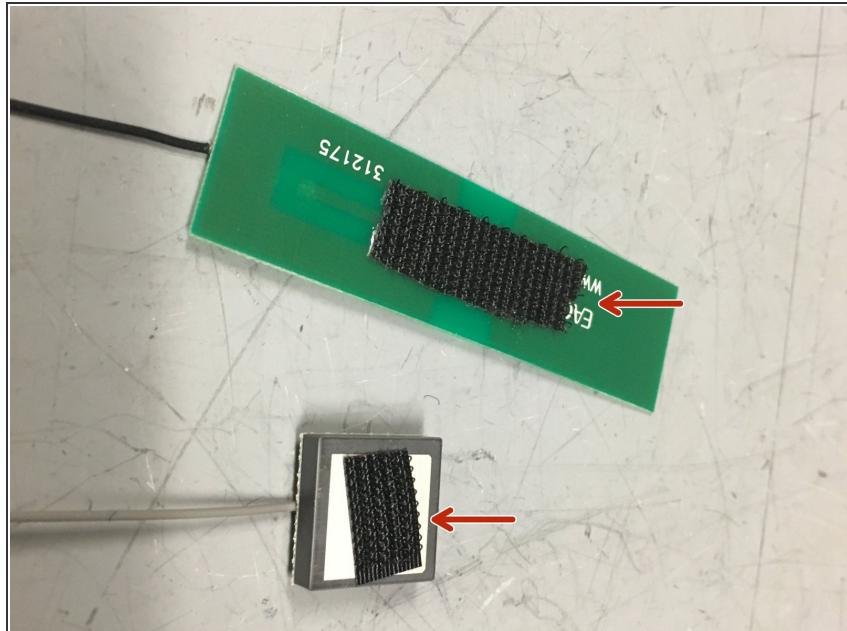
## Step 31 — Adding Velcro and Block Plug to Battery



- Obtain velcro and lithium ion 3.7V battery. Attach rough side of velcro on battery.
- Obtain a 2-position block plug.
- Twist the wires of the battery so they fit nicely in the pluggable-header block.
- Screw the wires into the block plug.

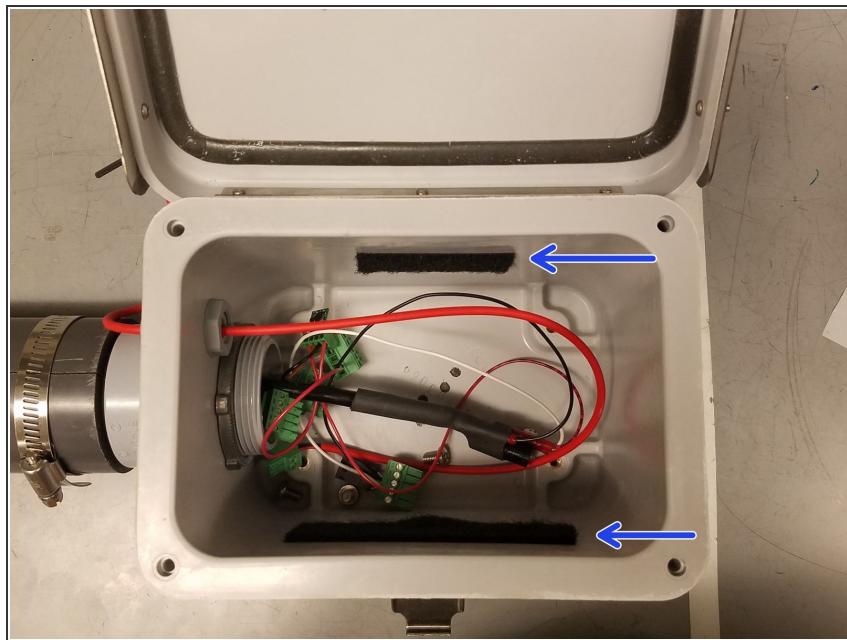
*(i)* Note: hand tight is just right

## Step 32 — Adding Velcro to GPS and Antenna



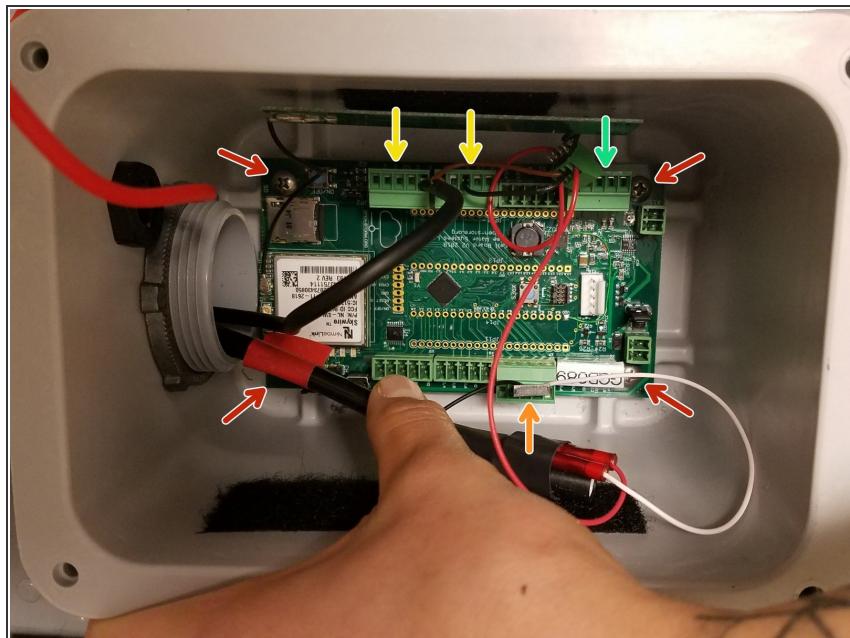
- Obtain an antenna and GPS unit. Attach rough-sided velcro on the antenna and GPS as shown in the picture.

## Step 33 — Adding the Velcro



- Add velcro with soft side inside the enclosure in the following places.

## Step 34 — Connecting Terminal Blocks to Board



- Screw the Open-Storm board with a cellular modem into enclosure as shown.
- Plug in terminal block 1 as shown. The black ground wire should go to GND, and the white data wire should go to P1.6.
- Plug in terminal blocks 2 and 3 as shown. The 6-inch black ground wire should go to GND, the orange data wire should go to P3.1, and the silver ground wire should go to GND.
- Plug in terminal block 5 as shown. The 6-inch red wire should go to P0.3

## Step 35 — Plug in the Battery and Solar Panel



- Attach the battery to the side of the node enclosure and plug in the battery into the Open-Storm board.
- Plug in the solar charger into the Open-Storm board.
- The final GI node should look like this!

ⓘ Test it for at least a half a day outside before installing in the field!