

# Instrument Construction and Installation

## Instructions for Making and Installing a Frost Tube to Measure Depth of Frozen Ground

### Materials

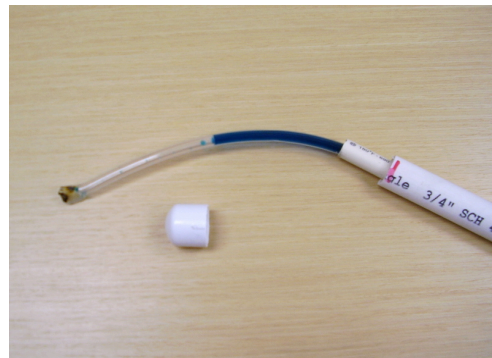
- 6 – 9 mm (1/4 – 3/8") outside diameter clear tubing, about 3 m (10') long (inner tube)
- 10 mm (7/16") outside diameter radiant heat tube, about 3 m (10') long (middle tube)
- 12 mm (1/2") inside diameter CPVC Pipe, about 3 m (10') long (outer tube)
- 1 CPVC cap, to fit over 12 mm pipe
- Epoxy putty
- Latex or vinyl gloves (for handling epoxy putty)
- Food coloring and water
  - Gas burner
- Black waterproof marker
- Meter stick with cm markings
- Soil auger

### Directions for Construction

The Frost Tube consists of three layers:



Parts of Frost Tube



Assembled Frost tube

- The innermost tube is a piece of clear tubing sealed on both ends, which holds colored water.
- The middle tube is a piece of radiant heat tubing sealed on the bottom.
- The outermost tube is a piece CPVC pipe, open on both ends with a removable cap on top.

#### 1. Determine the length of the Frost Tube.

*In areas of permafrost:* The length of the Frost Tube depends on the depth of the active layer.

- Check the thickness of the active layer using a steel stick (thaw probe) at the end of the summer.
- Pound the probe into the ground until you hit permafrost. It will feel like you have hit rock or something very hard. Your Frost Tube should extend to this depth.

*In areas of seasonally frozen ground:* The length of the Frost Tube should be a little longer than the depth to which the ground freezes in winter. A length of 2 m below the ground should be long enough.

2. Add 1 m to the estimated frost tube length so it will stick up above the winter snow cover. Drill using a soil auger into the ground .A height of 1m above ground should keep the top of the pipe above snow for most areas so that it is accessible to students.
3. Cut all three tubes (inner, middle and outer tubes) to the estimated final length.
4. Use the epoxy putty to seal the bottom end of the radiant heat (middle) tube. Following the manufacturer's instructions and wearing protective gloves, make a small ball out of the epoxy putty and affix it on one end of the radiant (middle) tube being careful to keep it from building up on the outside so that it will not prevent the bottom end of this middle tube from going down into the bottom of the open-ended CPVC pipe (outer tube).
5. In a large bowl mix water and enough food coloring to make deep/bright/strong color. Fill the clear tube with the colored water up to 15 cm from the top being careful to keep it from pouring out of the other end. (Eventually you will seal both ends of the inner tube but for now leave both ends unsealed. If you seal one end the water will not go into the tube since it will not displace the air present.) Figure 3 (photograph).
6. Seal one end of the clear tubing by heating it with the burner and press the ends together. **Be careful not to burn yourself.** Make sure that the seal does not distort the bottom of the tubing so it slides easily down into the radiant heat ( middle) tube and make sure that you do not stretch the tube so that it is still the same length as the radiant heat tube and CPVC pipe (outer tube). Figure 4 (photograph).
7. Seal the top end of the clear ( inner) tubing by heating it with the burner. **Be careful not to burn yourself.** Flatten this end so that it is just wider than the diameter of the radiant heat pipe (middle tube). This way the top of the clear (inner) tube will rest on top of the middle tube and can be easily retrieved for measuring depth of freezing.



8. Hold the inner tube against the outer tubing buried in the soil. Mark the inner tubing starting at 0 to mark ground level

9. Slip the clear inner tube, now filled with the colored water, into the radiant heat middle tube so that it extends to the sealed bottom of the middle tube.
10. Insert both into the outer CPVC pipe and place the cap on top of the outer tube.



### ***Directions for Installation***

1. Complete the Frost Tube Site Definition Data Sheet.
2. Dig a hole for the frost tube with the soil auger. The hole should be just deep enough to accommodate the “in ground” portion of the outer tube.
3. Save the removed soil. Maintain the order in which the different soil layers were removed. If possible, perform the soil characterization protocol on the soil that is removed (see GLOBE Soil Characterization protocol using an auger).
4. Place the entire Frost Tube assembly into the hole. It should fit snugly in the hole.
5. If there is a large gap between the outside of the CPVC Pipe and the hole wall:
  - Mix the removed soil with a little water. Mix each soil layer separately.
  - Fill the gap between the frost tube and the surrounding soil with this paste. Try to place the different kinds of soil back into the gap in the reverse order in which they were removed, i.e., the last removed is the first replaced.
  - Gently work the soil into the gap with a stick, trying to eliminate any air pockets.
6. Measure the distance between the soil surface and the top of the CPVC pipe ( outer tube).
7. Pull the inner clear tubing out and put close to the outer tube, lining up the top of the inner tube with the top of the outer tube. Clearly mark where the soil surface occurs with a permanent marker on the outside of the inner tube. Label the soil surface as 0 cm.
8. \*\*\*Mark 5 cm increments from the 0 cm line to the bottom of the inner tubing using a meter stick and permanent marker. Write in the number next to every 10 cm interval (i.e., 10, 20, 30, 40, etc.). Place hatch marks 1 cm apart so there are 4 evenly placed hatch marks between each 5 cm mark.
9. Return the inner tubing to the installed (middle and outer tubes of the Frost Tube assembly).

10. Cover the top of the Frost Tube with the CPVC cap (do not glue!) to minimize the chance of cold air, snow or water getting down inside.

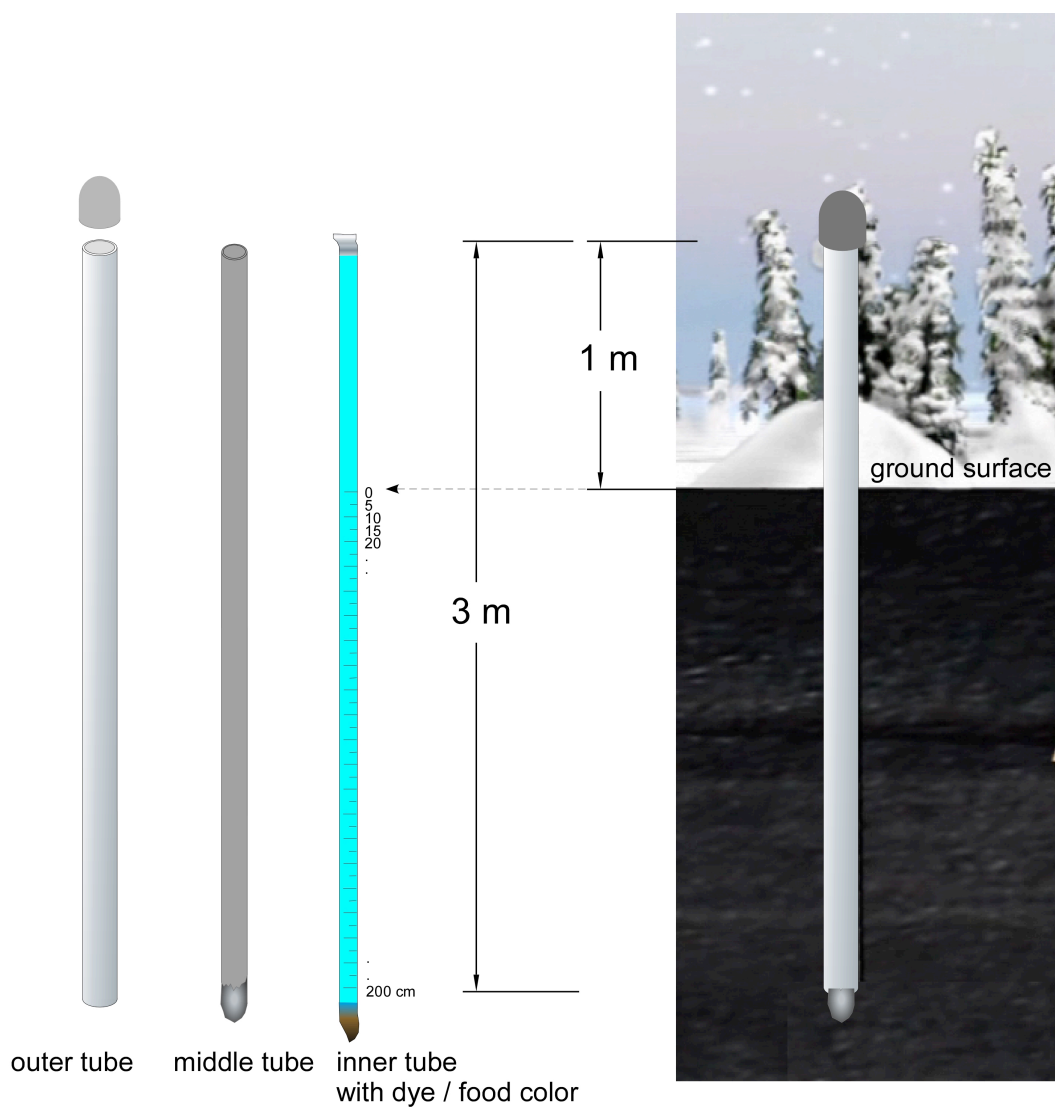


Figure 1. Frost Tube assembly (showing placed in ground and inner tube pulled out to check depth of freezing)



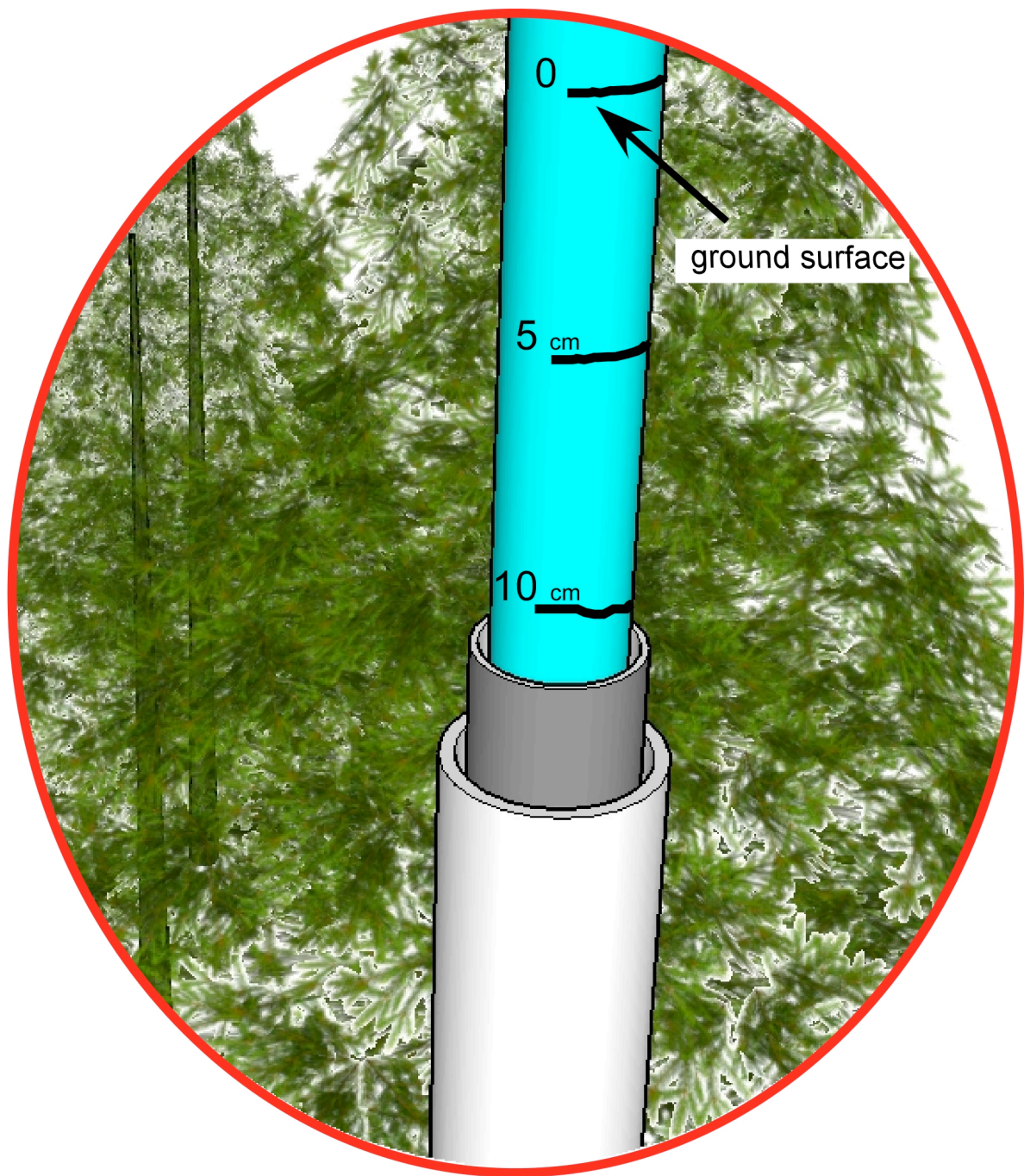


Figure 2. Ground surface marked on inner tube