Grounding System- Lab Examples

The lab examples in this course are designed to provide actual tests to confirm the performance of various types of grounding electrodes and equipment grounding systems. The examples will primarily utilize scale models of various electrodes in a water tub. These are the same types of tests that engineers used to predict the values of surface voltages around electrodes prior to the availability of computers and complex mathematical models. One of the tests will simulate hazardous transfer voltages to a remote TELCO pedestal.

In all of these examples, we will measure the voltage difference between the water surface and the grounding electrode. This would be the voltage (E_{TOUCH}) you would experience between your hand and foot at a given point if you were touching equipment connected to the grounding electrode. **The voltage measurements will be made while we are energizing the electrode with a safe voltage of 30 VAC or less**. The exact value of voltage is not important because we can scale it up to a real world voltage. For instance if we are injecting 27.7 V into the electrode, that could represent 277 V L-G in a 480/277 V system. The scale model would have a multiplier of 10 to get the voltage we would measure if we actually injected 277V into the electrode. In that case, if our meter measures 10 V at a point around the electrode, we would have to take the 10V and multiply by 10 to get 100V as the actual voltage we would see if we injected the full 277V.

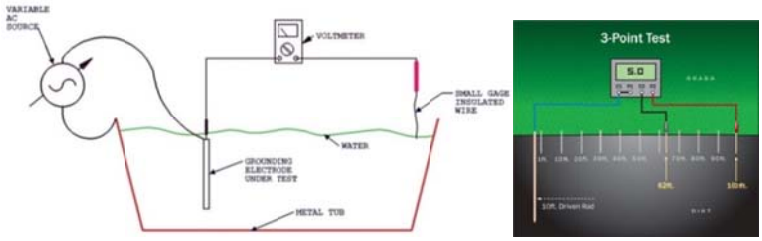
You should note that the injected voltage is the actual ground potential rise (GPR). At the center of each grid mesh you should measure the value and compare it to the GPR (Measured voltage / Injected voltage). This would give you the combined (Km x Ki) factor used to compute E_{MESH} using the formulas we discussed. You should also measure the voltages in the center of one of the center most meshes and the center of one of the corner meshes. The measured voltage at the corner mesh should be slightly higher and this value would be E_{MESH} for the grid that you would compute using IEEE Std 80 formulas.

The actual resistivity of the water is irrelevant. That is because, if we are injecting a fixed voltage, all the resistivity would change is the current flowing into the water from the electrode. It would not change the voltage profile at all. The current going into the electrode is not what will shock us. The voltage between the electrode and the water surface is what will shock us.

While making the voltage readings through the holes in the Plexiglas test grid, stick the probe into the hole just enough to contact the surface (voltage reading appears). If you go deeper, it can skew the results a bit.

The test hole spacing is 1/2 inches for each electrode setup. All electrodes are made from 14AWG wire (.073” diameter). We will make a 3-point resistance test of the electrode using a standard soil resistivity and ground electrode test set.

The quantity of test points you record is up to you. After you are done with the data, you can compare the voltage profile verses distance with what the equations would tell you.



Lab Test Setup

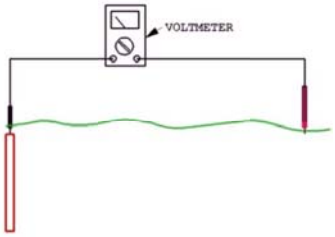
Single Vertical Ground Rod

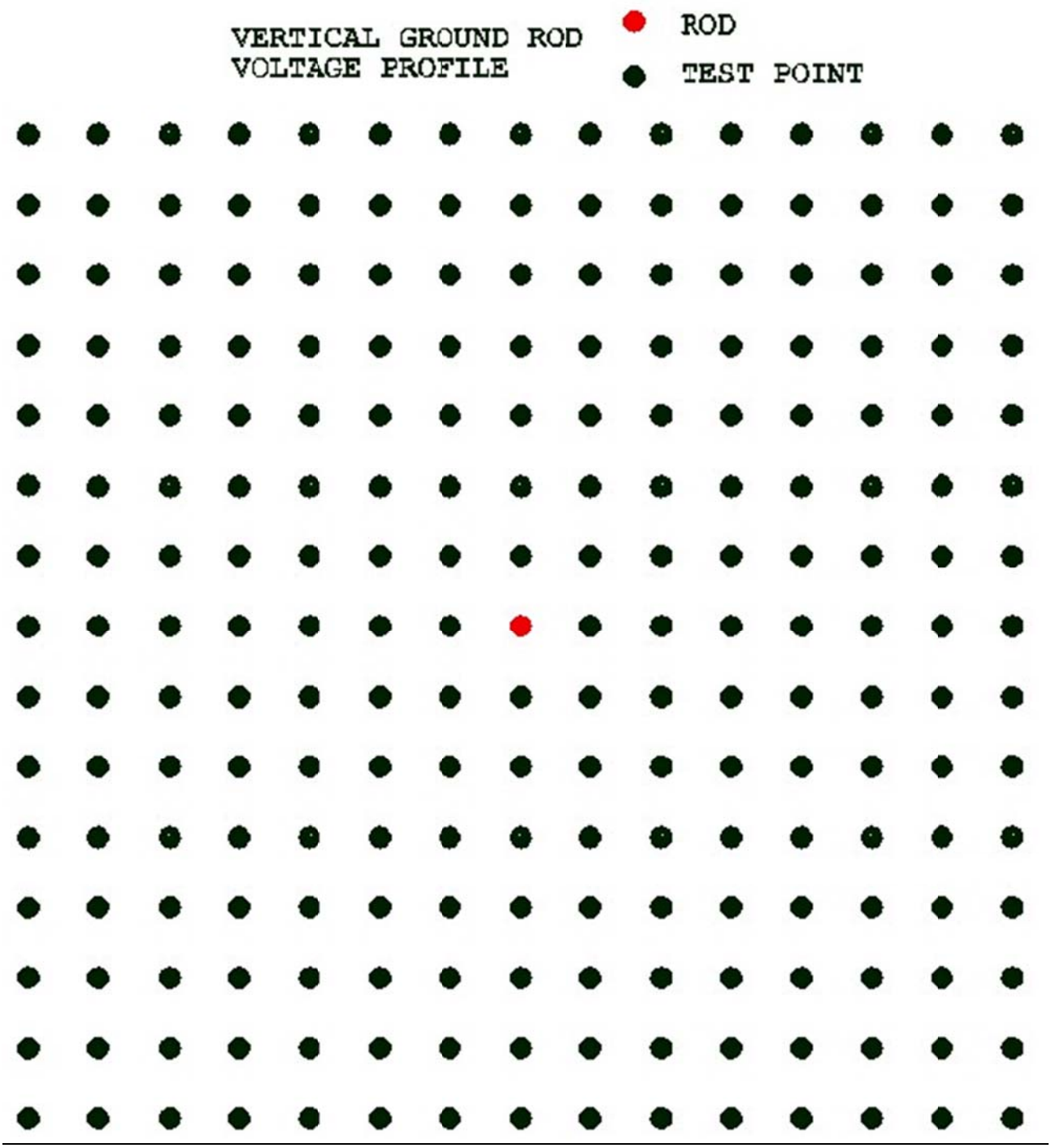
Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

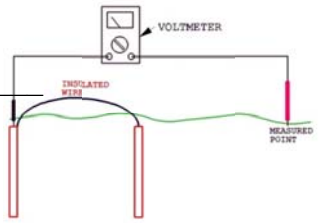
The actual length of the rod is 3 inches.

Record the surface voltage measured next to test locations shown in the layout grid diagram on the next page and compare it with the theoretical plot below.





Two Vertical Ground Rods



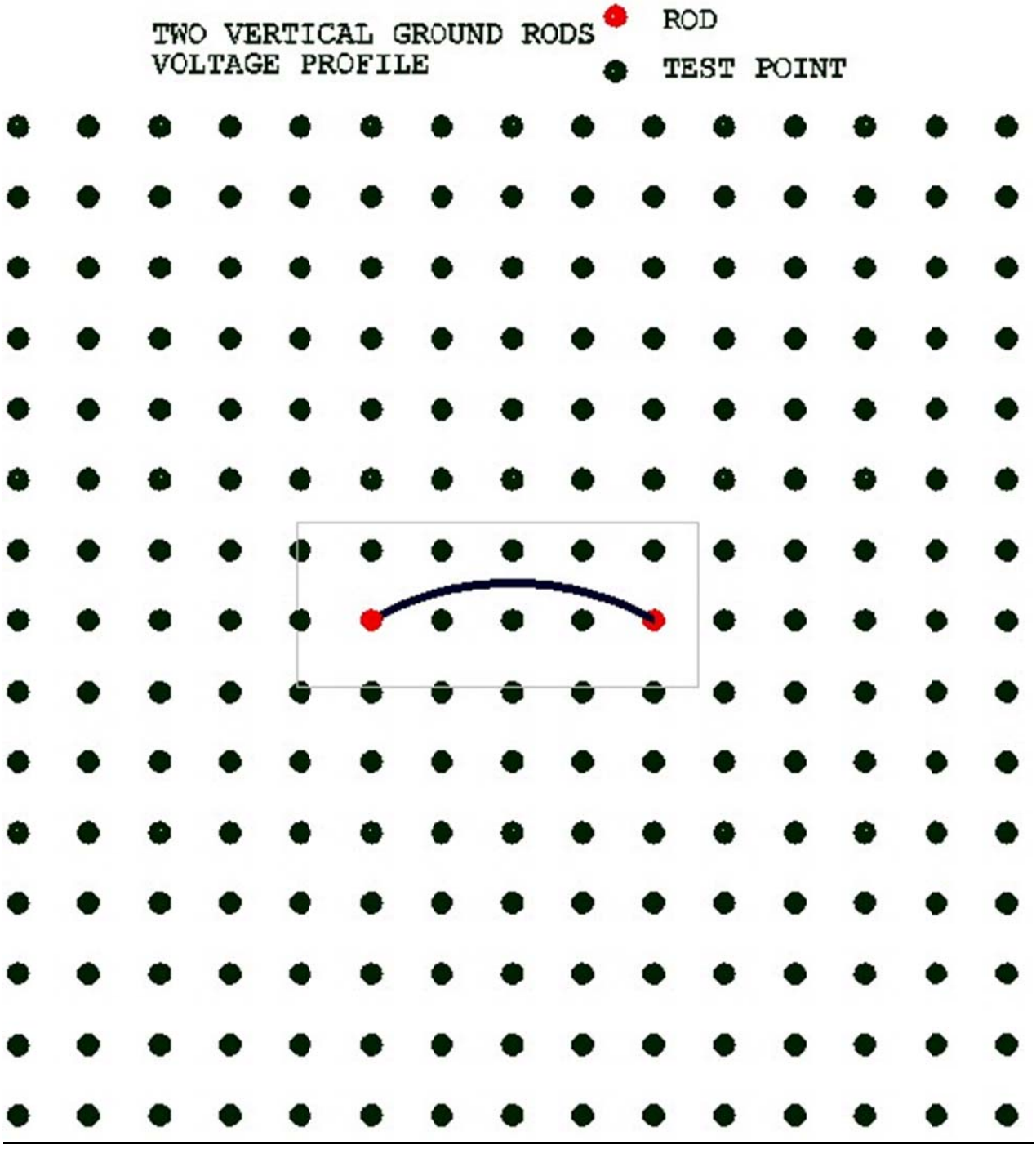
Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

The actual length of the rods is 3 inches.

Rod spacing is 2 inches (66% of length)

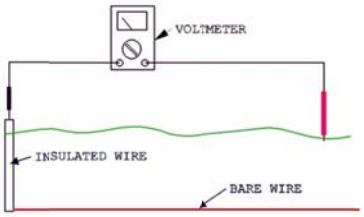
Record the surface voltage measured next to test points shown in the diagram.



Horizontal Ground Rod or Wire – Shallow depth

Voltage injected: _____ VAC. Measured resistance of electrode_____

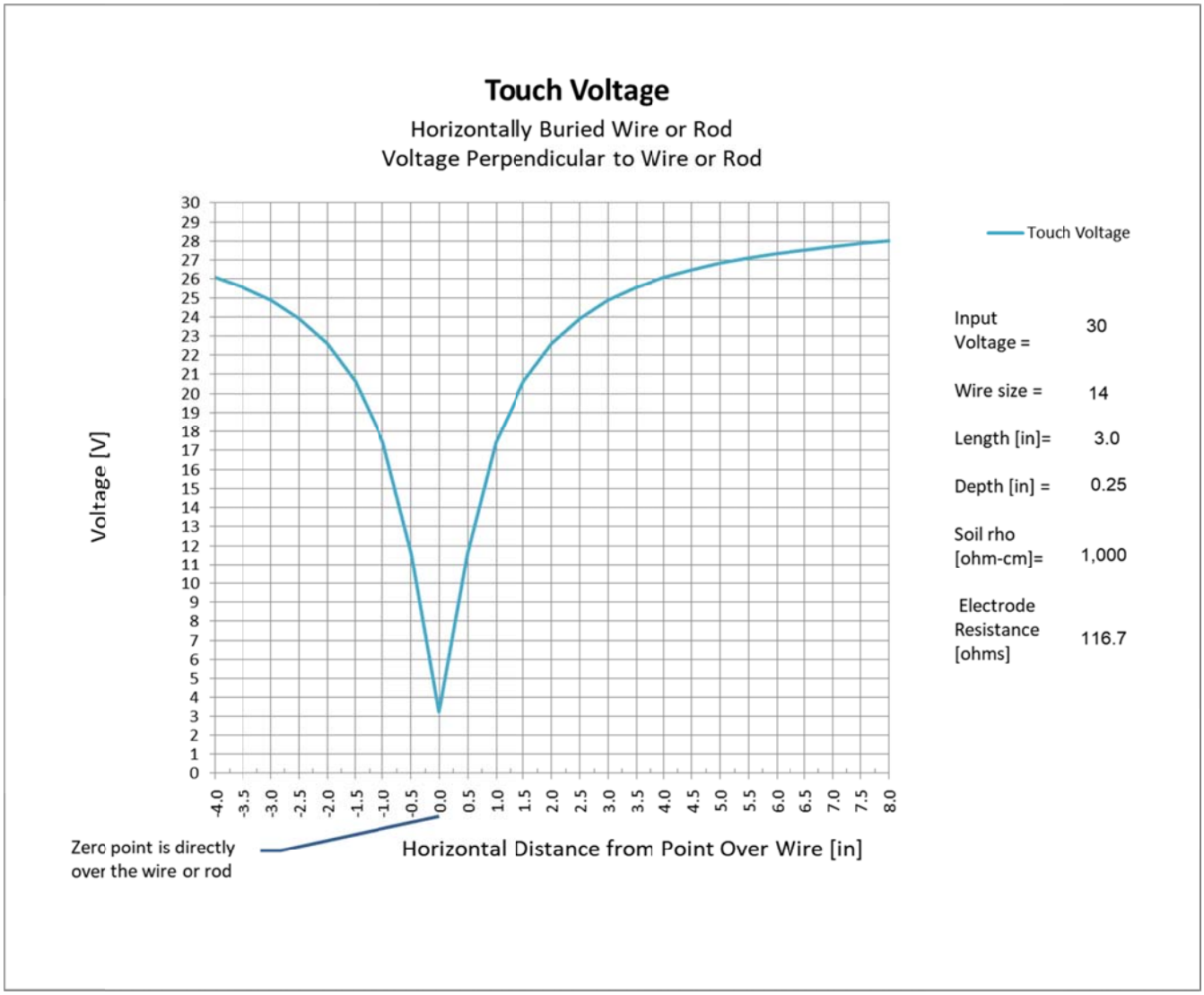
Computed resistance of electrode: _____ ohms



The approximate depth of the wire under surface is 0.25 inches.

The wire length is 3 inches.

Record the surface voltage measured next to test locations shown in the layout grid diagram on the next page and compare it with the theoretical plot below.



Horizontal Ground Rod or Wire – Greater depth

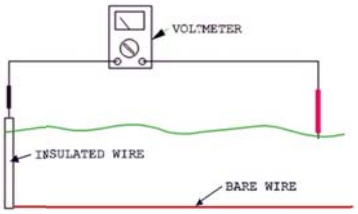
Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

The approximate depth of the wire under surface is 2 inches.

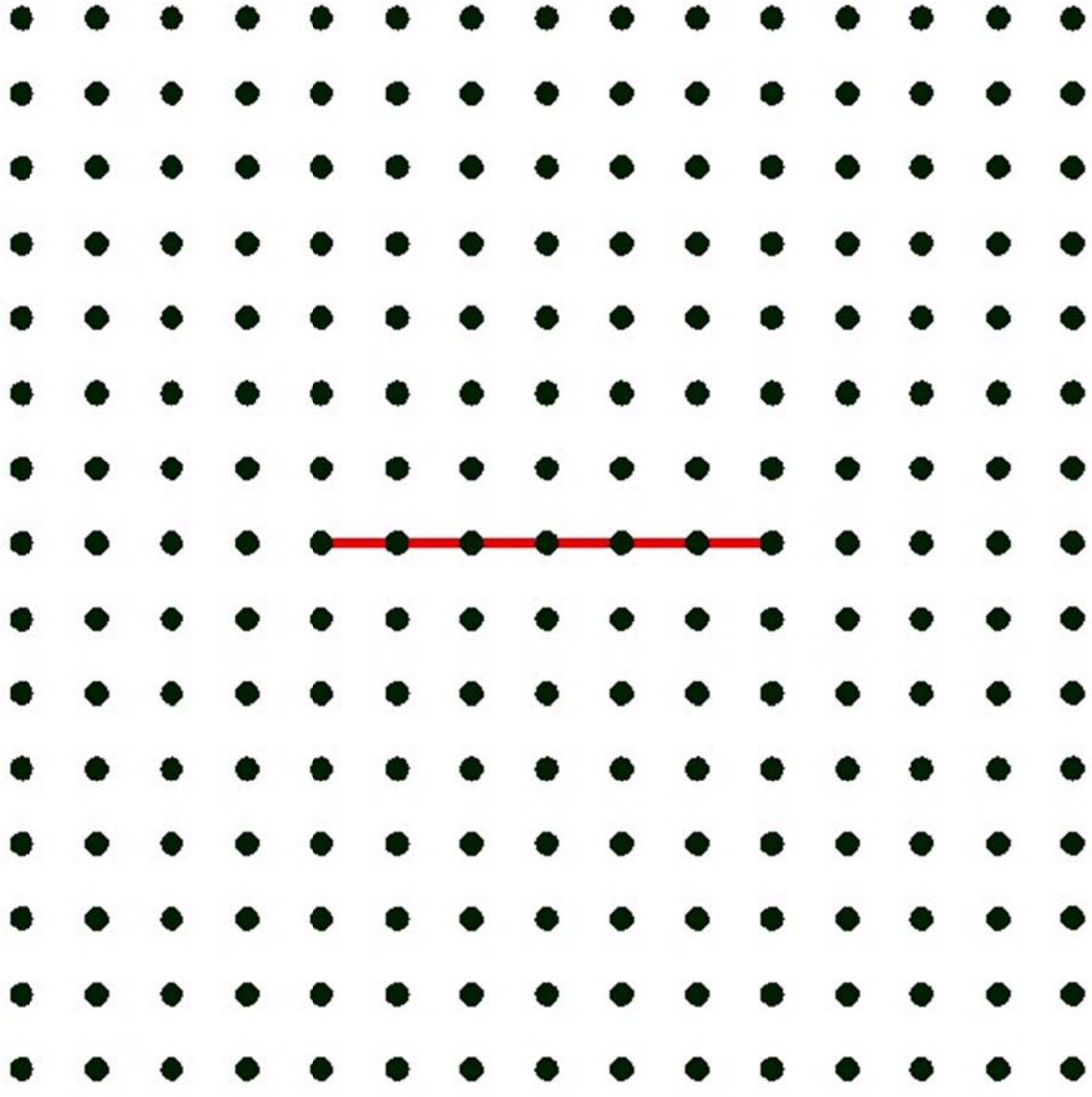
The wire length is 3 inches.

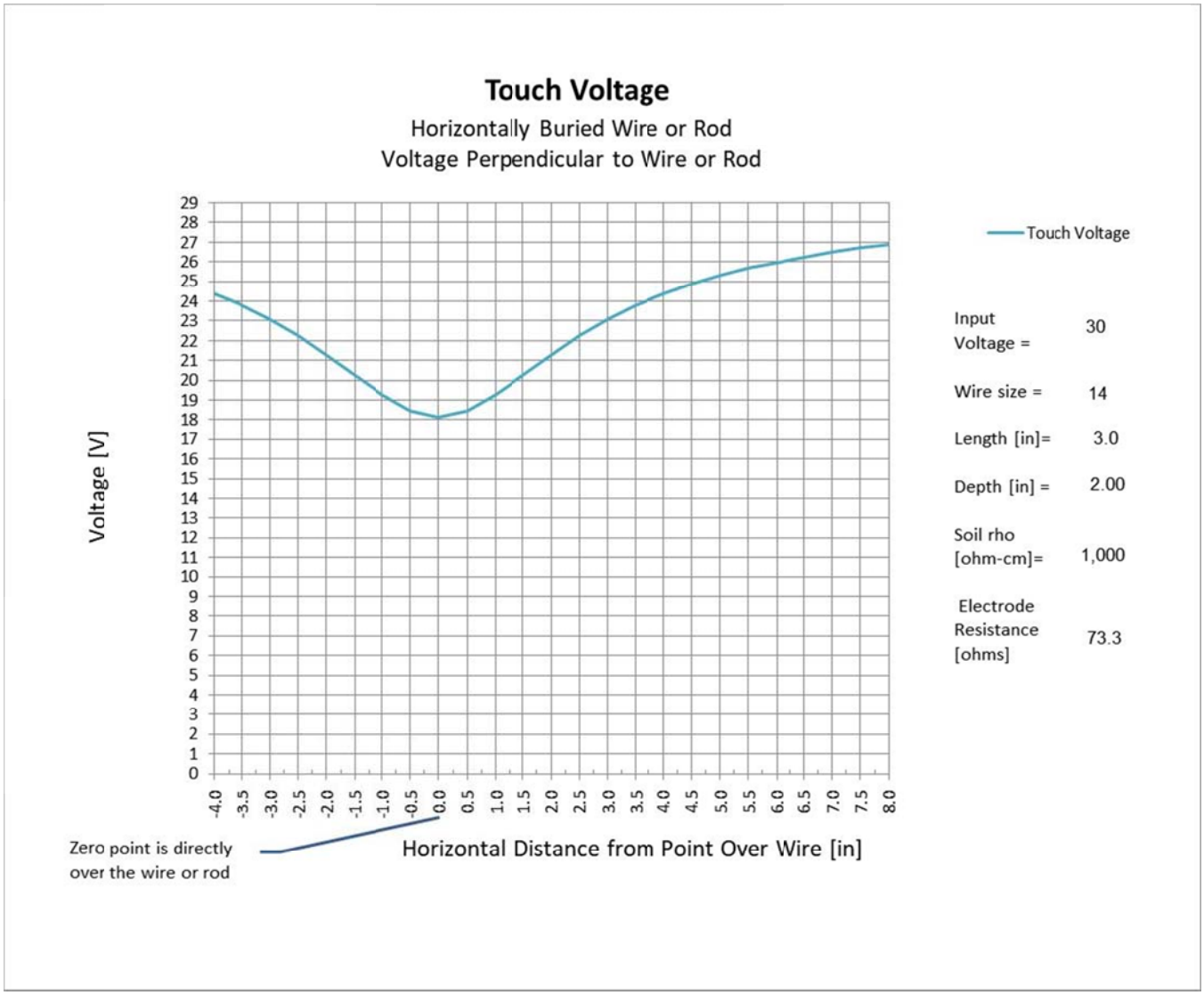
Record the surface voltage measured next to test locations shown in the layout grid diagram on the next page and compare it with the theoretical plot below.



HORIZONTAL WIRE OR ROD
VOLTAGE PROFILE

WIRE/ROD
TEST POINT





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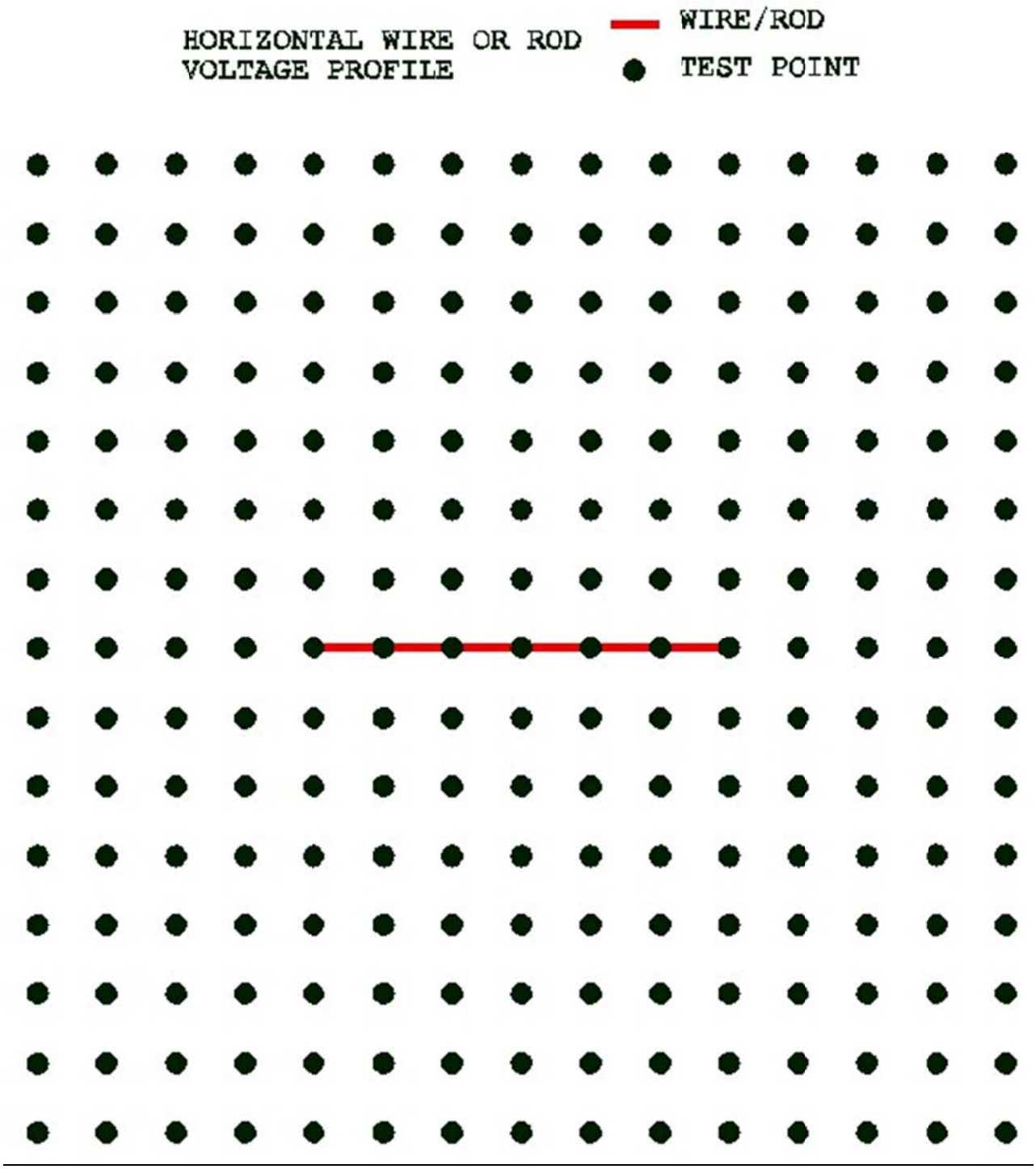


Rectangular Horizontal Wire – One mesh grid

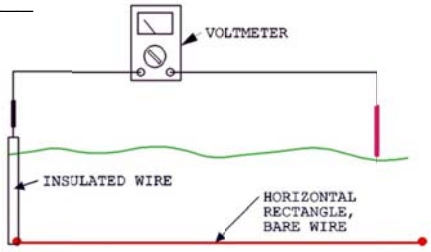
Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

The approximate depth of the grid under surface is 0.25 inches.

The dimensions are 2 x 3 inches.

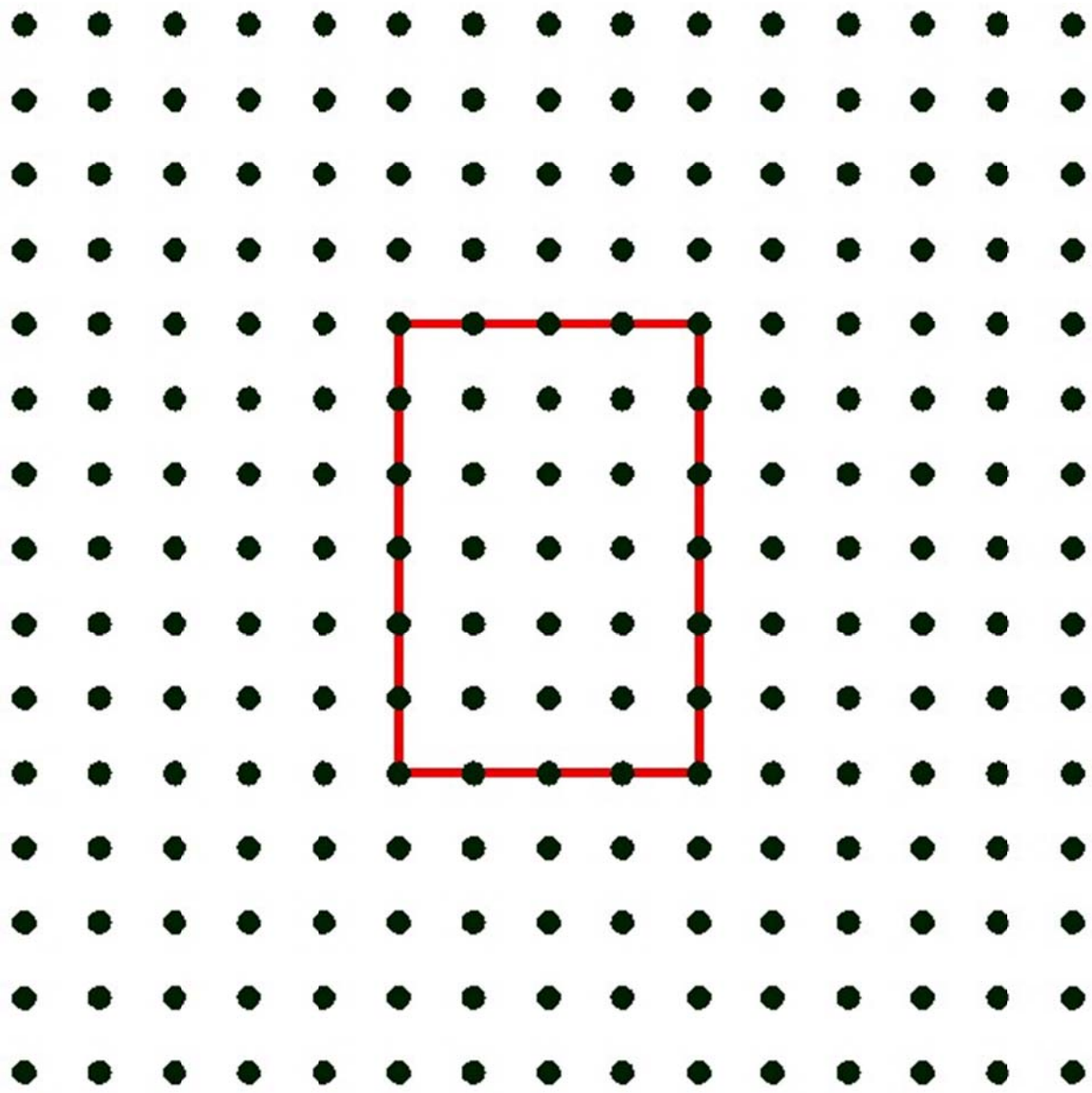
Record the surface voltage measured next to test points shown in the diagram.



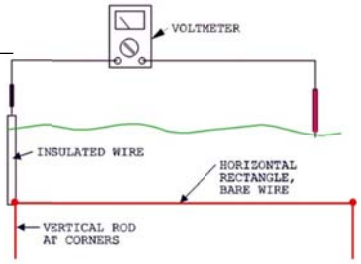
RECTANGULAR WIRE
VOLTAGE PROFILE

WIRE

TEST POINT



Rectangular Horizontal Wire with Rods at Corners



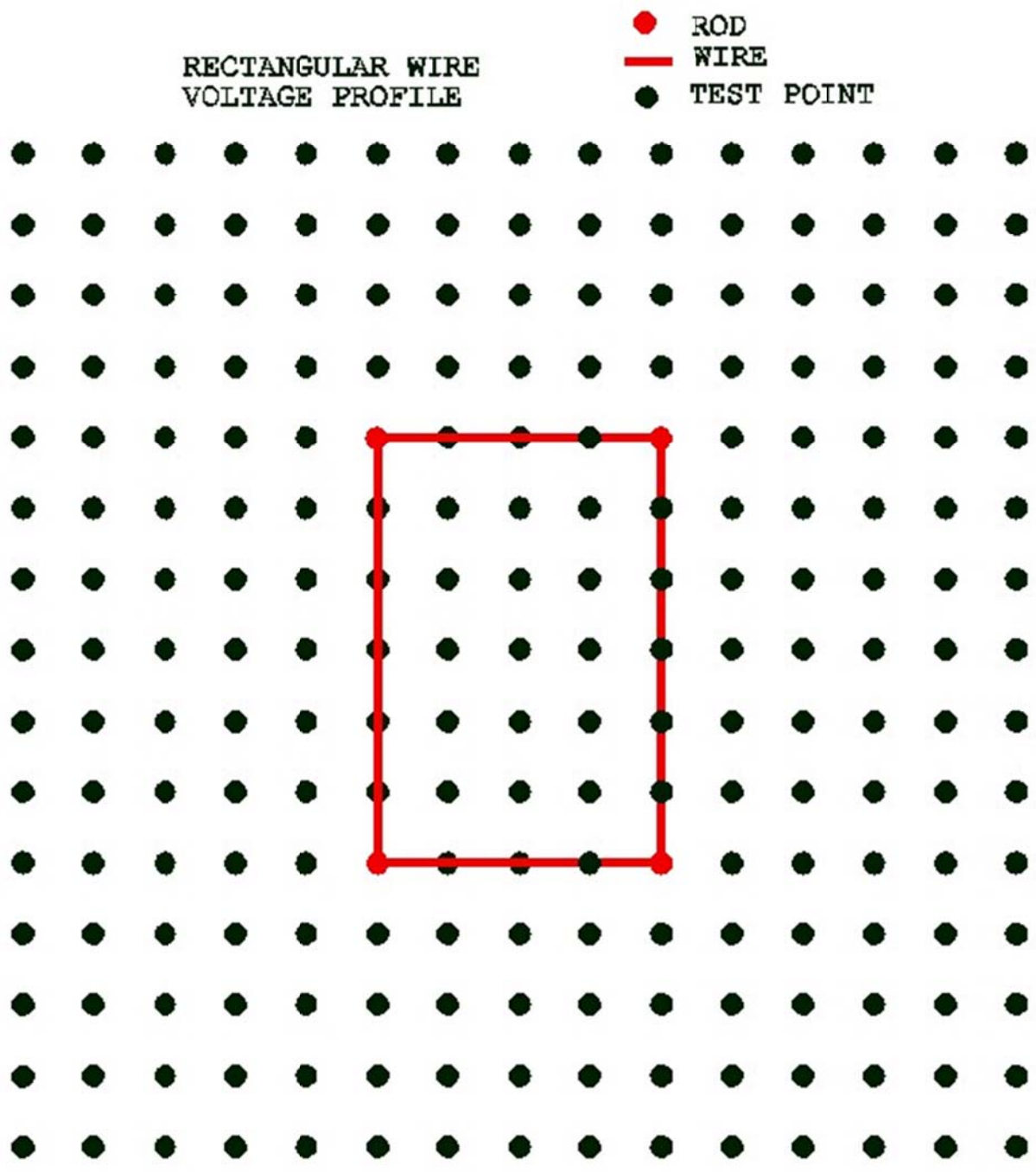
Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

The approximate depth of the grid under surface is 0.25 inches.

The dimensions are 2 x 3 inches and the length of the rods are 2 inches

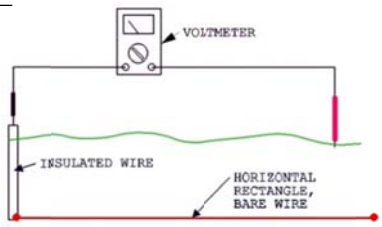
Record the surface voltage measured next to test points shown in the diagram.



Ground Grid 1x2 Mesh

Voltage injected: _____ VAC. Measured resistance of electrode_____

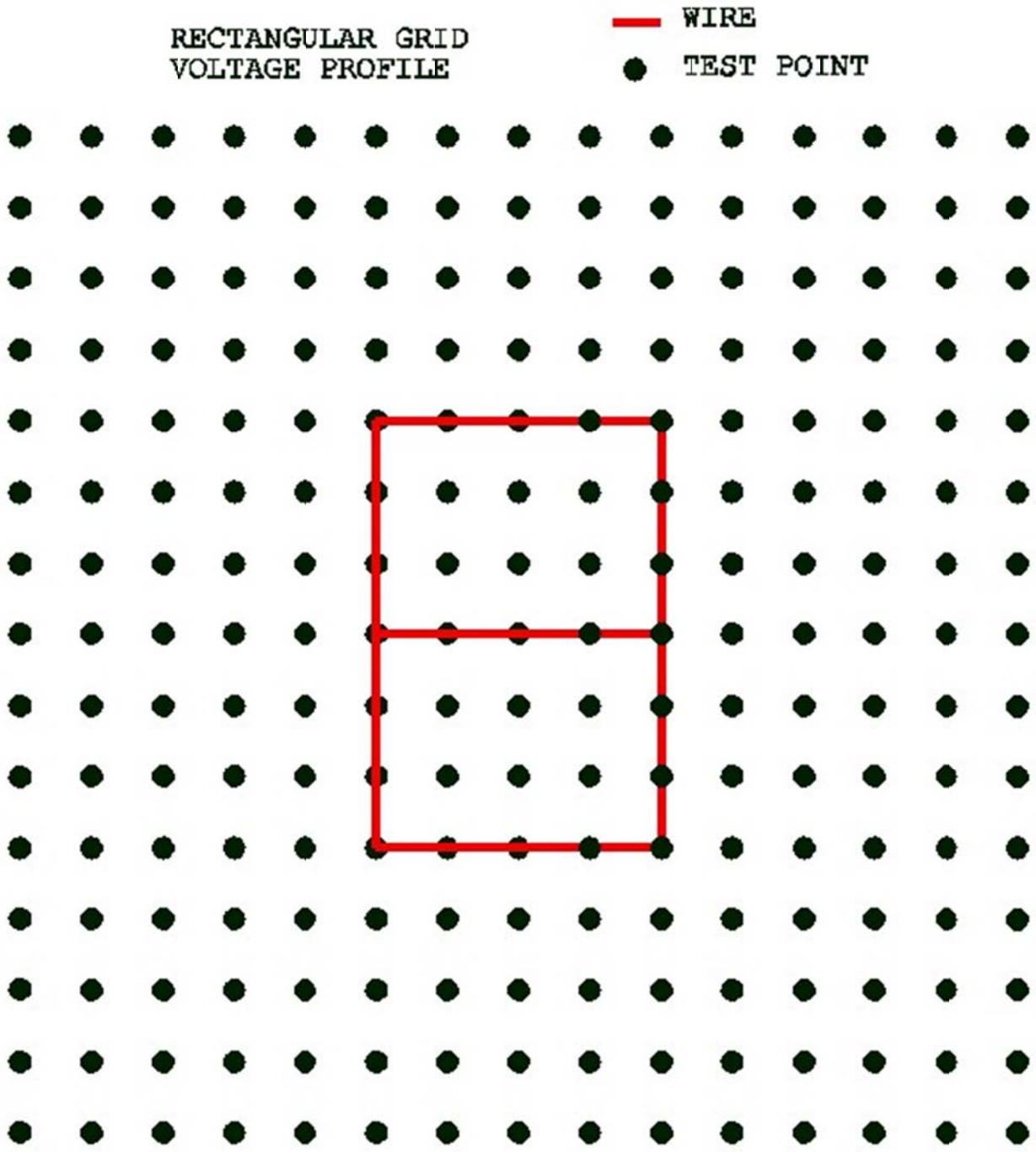
Computed resistance of electrode: _____ ohms



The approximate depth of the grid under surface is 0.25 inches.

The overall dimensions are 2 x 3 inches.

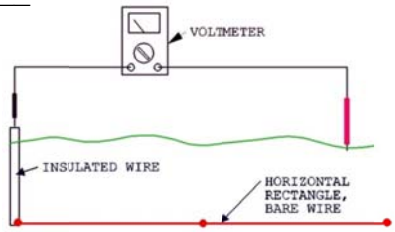
Record the surface voltage measured next to test points shown in the diagram.



Ground Grid 2x2 Mesh

Voltage injected: _____ VAC. Measured resistance of electrode_____

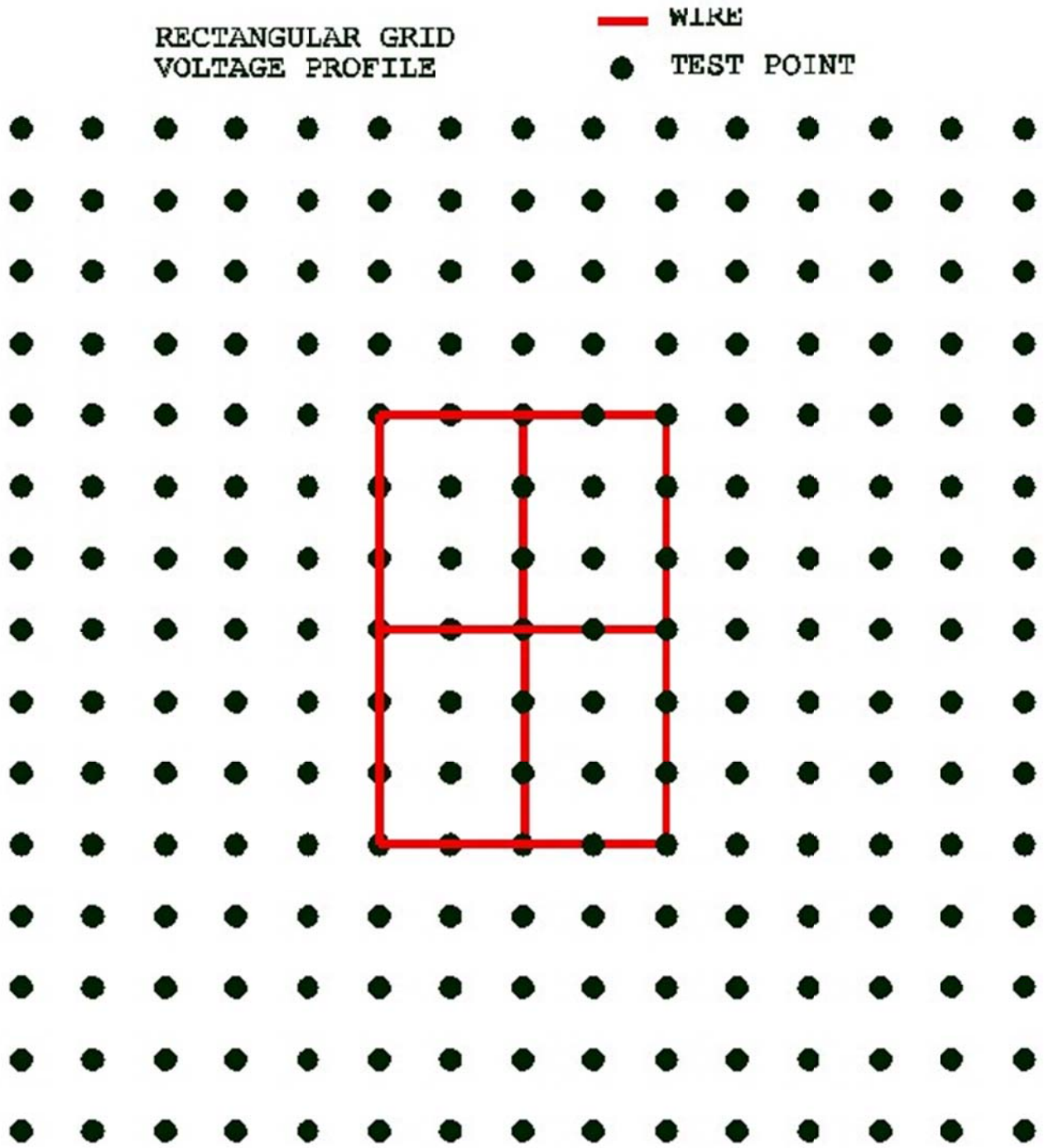
Computed resistance of electrode: _____ ohms



The approximate depth of the grid under surface is 0.25 inches.

The overall dimensions are 2 x 3 inches.

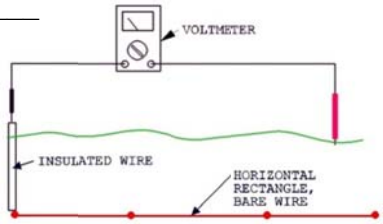
Record the surface voltage measured next to test points shown in the diagram. Include test points at center of mesh at corners.



Ground Grid, Irregular Shape

Voltage injected: _____ VAC. Measured resistance of electrode_____

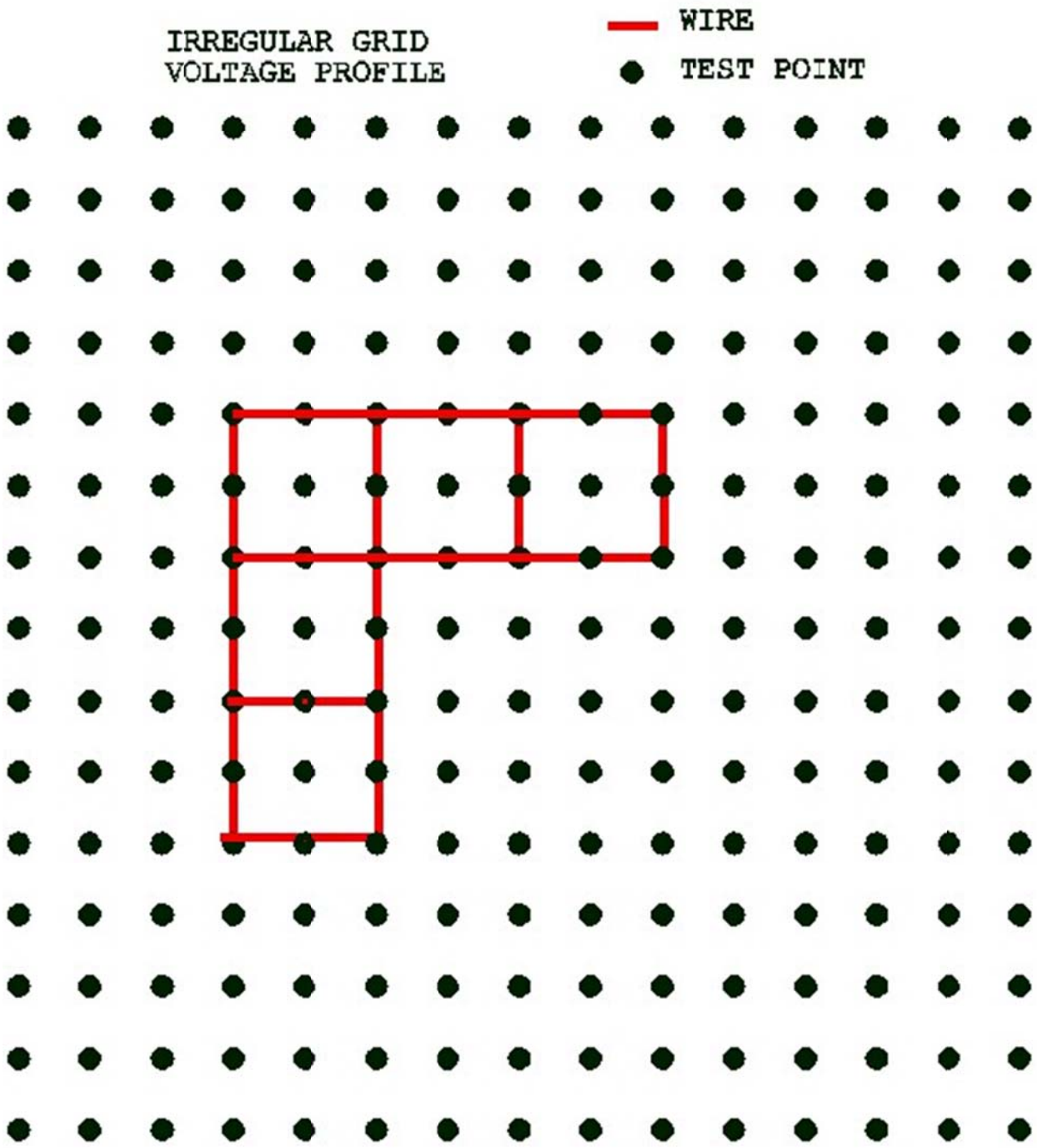
Computed resistance of electrode: _____ ohms



The approximate depth of the grid under surface is 0.25 inches.

The overall dimensions are 3 x 3 inches with 1 inch legs.

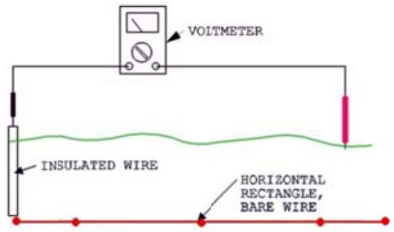
Record the surface voltage measured next to test points shown in the diagram. Include test points at center of mesh at corners.



Ground Grid 2x2 with closer perimeter grid conductors

Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

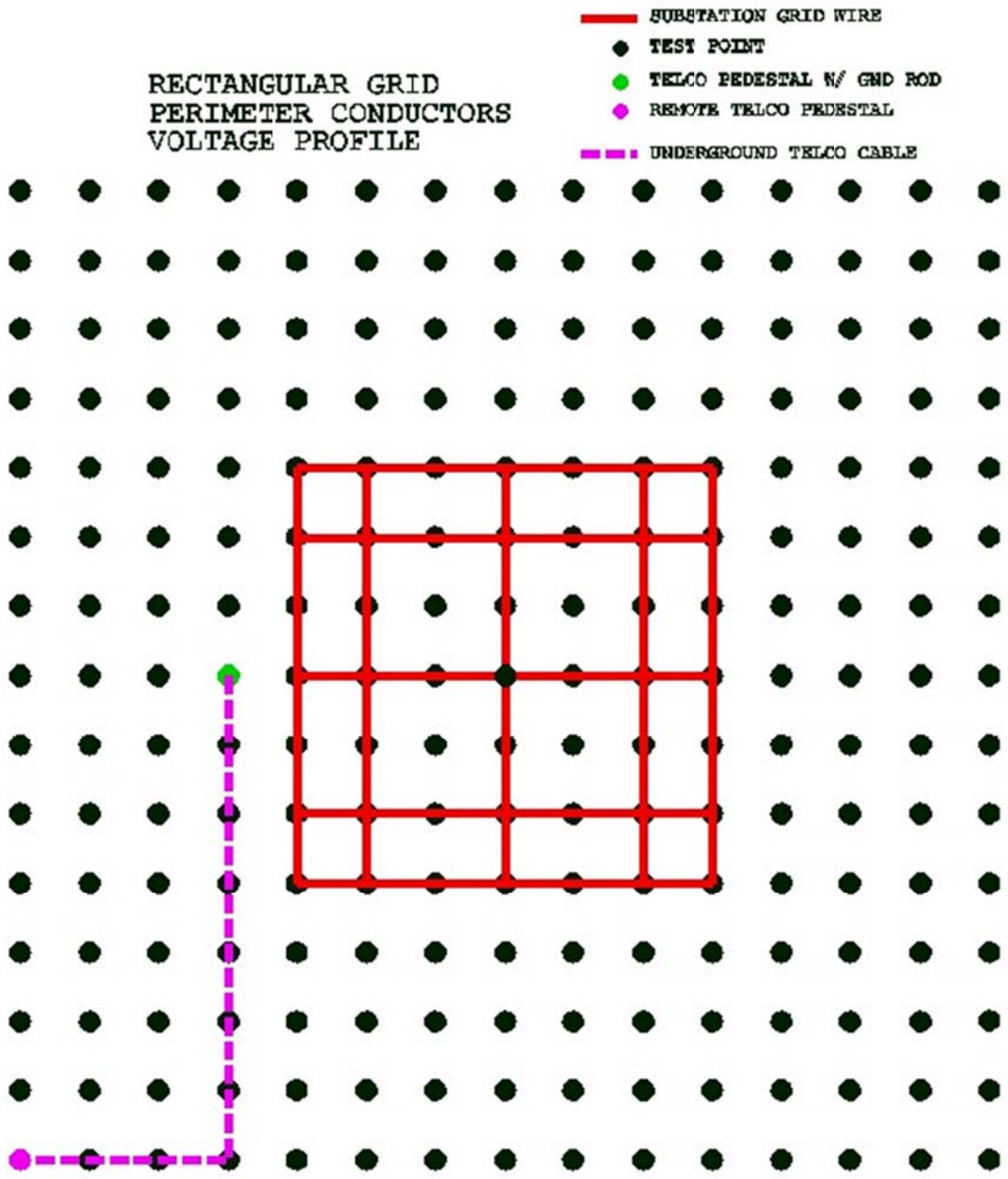


The approximate depth of the grid under surface is 0.25 inches.

The overall dimensions are 3 x 3 inches.

Record the surface voltage measured next to test points shown in the diagram. Include test points at center of mesh at corners.

Also measure the voltage at the TELCO remote pedestal between the remote pedestal wire and water surface. Recorded voltage : _____volts



Ground Grid – Solid Plate

Voltage injected: _____ VAC. Measured resistance of electrode_____

Computed resistance of electrode: _____ ohms

The approximate depth of the plated under surface is 0.25 inches.

The overall dimensions are 3 x 2 inches.

Record the surface voltage measured next to test points shown in the diagram. Include test points at center of mesh at corners.