



Earth
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September 17, 2014

State Radio Project c/o Abn Engineering, LLC
1317 East Thunderhill Place
Phoenix, Arizona
Attention: Sandeep Mane, P.E., S.E.

Phone: (480) 213-8524
Email: smane@abneng.com

**Subject: Resistivity Test Report
Proposed Oregon Department of Transportation (ODOT) Communication Tower
Cabbage Hill M/W #F73002
Near Pendleton, Umatilla County, Oregon
45.58889 Degrees Latitude, -118.57956 Degrees Longitude
EEI Report No. 14-096-2**

Dear Mr. Mane:

Earth Engineers, Inc. (EEI) is pleased to transmit our resistivity report for the above referenced project. This report is supplemental to our geotechnical report for the project (reference EEI Report No. 14-096-1). Please refer to the geotechnical report for details regarding our project understanding, scope, and site and subsurface descriptions.

In-situ electrical resistivity testing was performed at the site as selected by EEI's field personnel to establish resistivity values for the design of a grounding system. Four locations (R-1 to R-4) were tested. R-1 and R-2 were centered within the proposed tower footprint and ran in the north-south and east-west directions, respectively. R-3 and R-4 were centered near the northeast corner of the property and ran in the north-south and east-west directions, respectively. The locations of the tests are shown in the Resistivity Test Location Plan attached to the end of this report. We were unable to position all of the tests so that they did not cross any overhead or marked underground power and/or communication lines. Runs R-3 and R-4 passed beneath overhead power lines. Runs R-2, R-3 and R-4 crossed marked underground utilities.

The tests were generally conducted in accordance with ANSI/IEEE Std. 81-1983 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System. A Nilsson Model 400 solid-state four-pin soil resistance meter was used to conduct the testing. The resistivity test procedure involved placing four equally spaced electrodes (steel pins) into the ground along a straight line (Wenner arrangement), applying current to the two outer electrodes, and then measuring the resistance (in ohms) between the two inner electrodes. The planned electrode spacing along the straight line (per the guidelines from Harris Corp.) was 5, 10, 15, 20, 30, and 40 feet and we were able to complete our testing in accordance with this spacing sequence.

The Wenner electrical grounding procedure provides the average resistivity of the subsurface soil and rock to an approximate depth equal to the spacing between electrodes.

The average resistivity is calculated according to the formula:

$$\rho = 191.5 \cdot A \cdot R$$

Where ρ = resistivity (ohm-cm)
 A = spacing between electrodes (feet)
 R = resistance value (ohms)

The following are our test results:

TABLE 1: FIELD ELECTRICAL RESISTIVITY TEST RESULTS

TEST LOCATION	SPACING, A (feet)	RESISTANCE, R (ohms)	RESISTIVITY, ρ (ohm-cm) $191.5 \cdot A \cdot R$
R-1 (Runs N-S, centered near center of proposed tower)	5	6.6x1	6,320
	10	3.5x1	6,703
	15	2.5x1	7,181
	20	3.2x1	12,256
	30	2.9x1	16,661
	40	1.8x1	13,788
R-2 (Runs E-W, centered near center of proposed tower)	5	4.8x1	4,596
	10	1.6x1	3,064
	15	1.6x1	4,596
	20	6.9x0.1	2,643
	30	5.8x0.1	3,332
	40	6.2x0.1	4,749
R-3 (Runs N-S, centered near NW corner of property)	5	4.2x1	4,022
	10	2.4x1	4,596
	15	2.0x1	5,745
	20	1.3x1	4,979
	30	1.3x0.1	747
	40	2.7x0.1	2,068
R-4 (Runs E-W, centered near NW corner of property)	5	4.2x1	4,022
	10	2.8x1	5,362
	15	1.8x1	5,171
	20	1.5x1	5,745

TEST LOCATION	SPACING, A (feet)	RESISTANCE, R (ohms)	RESISTIVITY, ρ (ohm-cm) $191.5 \cdot A \cdot R$
	30	7.9x0.1	4,539
	40	4.1x0.1	3,141

We presume, given the presence of existing structures, that previous resistivity testing has been performed at this site. If that data is available, we recommend the grounding designer review that data along with ours before completing the system design.

We appreciate the opportunity to perform this resistivity study and look forward to any continued participation you may need. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
Earth Engineers, Inc.



EXPIRES: 6/30 15

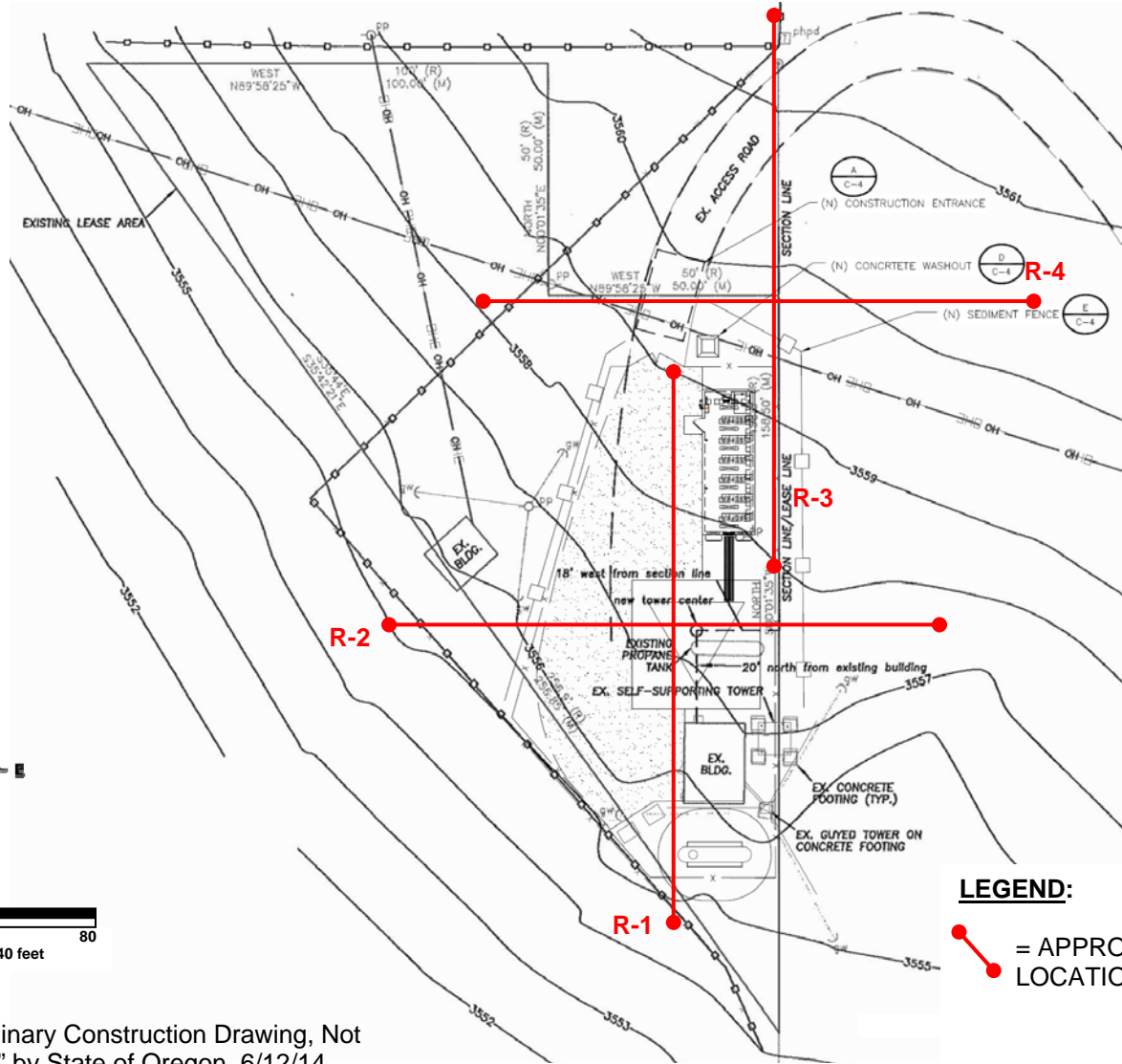
Troy Hull, P.E., G.E.
Principal Geotechnical Engineer

A handwritten signature in black ink, appearing to read "K. Andrieu".

Ken Andrieu, R.G.
Senior Geologist

Attachment: Resistivity Test Plan

APPENDIX A: RESISTIVITY TEST PLAN



DRAWING SOURCE: "Preliminary Construction Drawing, Not To Be Used For Construction," by State of Oregon, 6/12/14.



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