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GEOPHYSICAL SURVEY INVESTIGATION REPORT
EMERSON POWER TRANSMISSION FACILITY
ITHACA, NEW YORK

PREPARED

BY

ENVIRONMENTAL STRATEGIES CONSULTING LLC

OCTOBER 31, 2005

A QUANTA TECHNICAL SERVICES COMPANY

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Acronym List

bgs	below ground surface
EPA	Environmental Protection Agency
EPT	Emerson Power Transmission
ER	electrical resistivity
FES	Forrest Environmental Services, Inc.
NYSDEC	New York State Department of Environmental Conservation
R&D	research and development
RMS	root mean square
TCE	trichloroethene

1.0 Introduction

Environmental Strategies Consulting LLC, on behalf of Emerson, conducted a geophysical survey at the Emerson Power Transmission (EPT) facility in Ithaca, New York. The survey, which used electrical resistivity (ER) to remotely image the subsurface, was conducted using large-scale (up to 1,400 feet long), widely spaced transect lines along the EPT property lines and in the neighborhoods adjacent to the facility to produce a picture of the subsurface over a large geographical area. The objective was to identify potential water-bearing zones in the bedrock and provide an overall understanding of how groundwater is migrating through the bedrock and to provide a geologic context for evaluating the results of other investigation activities (e.g., the soil vapor and groundwater sampling activities). The work was conducted in accordance the Geophysical Survey and Supplemental Groundwater Investigation Work Plan approved by the New York State Department of Environmental Conservation (NYSDEC) on July 18, 2005. The work plan was submitted to NYSDEC in fulfillment of requirements outlined in the July 13, 1987, Consent Order entered into by the NYSDEC and Emerson. This report presents a brief site description and history, a description of the scope of work, and the results of the geophysical survey.

2.0 Site Background

The EPT facility is located at 620 South Aurora Street in Ithaca, New York (Figure 1). The site consists of three main buildings along the northeast and southwest edge of South Hill, one of many relatively steep hills that overlook the city of Ithaca (Figure 1). The majority of the floor space is in the main plant building, which stretches more than 1,600 feet along the eastern edge of the 110-acre site. The main building is flanked by a number of smaller buildings to the west and a series of access roads and parking lots that terrace the hillside above the plant. Further uphill and to the east are South Aurora Street and the campus of Ithaca College. Undeveloped woodland borders the site to the southwest along the steep embankments of the hill. West Spencer Street, which runs parallel to the EPT property, marks the western edge of the wooded section and the base of South Hill. Beyond Spencer Street to the west and in areas along the steep northern approach to South Hill and the EPT property are residential areas. These neighborhoods are bordered by Six Mile Creek, which flows north along the base of South Hill and eventually empties into Cayuga Lake approximately 2 miles northwest of the site.

2.1 Site History

The EPT site was first developed in 1906 by the Morse Industrial Corporation, which manufactured steel roller chain for the automobile industry. In 1928, the facility switched from chain production to the manufacture of automotive components and power transmission equipment. Borg-Warner operated the Morse facility until 1983, when it was acquired by Emerson. Emerson, under the new facility name of EPT, continues to manufacture automotive components and bearings, including roller chain and clutches.

During Borg-Warner's plant ownership, Borg-Warner used a number of chlorinated solvents in manufacturing operations. The solvent trichloroethene (TCE), which is widely used in the industry, was reportedly used to clean metal parts in degreasers including one located on the ground floor of the Main Plant building. TCE was discovered in a firewater reservoir that lies beneath one of the outbuildings directly across from the former vapor degreaser area in the main building (Figure 1). Subsequent investigations conducted by Emerson beginning in 1987 revealed TCE-contaminated groundwater in the area directly downhill from the reservoir. Emerson reported these findings to the NYSDEC in 1987. Additional investigation in the late

1980s and early 1990s led to the installation of the groundwater remediation system directly downgradient of the firewater reservoir and a groundwater investigation program that included a number of wells in the neighborhoods adjacent to the EPT facility.

2.2 Site Geology

The site is located on the northern edge of the Appalachian Plateau Physiographic Province, which is characterized in central New York by deeply dissected hilly uplands and glacially gouged stream valleys. The EPT facility occupies the edge of one of the dissected hills and overlooks the Cayuga Lake basin, which is formed in a former stream valley eroded and enlarged by the advance of glaciers. Underlying the site is a thin, discontinuous veneer of glacially till and man-made fill. The soil, also known as the A-zone, is typically a silty or clayey gravel and ranges in depth from 2.5 to 33 feet thick, though most of the EPT facility property and the western slope of South Hill is covered by less than 15 feet of soil. Soil depths generally increase with decreasing elevation and eventually merge with glacio-lacustrine silt and clay that lines the bottom of the valley floor below South Hill.

Beneath the overburden lies bedrock of the Ithaca Siltstone, which is a member of the Genesee Formation. The bedrock is typically well-cemented with generally non-fossiliferous beds ranging in thickness from 0.1 inch to 2.5 feet in thickness. Previous interpretations of the site bedrock, based on core logs recovered from borehole drilled for investigation activities, differentiated the rock into three zones based on the frequency of bedding plane fractures: an upper “stress relief zone” (B-zone), a middle “transitional zone” (C-zone), and a lower “lithologically controlled zone” (D-zone). The uppermost B-zone is weathered bedrock and very highly to highly fractured. The B-zone extends to a maximum depth of approximately 22 feet below ground surface (bgs) and has an average thickness of approximately 8 to 10 feet on the west portion of the site where the current remediation system is located (Figure 2).

The transitional zone (C-zone) extends from the base of the B-zone to a maximum depth of approximately 55 feet bgs beneath the site. The lower lithologically controlled zone (D-zone) extends from the bottom of the C-zone to a minimum depth of 145 feet bgs. In this lower zone, fractures are reportedly confined to intervals that are widely spaced, and their occurrence is controlled by lithology. This terminology was developed by Radian Corporation, the previous consultants at the site, and carried forward by Environmental Strategies.

The bedrock is in the Ithaca area is cut by at least three sets of nearly vertical fractures or joints. Limited geologic mapping performed by Radian at 16 outcrop locations on and around the EPT facility found three consistent joint orientations: N13W to N21W (north-northwest); N70E to N89E (east-northeast); and N45E to N55E (northeast). Two of the three strike orientations measured by Radian are in reasonably close agreement with regional joint set measurements of N19W and N7E made at outcrops of the Genesee Group in Tompkins County. All of the joints measured by Radian were within 8 degrees of vertical.

2.3 Site Hydrogeology

Groundwater is present within the overburden and bedrock at the EPT site. Overburden water appears to be restricted to limited areas of the site where the discontinuous cover of soil is thickest. Based on short duration pumping events and slug test performed by Radian, the overburden groundwater in the area surrounding the treatment system is in hydraulic communication with the underlying bedrock of the B-zone. The extent of the communication has not been quantified; however, in the area around the treatment system, the two units appear to act as a single hydraulic entity. Groundwater is also present in the deeper bedrock wells. Limited pumping and slug tests performed by Radian and Environmental Strategies suggest that the deeper wells in the treatment system area are hydraulically isolated from the overlying B-zone.

Groundwater elevation data collected in May 2005 from B-zone wells in and around the treatment area show a northwesterly flow direction. Groundwater flow in the deeper bedrock intervals likely follows the same flow direction towards the Cayuga Lake basin. However, given the vagaries of groundwater in bedrock wells, which is often dictated by the particular fracture or fractures intercepted by the borehole, flow may vary locally.

3.0 Scope of Work

Two phases of geophysical work were conducted at the EPT facility and the surrounding area. Eight transect lines, designated ER-1 through ER-8, covering more than 5,400 linear feet on and around the facility were surveyed during the first phase of work conducted between July 5 and 7, 2005 (Figure 2). Based on a review of the preliminary survey results, a second geophysical survey was conducted between September 27 and September 28, 2005, along an array of five additional survey lines, designated ER-9 through ER-14, covering approximately 3,600 feet. Proposed ER-13, which was to be survey along the north side of the former research and development (R&D) building, could not be completed due to access limitations along the proposed transect line. For the purpose of defining the map direction of specific areas at the EPT facility and surrounding areas, Emerson has divided the site into four directional quadrants (NW, NE, SW, and SE) with the center of the four quadrants being the fire water reservoir. Figure 2 present the four directional quadrants of the site.

Survey line ER-1, which because of its length was broken into two separate components, ER-1N (northwest) and ER-1S (south), was oriented northeast-southwest and located in the parking lots on the southeast and southwest portions of the EPT facility. The locations for ER-1N and ER-1S were selected to provide fracture information upgradient of the facility. The length of ER-1N was approximately 1,100 feet. Survey line ER-1S was slightly shorter at approximately 900 feet long.

Five ER survey lines were surveyed along the northwest, northeast, and southwest portions of the site to provide fracture information on the downgradient edge of the site. Survey lines ER-2, ER-7, ER-12, and ER-14 formed a roughly northeast-southwest oriented line parallel to the western property line (Figure 2). The northeastern line segment, ER-2, was approximately 675 feet long and extended along the edge of the northeast parking lot between the main plant building and the former R&D building. The line was surveyed to provide bedrock information directly downgradient of the fire water reservoir and current remedial system. The line was overlapped and extended by survey line ER-12, which extended approximately 840 feet and provides information along the northeast boundary directly east of the former R&D building. Survey line segment ER-7, which was later supplemented by survey line ER-14, extended from a point just east of the New York State Electric and Gas substation approximately 1,450 feet southwest along the former rail grade. This line provides information on the bedrock quality along the southwest portion of the site. The final onsite survey line, ER-3, was located along the access road to the EPT facility that connects northeast parking areas and the former R&D building with South Cayuga Street. This 400-foot-long survey line was installed to provide additional bedrock data directly downgradient of ER-2.

Six ER transect lines were surveyed in the public right-of-way in the neighborhoods directly northwest and downhill (northeast) of the main plant and former R&D buildings. Survey line ER-8 was located along the eastern side of South Cayuga Street from its terminus at the EPT facility and extended north approximately 400 feet to the intersection of South Hill Terrace (Figure 2). Two lines, ER-4 and its extension line ER-10, were surveyed to provide bedrock quality information along South Hill Terrace. The combined survey lines, which overlap, cover approximately 900 feet of the street. The remaining ER lines (ER-6, ER-9, and ER-10) were surveyed to evaluate the bedrock beneath Hillview Place (ER-6 and ER-10) and Turner Place (ER-9). Survey line ER-4, which was surveyed during the first phase of work, was extended by ER-10 to cover more than 900 feet of Hillview Place from its intersection with South Aurora Street west to its terminus just east of South Cayuga Street. Transect line ER-9, which is roughly the same length, was located along Turner Place from the EPT property line north to its intersection with South Hill Terrace.

The remaining line, ER-5, was located along West Spencer Street to provide subsurface information along the western face of South Hill (Figure 2). Because of the length, the line was split into two segments designated ER-5N (north) and ER-5S (south). The longer of the two lines, ER-5N, was surveyed from a point just southeast of the intersection with South Cayuga Street southeast approximately 1,090 feet to the traffic circle at the intersections of West Spencer, South Albany, and Park Streets. The southern ER line segment, ER-5S, continued along the west side of West Spence Street southeast of the traffic circle.

3.1 Geophysical Survey Equipment and Methods

The geophysical survey was performed by Forrest Environmental Services, Inc. (FES), of Oak Hill, Virginia. An FES geophysical technician performed all of the data processing and provided preliminary analyses of the findings. Environmental Strategies evaluated the ER findings and hydrogeologic information gained from previous investigations in preparing this report. The geophysical cross-sections (profiles) constructed from the data are included in FES's final report (Appendix A) and are presented in figures 3 through 17.

Each ER survey line was evaluated using a Swift-brand automatic electrode system (Swift), which was connected to a Sting R8-brand earth resistivity meter. The electrodes were placed along the designated ER survey line with approximately 13 feet between each dipole. Each electrode was installed to a depth of approximately 18 inches bgs using a steel sledgehammer. Where the electrodes were to pass through concrete, a portable hammer drill was used to core a small hole to allow the electrode to be installed in the subsurface. In areas where bedrock was encountered at depths less than 18 inches, the electrode was advanced until it was in direct contact with the underlying rock. As many as 84 electrodes were installed along a single line yielding a maximum survey line of approximately 1,100 feet. Once the information was collected from the survey line, the electrodes were removed from the ground and the area was restored with material (e.g., concrete/asphalt) to match the surrounding grade.

3.2 Geophysical Interpretation

The ER data collected from each survey line were converted into a resistivity-depth model using a Rapid 2-dimensional resistivity inversion model and the least-squares method (RES2DINV). Soundings from each survey line were modeled to calculate the apparent resistivities and develop pseudosections based on the model predictions. The pseudosections were then contoured in SURFER, a contouring software package developed by Golden Software, of Golden, Colorado, to produce a color-coded cross section or profile for each ER line displaying the distribution of resistivities between the various subsurface materials. The resistivity scale runs from 1 ohm-meter, which represents low resistivities (i.e., high electrical conductivity), to a high of 5,000 ohm-meters, which represents highly resistive materials. Each resistivity measurement was assigned a color from dark blue (1 ohm-meter) to red (5,000 ohm-meters). Bedrock, a typically highly resistive material, generally yields resistivity measurements of 200 to 5,000-ohm meters, which plot as regions of light green, yellow, and red. Regions with resistivities below 200 ohm-meters generally plot as shades of green and light blue. Water-bearing zones, which have dramatically reduced resistivities due to the highly conductive nature of groundwater, typically yield regions of blue or dark blue within the more resistive areas. The focus of the geophysical interpretation was to identify and generally locate the highly conductive water bearing zones within the subsurface.

The modeling is an iterative process which is designed to match the measured, or true, resistivities to the models interpretation. Generally, the higher the number of iterations the closer is the approximation of the model to the actual measurements. The root mean square (RMS) error is a measure of how closely the model is approximating the measured conditions. Low model iterations and relatively high RMS error (e.g., less than 6 iterations and an RMS error greater than 50) are generally undesirable as they often skew the size and location of the buried features. However, in situations where the subsurface contains extremely high resistivity contrasts or the structure of the bedrock is highly variable or exists in patterns that are not expected by the model (e.g., karst) the iterative process can yield unwanted artifacts that do not reflect the subsurface geology. Interpretation of what is a real feature and what is an artifact is a function of the operator's experience level using the software. A number of the profiles generated during the EPT facility survey exhibited similar artifacts at higher iterations of the model (as interpreted by FES) do to the variability in the subsurface. Consequently, several profiles (e.g., ER-7, ER-10, ER-14) were reevaluated at lower model iterations, which resulted in higher RMS errors. The size and position of the mapped features in the resulting profiles may be slightly offset from their actual locations in the subsurface but still represent the overall pattern of bedrock features and, thus, are consistent with the approach of a low resolution survey of the site.

4.0 Results

Thirteen ER survey lines, designated ER-1 through ER-12 and ER-14, were sounded and evaluated at various locations on and around the EPT facility (Figure 2). Six of the survey lines, ER-1 through ER-3, ER-7, ER-12, and ER-14, were located on the EPT property to characterize the subsurface onsite. Six ER survey lines, ER-4, ER-6, ER-8, and ER-9 through ER-11, were located in the residential areas northwest and northeast of the firewater reservoir. Survey ER-5 was located along the residential areas northwest and southwest of the facility near the base of South Hill. Maximum penetration depths, which depended on the length of the line, ranged from approximately 70 feet along survey line ER-5S to 280 feet along survey line ER-1N. Geophysical cross-sections (profiles) were developed based on the interpretation of the ER data. The ER profiles are presented in Appendix A and show the electrode array, the corresponding elevation, and the interpreted water-bearing zones based on the ER data. A summary of the results of each survey line is presented below. The geophysical profiles for each line are presented in figures 3 though 17. A copy of FES's report is included in Appendix A.

4.1 ER-1 North

Four conductive anomalies were detected in the profile designated as ER-1N. Two of the anomalies, 1N-A and 1N-B, were detected near the middle of the survey line and are centered approximately 50 feet bgs (Figure 3). These near-surface anomalies are surrounded by more resistive near surface bedrock features and may represent a weathered bedrock zone. Both zones appear to be highly conductive with resistivities in the 1- to 5-ohm-meter range. Two other anomalies, 1N-C and 1N-D, were identified at depths of approximately 100 feet bgs. 1N-D appears to be more conductive than 1N-C: the resistivity on 1N-D is in the 2- to 5-ohm-meter range versus the 10- to 20-ohm-meter range for 1N-C. The area of blue near the northeast end of the profile was not considered a conductive anomaly because the data set that defines the feature extends off the edge of the profile and, thus, is incomplete. Anomalies of this type are believed to represent artifacts of the modeling process (i.e., an edge effect) rather than an actual conductive anomaly.

4.2 ER-1 South

Three relatively small, shallow anomalies, 1S-A through 1S-C, were identified in the southern third of the survey line (Figure 4). The anomalies are relatively weak with resistivities ranging from approximately 25 to 50 ohm-meters. No other reliable anomalies were noted in the profile. The blue area near the bottom of the profile was not considered to be an anomaly due to its location near the edge of the profile (i.e., the anomaly is an edge effect).

4.3 ER-2/ER-12

Four conductive anomalies, 2-A through 2-D, were identified in the profile of survey line ER-2 at depths ranging from 40 to 60 feet bgs (Figure 5). Anomalies 2-A and 2-D are highly conductive with resistivities ranging as low as 1 ohm-meter. Anomalies 2-B and 2-C exhibited a somewhat lower conductivity with a mapped resistivity of between 5 and 50 ohm-meters. A number of other anomalies were noted along the ground surface, especially between 0 and 200 feet and 320 and 480 feet along the ER-2 survey line. These anomalies likely represent the overburden in the area of ER-2, which was likely installed as part of the former rail grade that follows the ER-2 transect. Both the native and fill materials onsite typically contain high concentrations of clay minerals, which can yield resistivity signatures that are similar to those of water-bearing zones in bedrock. The anomaly between 0 and 160 feet may also have been exaggerated by local infiltration of surface water from the non-contact cooling water drainage sluice that is adjacent to the ER-2 survey line.

No conductive anomalies were identified within the current remediation area downgradient of the fire water reservoir (Figures 2 and 5). The closest conductive anomaly in this area is 2-A, which was identified 120 feet to the northeast.

Two additional conductive anomalies, 12-A and 12-B, were noted in the profile ER-12, which extends transect ER-2 to the northeast (Figure 16). Both anomalies were located at approximately the same depth (centered at approximately 20 feet bgs); however, anomaly 12-A is more conductive with a resistivity of 2 to 5 ohm-meters than 12-B, which has a resistivity between 10 and 40 ohm-meters. Anomaly 12-A is also located within a region of relatively low resistivity that may indicate weathered bedrock or, as in the case with features in ER-2, may be the result of fill installed as part of the former rail grade. In contrast, anomaly 12-B appears to be contained within a region of highly resistive bedrock. The blue region along the southwest edge of the profile beneath 12-B was considered an edge effect and, thus, not a valid anomaly. Likewise, the numerous small, shallow (less than 10 feet) anomalies between 12-A and 12-B were rejected from the classification as likely buried utilities.

4.4 ER-3

No reliable conductive anomalies were noted in this profile (Figure 6). The blue near-surface areas at the eastern and western ends of the profile are likely due to clay in the overburden, which was placed as part of the construction of the access road where survey ER-3 was conducted.

4.5 ER-4/ER-10

Three conductive anomalies, 4-A through 4-C, were identified in ER-4 centered at approximately 30 feet bgs (Figure 7). All three anomalies are highly conductive with resistivities between 2 and 5 ohm-meters. The anomalies are located within a relatively conductive zone extending from just below grade to a depth of approximately 70 feet bgs, which is underlain by highly resistive material. The 70-foot-thick zone is consistent with weathered bedrock.

Three additional anomalies, 10-A through 10-C, were detected in profile ER-10, which overlaps ER-4 (Figures 2 and 14). Anomalies 10-B and 10-C are centered at approximately the same depth as 4-A through 4-C and appear to be within a similar zone of lower resistance consistent with weathered bedrock. Anomaly 10-A is centered at 50 feet bgs and appears to be flanked on both sides by highly resistive bedrock. The extent to which anomaly 10-A extends down is unknown because the data set at the bottom of the profile is not complete and the lower portion of this blue region may represent an edge effect.

4.6 ER-5 North

Only two reliable conductive anomalies, 5N-A and 5N-B, were noted in profile ER-5N (Figure 8). These anomalies were centered approximately 40 and 50 feet bgs, respectively. Several other anomalous areas were noted; however, many were located less than 10 feet below ground surface and can be attributed to the sewer lines, gas lines, or other buried utilities crossed by the ER-5 transect. The large anomaly at the bottom of the profile is not considered reliable based on the fact that the data set is incomplete (i.e., the anomaly may be an edge effect).

4.7 ER-5 South

Four conductive anomalies, 5S-A through 5S-D, were detected in the profile ER-5S (Figure 9). Two of the anomalies, 5S-A and 5S-B, were relatively small and shallow, with depths of approximately 20 and 30 feet respectively. The two larger anomalies, 5S-C and 5S-D, were centered near 60 feet bgs. All four anomalies appear to be highly conductive with resistivity lows between 2 and 5 ohm-meters, and each appears to be located within a zone relatively low resistivity that may be indicative of either unconsolidated material such as sand or silt, or weathered bedrock.

4.8 ER-6/ER-11

Six conductive anomalies were identified in the profile ER-6. Five of the anomalies, 6-A through 6-E, were relatively small and shallow, with depths ranging between 10 and 30 feet bgs (Figure 10). A larger conductive anomaly was detected near the center of the profile centered at a depth of approximately 50 feet bgs. All of the anomalies appear to be highly conductive with resistivity lows between 1 and 5 ohm-meters.

Five additional conductive anomalies (11-A through 11-E) were identified along Hillview Place in profile ER-11, which extends beyond ER-6 (Figures 2 and 15). With the exception of anomalies 11-B and 11-E, each was generally shallow (approximately 20 feet bgs) and located in a region of relatively low (50- to 100-ohm-meter) resistivity overlying more resistive bedrock. These regions of relatively low resistivity are consistent with weathered bedrock. Anomalies 11-B and 11-E were located significantly deeper in the profile (centered at approximately 40 feet bgs) and were surrounded by highly resistive bedrock. All of the anomalies were highly conductive with resistivities ranging as low as 2 ohm-meters.

4.9 ER-7/ER-14

A single conductive anomaly was identified in the profile ER-7. The anomaly (7-A) appears to be highly conductive (2 to 5 ohm-meters) and was centered at approximately 50 feet bgs (Figure 11). The anomaly appears to be surrounded by highly resistive bedrock.

Two similar conductive anomalies, 14-A and 14-B, were identified in the profile ER-14, which extends ER-7 to the south (Figure 17). Both anomalies are equally conductive with resistivities in the 2- to 5-ohm-meter range and both appear to be contained within a zone of relatively low resistivities that is completely encased in more resistive bedrock. These mapped features appear to represent sediment filled voids within the bedrock.

4.10 ER-8

Five conductive anomalies, 8-A through 8-E, were identified in the profile ER-8 (Figure 12). All of the anomalies were highly conductive (1 to 5 ohm-meters), centered at approximately the same depth (40 feet bgs), and are located within an area of relatively low resistivity. This area is consistent with weathered bedrock. The anomaly near the northern end of the profile is considered an artifact.

4.11 ER-9

Nine conductive anomalies, 9-A through 9-I, were identified in the profile ER-9 (Figure 13). The anomalies ranged in size and resistivity (1 to 20 ohm-meters) and all were located within region of relatively low (50 to 100) resistivity between 25 and 75 feet bgs. The relatively low resistivity zone appears to be a weathered bedrock zone that lies between areas of higher resistivity bedrock. Several smaller, near-surface anomalies located less than 10 feet bgs were not considered reliable. These anomalies can be attributed to buried utilities along the ER-9 transect.

4.12 Discussion of Survey Results

The results of the geophysical survey reveal a complex geologic and hydrogeolgic network. Two highly conductive anomalies were identified along the northeast portion of the site in profile ER-2 (2A and 2D) and overlapped profile ER-12 (12A). Three highly conductive anomalies were also observed along the southwestern portion of the site in profile ER-7 (7A) and in ER profile 14 (14A and 14B). No major conductive zones were identified within the current groundwater remediation area downgradient of the fire water reservoir. Although bedrock cores recovered from groundwater monitoring well borings are generally similar (i.e., all are siltstone of the Ithaca Member), wide variations were noted in electrical response. Highly resistive material (i.e., resistivities greater than 250 ohm-meters) was identified both above and below rock with lower resistivities (i.e., resistivities between 50 and 250 ohm-meters). These lower resistivity regions may represent higher fracture concentrations (such as bedding plane partings) that contain greater amounts of pore water than the highly resistive rock (but not as much as the conductive anomalies); areas of rock that have undergone differential chemical weathering resulting in higher conductive clay content (from in-situ rock degradation) or voids; a lithology change, or some combination of the three.

The conductive anomalies, which likely represent saturated conditions, were noted within large areas of apparently weathered bedrock (e.g., ER-4, ER-5 South) and in regions surrounded by apparently highly-resistive bedrock (e.g., ER-1 South, ER-2, ER-5 North, and ER-12). In both cases, the conductive anomalies varied greatly from relatively small (less than 20 feet in mapped diameter), shallow areas with moderate conductivities (e.g., ER-1 South, ER-5 North) to large scale regions of apparent saturation covering over 100 linear feet of the profile (e.g., ER-4, ER-5 South, ER-7). In some cases both features appeared in a single profile (e.g., ER-1 North, ER-9, ER-10). The data clearly demonstrates that the majority of groundwater within the bedrock is contained within these relatively well defined, discrete zones, which suggests that groundwater flow is in the secondary porosity of the rock (i.e., within fractures, joints, and other openings within the rock) and not the rock itself (i.e., primary porosity). This preferential flow through the openings often results in greater groundwater flow velocities (as compared to flow through the rock matrix) and can yield unexpectedly tortuous flow paths depending upon the level of connectivity between the various openings in the rock. The pathways by which the groundwater flows through bedding plane fractures, joints, faults, or all of the above at the EPT facility is not directly addressed by this survey.

5.0 Summary

The geophysical survey results indicate that five major conductive zones are located along the northeast and southwest portion of the EPT site. No major conductive zones were identified in the immediate vicinity of the current remediation area downgradient of the fire water reservoir, which was identified in 1987 as the source of the TCE release.

The results of the geophysical survey also demonstrate that groundwater migration at EPT is controlled by the orientation of bedrock structures, including bedding plane fractures and vertical joint sets. Groundwater flow through the bedrock, as indicated by the conductive anomalies, is confined to relatively well-defined, discrete water-bearing zones that correspond to the secondary porosity of the rock. In the area directly downgradient of the remediation area where affected groundwater is found in wells that are not near any significant water-bearing anomaly, the flow is likely controlled by the amount of horizontal bedding plane fractures and, thus, the terms stress relief, transition, and lithologically controlled zones (i.e., “B,” “C,” and “D” zones) are useful for discussing the distribution of affected groundwater. However, it is clear from the geophysical results that the partings alone are not controlling the migration of groundwater over other portions of the site and a horizontally zoned conceptual model cannot be used to generalize the hydrogeologic framework of the site.

Figures

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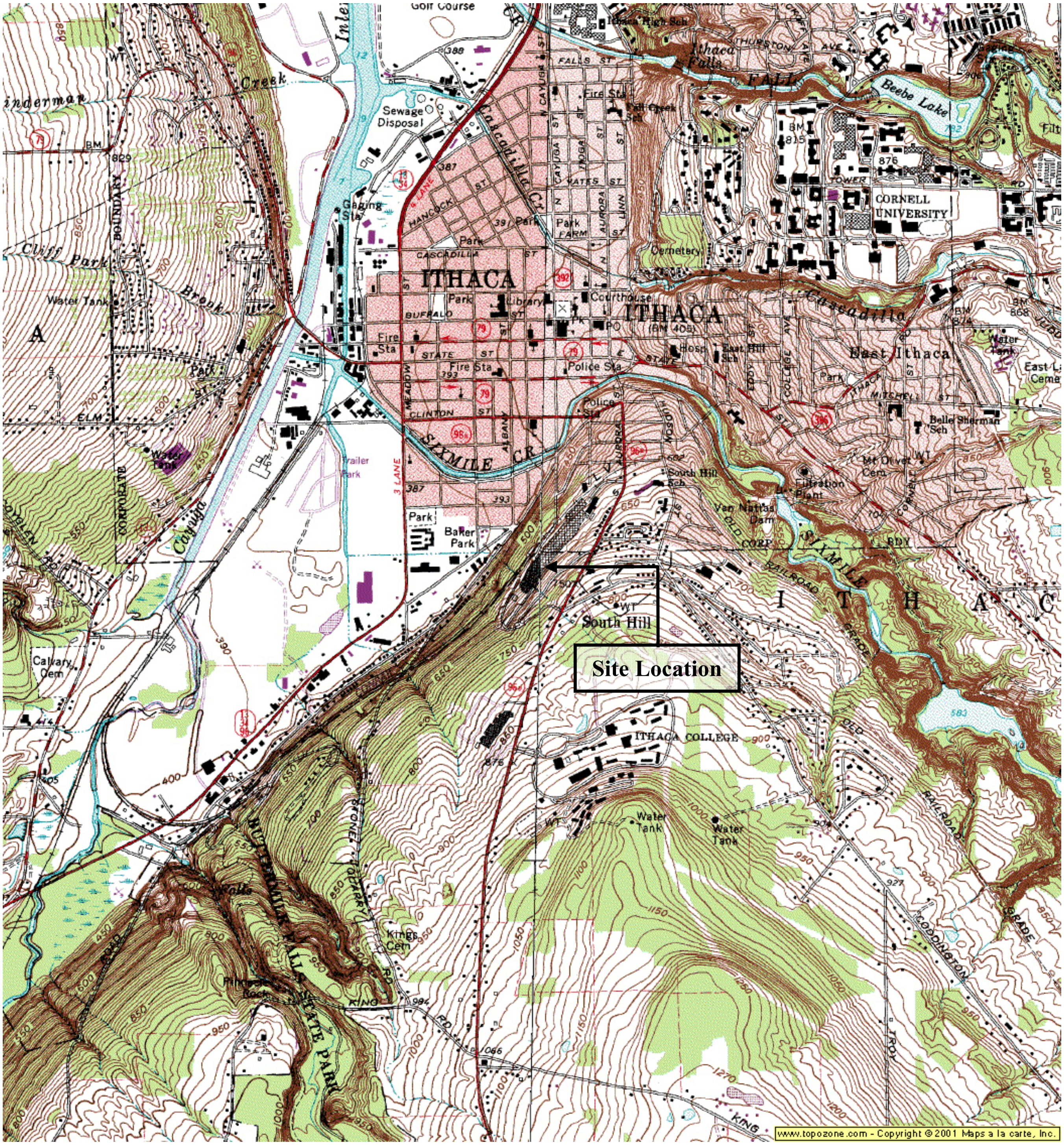

Reference
7.5 Minute Series Topographic Quadrangle
Ithaca East, New York
Photorevised 1976 Scale 1:25,000 Metric

Quadrangle Location

Scale in Meters
0 500 1000

0 1000 2000
Scale in Feet

ENVIRONMENTAL STRATEGIES CONSULTING LLC
11911 FREEDOM DRIVE SUITE 900
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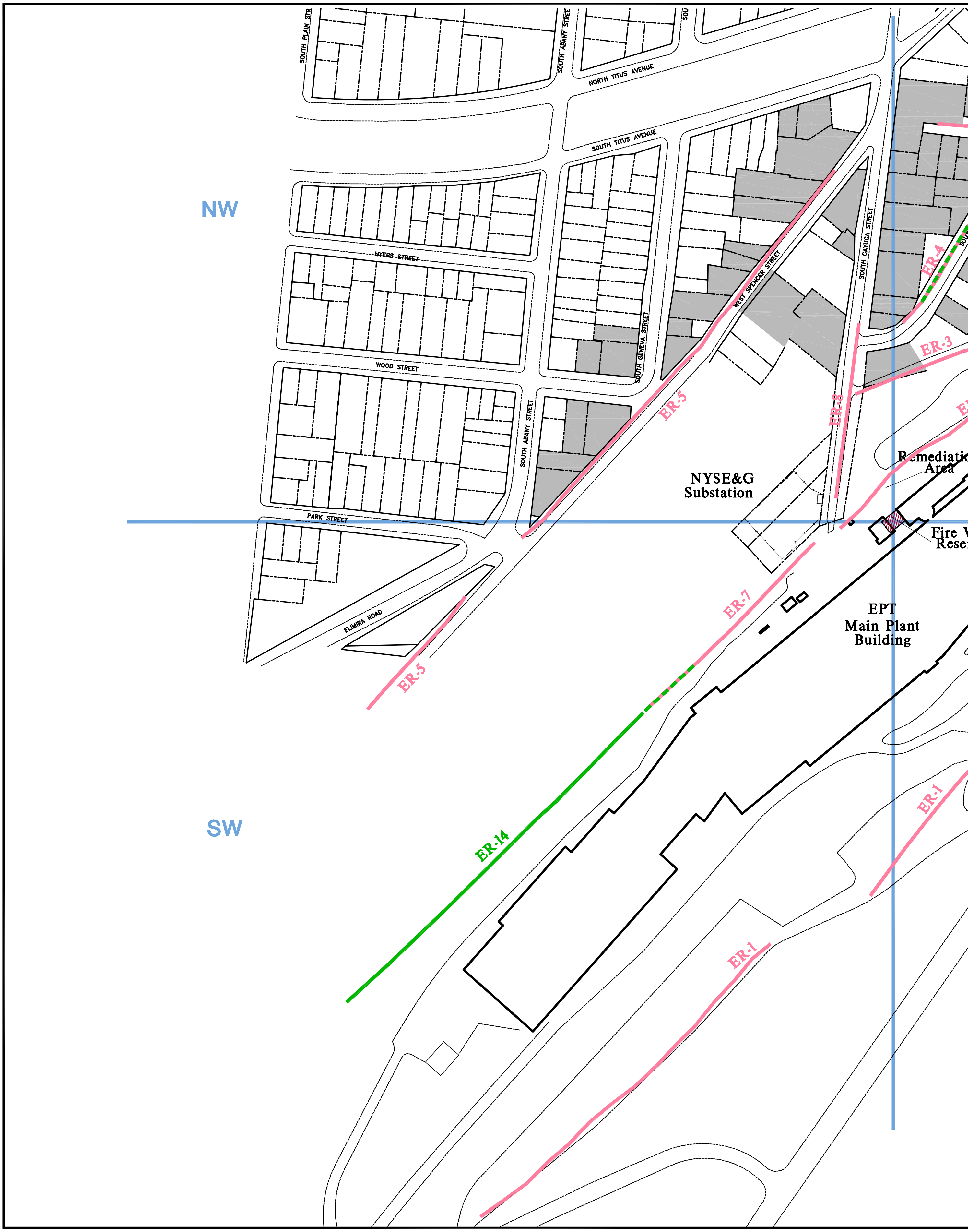
(703)-709-6500

N

Figure 1
Site Location
Emerson Power Transmission
Ithaca, New York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SW
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SOUTH TITUS AVENUE
HYERS STREET
WOOD STREET
PARK STREET
SOUTH ABANY STREET
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WEST SPENCER STREET
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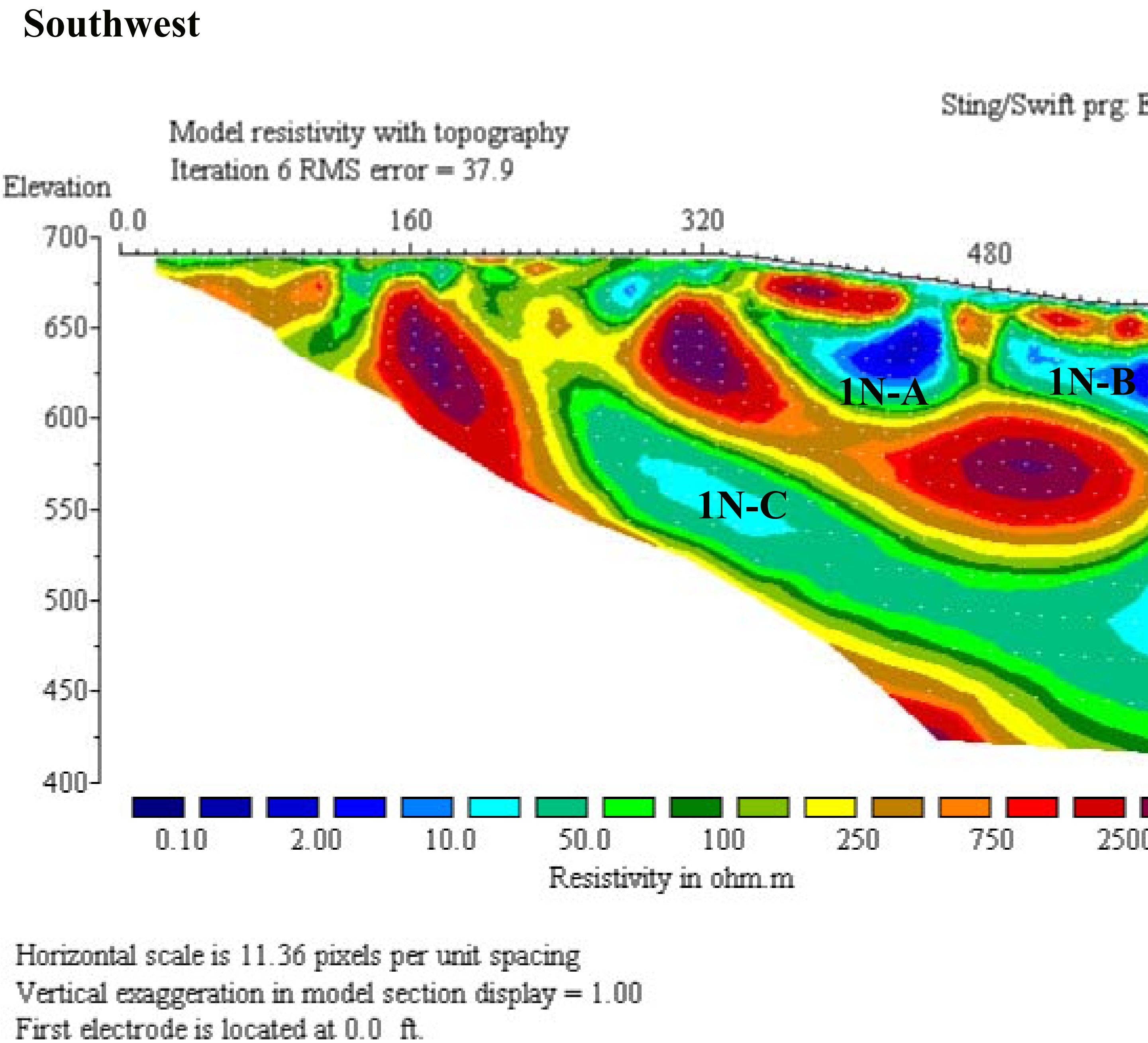
ER-5
ER-7
ER-8
ER-14


Southwest
Sting/Swift prg:
Model resistivity with topography
Iteration 6 RMS error = 37.9
Elevation
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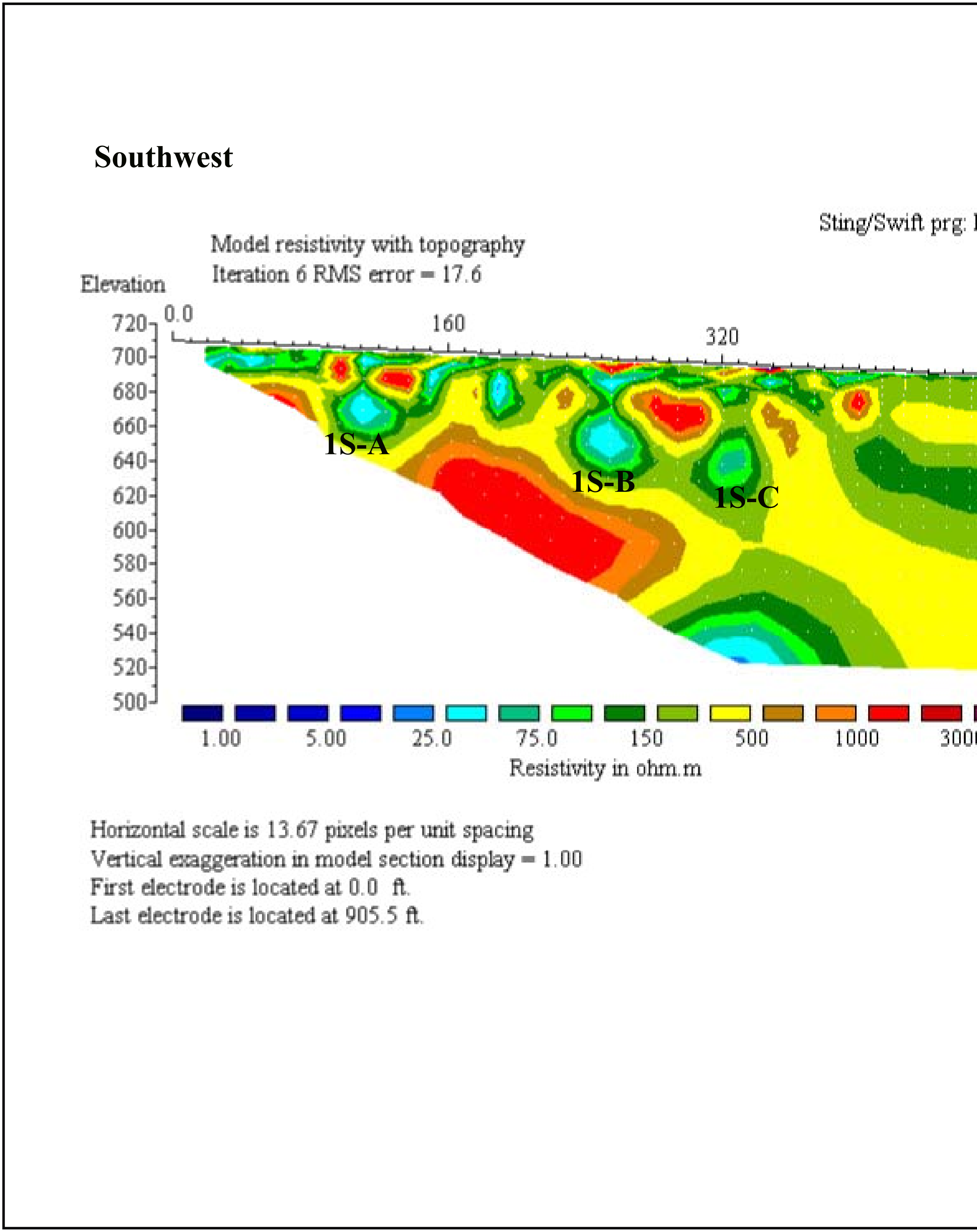
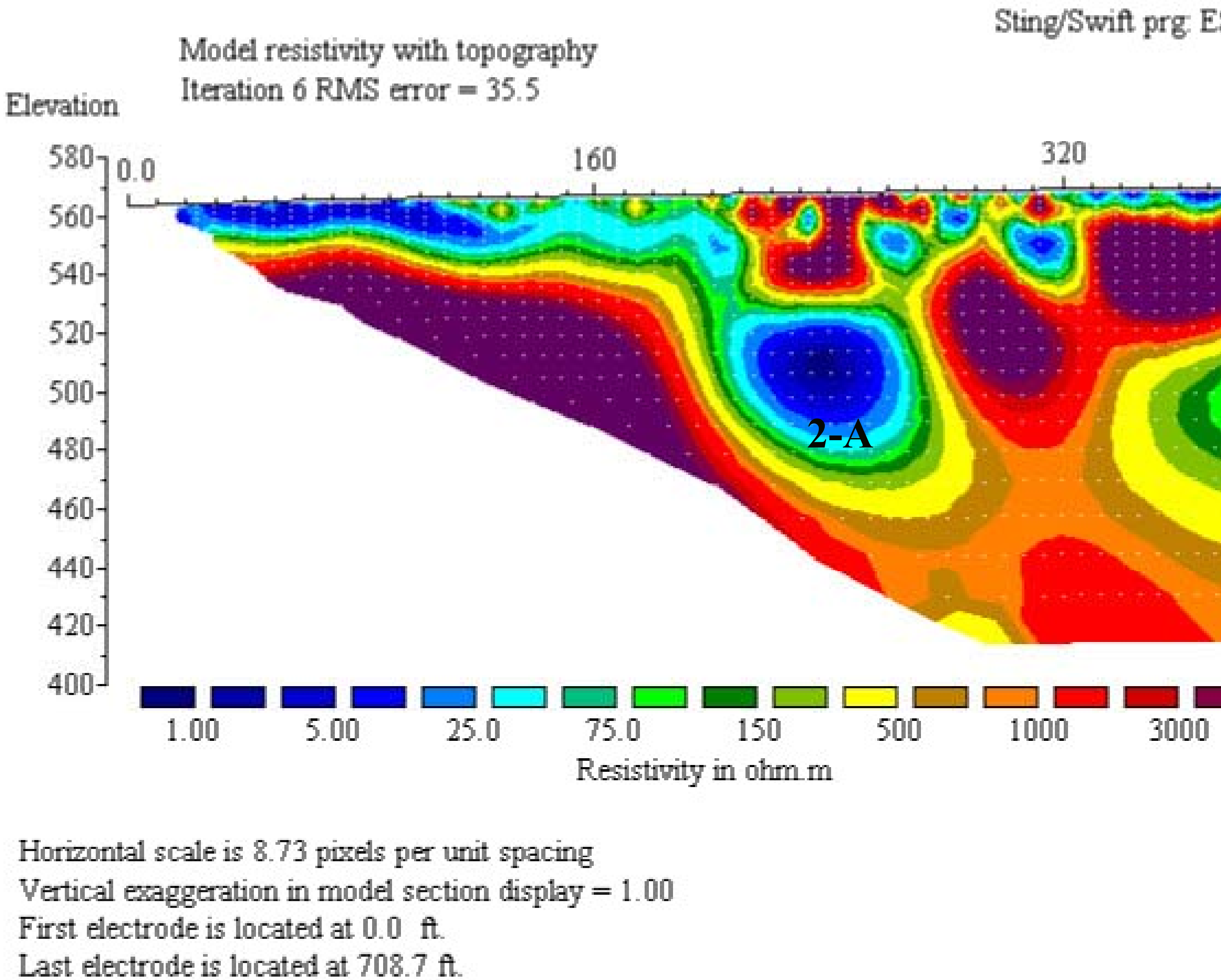
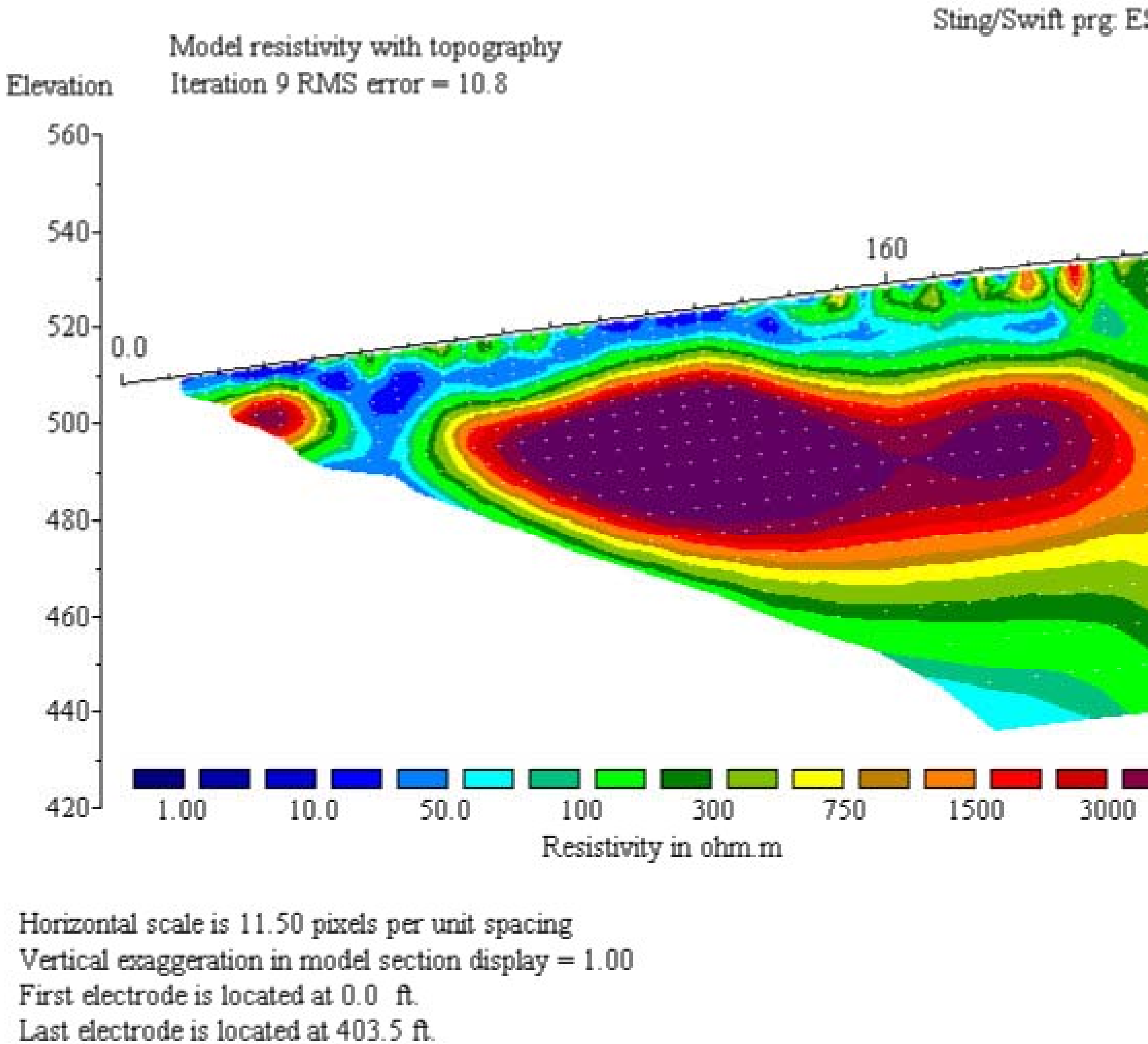
160
320
480
700
650
600
550
500
450
400
1N-A
1N-B
1N-C
0.10
2.00
10.0
50.0
100
250
750
Resistivity in ohm.m
Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.


Southwest
Sting/Swift prg: I
Model resistivity with topography
Iteration 6 RMS error = 17.6
Elevation
720
700
680
660
640
620
600
580
560
540
520
500
0.0
160
320
1S-A
1S-B
1S-C
1.00
5.00
25.0
75.0
150
500
1000
Resistivity in ohm.m
Horizontal scale is 13.67 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 905.5 ft.

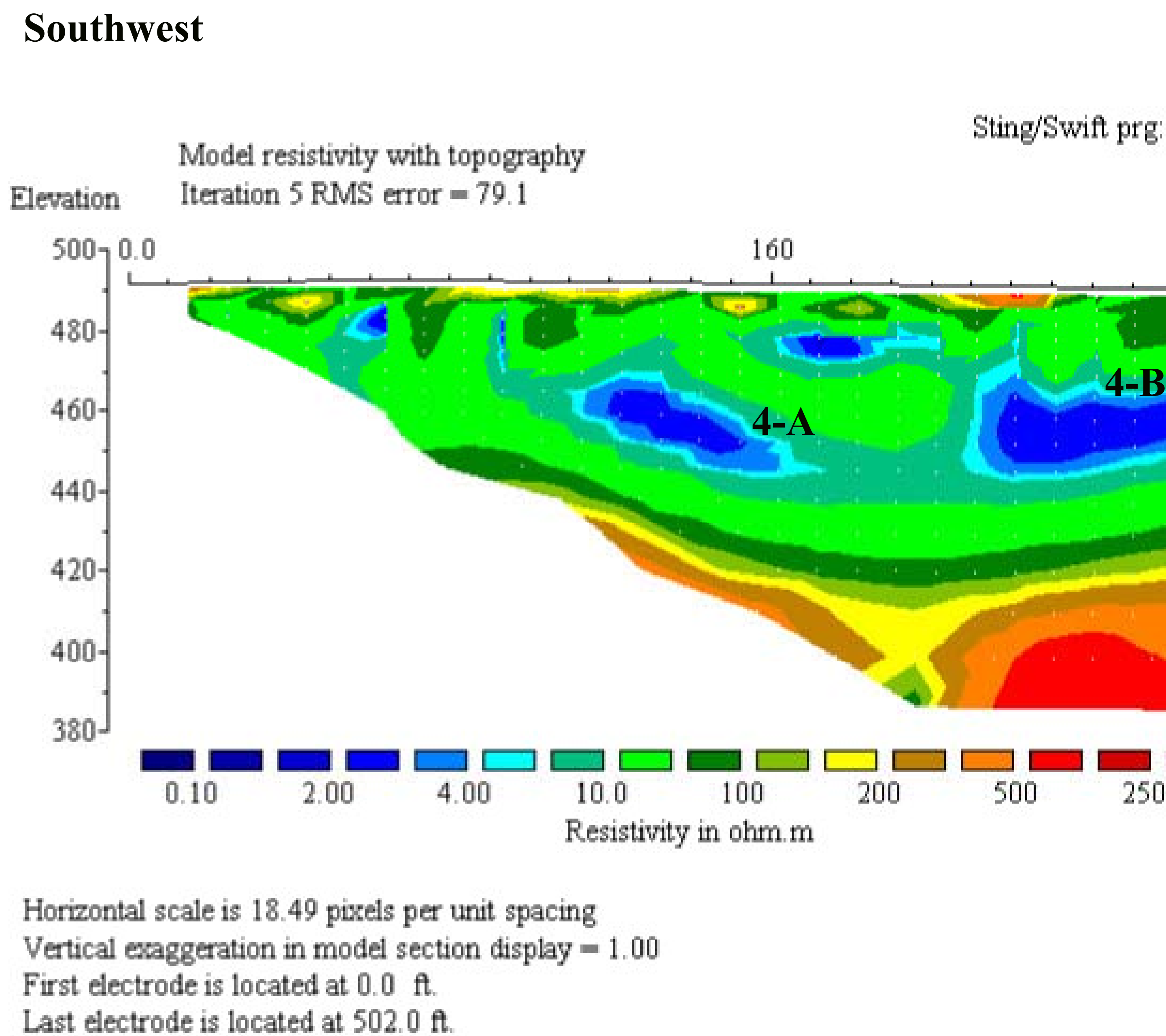
Southwest


Sting/Swift prg: E
Model resistivity with topography
Iteration 6 RMS error = 35.5
Elevation
580
560
540
520
500
480
460
440
420
400
0.0
160
320
2-A
1.00
5.00
25.0
75.0
150
500
1000
3000
Resistivity in ohm.m
Horizontal scale is 8.73 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 708.7 ft.

West

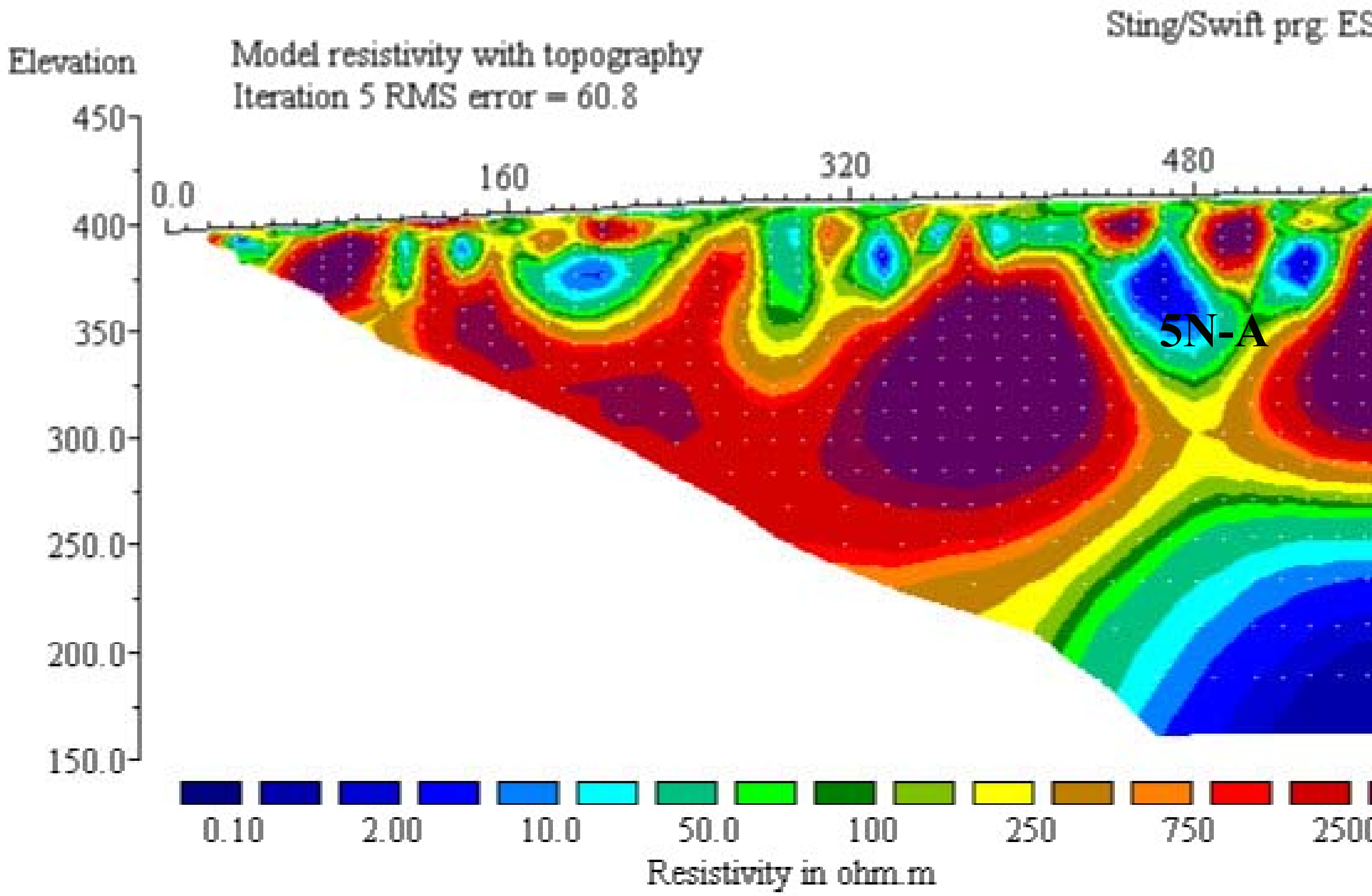


Sting/Swift prg: E
Model resistivity with topography
Iteration 9 RMS error = 10.8
Elevation
560
540
520
500
480
460
440
420
0.0
160
1.00
10.0
50.0
100
300
750
1500
3000
Resistivity in ohm.m
Horizontal scale is 11.50 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 403.5 ft.

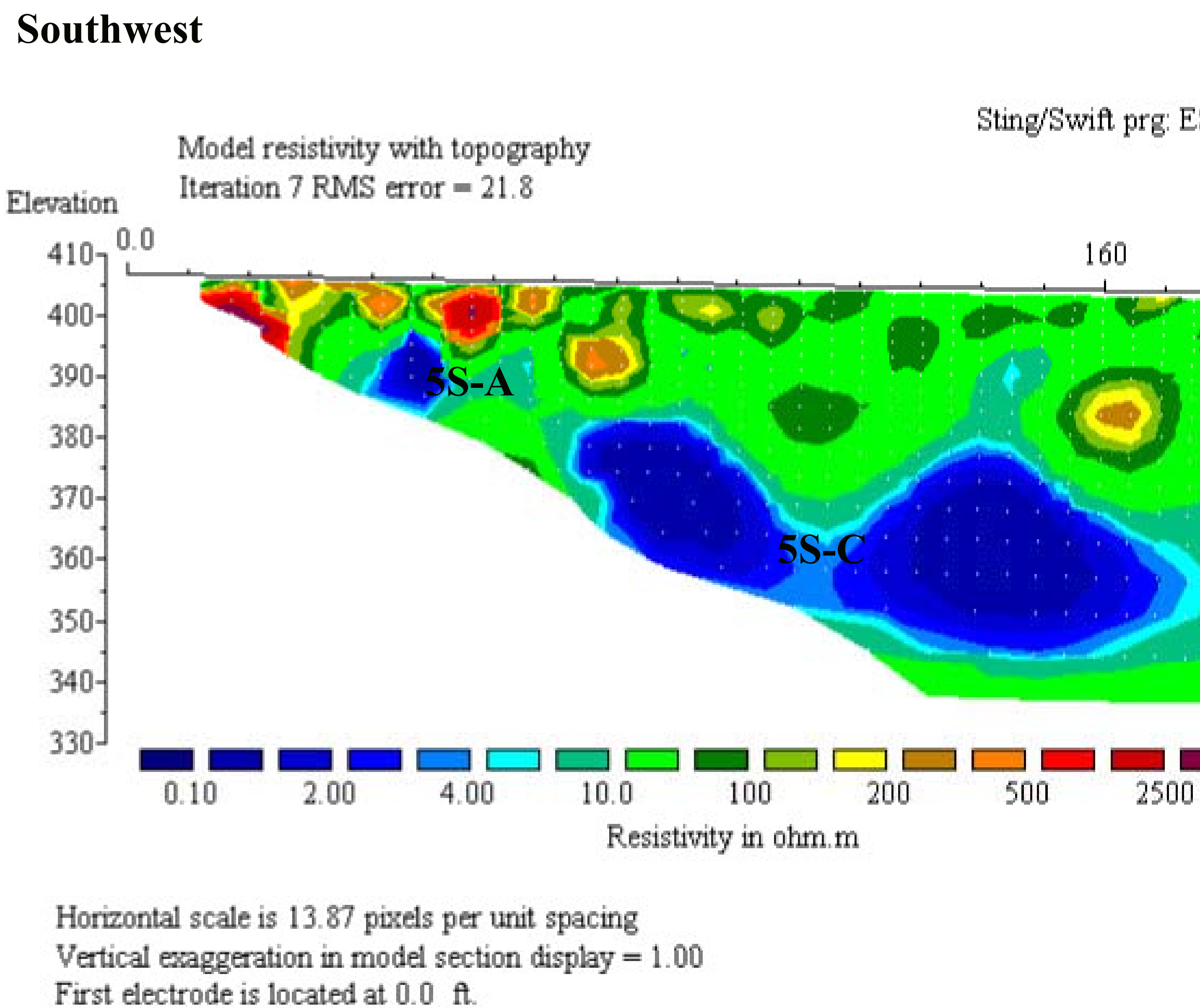


Southwest
Sting/Swift prg:
Model resistivity with topography
Iteration 5 RMS error = 79.1
Elevation
500
480
460
440
420
400
380
0.0
160
4-A
4-B
0.10
2.00
4.00
10.0
100
200
500
250
Resistivity in ohm.m
Horizontal scale is 18.49 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 502.0 ft.

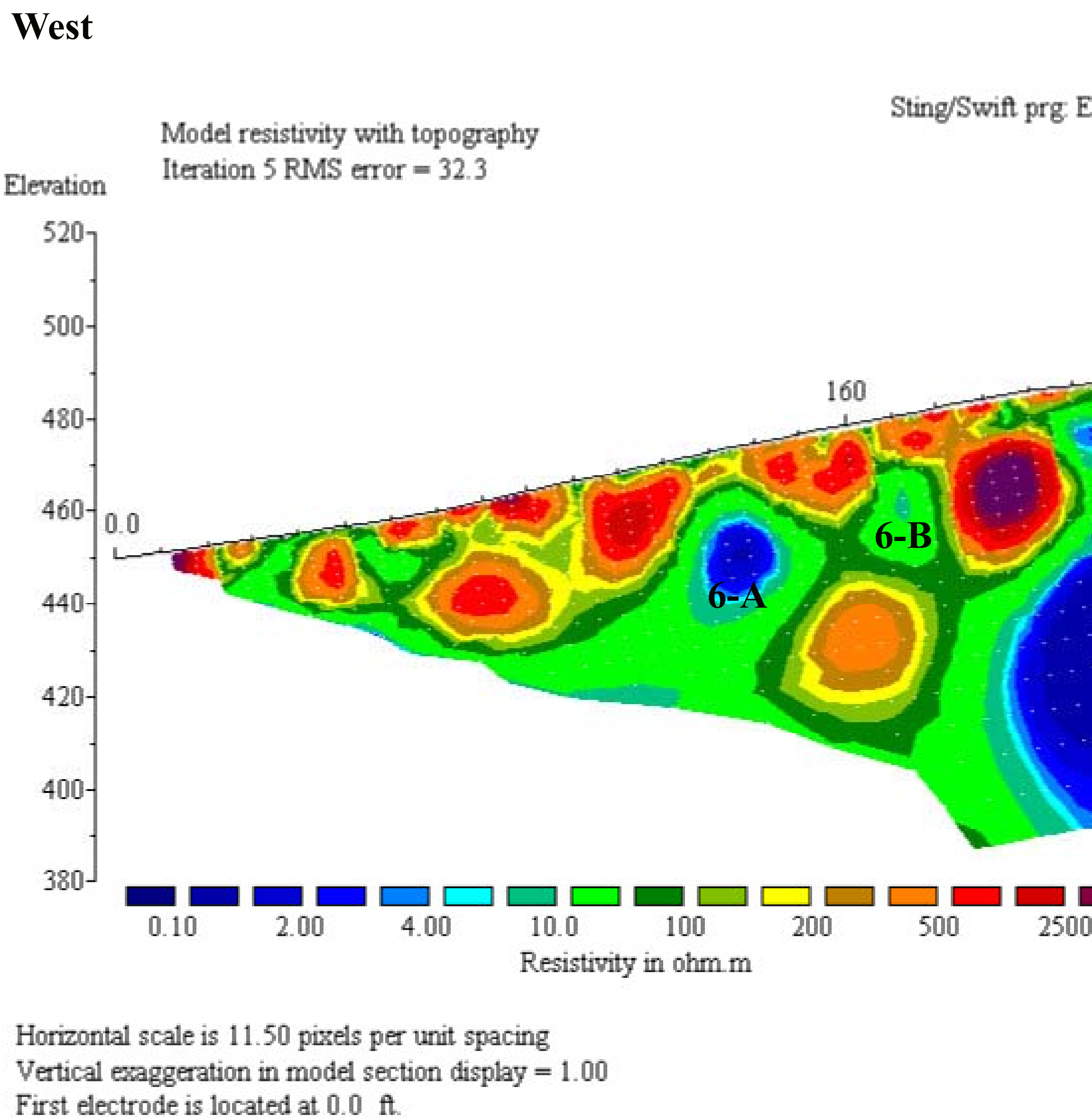
Southwest



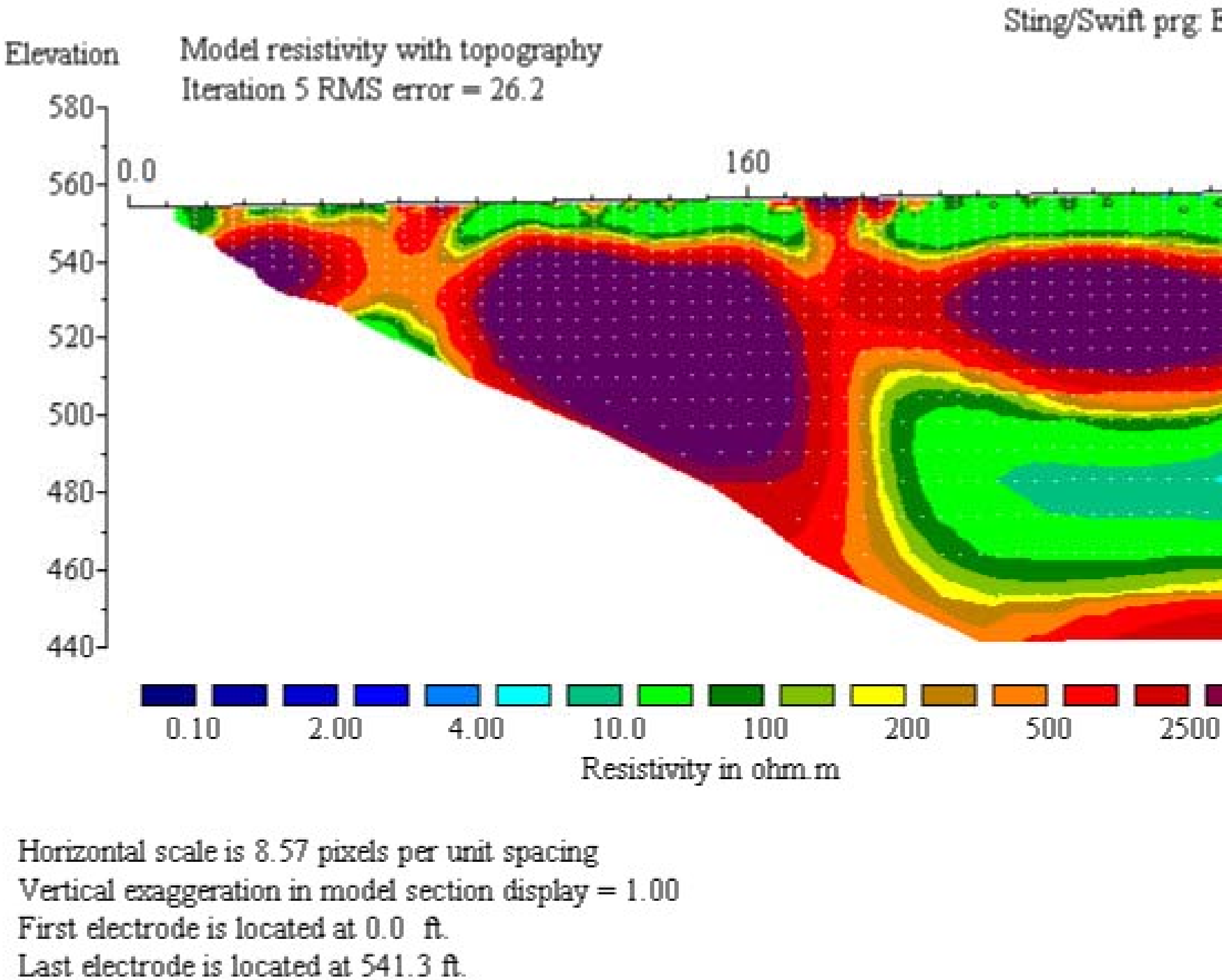
Horizontal scale is 11.35 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 1089.2 ft.

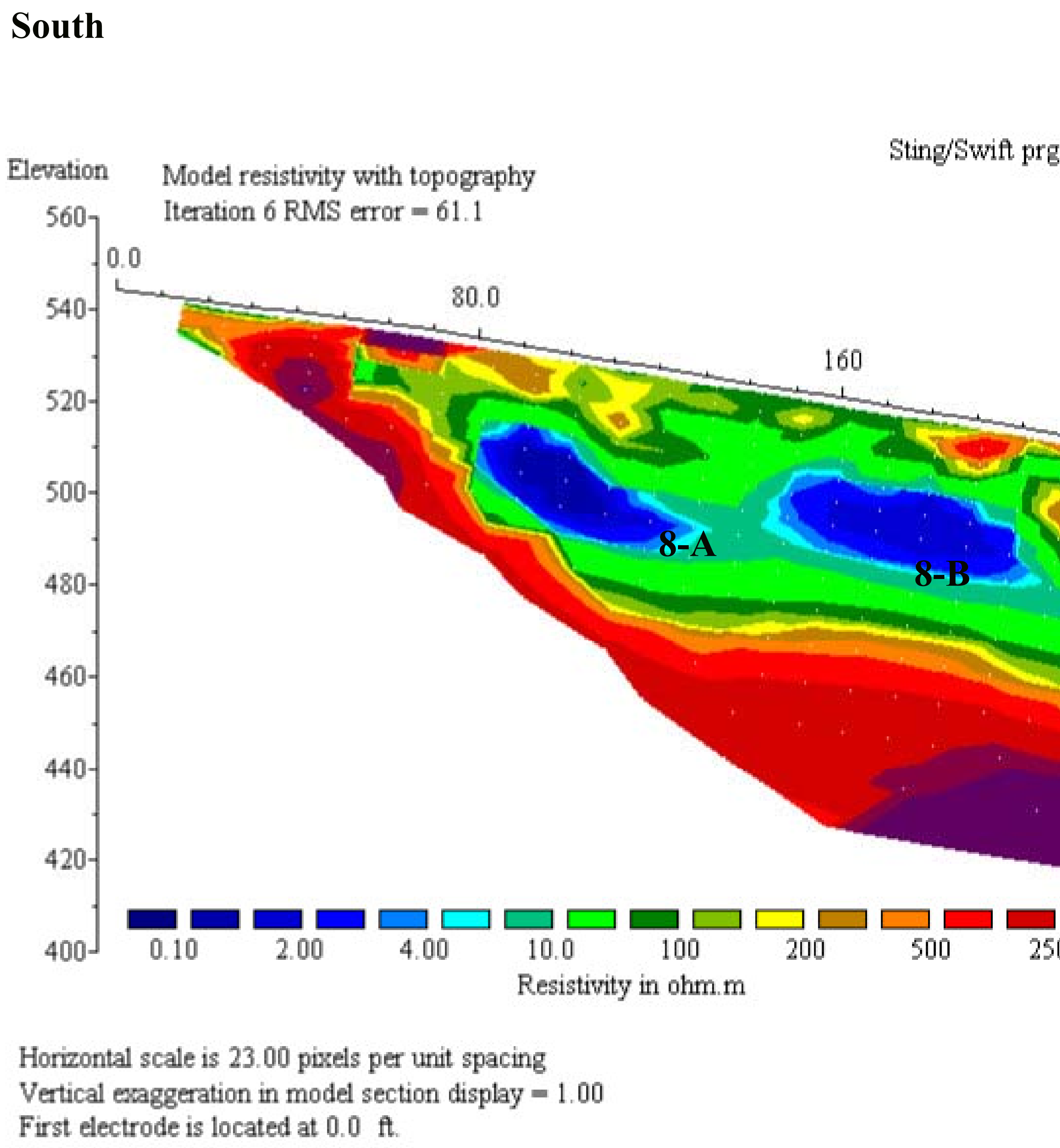


Southwest
Sting/Swift prg: E
Model resistivity with topography
Iteration 7 RMS error = 21.8
Elevation
0.0
160
410
400
390
380
370
360
350
340
330
5S-A
5S-C
0.10
2.00
4.00
10.0
100
200
500
2500
Resistivity in ohm.m
Horizontal scale is 13.87 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.

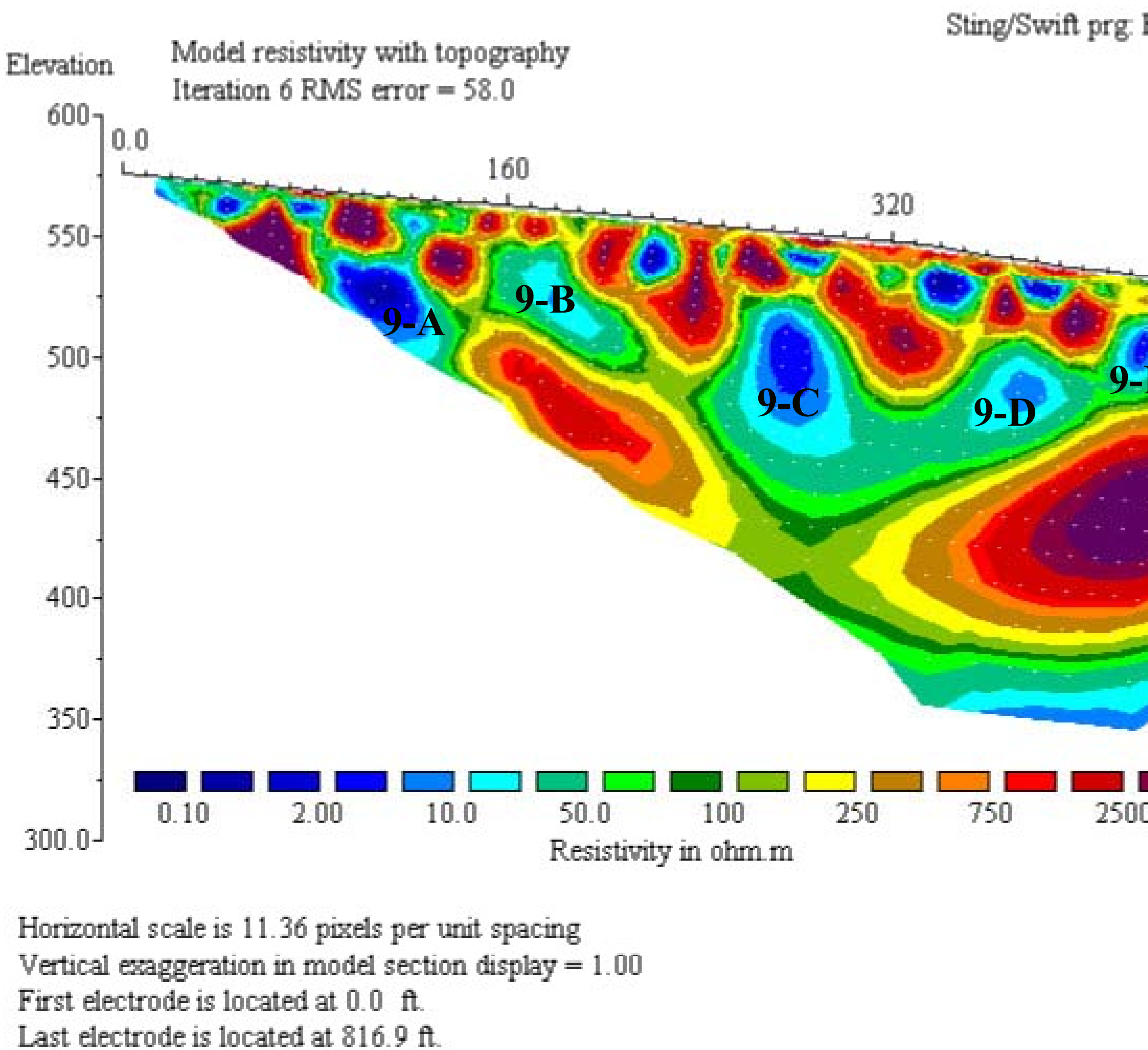

West
Sting/Swift prg: E
Model resistivity with topography
Iteration 5 RMS error = 32.3
Elevation
520
500
480
460
440
420
400
380
0.0
160
6-A
6-B
0.10
2.00
4.00
10.0
100
200
500
2500
Resistivity in ohm.m
Horizontal scale is 11.50 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.

Southwest


Sting/Swift prg: E
Elevation
Model resistivity with topography
Iteration 5 RMS error = 26.2
580
560
540
520
500
480
460
440
0.0
160
0.10
2.00
4.00
10.0
100
200
500
2500
Resistivity in ohm.m
Horizontal scale is 8.57 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 541.3 ft.

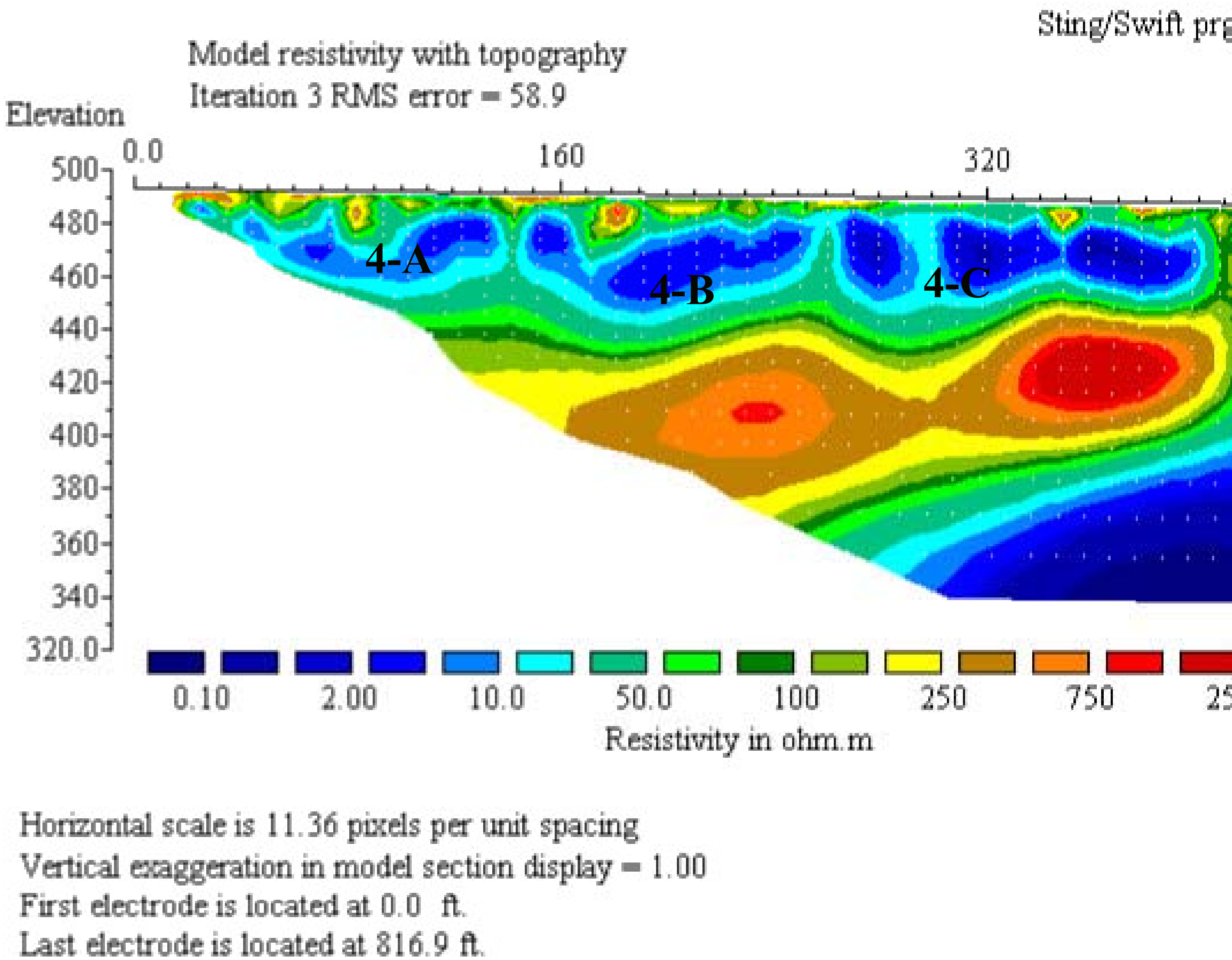

South
Sting/Swift prg
Elevation
Model resistivity with topography
Iteration 6 RMS error = 61.1
560
540
520
500
480
460
440
420
400
0.0
80.0
160
8-A
8-B
0.10
2.00
4.00
10.0
100
200
500
Resistivity in ohm.m
Horizontal scale is 23.00 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.

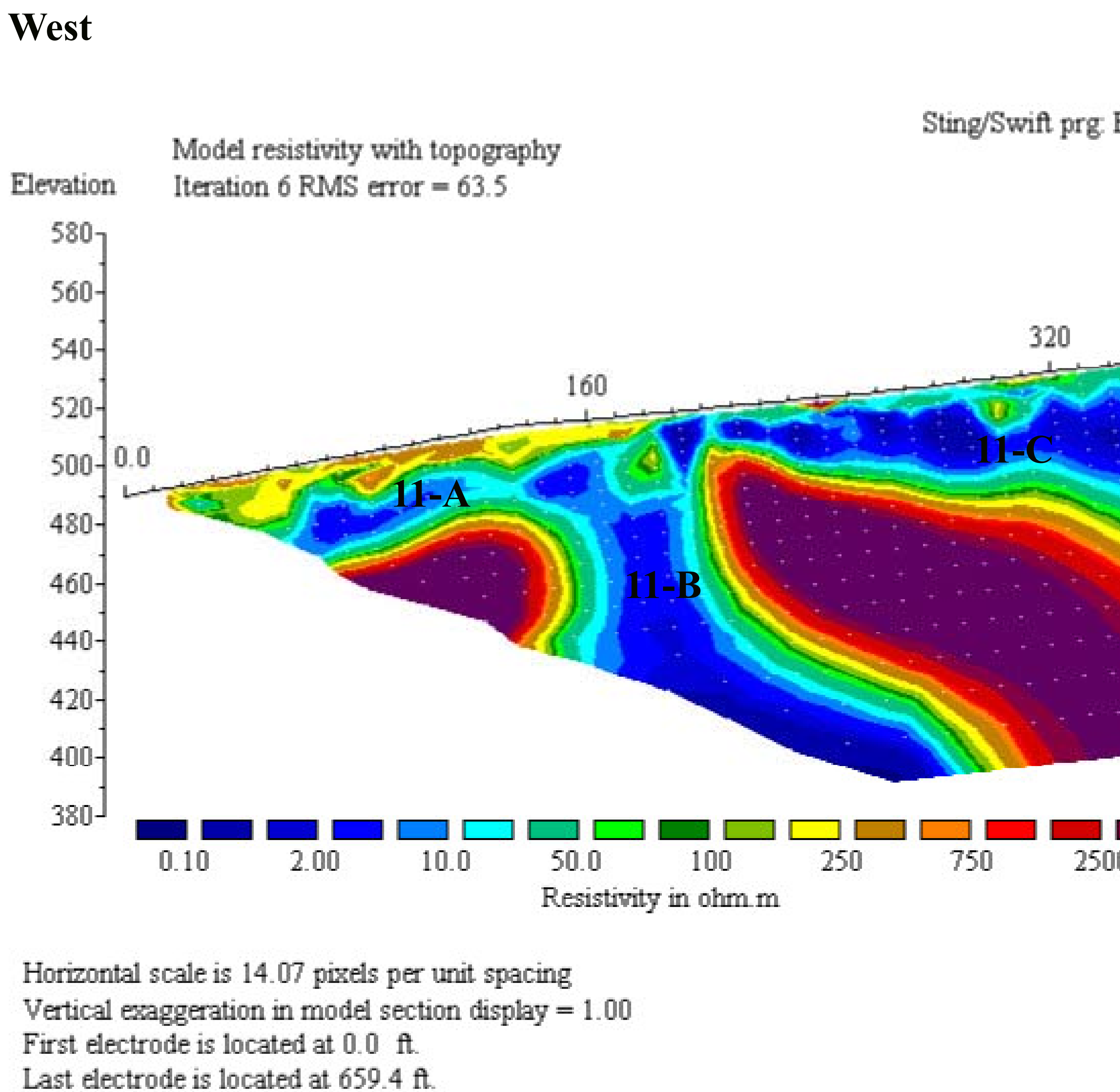
South



Sting/Swift prg:
Elevation
Model resistivity with topography
Iteration 6 RMS error = 58.0
600
550
500
450
400
350
300.0
0.0
160
320
9-A
9-B
9-C
9-D
0.10
2.00
10.0
50.0
100
250
750
Resistivity in ohm.m
Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 816.9 ft.

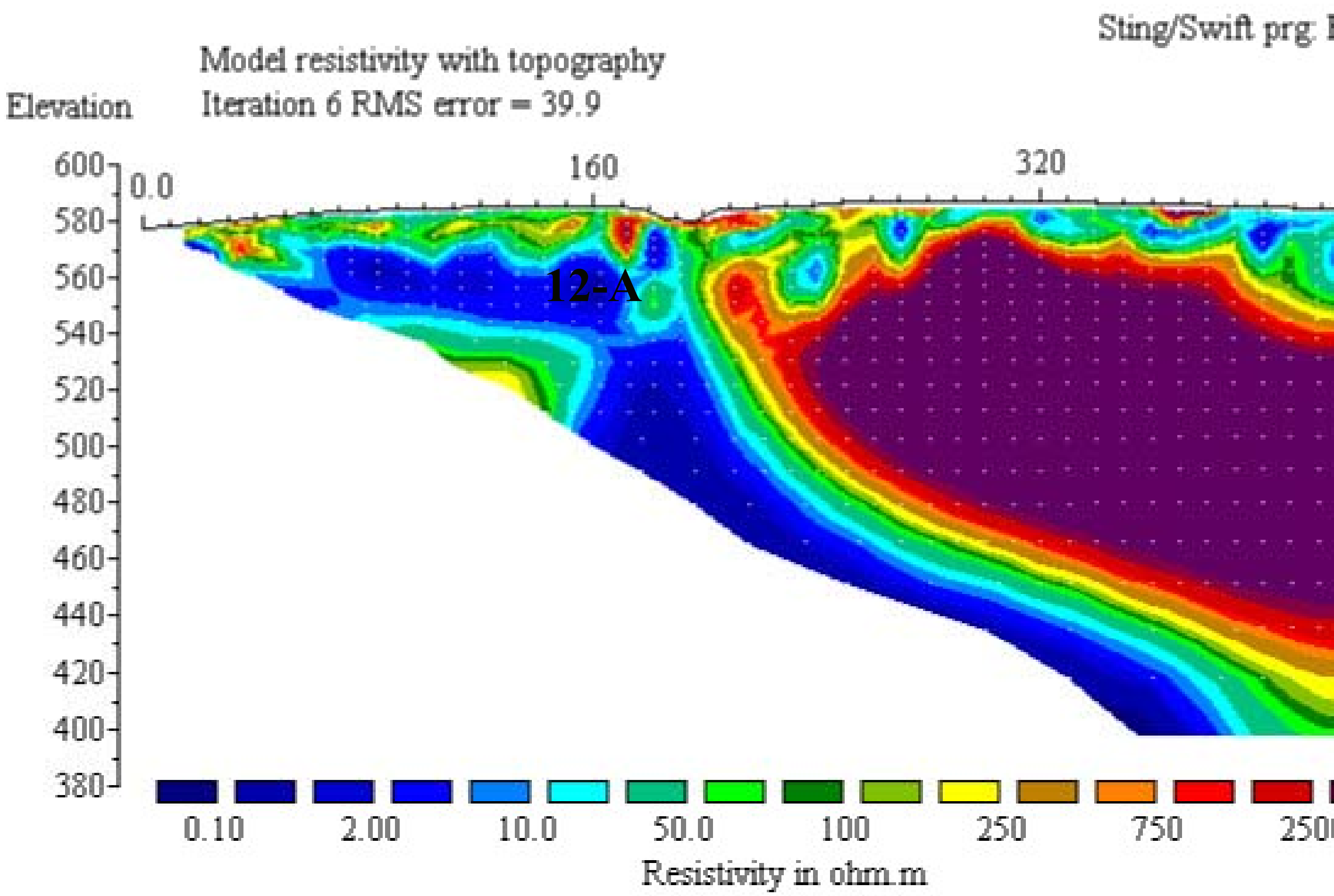
Southwest


Sting/Swift prg
Model resistivity with topography
Iteration 3 RMS error = 58.9
Elevation
0.0
160
320
500
480
460
440
420
400
380
360
340
320.0
4-A
4-B
4-C
0.10
2.00
10.0
50.0
100
250
750
Resistivity in ohm.m
Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 816.9 ft.



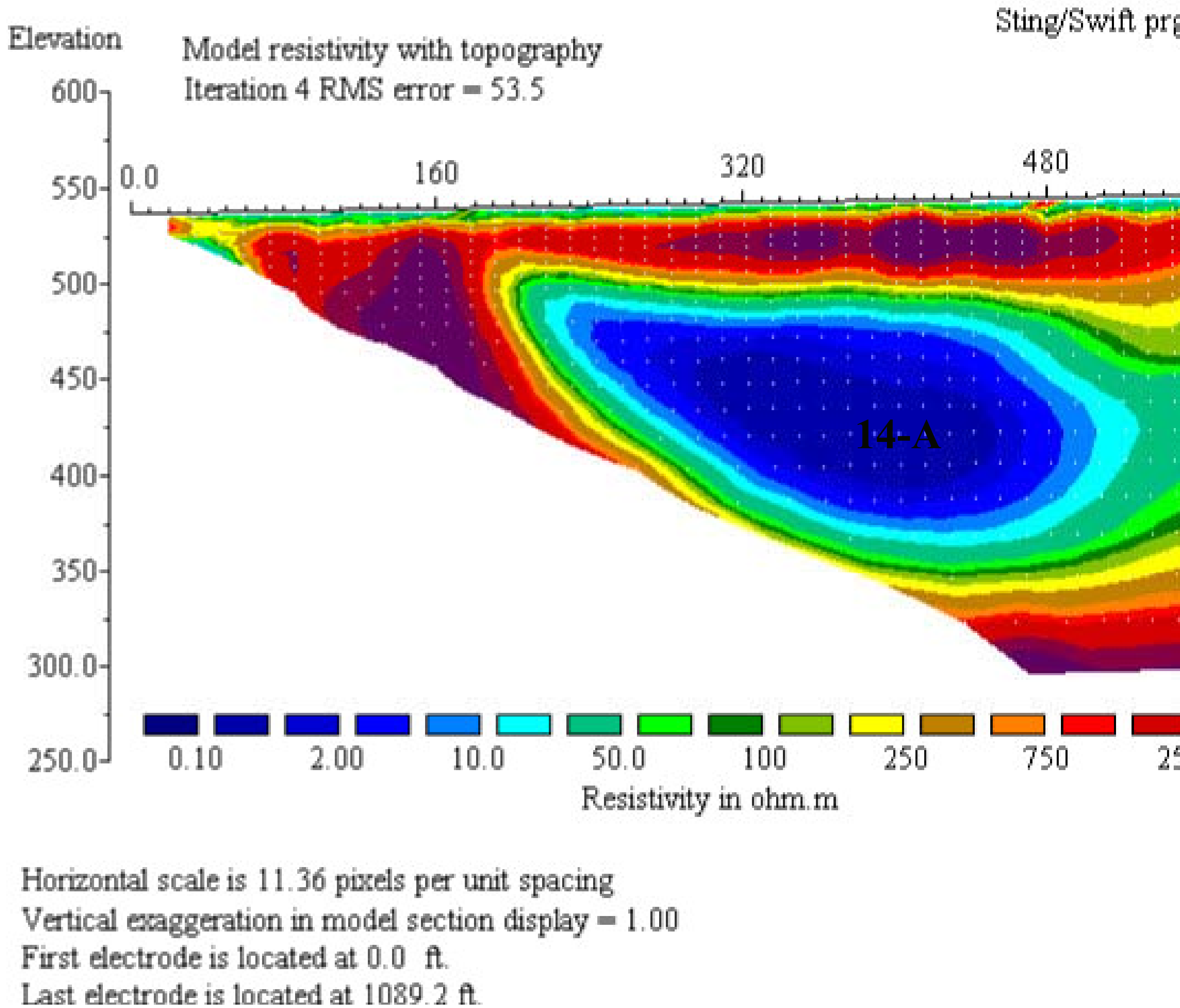
West
Sting/Swift prg: I
Model resistivity with topography
Iteration 6 RMS error = 63.5
Elevation
580
560
540
520
500
480
460
440
420
400
380
0.0
160
320
11-A
11-B
11-C
0.10
2.00
10.0
50.0
100
250
750
2500
Resistivity in ohm.m
Horizontal scale is 14.07 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 659.4 ft.

Southwest



Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 816.9 ft.

Southwest



Sting/Swift pr
Elevation
Model resistivity with topography
Iteration 4 RMS error = 53.5
600
550
500
450
400
350
300.0
250.0
0.0
160
320
480
14-A
0.10
2.00
10.0
50.0
100
250
750
Resistivity in ohm.m
Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 1089.2 ft.

Appendix A – Geophysical Survey Emerson Power Transmission

Geophysical Survey
Emerson Power Transmission
Ithaca, New York

Prepared For:

Environmental Strategies Consulting LLC

5 Sullivan Street

Cazenovia, New York 13035

Prepared By:

Forrest Environmental Services, Inc.

3057 Crosen Court

Oak Hill, Virginia 20171

(703) 648-8090

July 2005

FES Project No. 05156

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1.0 Introduction

Forrest Environmental Services (FES) performed a geophysical survey at the Emerson Power Transmission Site located in Ithaca, New York on the 5th through the 7th July 2005. The survey consisted of an electric resistivity imaging (ER) survey to located saturated fractures that may indicate that the major groundwater path flows to placement of monitor/remediation wells.

Eight northeast-southwest (ER lines 1 North, 1 South, 2, 3, 4, 5 North, 5 South, and 7), one east-west (ER Line 6) and one north-south (ER Line 8) resistivity lines were conducted adjacent to the Emerson Power Transmission plant. The electrode spacing (dipole size) was 3 meters (10 feet) to 4 meters (16.4 feet) for ER lines 1 through 8. The ER lines were placed in areas of accessibility.

ER lines 1 through 8 used 35 to 84 electrodes for a total line length of 335 feet to 1100 feet. The survey covered an area approximately 5,400 linear feet and approximately 10,000 soundings were collected.

Topographically, the site slopes toward the northwest. The site consists mostly of a grassed field with wooded areas to the north. Details of the geophysical survey are described in the following sections.

2.0 Equipment and Procedures

The geophysical survey instrument used during this survey was an earth resistivity meter that maps the resistivity changes in the earth. ER is a fundamental parameter of the material that describes how easily the material can transmit electrical current. High values of resistivity imply that the material is very resistant to the flow of electricity, and low values of resistivity imply that the material transmits electrical current very easily.

The primary factors affecting resistivity of earth materials are porosity, water saturation, clay content, and ionic strength of the pore water. The minerals making up soil and rock generally do not readily conduct electric current. Most of the current flow takes place through the material's pore water in which ER decreases with increasing porosity and water saturation. Clay minerals are conductive because of the availability of free ions in the sheet structure of the clay particles in which ER decreases with increasing clay content. Similarly, dissolved ions in groundwater make the water more conductive to electrical current in which ER decreases with increasing ionic strength.

The ER survey was conducted by introducing a measured current into the earth through two adjacent electrodes and measuring the resultant voltage across two different electrodes at a predetermined distance apart. The voltage across two other electrodes is measured simultaneously with the applied current. At the low currents used, voltage is proportional to the current. The meter measures the voltage/current ratio or resistance in Ohms.

The ER survey was conducted using a Sting R8 earth resistivity meter (Sting), which measures the apparent resistivity of the subsurface employing an artificial source that is introduced through point electrodes. The Sting measures electrical potentials at other electrodes.

The Swift automatic electrode system (Swift) was connected to the Sting to optimize survey efficiency by gathering maximum information with a minimum of electrodes. The Swift also uses redundancies in the data set to reduce the effects of lateral heterogeneities in the earth and to calculate uncertainties in the data. The survey was conducted automatically using the Sting/Swift dipole-dipole array system.

A contact resistance test was conducted before the Sting/Swift dipole-dipole survey commenced. The contact resistance test ensures the stake has good contact with the ground. The Sting produces a current between the first two stakes and measures the voltage. The instrument measures the resistance between the first and second stakes and the ground. The contact resistance is also checked for the measurements consistent for all of the 84 electrodes.

The Swift cable resistance checks the voltage difference signal between two electrodes. Four leads of the Swift cable using two electrodes send a current through a 1 ohm resistor in the Swift box. The test is checked before the first ER survey and after the last ER line for each day.

The Swift switch relays test is performed to check the Swift box is continuous and the relays in the electrodes are working properly. A current is sent through each lead in the Swift cable to make sure the relays are functioning properly and there is no leakage between leads, and to test the relays for sticking. The test is checked before the first ER survey and after the last ER line for each day.

The depth of investigation by Sting is a function of the total distance of the electrode layout was between 335 feet for ER Line 5 South to 1,100 feet for ER Line 1 North and ER Line 5 North. The Sting has an effective analysis depth of approximately 60 to 250 feet using a 3 meter (10 feet) to 4 meters (16 feet) electrode spacing. This depth is considered sufficient to locate resistive areas that appear to be saturated zones at the Emerson Power Transmission site.

3.0 Interpretation Methods

The ER data were converted into a resistivity depth model using Rapid 2D resistivity inversion model and the least-squares method (RES2DINV). Soundings from each line were modeled to produce the measured apparent resistivity cross-sections. The model calculated the apparent resistivity cross-sections using finite-difference forward modeling. The least-squares optimization technique was used for the inversion routine that calculated the modeled resistivity section. The ER output consists of the inverse model resistivity cross-section. The model fits the measured data to an earth model that represents actual resistivities in the profile. The model is completed by back calculating apparent resistivities from the earth model for comparison to the measured data. The horizontal and vertical scales are in feet.

The cross-section is the inverse model resistivity pseudo-section. The ER data was converted into a resistivity depth model (RES2DINV) using a resistivity inversion model by the least-squares method and is topographically corrected. The ground surface elevations were determined by interpolating between contours on the site plan provided by Environmental Strategies Consulting LLC. RES2DINV confirms the model reliability by calculating the modeled data into empirical data or the calculated resistivity pseudo-section. The difference between the measured and calculated data is the root mean square percent error. The modeled calculated mean root square error averaged approximately 10 rms error which is considered accurate.

Resistive materials resist the flow of electrical current such as sand and gravel. Conductive materials are media that current flows relatively easy such as clay.

Low resistive materials can be caused by certain conductive soils such as clay. High resistive materials are caused generally by wood and air. Low ER values represent thick overburden. Lower ER anomalies are generally found over saturated mine shafts.

Typical resistivities of the overburden (clay) are 100 ohm meters (blue). Bedrock resistivities typically range from 200 (green) to 5,000 (red) ohm meters. The saturated zones resistivities typically measure approximately 50 ohm meters (dark blue).

4.0 Survey Results

The objective of the ER survey was to locate saturated fractures that may indicate the major groundwater path flows. ER cross-sections are provided in Appendix A. The horizontal scale is in meters. The vertical scale is in meters above mean sea level (msl).

ER Line 1 North indicates three conductive anomalies centered at approximately 350 feet Northeast, 660 feet Northeast, and 870 feet North approximately 100 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 1 South indicates three shallow conductive anomalies centered at approximately 120 feet Northeast, 260 feet Northeast, 330 feet Northeast, and 730 feet Northeast approximately 60 feet below ground surface. One deeper conductive anomaly is centered at approximately 320 feet Northeast approximately 150 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 2 indicates four conductive anomalies centered at approximately 240 feet Northeast, 410 feet Northeast, 510 feet Northeast, and 560 feet Northeast approximately 40 feet to 60 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 3 indicates one conductive anomaly centered at approximately 170 feet Northeast approximately 100 feet below ground surface. The conductive anomalies appear to be a saturated fracture.

ER Line 4 indicates three conductive anomalies centered at approximately 140 feet Northeast, 250 feet Northeast, and 350 feet East approximately 40 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 5 North indicates two shallow conductive anomalies centered at approximately 490 feet Northeast and 870 feet Northeast approximately 40 feet below ground surface. One deeper conductive anomaly is centered at approximately 320 feet Northeast approximately 200 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 5 South indicates two shallow conductive anomalies centered at approximately 50 feet Northeast and 170 feet Northeast approximately 30 feet below ground surface. Two deeper conductive anomalies are centered at approximately 150 feet Northeast and 220 feet Northeast approximately 50 feet below ground surface. The conductive anomalies appear to be saturated fractures.

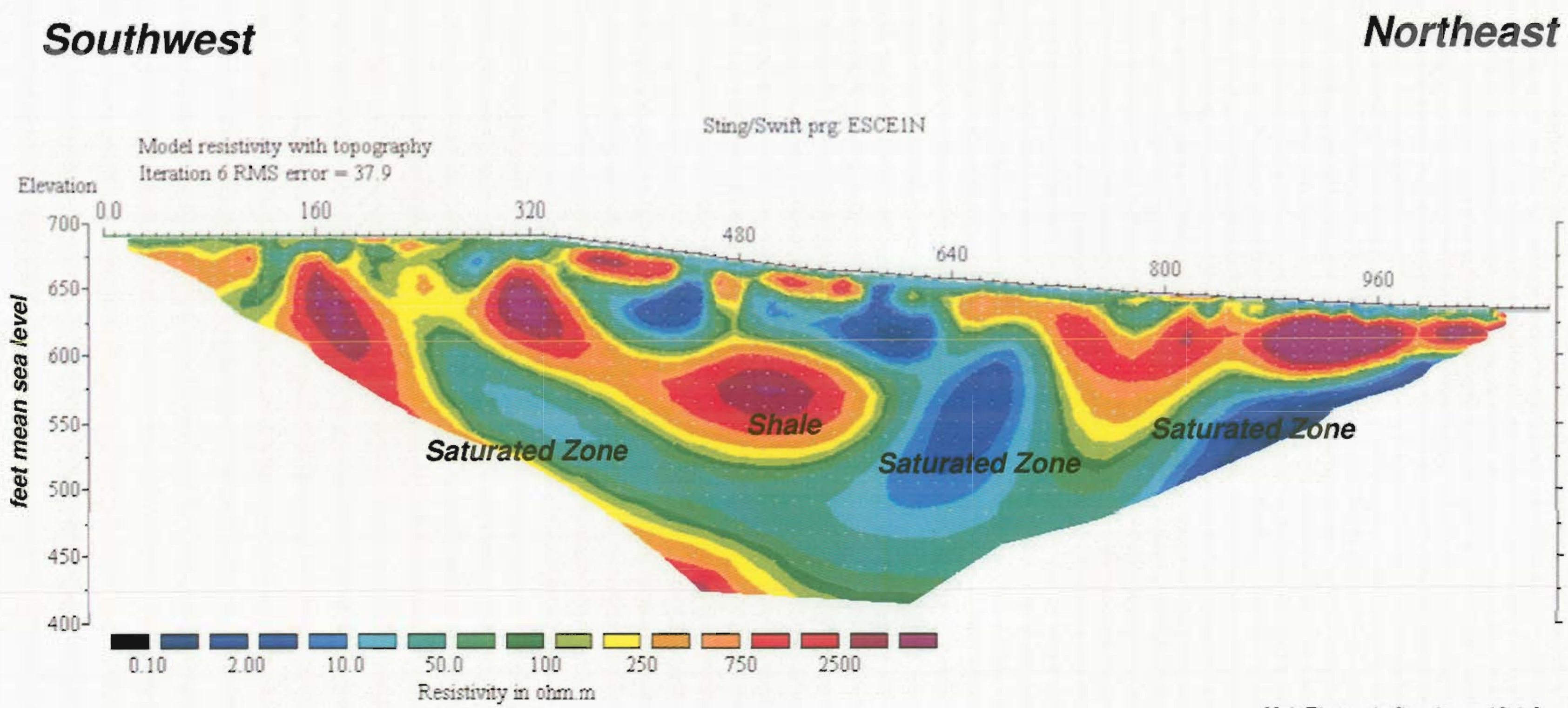
ER Line 6 indicates four shallow conductive anomalies centered at approximately 140 feet East, 250 feet East, 290 feet East, and 340 feet East approximately 20 feet below ground surface. One deeper conductive anomaly is centered at approximately 220 feet East approximately 50 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 7 indicates one conductive anomaly centered at approximately 340 feet Northeast approximately 80 feet below ground surface. The conductive anomaly appears to be a saturated fracture.

ER Line 8 indicates four anomalies centered at approximately 110 feet North, 180 feet North, 270 feet North, and 340 feet North approximately 50 feet below ground surface. The conductive anomalies appear to be saturated fractures.

Appendix A

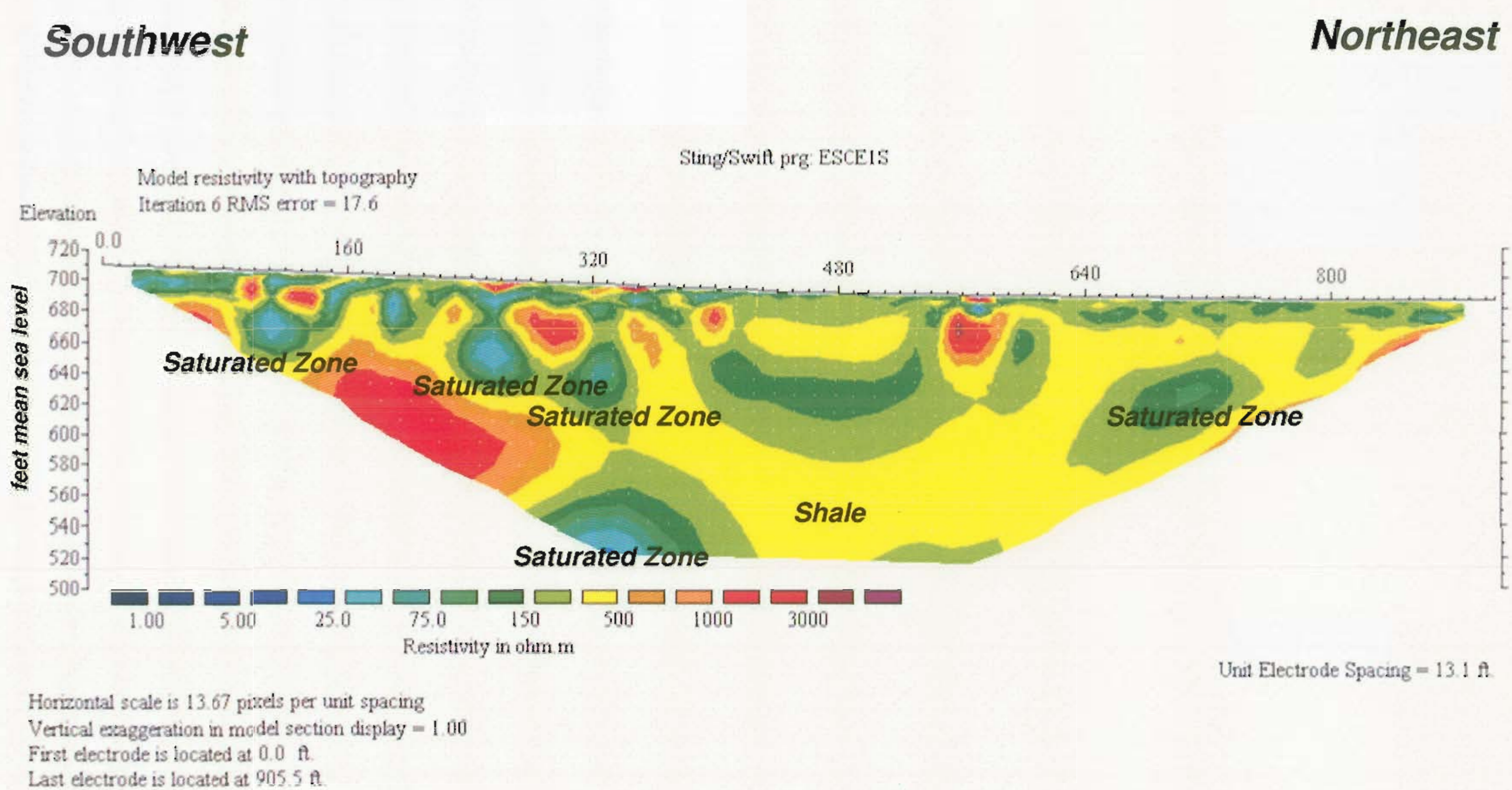
ER Cross-Sections



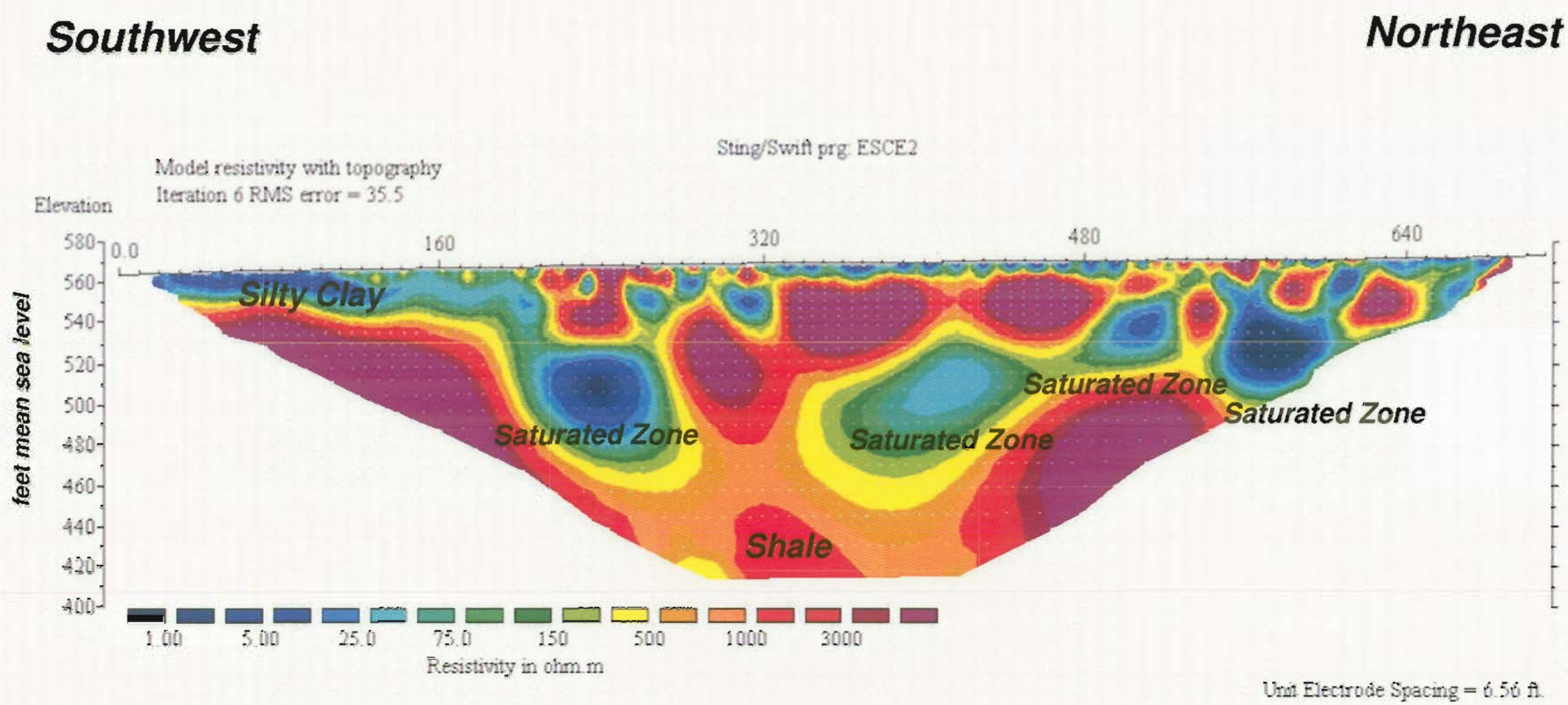
Unit Electrode Spacing = 13.1 ft.

Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 1089.2 ft.

Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE July 2005	SCALE shown in feet	TITLE ER Line 1 North Emerson Power Transmission Ithaca, New York	
	DRAWN BY	APPROVED BY		
	JOB NO. 05156	DWG. NO./REV. NO. ESCE1N.SRF	CLIENT Environmental Strategies Consulting LLC	FIGURE



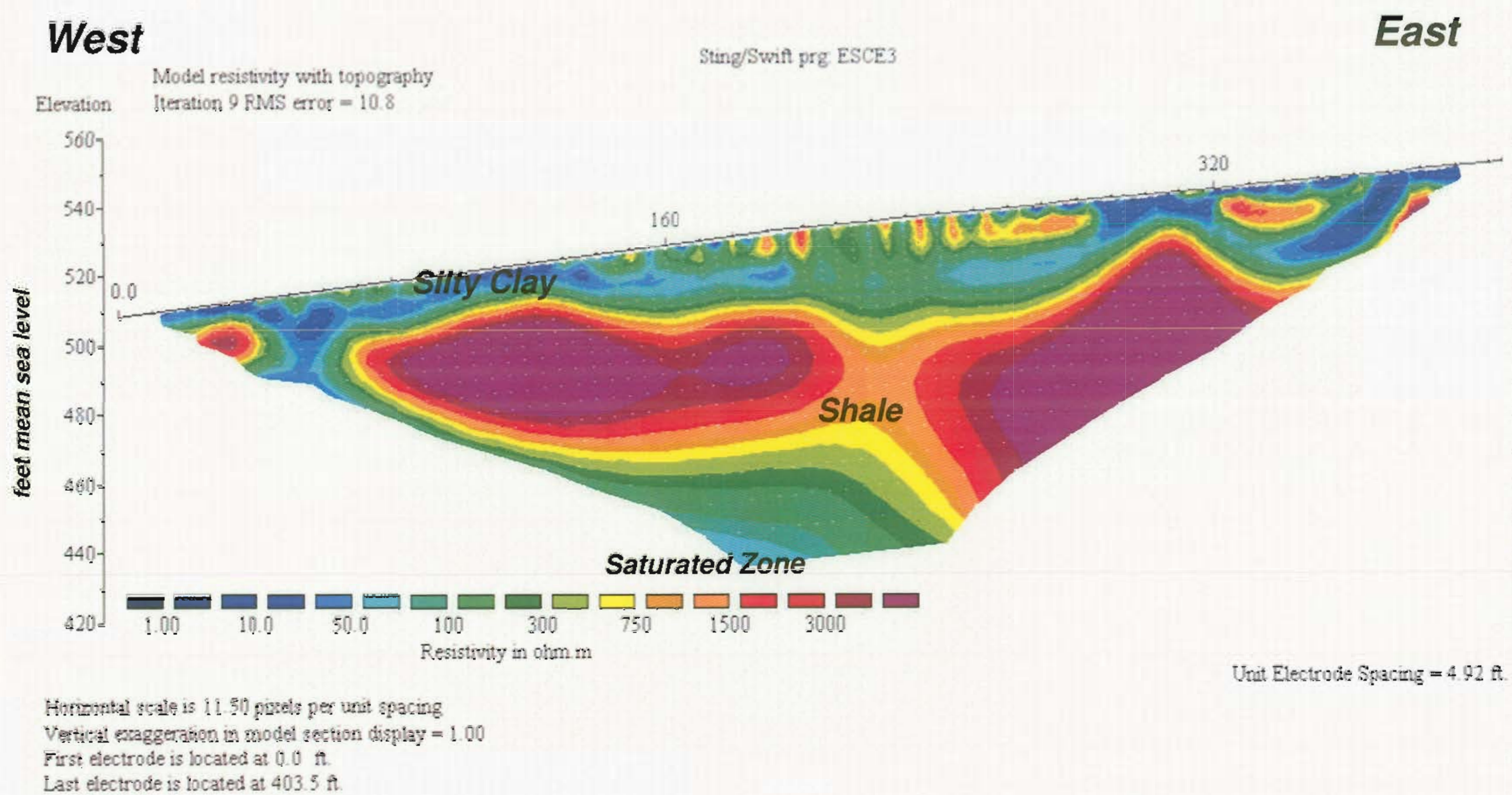
Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE July 2005	SCALE shown in feet	TITLE *ER Line 1 South* *Emerson Power Transmission* *Ithaca, New York*
	DRAWN BY	APPROVED BY	
	JOB NO. 05156	DWG. NO./ REV. NO. ESCE1S.SRF	CLIENT Environmental Strategies Consulting LLC



Horizontal scale is 8.73 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 708.7 ft.

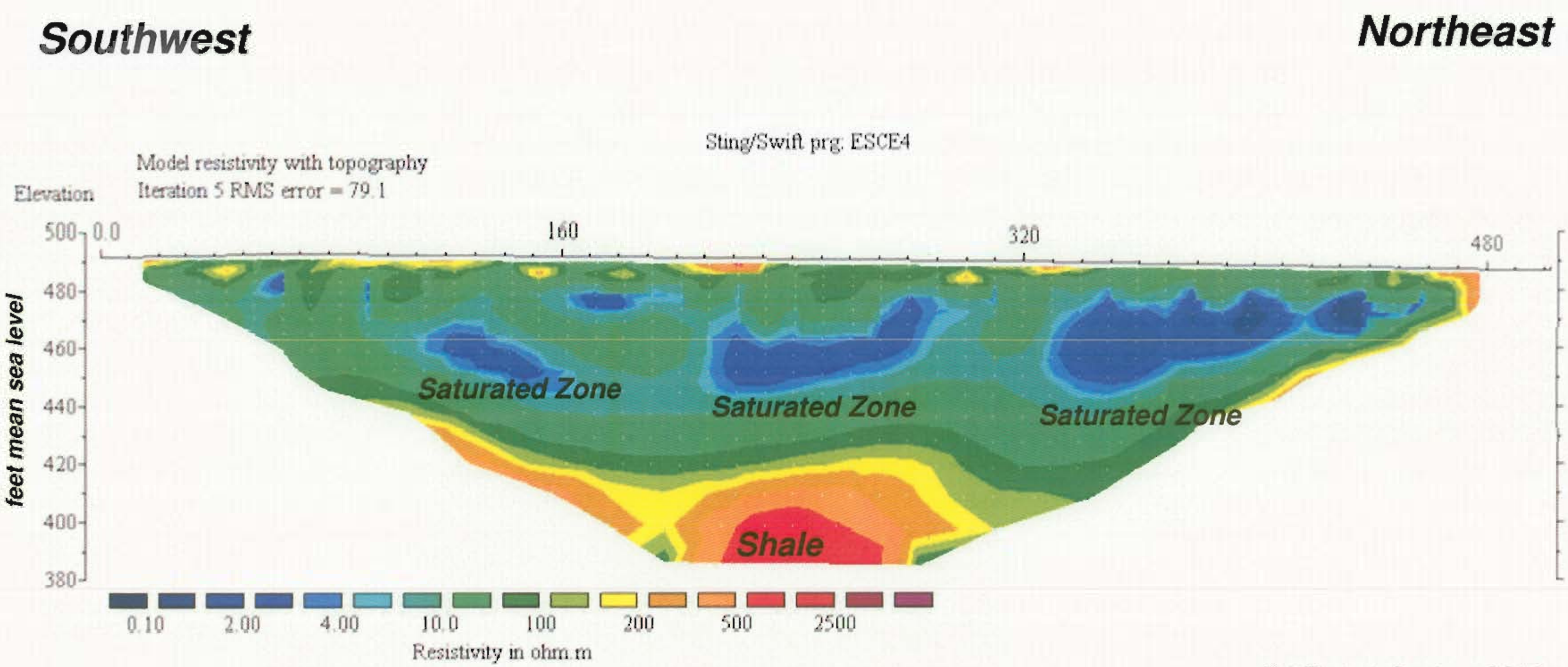
Forrest Environmental Services, Inc.
Oak Hill, Virginia
(703) 648-9090
www.fesinc.net

DATE	SCALE	TITLE
July 2005	shown in feet	*ER Line 2*
DRAWN BY	APPROVED BY	*Emerson Power Transmission*
		Ithaca, New York
JOB NO. 05156	DWG. NO./REV. NO. ESCE2.SRF	CLIENT Environmental Strategies Consulting LLC
FIGURE		



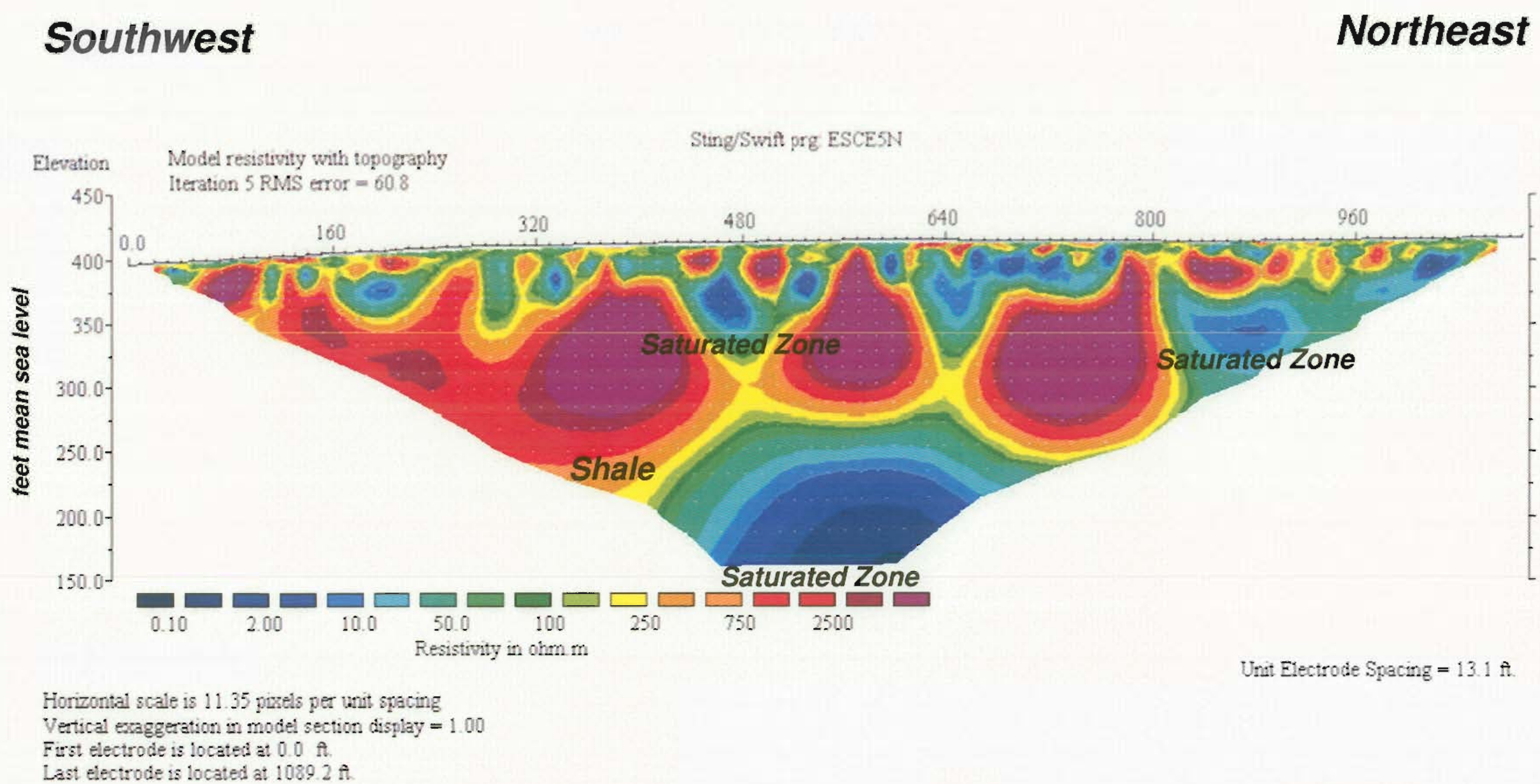
Forrest Environmental Services, Inc.
Oak Hill, Virginia
(703) 648-9090
www.fesinc.net

DATE: July 2005	SCALE: shown in feet	TITLE: *ER Line 3 Emerson Power Transmission Ithaca, New York*	
DRAWN BY	APPROVED BY		
JOB NO.: 05156	DWG. NO./REV. NO.: ESCE3.SRF	CLIENT: Environmental Strategies Consulting LLC	FIGURE



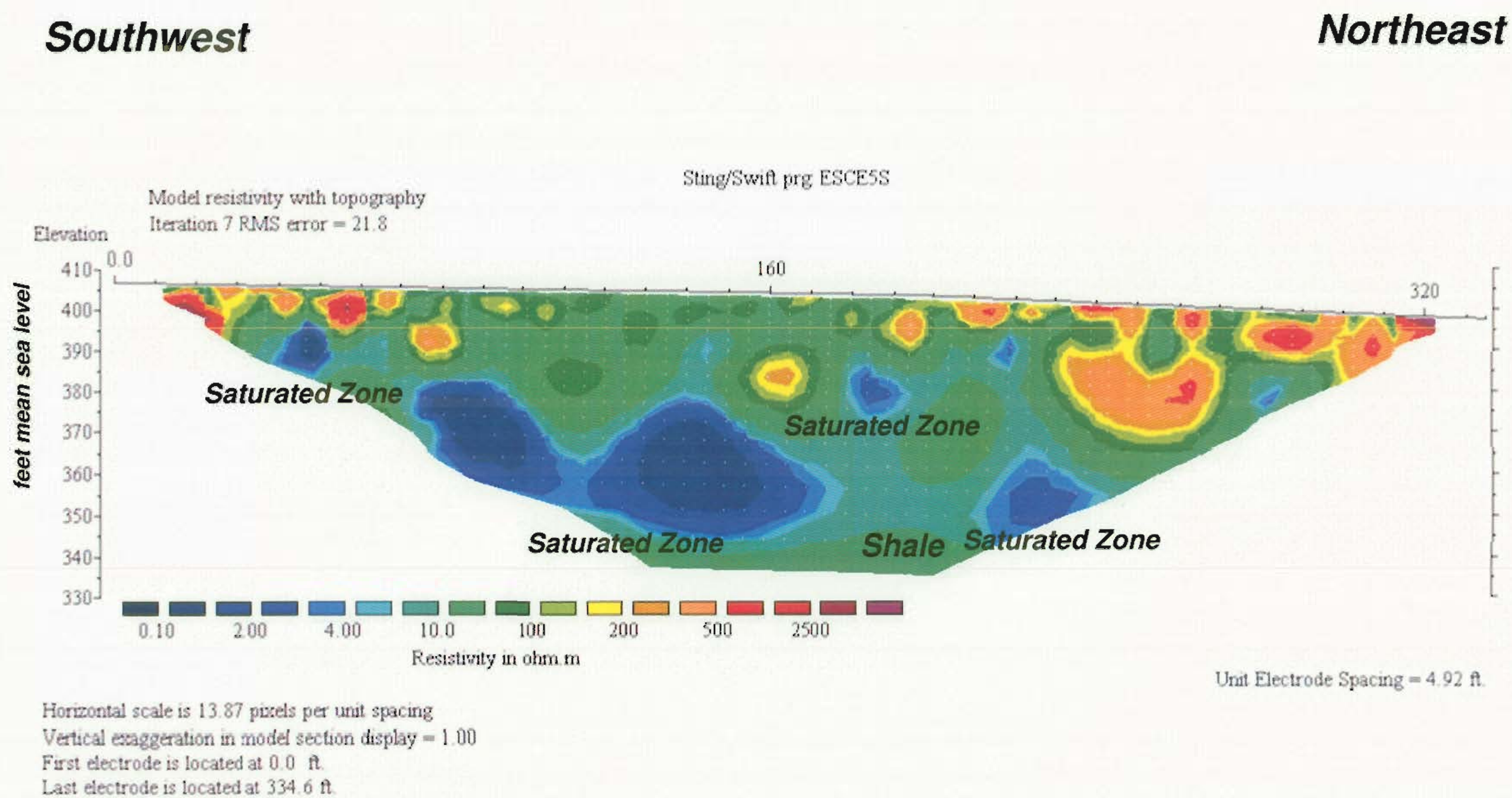
Horizontal scale is 18.49 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 502.0 ft.

Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE July 2005	SCALE shown in feet	TITLE *ER Line 4* *Emerson Power Transmission* *Ithaca, New York*	
	DRAWN BY	APPROVED BY		
	JOB NO. 05156	DWG. NO./ REV. NO. ESCE4.SRF	CLIENT Environmental Strategies Consulting LLC	FIGURE



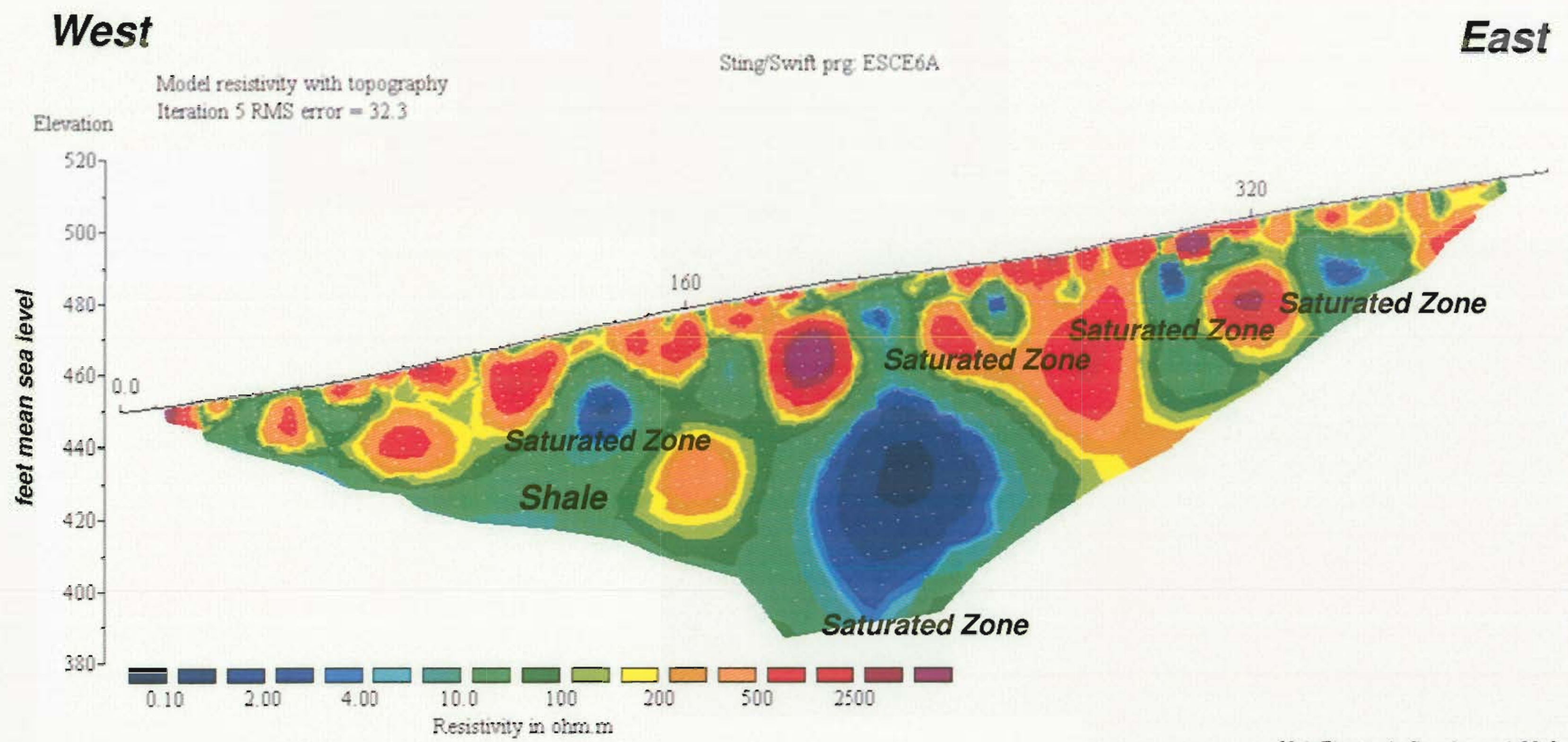
Forrest Environmental Services, Inc.
Oak Hill, Virginia
(703) 648-9090
www.fesinc.net

DATE	SCALE	TITLE
July 2005	shown in feet	*ER Line 5 North* *Emerson Power Transmission* *Ithaca, New York*
DRAWN BY	APPROVED BY	
JOB NO. 05156	DWG. NO./ REV. NO. ESCE5N.SRF	CLIENT Environmental Strategies Consulting LLC
		FIGURE



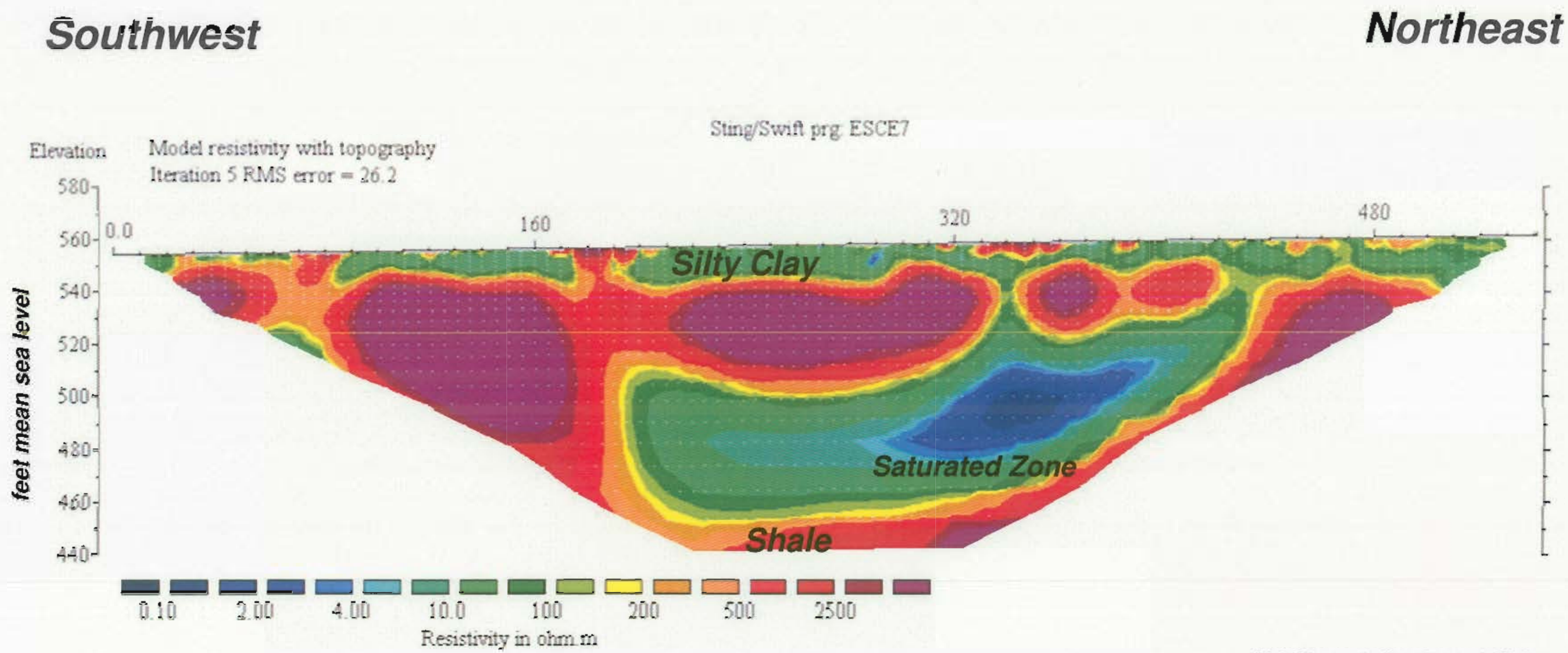
Forrest Environmental Services, Inc.
Oak Hill, Virginia
(703) 648-9090
www.fesinc.net

DATE	SCALE	TITLE
July 2005	shown in feet	*ER Line 5 South* *Emerson Power Transmission* *Ithaca, New York*
DRAWN BY	APPROVED BY	
JOB NO. 05156	DWG. NO./REV. NO. ESCE5S.SRF	CLIENT Environmental Strategies Corporation LLC
		FIGURE



Horizontal scale is 11.50 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.

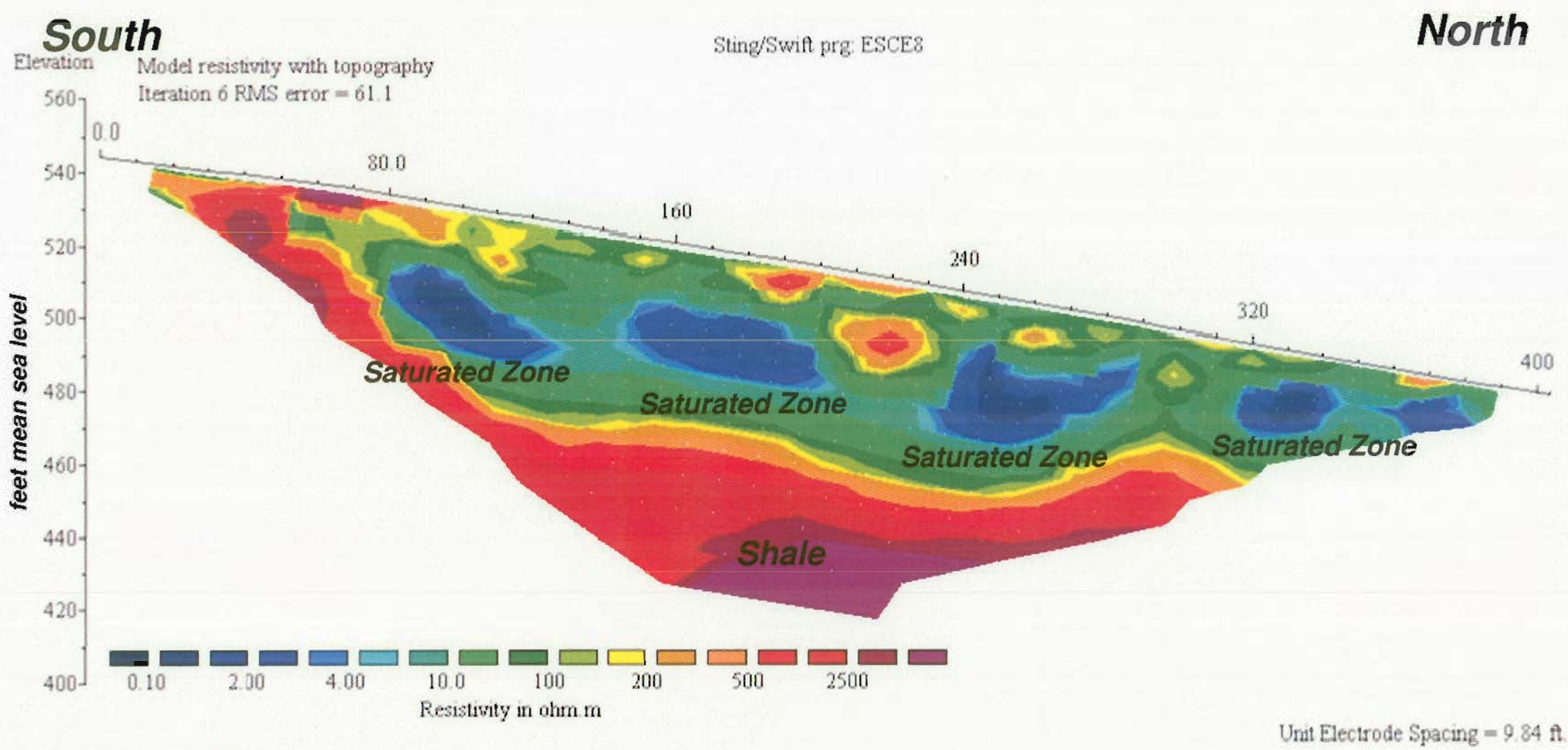
Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE July 2005	SCALE shown in feet	TITLE *ER Line 6* *Emerson Power Transmission* *Ithaca, New York*
	DRAWN BY	APPROVED BY	
	JOB NO. 05156	DWG. NO./ REV. NO. ESCE6.SRF	CLIENT Environmental Strategies Consulting LLC / FIGURE



Unit Electrode Spacing = 4.92 ft.

Horizontal scale is 8.57 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 541.3 ft.

Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE July 2005	SCALE shown in feet	TITLE ER Line 7 Emerson Power Transmission Ithaca, New York
	DRAWN BY	APPROVED BY	
	JOB NO. 05156	DWG. NO./ REV. NO. ESCE7.SRF	CLIENT Environmental Strategies Consulting LLC; FIGURE



Horizontal scale is 23.00 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 403.5 ft.

Forrest Environmental Services, Inc.
Oak Hill, Virginia
(703) 648-9090
www.fesinc.net

DATE	SCALE	TITLE
July 2005	shown in feet	*ER Line 8* *Emerson Power Transmission* *Ithaca, New York*
DRAWN BY	APPROVED BY	
JOB NO. 05156	DWG. NO./ REV. NO. ESCE8.SRF	CLIENT Environmental Strategies Consulting LLC
		FIGURE

Geophysical Survey Phase 2
Emerson Power Transmission
Ithaca, New York

Prepared For:

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October 2005

FES Project No. 05197

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1.0 Introduction

Forrest Environmental Services (FES) performed an additional geophysical survey at the Emerson Power Transmission Site located in Ithaca, New York on the 27th and 28th September 2005. The survey in July 2005 consisted of eight electric resistivity (ER) lines to located saturated fractures that may indicate that the major groundwater path flows to placement of monitor/remediation wells. The additional geophysical survey was to increase the coverage at the southwestern and northern section of the study area.

Three northeast-southwest (ER lines 10, 12, and 14), one east-west (ER Line 11), and one north-south (ER Line 9) resistivity lines were conducted adjacent to the Emerson Power Transmission plant. The electrode spacing (dipole size) was 3 meters (10 feet) to 4 meters (16.4 feet) for ER lines 9 through 14. The ER lines were placed in areas of accessibility.

ER lines 9 through 12 and 14 used 70 to 84 electrodes for a total line length of 660 feet to 1,300 feet. The survey covered an area approximately 4,200 linear feet and approximately 7,200 soundings were collected.

Topographically, the site slopes toward the northwest. The site consists mostly of a grassed areas and asphalt roads with wooded areas to the southwest. Details of the geophysical survey are described in the following sections.

2.0 Equipment and Procedures

The geophysical survey instrument used during this survey was an earth resistivity meter that maps the resistivity changes in the earth. ER is a fundamental parameter of the material that describes how easily the material can transmit electrical current. High values of resistivity imply that the material is very resistant to the flow of electricity, and low values of resistivity imply that the material transmits electrical current very easily.

The primary factors affecting resistivity of earth materials are porosity, water saturation, clay content, and ionic strength of the pore water. The minerals making up soil and rock generally do not readily conduct electric current. Most of the current flow takes place through the material's pore water in which ER decreases with increasing porosity and water saturation. Clay minerals are conductive because of the availability of free ions in the sheet structure of the clay particles in which ER decreases with increasing clay content. Similarly, dissolved ions in groundwater make the water more conductive to electrical current in which ER decreases with increasing ionic strength.

The ER survey was conducted by introducing a measured current into the earth through two adjacent electrodes and measuring the resultant voltage across two different electrodes at a predetermined distance apart. The voltage across two other electrodes is measured simultaneously with the applied current. At the low currents used, voltage is proportional to the current. The meter measures the voltage/current ratio or resistance in Ohms.

The ER survey was conducted using a Sting R8 earth resistivity meter (Sting), which measures the apparent resistivity of the subsurface employing an artificial source that is introduced through point electrodes. The Sting measures electrical potentials at other electrodes.

The Swift automatic electrode system (Swift) was connected to the Sting to optimize survey efficiency by gathering maximum information with a minimum of electrodes. The Swift also uses redundancies in the data set to reduce the effects of lateral heterogeneities in the earth and to calculate uncertainties in the data. The survey was conducted automatically using the Sting/Swift dipole-dipole array system.

A contact resistance test was conducted before the Sting/Swift dipole-dipole survey commenced. The contact resistance test ensures the stake has good contact with the ground. The Sting produces a current between the first two stakes and measures the voltage. The instrument measures the resistance between the first and second stakes and the ground. The contact resistance is also checked for the measurements consistent for all of the 84 electrodes.

The Swift cable resistance checks the voltage difference signal between two electrodes. Four leads of the Swift cable using two electrodes send a current through a 1 ohm resistor in the Swift box. The test is checked before the first ER survey and after the last ER line for each day.

The Swift switch relays test is performed to check the Swift box is continuous and the relays in the electrodes are working properly. A current is sent through each lead in the Swift cable to make sure the relays are functioning properly and there is no leakage between leads, and to test the relays for sticking. The test is checked before the first ER survey and after the last ER line for each day.

The depth of investigation by Sting is a function of the total distance of the electrode layout was between 660 feet for ER Line 11 to 1,100 feet for ER Line 14. The Sting has an effective analysis depth of approximately 120 to 250 feet using a 3 meter (10 feet) to 4 meters (16 feet) electrode spacing. This depth is considered sufficient to locate resistive areas that appear to be saturated zones at the Emerson Power Transmission site.

3.0 Interpretation Methods

The ER data were converted into a resistivity depth model using Rapid 2D resistivity inversion model and the least-squares method (RES2DINV). Soundings from each line were modeled to produce the measured apparent resistivity cross-sections. The model calculated the apparent resistivity cross-sections using finite-difference forward modeling. The least-squares optimization technique was used for the inversion routine that calculated the modeled resistivity section. The ER output consists of the inverse model resistivity cross-section. The model fits the measured data to an earth model that represents actual resistivities in the profile. The model is completed by back calculating apparent resistivities from the earth model for comparison to the measured data. The horizontal and vertical scales are in feet.

The cross-section is the inverse model resistivity pseudo-section. The ER data was converted into a resistivity depth model (RES2DINV) using a resistivity inversion model by the least-squares method and is topographically corrected. The ground surface elevations were determined by interpolating between contours on the site plan provided by Environmental Strategies Consulting LLC. RES2DINV confirms the model reliability by calculating the modeled data into empirical data or the calculated resistivity pseudo-section. The difference between the measured and calculated data is the root mean square percent error.

Resistive materials resist the flow of electrical current such as sand and gravel. Conductive materials are media that current flows relatively easy such as clay.

Low resistive materials can be caused by certain conductive soils such as clay. High resistive materials are caused generally by wood and air. Low ER values represent thick overburden. Lower ER anomalies are generally found over saturated fractures.

Typical resistivities of the overburden (clay) are 100 ohm meters (blue). Bedrock resistivities typically range from 200 (green) to 5,000 (red) ohm meters. The saturated zones resistivities typically measure approximately 50 ohm meters (dark blue).

4.0 Survey Results

The objective of the ER survey was to locate saturated fractures that may indicate the major groundwater path flows. ER cross-sections are provided in Appendix A. The horizontal scale is in meters. The vertical scale is in meters above mean sea level (msl).

ER Line 9 indicates four conductive anomalies centered at approximately 100 feet North, 280 feet North, 530 feet North, and 680 feet Northeast approximately 40 feet to 60 feet below ground surface. The conductive anomalies appear to be saturated fractures.

ER Line 10 indicates one conductive anomaly centered at approximately 460 feet Northeast approximately 100 feet below ground surface. The conductive anomaly appears to be a vertical saturated fracture.

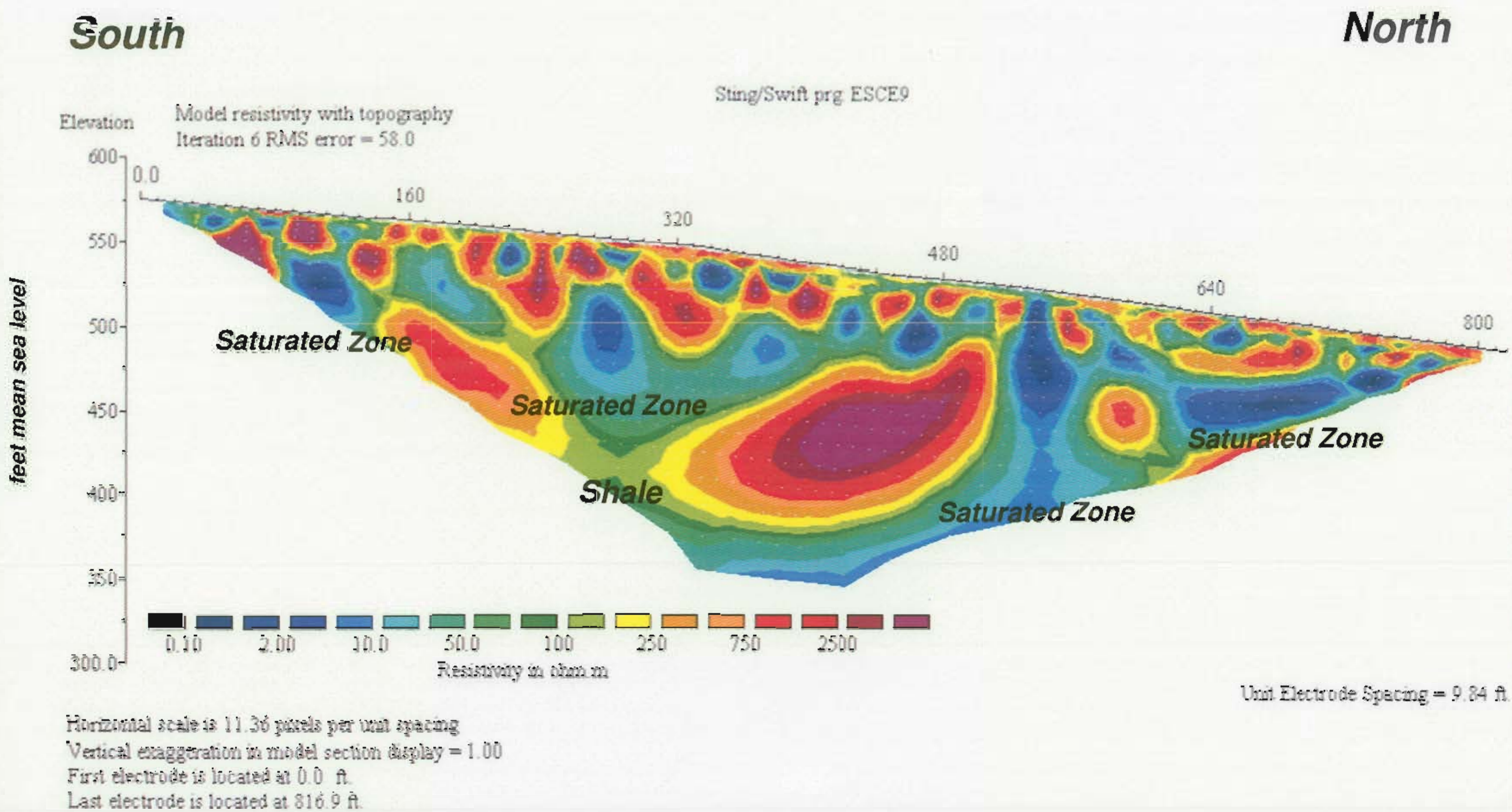
ER Line 11 indicates two conductive anomalies centered at approximately 180 feet East and 520 feet East approximately 40 feet below ground surface. The conductive anomalies appear to be vertical saturated fractures.

ER Line 12 indicates conductive anomalies centered at approximately 180 feet Northeast and 570 feet Northeast approximately 40 feet below ground surface. The southwestern conductive anomaly appears to be a vertical saturated fracture. The northeastern conductive anomaly appears to be a saturated fracture.

ER Line 14 indicates two conductive anomalies centered at approximately 400 feet Northeast and 660 feet Northeast approximately 80 feet below ground surface. The conductive anomalies appear to be saturated fractures.

Appendix A

ER Cross-Sections



Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE October 2005	SCALE shown in feet	TITLE *ER Line 9* *Emerson Power Transmission* *Ithaca, New York*
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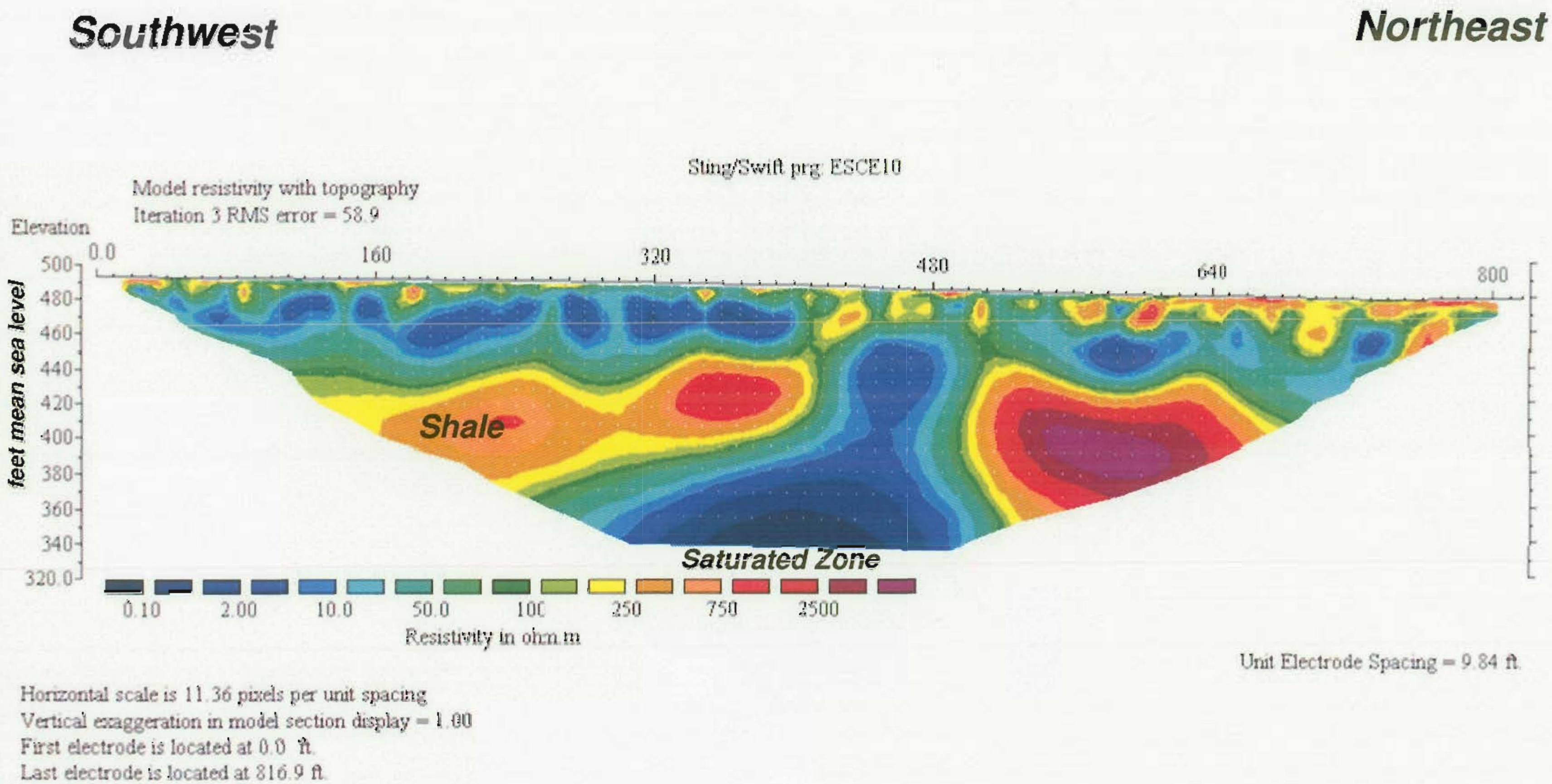
	JOB NO. 05197	DWG. NO./ REV. NO. ESCE9.SRF	CLIENT Environmental Strategies Consulting LLC / FIGURE



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DATE: October 2005	SCALE: shown in feet	TITLE: ***ER Line 10*** / ***Emerson Power Transmission*** / ***Ithaca, New York***
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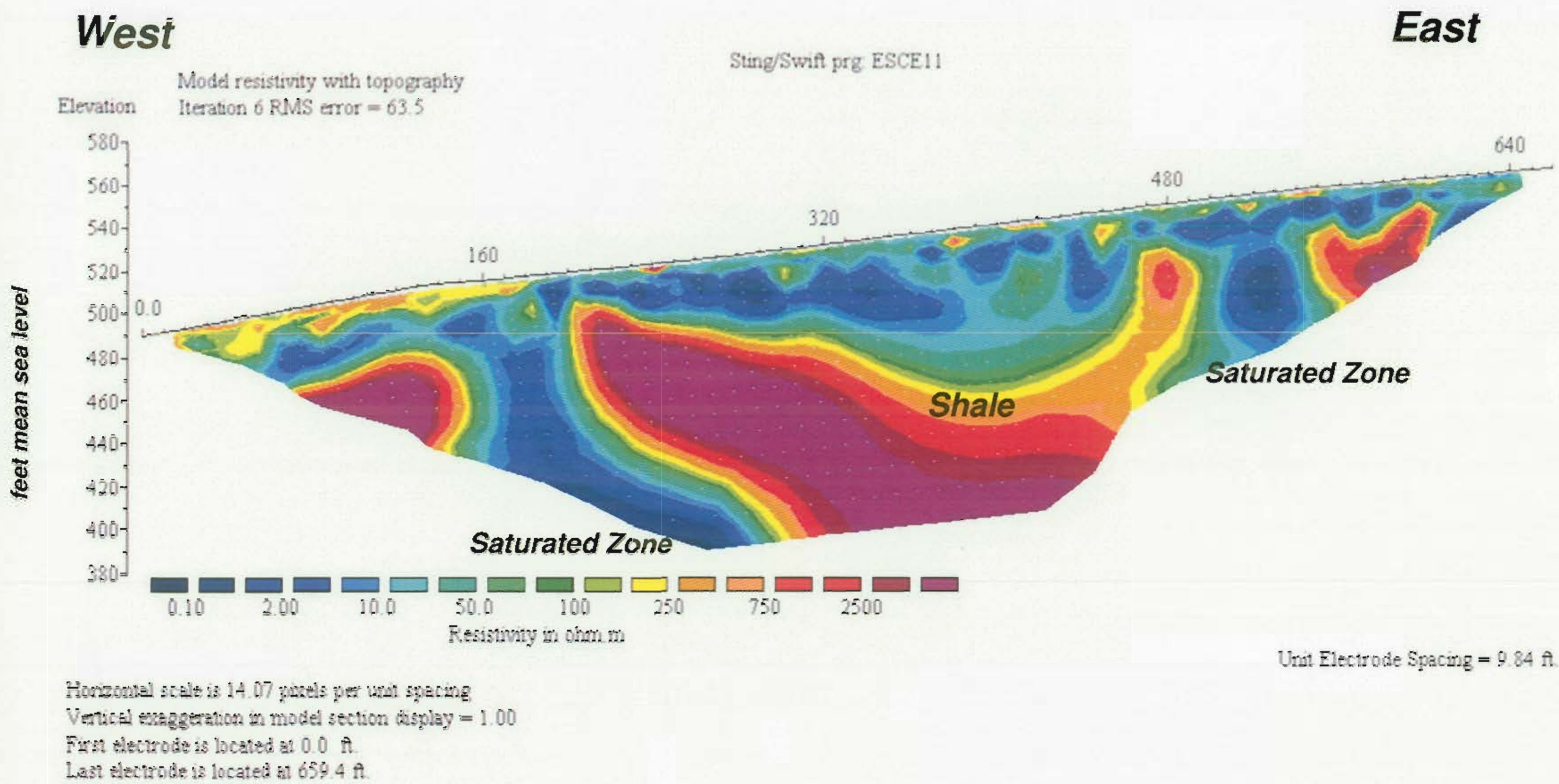
JOB NO. 05156	DWG. NO./ REV. NO. ESCE10.SRF	CLIENT: Environmental Strategies Consulting LLC



Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE October 2005	SCALE shown in feet	TITLE *ER Line 11* *Emerson Power Transmission* *Ithaca, New York*
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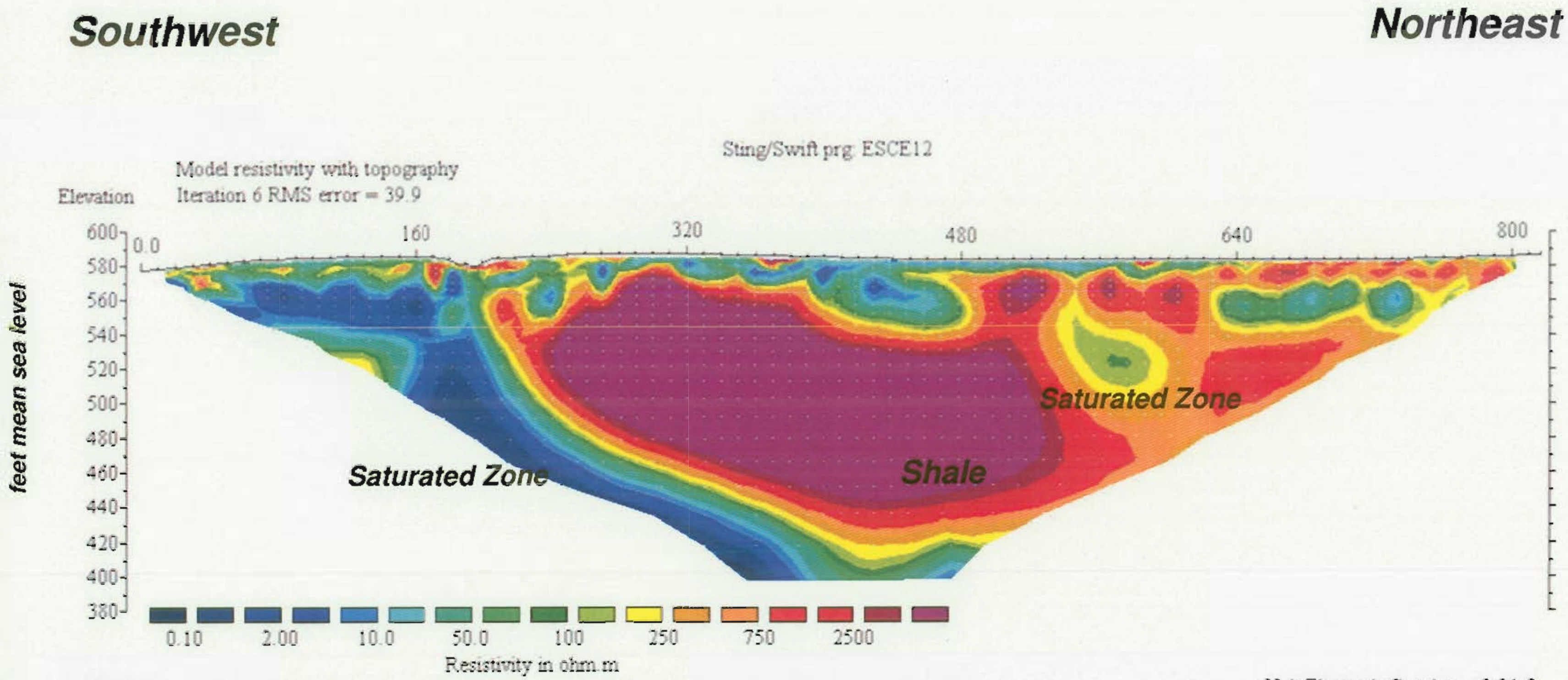
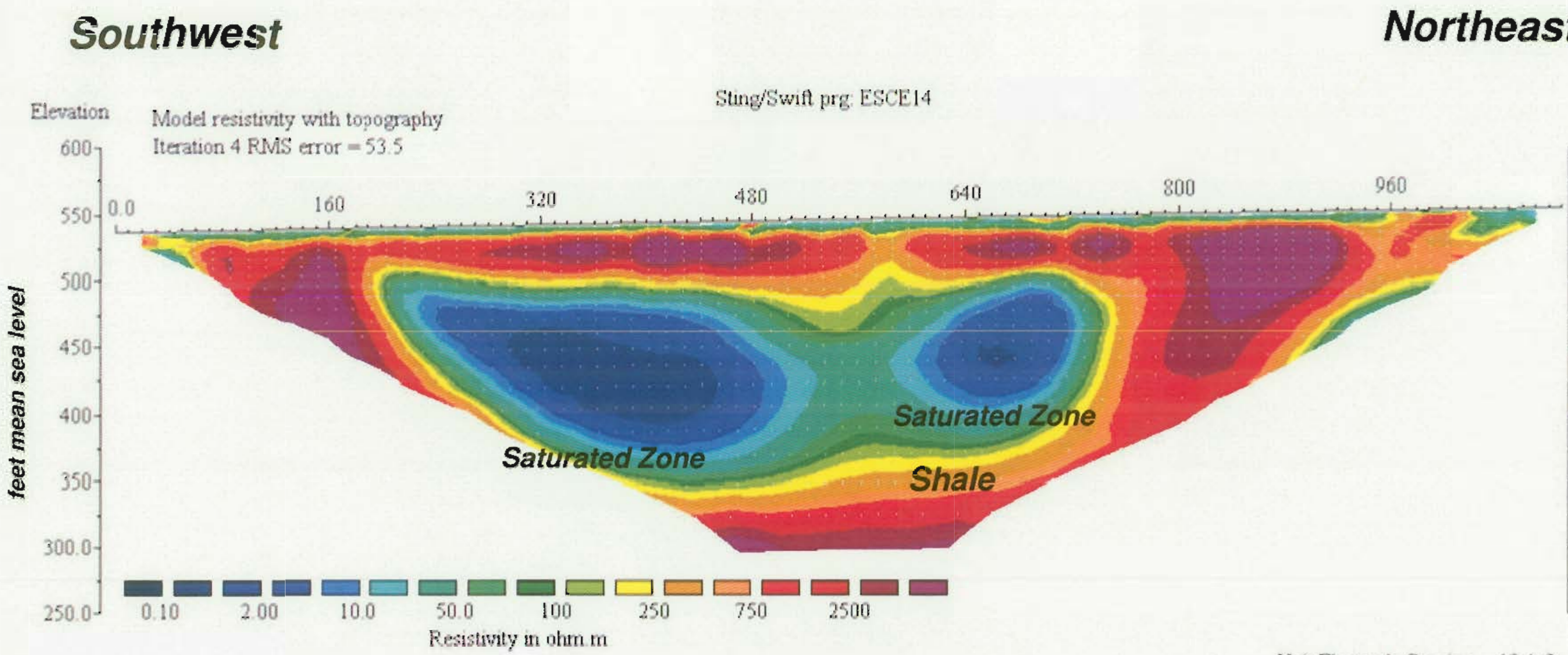
	JOB NO. 05197	DWG. NO./ REV. NO. ESCE11.SRF	CLIENT Environmental Strategies Consulting LLC / FIGURE



Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 816.9 ft.

Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE: October 2005	SCALE: shown in feet	TITLE: *ER Line 12* *Emerson Power Transmission* *Ithaca, New York*
	DRAWN BY:	APPROVED BY:	
	JOB NO.: 05197	DWG. NO./REV. NO.: ESCE12.SRF	CLIENT: Environmental Strategies Consulting LLC; FIGURE:



Horizontal scale is 11.36 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 ft.
Last electrode is located at 1089.2 ft.

Forrest Environmental Services, Inc. Oak Hill, Virginia (703) 648-9090 www.fesinc.net	DATE October 2005	SCALE shown in feet	TITLE ER Line 14 Emerson Power Transmission Ithaca, New York	
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	JOB NO. 05197	DWG. NO./REV. NO. ESCE14.SRF	CLIENT Environmental Strategies Consulting LLC	FIGURE