

**REPORT  
ON  
PATH LOSS MEASUREMENTS  
AT 1810 MHz**

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IMAGINEERING  
LIMITED

REPORT  
ON  
PATH LOSS MEASUREMENTS  
AT 1810 MHz

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**REPORT**  
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1.0 INTRODUCTION

The following report details the results of a field strength survey conducted during early March, 1995, for the purpose of compiling radio-frequency field values measured along defined radial paths from a radio transmitting antenna. This data is intended to be compared with the results of the CRC Propagation Prediction Program.

With particular interest in the 2 GHz frequency range, measurements were conducted from two transmitter locations at a frequency of 1810 MHz, along a number of radial paths. Criteria for the selection of the transmitter locations and the specific radial paths are discussed in Section 2.0 and 3.0, respectively. Temporary experimental licences were obtained from Industry Canada for each site.

Measurements were done using a roof-mounted, monopole receive antenna, a precision radio test receiver, and a computer control/data logging system, all mounted in a small car. Each measurement was triggered by a bicycle odometer wheel mounted to the back of the car. Measurements were taken every half a metre over an approximate span of 50-100 m on either side of each selected radial measurement point. The transmit arrangement consisted of a 4 ft. parabolic grid antenna fed by a frequency synthesizer/power amplifier controlled via a local computer. Details of the methodology are provided in Section 4.0.

Details on the transmit and receiver parameters are given in Section 5.0.

The data collected at each point were analyzed to determine the median field and standard deviation. Terrain profiles were generated for the cross-section of each radial path. These are discussed in Section 6.0 and are included within this report.

2.0 TRANSMITTING ANTENNA SITES

Two transmit locations were chosen which satisfied the general criteria of being of sufficient elevation to be substantially clear of local clutter and in the neighbourhood of relatively interesting terrain, as well as such requirements as availability of power, telephone lines and equipment space.

The first site was the Edgar VHCM hub of Trillium Cable Communications Limited, located approximately 15 km north of Barrie. The transmit antenna was mounted on the rooftop of the Edgar VHCM equipment hut, which is located on the highest point of land in the region. The area is characterized by low population density and very hilly terrain, particularly towards the north of the site.

The second site was the rooftop of a 17-storey apartment building in St. Catharines, which is the location of CJRN 710 Inc.'s synchronous FM repeater site (CKEY-FM, 101.1 MHz). The building is the highest in the immediate vicinity, and is located near the Niagara Escarpment.

### 3.0 RADIAL MEASUREMENT PATHS

At Edgar, measurement paths were generally selected in the northern sector due to the hilly terrain. Specific radials were chosen to traverse at least one significant hilltop such that diffraction phenomena would be present. Two of the radials (328° and 150°) were chosen simply on the basis of the existence of roads along these exact directions.

At St. Catharines, the 209° radial was chosen to traverse Fonthill, which is the highest hilltop in the region. The radials at 252° and 262° were selected to take advantage of the Niagara Escarpment. The radial at 358° was selected as a typical urban/suburban path.

Plots of the terrain elevation profiles are given in Appendix C. Locations of the radial paths are shown on 1:250,000 scale topographic maps in Appendix D.

#### 4.0 TEST EQUIPMENT AND METHODOLOGY

A list of the test equipment used is provided in Appendix F.

The transmit equipment consisted of a 1.8m parabolic grid dish fed via approximately 15m of LDF4-50A coaxial cable by a synthesizer/power amplifier. Power output was monitored by a directional coupler/power metre configuration. The power metre and amplifier were remotely controlled from the receive vehicle via a cellular phone and modem communicating with a local computer. The transmit antenna was mounted on a pedestal with a rotor which was also remotely-controllable, allowing the antenna azimuth to be varied from the vehicle.

The transmit signal was an unmodulated CW tone at 1810 MHz.

For the receive configuration, a monopole antenna was roof-mounted on the vehicle via a non-conducting extension of approximately 35 cm. This fed a Rohde & Schwarz ESVD precision test receiver via approximately 3 m of low-loss flexible coax. The receiver was triggered via a bicycle wheel odometer arrangement, mounted on the back of the car and calibrated to provide a trigger signal approximately every half metre. The test receiver was controlled via a notebook computer running custom CRC software which also logged the data. A GPS unit was also connected to the notebook to provide co-ordinates within the data files, at approximate 3 second intervals.

A reference orientation location was chosen on each radial, where it was verified that the transmit antenna direction was correct by maximizing the received signal level. It was found that this was necessary since the indicated azimuth of the antenna rotor was not consistent for the Edgar paths (a software problem was later discovered). For the St. Catharines paths, the antenna was manually aligned optically with visible landmarks, and the direction was verified by confirming that maximum field readings were received at the correct location along a convenient path perpendicular to the subject radial.

The selected radial paths were plotted on 1:50,000 scale topographic maps. At every location along the radial where an accessible road crossed the radial, measurements were taken. In general, 100 - 500 measurements points were recorded with the majority of measurement points numbering in the 350 -400 range. Measurements were conducted at approximately

equal distances on either side of the radial/road intersection. Important features such as heavy tree cover, urbanization, building or road embankment shadowing were noted at each measurement point. For those radials where the direction of travel was along the radial (Edgar 328° and 150°, St. Catharines 358°), measurement points were limited to approximately 300 to minimize changing-distance effects.

A custom program was developed to read the output data files for each measurement point to determine the median field strength and the standard deviation about the average.



5.0 REFERENCE DATA

The following sections provide the reference data and calculations for the transmit and receive parameters.

5.1 Receive Parameters

The receive antenna consisted of a monopole with inclined ground-plane elements, constructed by CRC, and mounted several wavelengths above the vehicle rooftop. Anechoic chamber measurements conducted by CRC established the gain of the antenna at 1.97 dBi. The measured antenna radiation pattern is given in Appendix E.

The theoretical isotropic antenna factor, which is defined as the conversion in dB between measured signal level in dBuV to ambient field in dBuV/m as used in the Tables of Appendix A, is given by the following formula:

$$E = V \sqrt{\frac{4 \pi \Omega}{w^2 R}}$$

where E = field  
V = voltage  
 $\Omega$  = 377  $\Omega$  (free-space impedance)  
w = wavelength  
R = 50  $\Omega$  (system impedance)

The actual antenna conversion factor is as given below. Line losses and antenna gain were measured by CRC. A nominal .3 dB miscellaneous/connector loss has been included.

Frequency (MHz)	Theo. Ant. Factor (dB)	Gain (dBi)	Line Loss (dB)	Misc. (dB)	Total Ant. Factor (dB)
1810	35.38	1.97	1.16	0.30	34.87

The receiver settings were 10 ms sampling interval, average (RMS) detection, 10 kHz IF bandwidth.

5.2 Transmit Parameters

The parameters used for each site, for each radial direction, are provided at the top of the measurement result Tables A1 through A11, given in Appendix A. The transmit antenna gain figure and radiation pattern is contained in Appendix E.

At both transmit locations, the antenna input power was adjusted to be 10 watts for all radials. Reflected power was measured and found to be more than 25 dB below forward power. As a verification of actual radiated power, measurements taken at the best locations (free-space conditions) along one radial for each site were compared to theoretical free-space values as detailed below:

Site	Azimuth (°)	EIRP (W)	Distance (km)	Expected Signal (dBuV)	Measured Signal (dBuV)	Std. Dev. (dB)
Edgar	328	3388	0.6	79.7	76.2	1.6
St. Catharines	262	3388	4.9	61.5	61.6	4.5

At Edgar, the measured value differs from the theoretical by 3.5 dB. The measurement location was, however, relatively close to the site and therefore approximately 4° below the antenna main beam. The manufacturer's radiation pattern indicates a 2.5 dB discrimination at 4°, which brings the measured value to within 1 dB of the theoretical. For St. Catharines, the measurement location was of sufficient distance that the vertical pattern was not a factor and the measured value is within 0.1 dB of the theoretical.

## 6.0 DATA AND ANALYSIS

Data for each of the eleven radials for both sites are provided in Tables A1 through A11 of Appendix A with accompanying terrain profiles generated from the CRC Topographic Terrain Data Base in Figures 1 through 11 of Appendix C. At the end of each table a graph of the measured median fields versus distance is provided along with a scatter plot of standard deviation of each point.

Appendix B provides representative distributions of the measured signal levels at two locations for each radial, at points of relatively low (1-3 dB) and high (5-7 dB) standard deviations, respectively. The sampling interval is 1 dB, i.e., the ordinate indicates the percent of values falling within 1 dB of the values given along the abscissa.

The following points should be noted concerning specific radials.

- Edgar radial 328° was measured over two separate days. The values measured at point 7 at the end of the first day and repeated at the beginning of the next day (point 7a) are within 1.7 dB of each other.
- At the end of radial 328°, the remote computer indicated that the antenna pointing azimuth was not at the same value as it was set at the beginning of the measurements. As noted, software problems with the rotator program were experienced and therefore it is unknown if, how or when the azimuth was changed. Analysis of the measurements for this radial may indicate inconsistencies.
- For Edgar radial 290°, the transmit antenna aperture was obstructed by the Edgar VHCM microwave tower located approximately 5 metres away. Actual EIRP for this radial is therefore not well-defined.
- For Edgar radials 37° and 150°, there was foreground clutter of unleaved trees within about 300 metres.

- St. Catharines radial 358° was oriented towards a 15-storey apartment building at 2 km distance. Measurements in the 3-4 km range may indicate shadowing effects of this building.

While detailed data analysis and correlation with path terrain characteristics is beyond the scope of this report, the following general observations are made.

The 1810 MHz measurements for both sites exhibit standard deviations in the range of 1-8 dB, averaging 4-5 dB. No obvious correlations between decreased signal levels, increased standard deviations, and existence of tree cover or urbanization are apparent. For the St. Catharines 358° radial, which was entirely urban/suburban, the standard deviations are surprisingly consistent in the range of 3-5 dB. The field trends do correlate with the general profile characteristics, showing definite shadow loss in obstructed locations, and increases at elevated, unobstructed locations.

The field distributions do not exhibit any consistent behaviour. While some of the distributions of medium standard deviation (2-3 dB) indicate the skewed behaviour typical of a single dominant reflected signal interacting with the direct signal, the majority of the distributions indicate symmetrical behaviour about the median, indicative of a large number of reflected signals.

7.0 ACKNOWLEDGEMENTS

Imagineering Limited wishes to thank Trillium Cable Communications Limited and CJRN 710 Inc. for the use of their facilities in conducting the measurement survey.

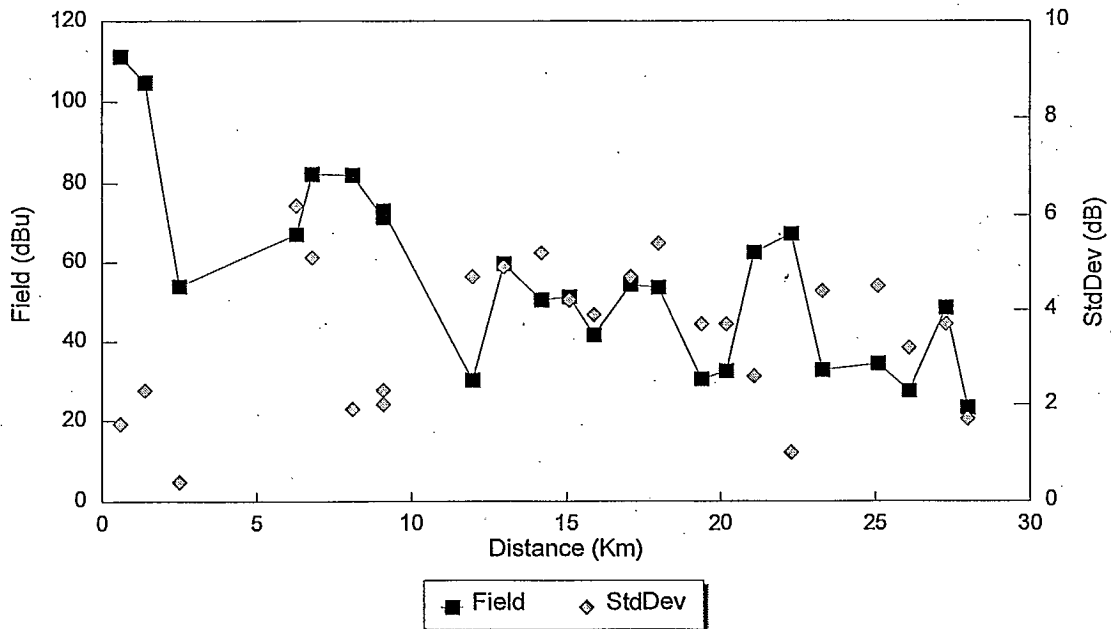
APPENDIX A

FIELD MEASUREMENT DATA

**TABLE A1**

**Site Name :** Edgar **Date :** 9/10-3-95  
**Co-ordinates :** 44 31 52 N. Lat. **Temp :** -10C  
 79 39 33 W. Long. **Weather :** Clear  
**Azimuth :** 328 Deg  
**Frequency :** 1810 MHz  
**Antenna Ht:** 5 mAGL  
**ERP:** 3388 Watts

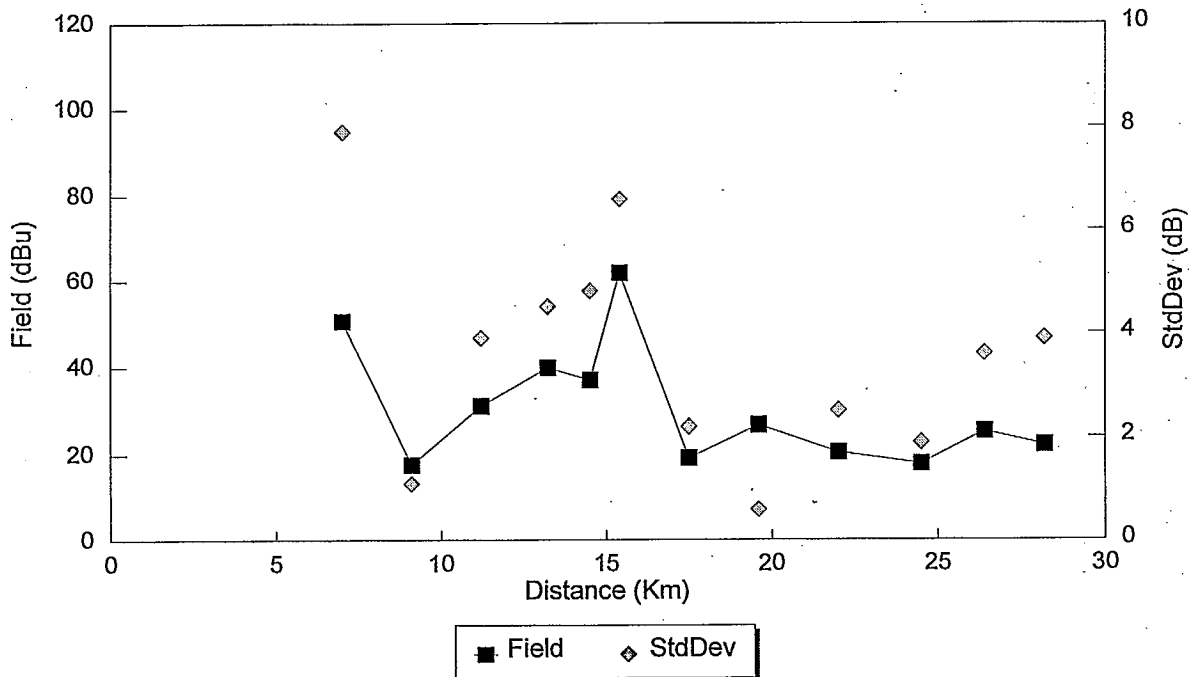
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	1	0.6	76.2	111.1	1.6	Reference point
2	2	1.4	69.8	104.7	2.3	Trees
3	3	2.5	19.1	54.0	0.4	
4	4	6.3	32.3	67.2	6.2	
5	5	6.8	47.4	82.3	5.1	
6	6	8.1	47.1	82.0	1.9	
7	7	9.1	36.6	71.5	2.3	
8	7a	9.1	38.3	73.2	2	Point 7 repeated next day
9	8	12.0	-4.6	30.3	4.7	
10	9	13.0	24.8	59.7	4.9	
11	10	14.2	15.6	50.5	5.2	
12	11	15.1	16.4	51.3	4.2	
13	12	15.9	6.8	41.7	3.9	
14	13	17.1	19.5	54.4	4.7	
15	14	18.0	18.8	53.7	5.4	
16	15	19.4	-4.4	30.5	3.7	
17	16	20.2	-2.3	32.6	3.7	
18	17	21.1	27.6	62.5	2.6	
19	18	22.3	32.4	67.3	1	
20	19	23.3	-2.1	32.8	4.4	
21	20	25.1	-0.4	34.5	4.5	
22	21	26.1	-7.4	27.5	3.2	
23	22	27.3	13.7	48.6	3.7	Trees
24	23	28.0	-11.6	23.3	1.7	Trees both sides



**TABLE A2**

Site Name : Edgar Date : 12-3-95  
 Co-ordinates : 44 31 52 N. Lat. Temp : +5C  
 79 39 33 W. Long. Weather : Clear  
 Azimuth : 316 Deg  
 Frequency : 1810 MHz  
 Antenna Ht: 5 mAGL  
 ERP: 3388 Watts

Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	1	7.0	15.8	50.7	7.9	
2	2	9.1	-17.2	17.7	1.1	Coniferous trees
3	3	11.2	-3.8	31.1	3.9	
4	4	13.2	5	39.9	4.5	
5	5	14.5	2.2	37.1	4.8	
6	6	15.4	27	61.9	6.6	
7	7	17.5	-15.7	19.2	2.2	
8	8	19.6	-8.1	26.8	0.6	Coniferous trees
9	9	22.0	-14.3	20.6	2.5	Coniferous trees
10	10	24.5	-17	17.9	1.9	
11	11	26.4	-9.6	25.3	3.6	
12	12	28.2	-12.7	22.2	3.9	

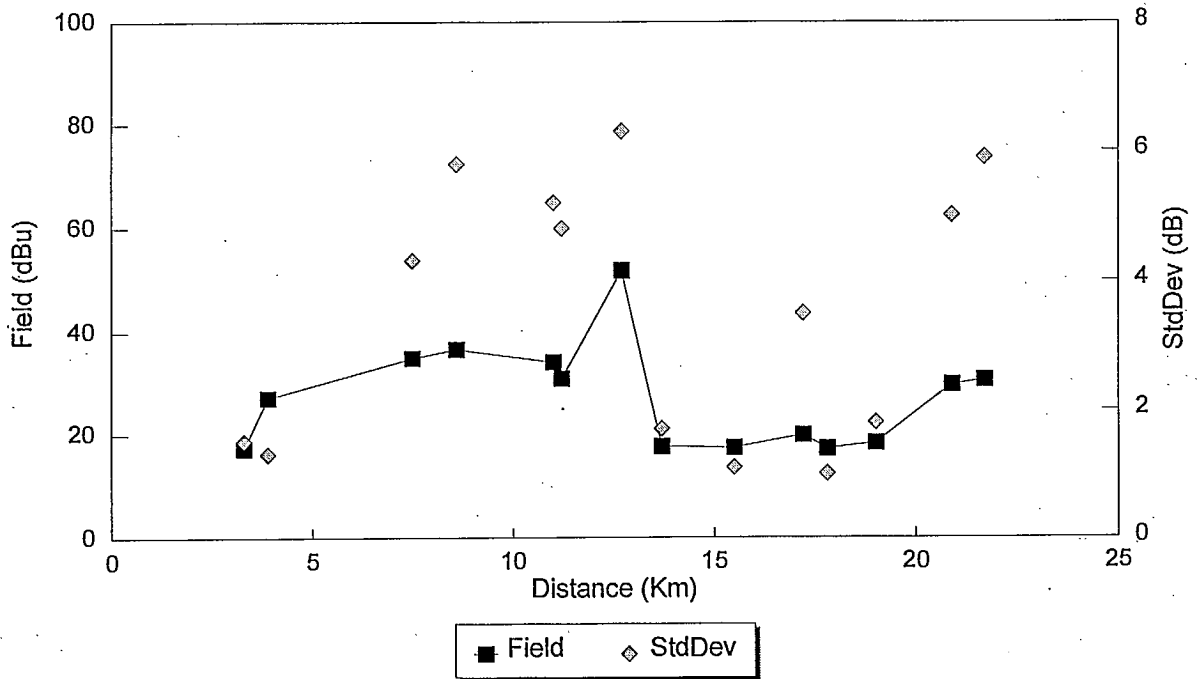




**TABLE A3**

**Site Name :** Edgar **Date :** 10-3-95  
**Co-ordinates :** 44 31 52 N. Lat. **Temp :** 0C  
 79 39 33 W. Long. **Weather :** Clear  
**Azimuth :** 290 Deg  
**Frequency :** 1810 MHz  
**Antenna Ht:** 5 mAGL  
**ERP:** 3388 Watts

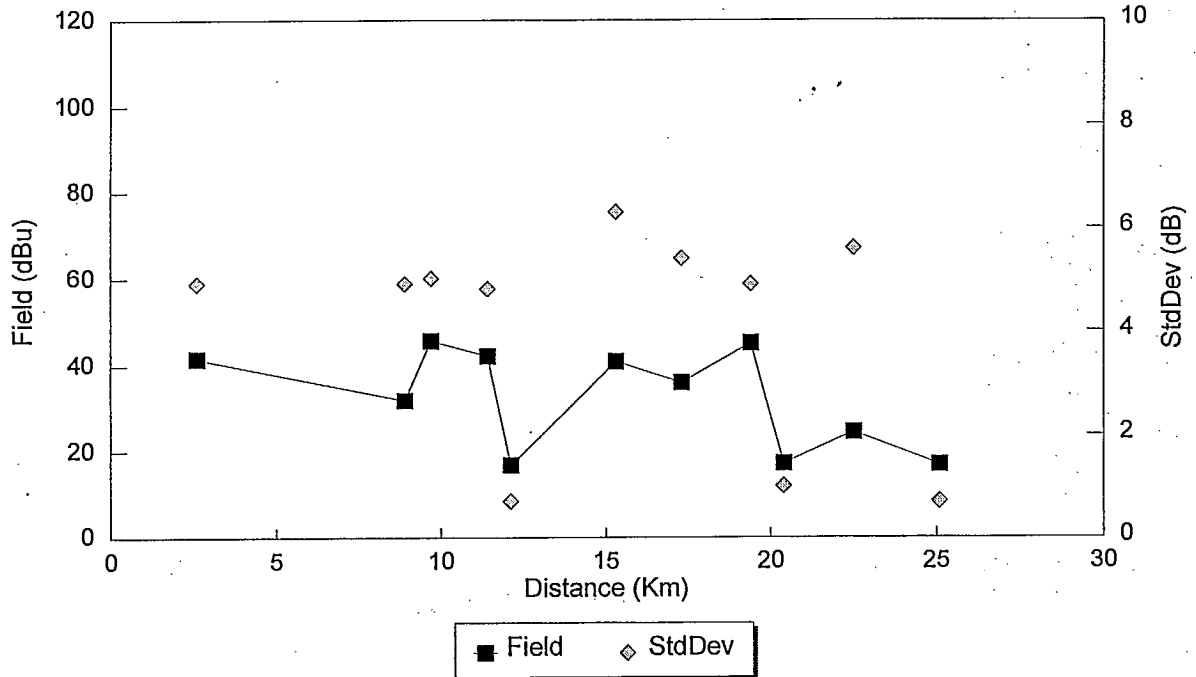
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	114	3.3	-17.5	17.4	1.5	
2	113	3.9	-7.6	27.3	1.3	
3	101	7.5	0.2	35.1	4.3	Trees
4	102	8.6	1.9	36.8	5.8	
5	103	11.0	-0.6	34.3	5.2	
6	104	11.2	-3.8	31.1	4.8	
7	105	12.7	17	51.9	6.3	
8	106	13.7	-17.1	17.8	1.7	
9	107	15.5	-17.3	17.6	1.1	
10	108	17.2	-14.8	20.1	3.5	Suburban
11	109	17.8	-17.5	17.4	1	Suburban
12	110	19.0	-16.4	18.5	1.8	
13	111	20.9	-5	29.9	5	
14	112	21.7	-4	30.9	5.9	



**TABLE A4**

**Site Name :** Edgar **Date :** 12-3-95  
**Co-ordinates :** 44 31 52 N. Lat. **Temp :** +5C  
 79 39 33 W. Long. **Weather :** Clear  
**Azimuth :** 337 Deg  
**Frequency :** 1810 MHz  
**Antenna Ht:** 5 mAGL  
**ERP:** 3388 Watts

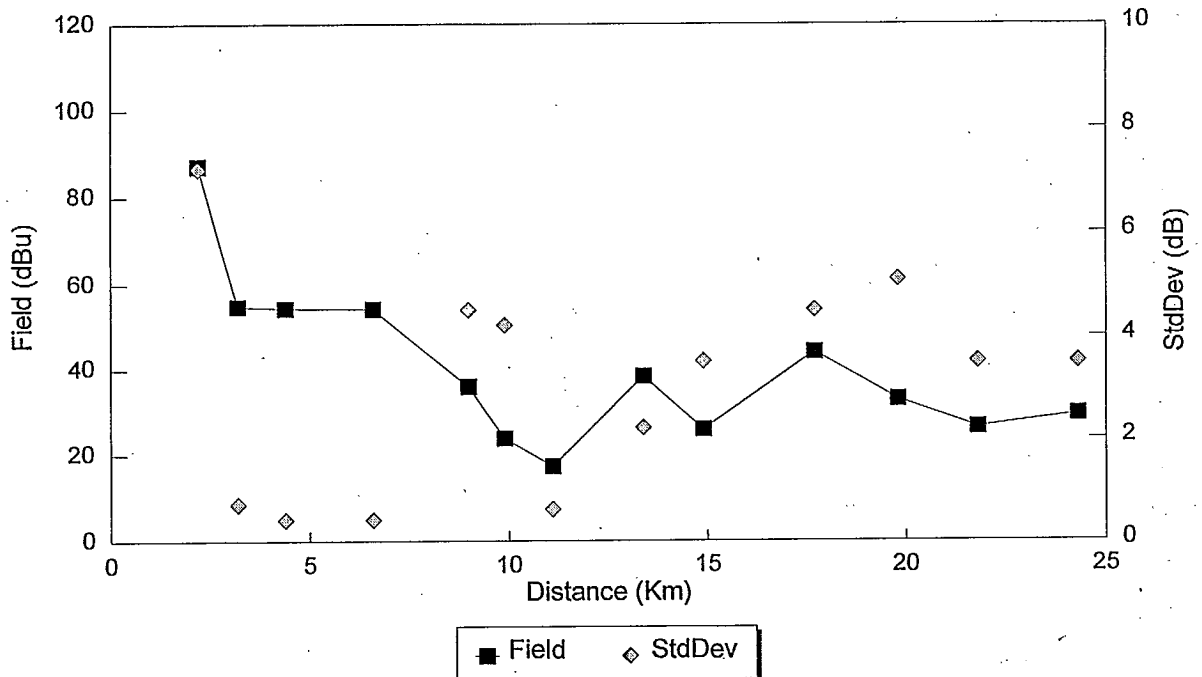
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	111	2.6	6.7	41.6	4.9	
2	109	8.9	-2.9	32.0	4.9	Coniferous trees
3	108	9.7	10.8	45.7	5	
4	110	11.4	7.4	42.3	4.8	Deciduous trees
5	107	12.1	-18	16.9	0.7	Coniferous trees
6	106	15.3	6.1	41.0	6.3	
7	105	17.3	1.3	36.2	5.4	
8	104	19.4	10.3	45.2	4.9	
9	103	20.4	-17.6	17.3	1	Trees both sides
10	102	22.5	-10.2	24.7	5.6	
11	101	25.1	-17.9	17.0	0.7	



**TABLE A5**

**Site Name :** Edgar **Date :** 12-3-95  
**Co-ordinates :** 44 31 52 N. Lat. **Temp :** +5C  
 79 39 33 W. Long. **Weather :** Clear  
**Azimuth :** 6 Deg  
**Frequency :** 1810 MHz  
**Antenna Ht:** 5 mAGL  
**ERP:** 3388 Watts

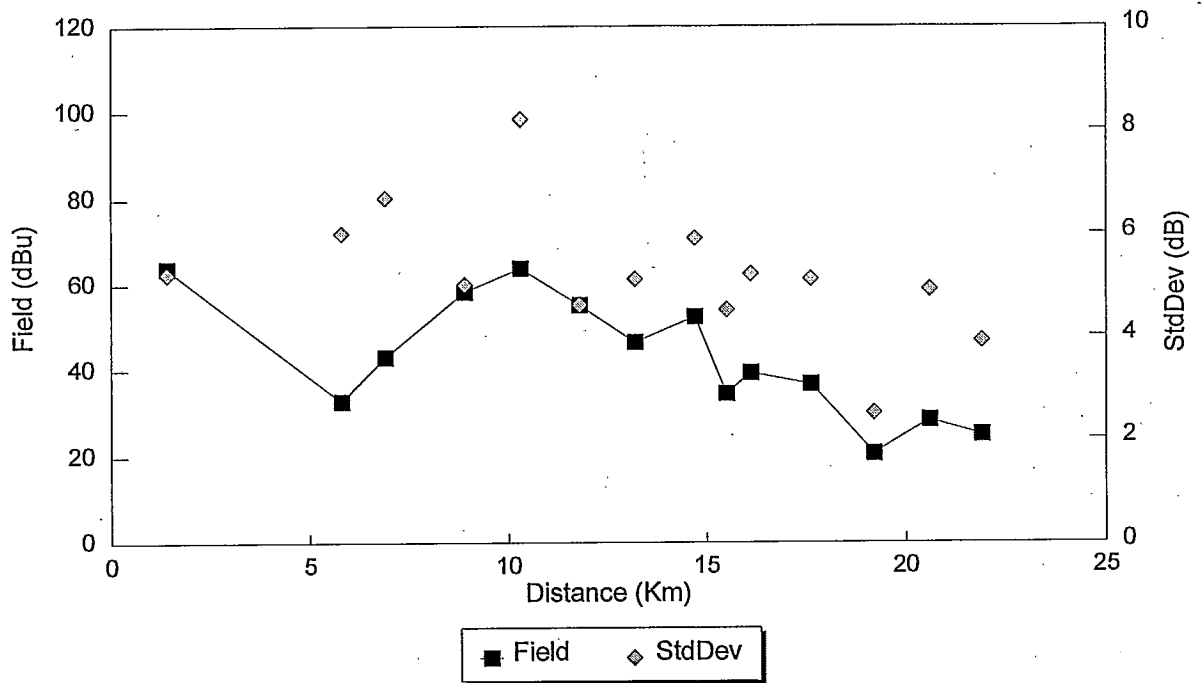
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	1	2.2	52.2	87.1	7.2	
2	2	3.2	20	54.9	0.7	
3	3	4.4	19.5	54.4	0.4	Coniferous trees
4	4	6.6	19.4	54.3	0.4	Deciduous trees
5	5	9.0	1.2	36.1	4.5	
6	6	9.9	-11	23.9	4.2	
7	7	11.1	-17.6	17.3	0.6	
8	8	13.4	3.6	38.5	2.2	
9	9	14.9	-8.8	26.1	3.5	
10	10	17.7	9.2	44.1	4.5	
11	11	19.8	-1.8	33.1	5.1	
12	12	21.8	-8.3	26.6	3.5	
13	13	24.3	-5.2	29.7	3.5	



**TABLE A6**

**Site Name :** Edgar **Date :** 12-3-95  
**Co-ordinates :** 44 31 52 N. Lat. **Temp :** +5C  
 79 39 33 W. Long. **Weather :** Clear  
**Azimuth :** 37 Deg  
**Frequency :** 1810 MHz  
**Antenna Ht:** 5 mAGL  
**ERP:** 3388 Watts

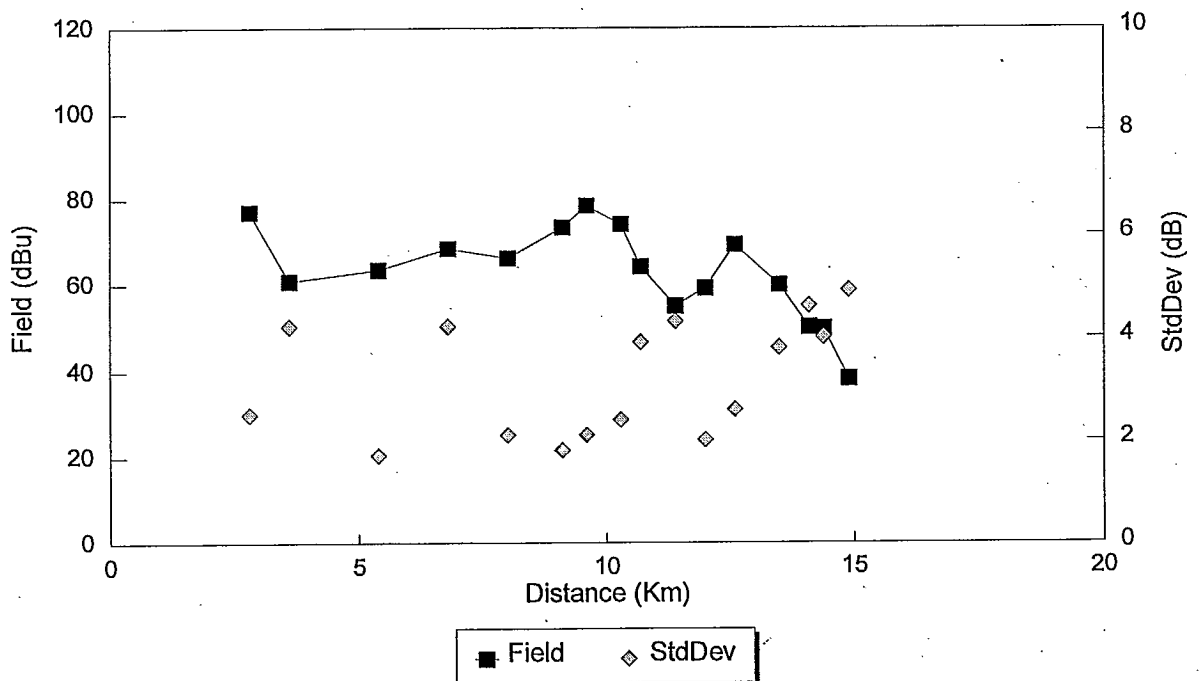
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	114	1.4	28.9	63.8	5.2	
2	113	5.8	-2.2	32.7	6	
3	112	6.9	8.2	43.1	6.7	
4	111	8.9	23.4	58.3	5	
5	110	10.3	28.9	63.8	8.2	
6	109	11.8	20.3	55.2	4.6	
7	108	13.2	11.6	46.5	5.1	
8	107	14.7	17.6	52.5	5.9	Residential
9	106	15.5	-0.4	34.5	4.5	
10	105	16.1	4.4	39.3	5.2	
11	104	17.6	1.8	36.7	5.1	
12	103	19.2	-14.3	20.6	2.5	Deciduous trees
13	102	20.6	-6.6	28.3	4.9	
14	101	21.9	-9.9	25.0	3.9	



**TABLE A7**

**Site Name :** Edgar **Date :** 12-3-95  
**Co-ordinates :** 44 31 52 N. Lat. **Temp :** +5C  
 79 39 33 W. Long. **Weather :** Clear  
**Azimuth :** 150 Deg  
**Frequency :** 1810 MHz  
**Antenna Ht:** 5 mAGL  
**ERP:** 3388 Watts

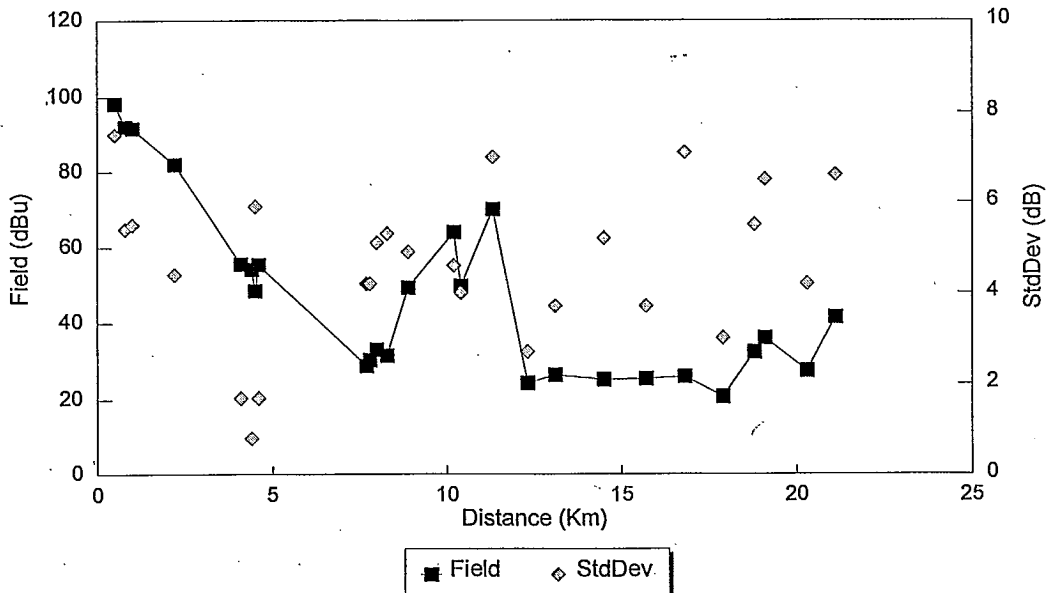
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	1	2.8	42.2	77.1	2.5	
2	2	3.6	26	60.9	4.2	
3	3	5.4	28.6	63.5	1.7	Trees both sides
4	4	6.8	33.6	68.5	4.2	
5	5	8.0	31.3	66.2	2.1	
6	6	9.1	38.6	73.5	1.8	
7	7	9.6	43.7	78.6	2.1	Coniferous trees
8	8	10.3	39.3	74.2	2.4	
9	9	10.7	29.3	64.2	3.9	Coniferous trees
10	10	11.4	20.2	55.1	4.3	Deciduous trees
11	11	12.0	24.4	59.3	2	
12	12	12.6	34.5	69.4	2.6	
13	13	13.5	25.1	60.0	3.8	
14	14	14.1	15.4	50.3	4.6	
15	15	14.4	15.1	50.0	4	
16	16	14.9	3.5	38.4	4.9	



**TABLE A8**

**Site Name :** St. Catharines      **Date :** 16-3-95  
**Co-ordinates :** 43 08 30 N. Lat.      **Temp :** +15C  
                          79 14 12 W. Long.      **Weather :** Clear  
**Azimuth :** 209      Deg  
**Frequency :** 1810      MHz  
**Antenna Ht:** 65      mAGL  
**ERP:** 3388      Watts

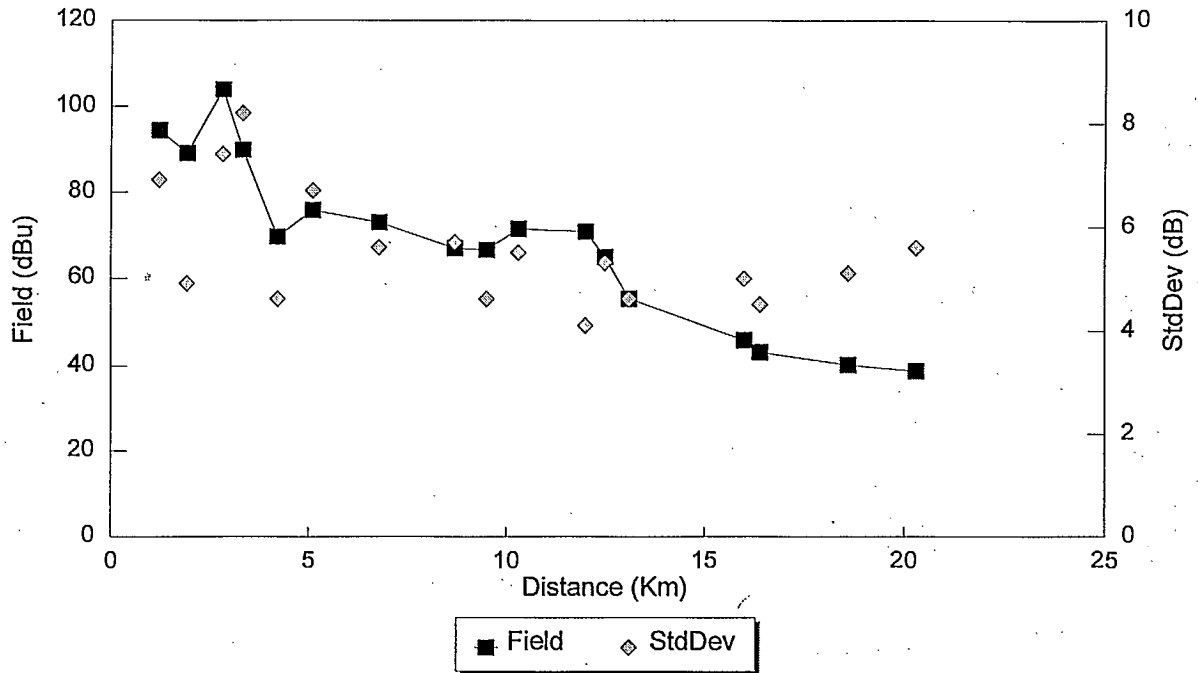
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	1	0.5	63.5	98.4	7.5	Suburban
2	1a	0.5	63.5	98.4	7.5	Repeated point 1
3	2	0.8	57.3	92.2	5.4	Suburban
4	3	1.0	56.9	91.8	5.5	Suburban
5	4	2.2	47.2	82.1	4.4	Suburban
6	5	4.1	20.8	55.7	1.7	Coniferous trees
7	6	4.4	19.4	54.3	0.8	
8	7a	4.5	13.7	48.6	5.9	Deciduous trees
9	7	4.6	20.5	55.4	1.7	
10	8	7.7	-6.1	28.8	4.2	Deciduous trees
11	8a	7.8	-4.6	30.3	4.2	Deciduous trees
12	9	8.0	-2	32.9	5.1	Deciduous trees
13	9b	8.3	-3.5	31.4	5.3	Trees
14	9a	8.9	14.5	49.4	4.9	Overhead Hydro lines
15	10	10.2	29.1	64.0	4.6	Deciduous trees
16	10a	10.4	14.9	49.8	4	
17	11	11.3	35.2	70.1	7	Fonthill-nearby towers
18	12	12.3	-10.6	24.3	2.7	
19	13	13.1	-8.5	26.4	3.7	Suburban
20	14	14.5	-9.8	25.1	5.2	
21	15	15.7	-9.5	25.4	3.7	
22	16	16.8	-9	25.9	7.1	
23	17	17.9	-14.1	20.8	3	
24	21	18.8	-2.6	32.3	5.5	
25	18	19.1	1	35.9	6.5	
26	20	20.3	-7.5	27.4	4.2	
27	19	21.1	6.5	41.4	6.6	



**TABLE A9**

**Site Name :** St. Catharines      **Date :** 16-3-95  
**Co-ordinates :** 43 08 30 N. Lat.      **Temp :** +15C  
                          79 14 12 W. Long.      **Weather :** Clear  
**Azimuth :** 252      Deg  
**Frequency :** 1810      MHz  
**Antenna Ht:** 65      mAGL  
**ERP:** 3388      Watts

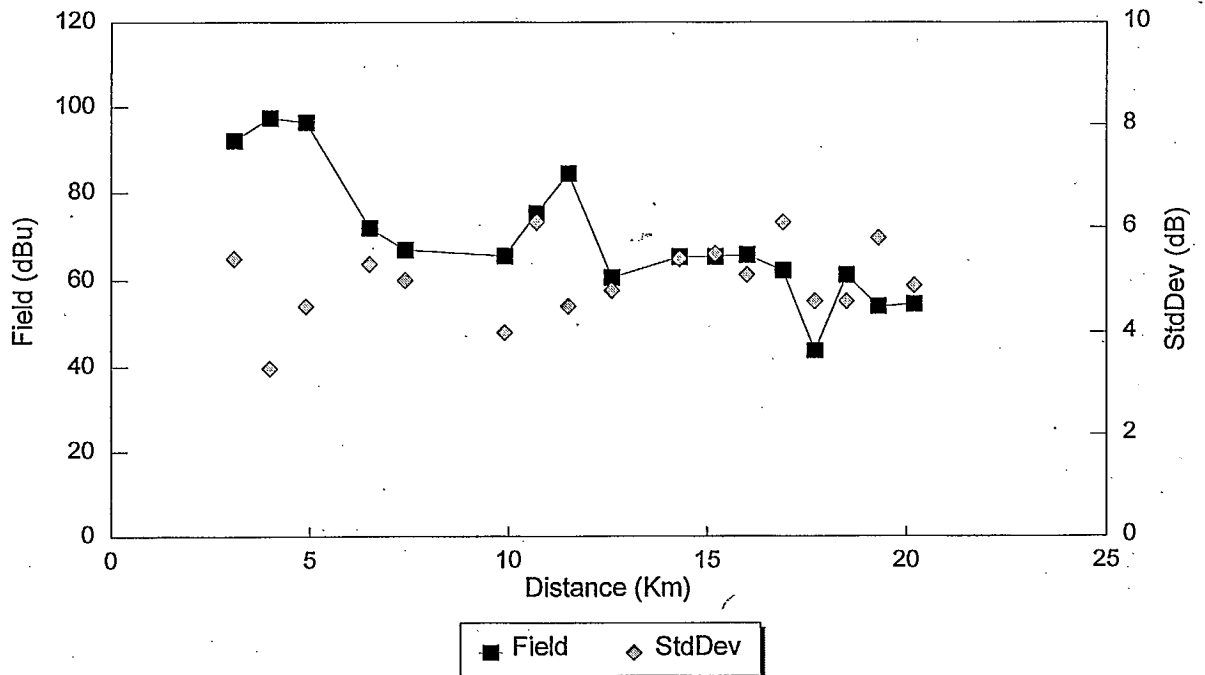
Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	117	1.2	59.5	94.4	6.9	Overhead Hydro lines
2	116	1.9	54.2	89.1	4.9	Suburban
3	115	2.8	69.1	104.0	7.4	
4	114	3.3	55	89.9	8.2	
5	113	4.2	34.9	69.8	4.6	Coniferous trees
6	112	5.1	41	75.9	6.7	
7	111	6.8	38.2	73.1	5.6	
8	110	8.7	32.2	67.1	5.7	
9	109	9.5	31.8	66.7	4.6	Light residential
10	108	10.3	36.7	71.6	5.5	
11	107	12.0	36.1	71.0	4.1	
12	106	12.5	30.2	65.1	5.3	
13	105	13.1	20.5	55.4	4.6	
14	104	16.0	11.1	46.0	5	
15	103	16.4	8.3	43.2	4.5	
16	102	18.6	5.4	40.3	5.1	
17	101	20.3	4	38.9	5.6	



**TABLE A10**

**Site Name :** St. Catharines      **Date :** 17-3-95  
**Co-ordinates :** 43 08 30 N. Lat.      **Temp :** 0C  
                          79 14 12 W. Long.      **Weather :** Clear  
**Azimuth :** 262      Deg  
**Frequency :** 1810      MHz  
**Antenna Ht:** 65      mAGL  
**ERP:** 3388      Watts

Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	17	3.1	57.3	92.2	5.4	Overhead Hydro lines
2	16	4.0	62.6	97.5	3.3	
3	15	4.9	61.6	96.5	4.5	Reference point
4	14	6.5	37	71.9	5.3	
5	13	7.4	32	66.9	5	Deciduous trees
6	12	9.9	30.6	65.5	4	
7	11	10.7	40.4	75.3	6.1	
8	10	11.5	49.6	84.5	4.5	
9	9	12.6	25.7	60.6	4.8	
10	8	14.3	30.4	65.3	5.4	
11	7	15.2	30.5	65.4	5.5	
12	6	16.0	30.8	65.7	5.1	
13	5	16.9	27.3	62.2	6.1	
14	1	17.7	8.9	43.8	4.6	
15	2	18.5	26.3	61.2	4.6	
16	3	19.3	19.2	54.1	5.8	
17	4	20.2	19.7	54.6	4.9	

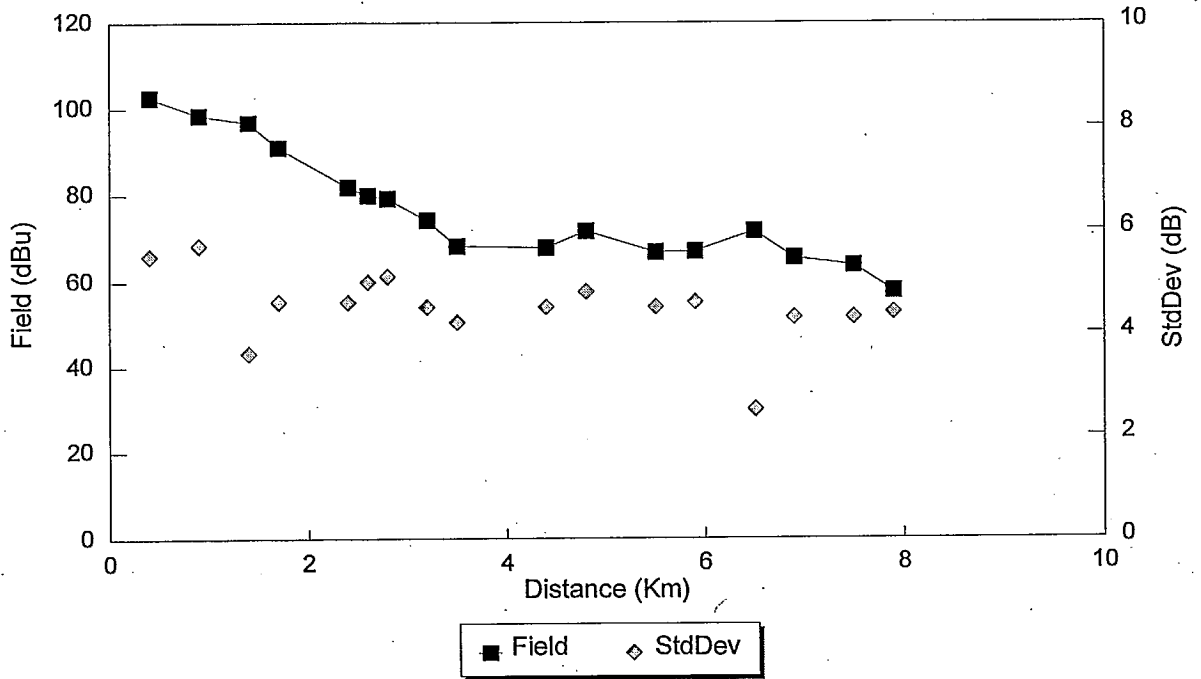




**TABLE A11**

**Site Name :** St. Catharines      **Date :** 17-3-95  
**Co-ordinates :** 43 08 30 N. Lat.      **Temp :** 0C  
                          79 14 12 W. Long.      **Weather :** Clear  
**Azimuth :** 358      Deg  
**Frequency :** 1810      MHz  
**Antenna Ht:** 65      mAGL  
**ERP:** 3388      Watts

Point #	File #	Distance (km)	Med Sig (dBuV)	Med Fld (dBu)	StdDev (dB)	Notes
1	101	0.4	67.8	102.7	5.5	Urban
2	102	0.9	63.6	98.5	5.7	Urban
3	103	1.4	61.9	96.8	3.6	Urban
4	104	1.7	56.1	91.0	4.6	Urban
5	105	2.4	46.9	81.8	4.6	Shadowing by 15-storey bldg.
6	106	2.6	45	79.9	5	Urban
7	107	2.8	44.3	79.2	5.1	Urban
8	108	3.2	39.3	74.2	4.5	Urban
9	109	3.5	33.4	68.3	4.2	Urban
10	110	4.4	33	67.9	4.5	Suburban
11	111	4.8	36.8	71.7	4.8	Suburban
12	112	5.5	31.9	66.8	4.5	Suburban
13	113	5.9	32.2	67.1	4.6	Suburban
14	114	6.5	36.8	71.7	2.5	Suburban
15	115	6.9	30.7	65.6	4.3	Clear (park)
16	116	7.5	28.9	63.8	4.3	Suburban
17	117	7.9	23	57.9	4.4	Suburban

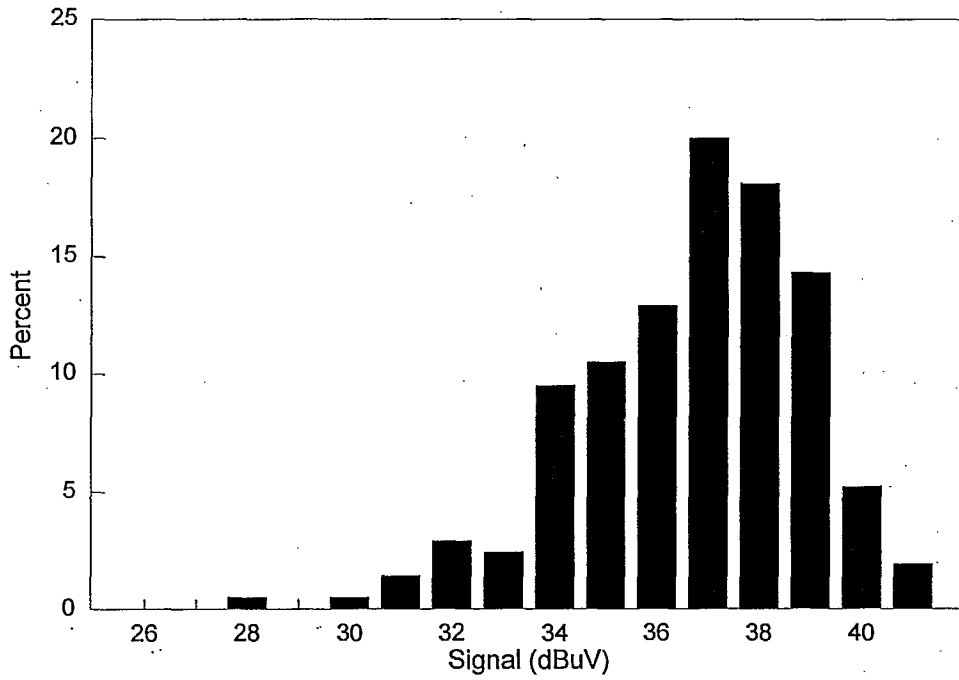


APPENDIX B

SAMPLE DISTRIBUTIONS

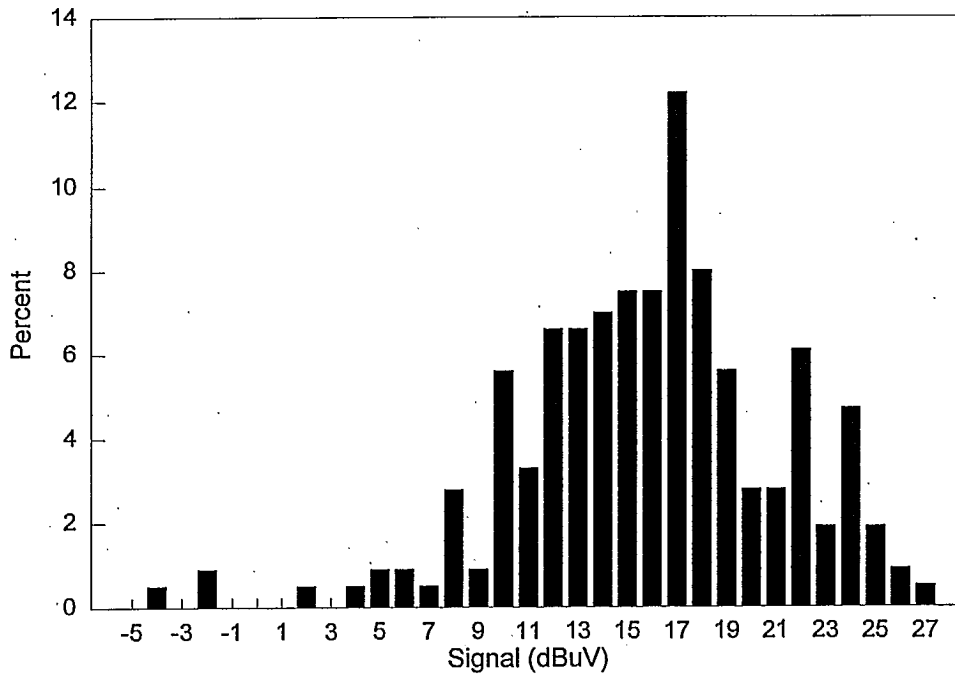
**CHART 1**

**Site:** Edgar  
**Azimuth:** 328  
**Point #:** 7  
**# Points:** 210  
**Avg Signal:** 36.2  
**Med Signal:** 36.6  
**StdDev:** 2.3



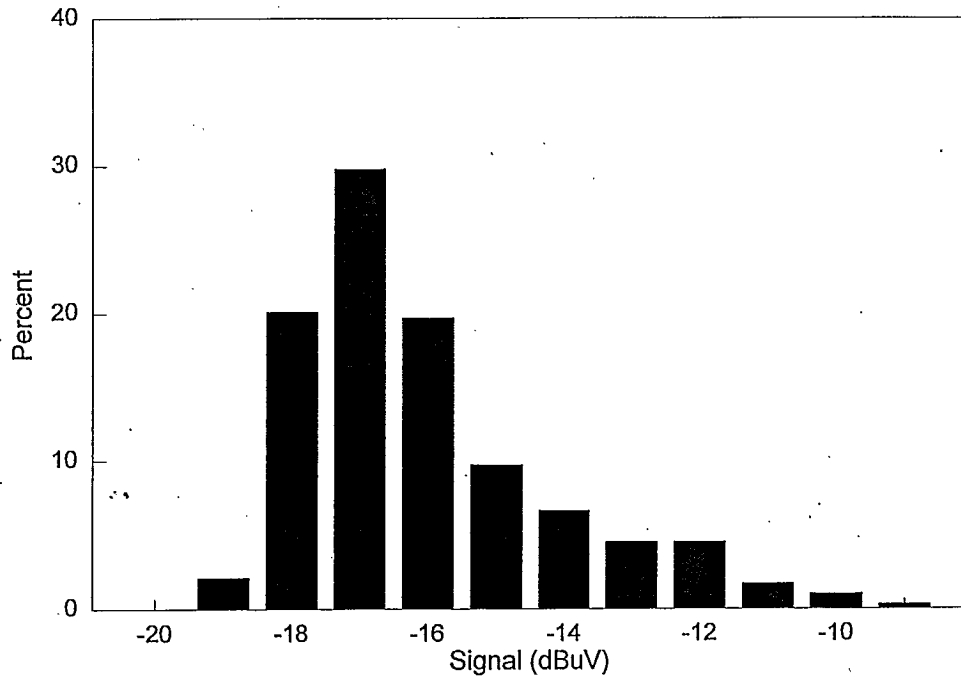
**CHART 1a**

**Site:** Edgar  
**Azimuth:** 328  
**Point #:** 10  
**# Points:** 213  
**Avg Signal:** 15.3  
**Med Signal:** 15.6  
**StdDev:** 5.2



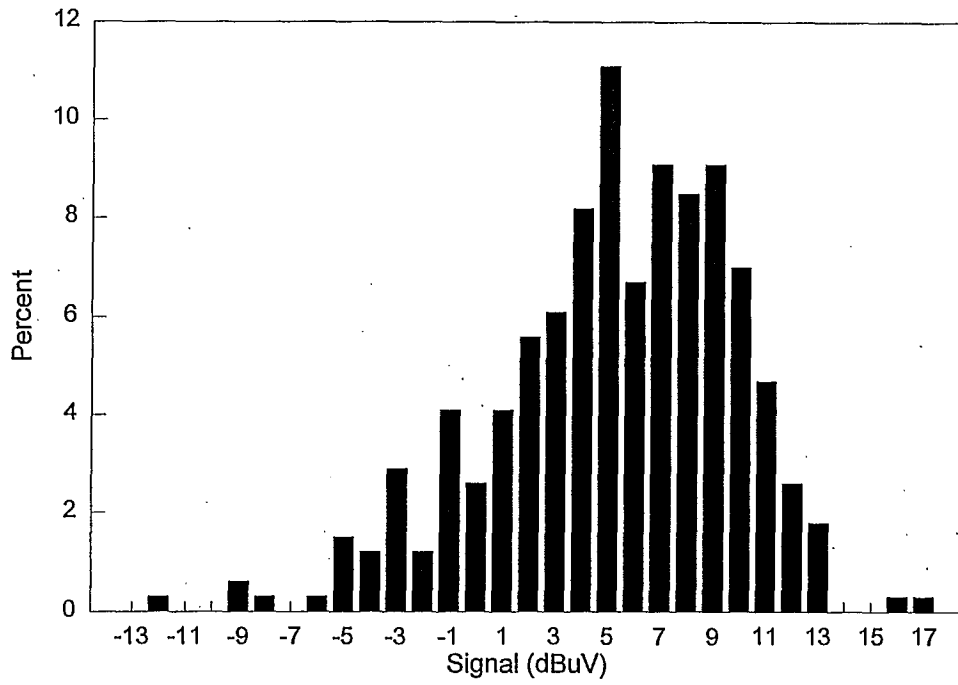
**CHART 2**

Site: Edgar  
Azimuth: 316  
Point #: 10  
# Points: 289  
Avg Signal: -16.6  
Med Signal: -17  
StdDev: 1.9



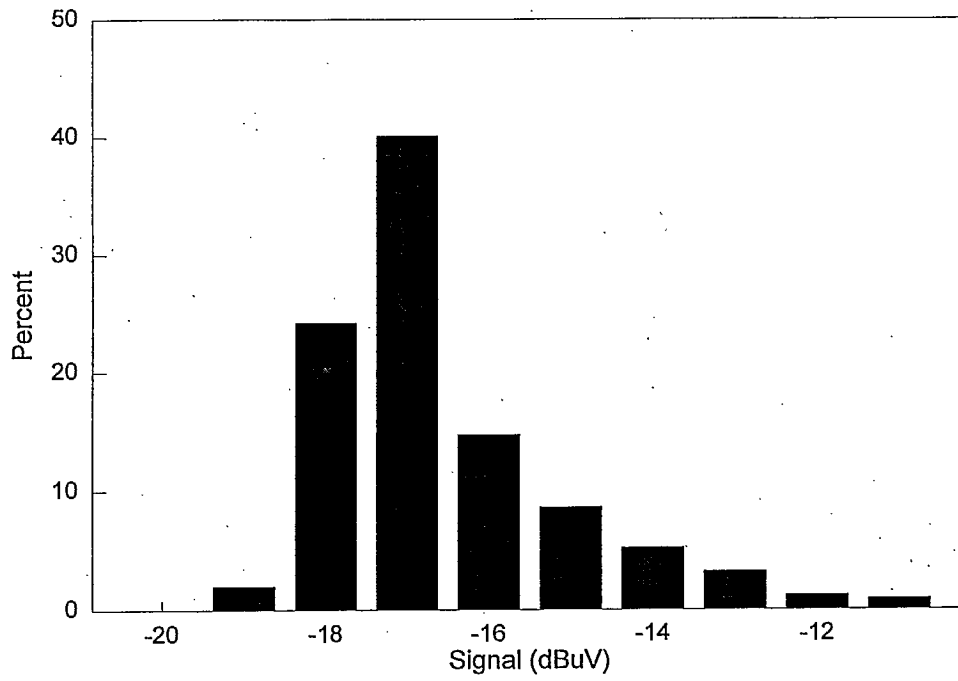
**CHART 2a**

**Site:** Edgar  
**Azimuth:** 316  
**Point #:** 4  
**# Points:** 342  
**Avg Signal:** 4.7  
**Med Signal:** 5  
**StdDev:** 4.5



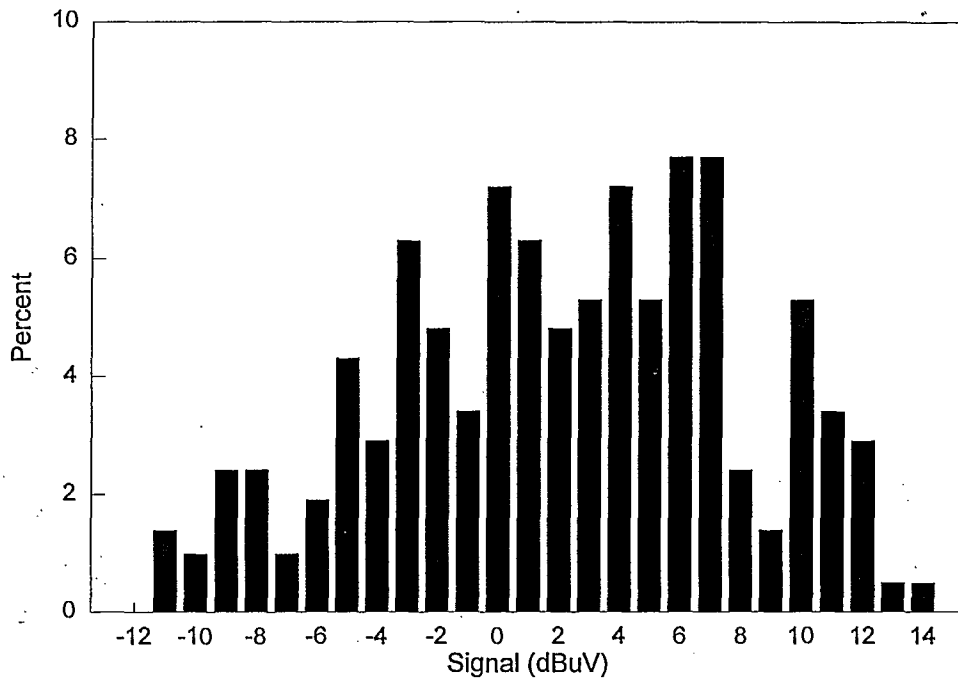
**CHART 3**

**Site:** Edgar  
**Azimuth:** 290  
**Point #:** 114  
**# Points:** 347  
**Avg Signal:** -17.1  
**Med Signal:** -17.5  
**StdDev:** 1.5



**CHART 3a**

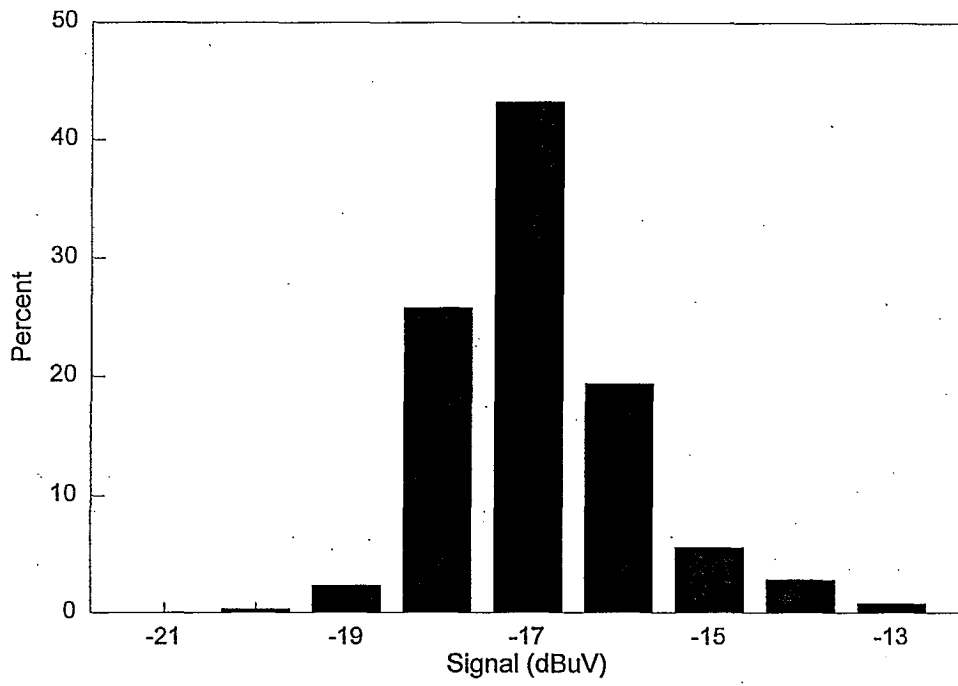
**Site:** Edgar  
**Azimuth:** 290  
**Point #:** 102  
**# Points:** 207  
**Avg Signal:** 1.6  
**Med Signal:** 1.9  
**StdDev:** 5.8





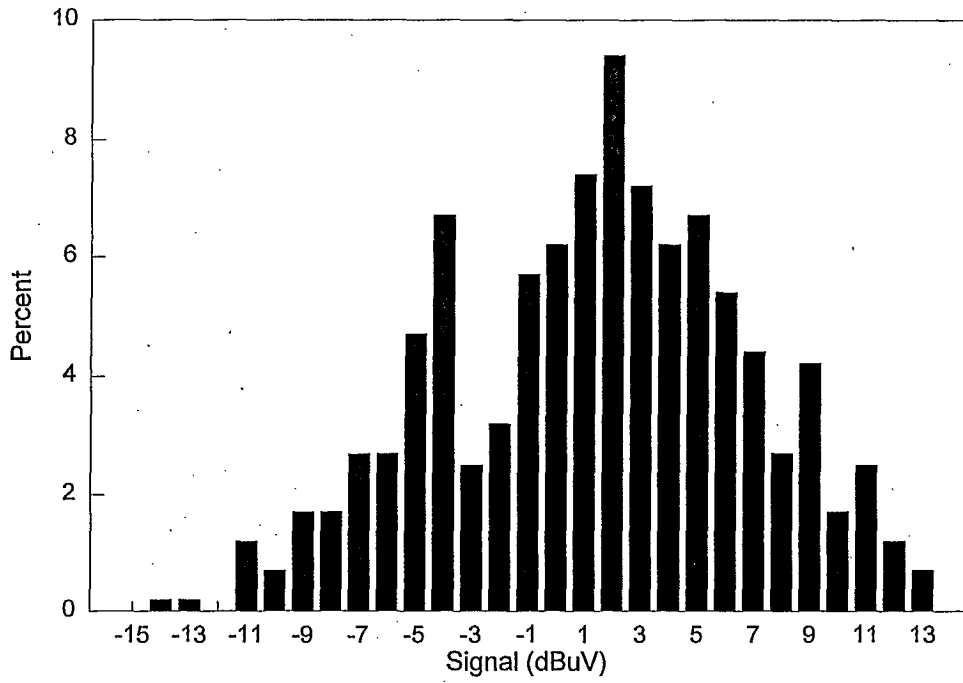
**CHART 4**

**Site:** Edgar  
**Azimuth:** 337  
**Point #:** 103  
**# Points:** 396  
**Avg Signal:** -17.4  
**Med Signal:** -17.6  
**StdDev:** 1



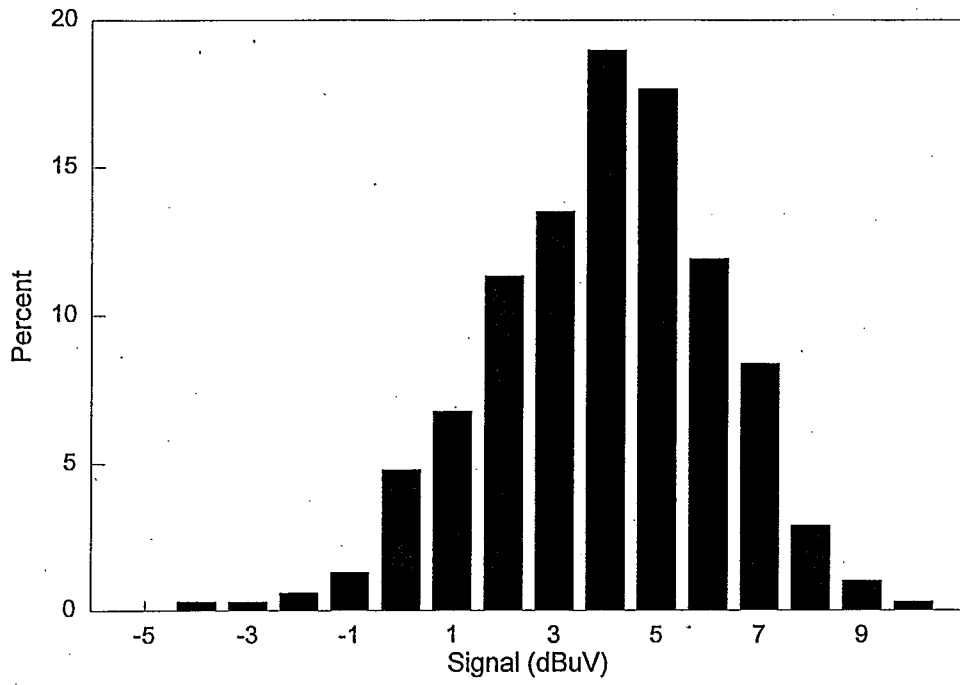
**CHART 4a**

**Site:** Edgar  
**Azimuth:** 337  
**Point #:** 105  
**# Points:** 405  
**Avg Signal:** 0.9  
**Med Signal:** 1.3  
**StdDev:** 5.4



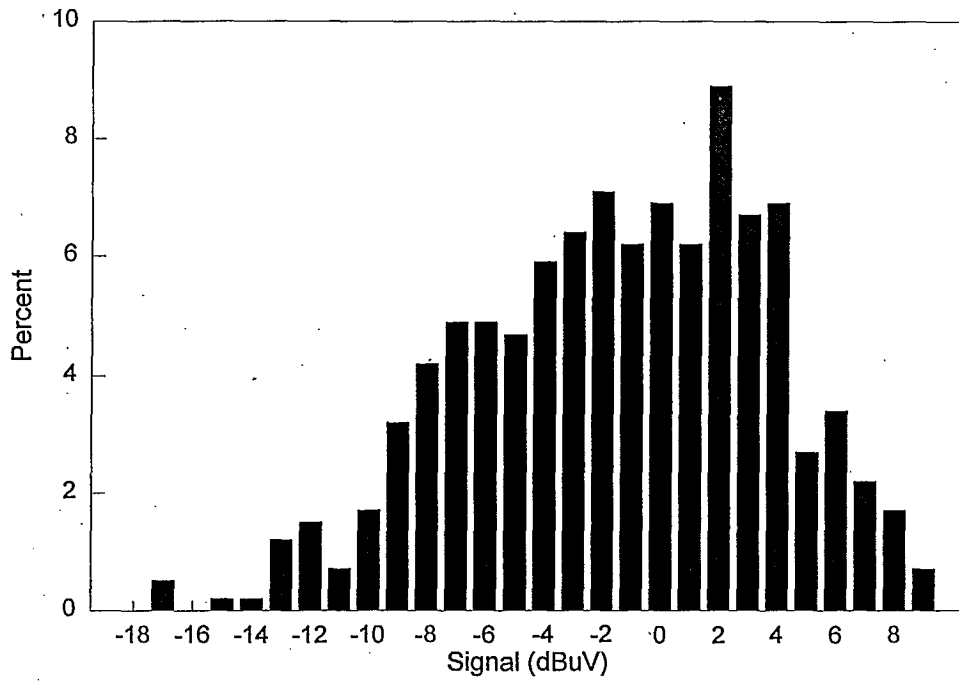
**CHART 5**

Site: Edgar  
Azimuth: 6  
Point #: 8  
# Points: 311  
Avg Signal: 3.4  
Med Signal: 3.6  
StdDev: 2.2



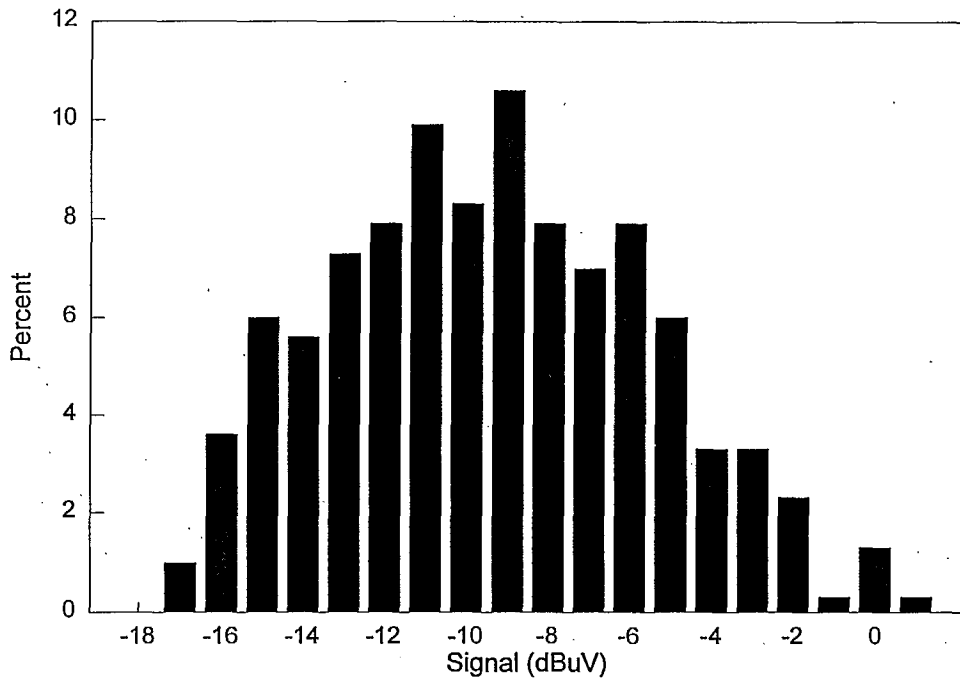
**CHART 5a**

**Site:** Edgar  
**Azimuth:** 6  
**Point #:** 11  
**# Points:** 406  
**Avg Signal:** -2  
**Med Signal:** -1.8  
**StdDev:** 5.1



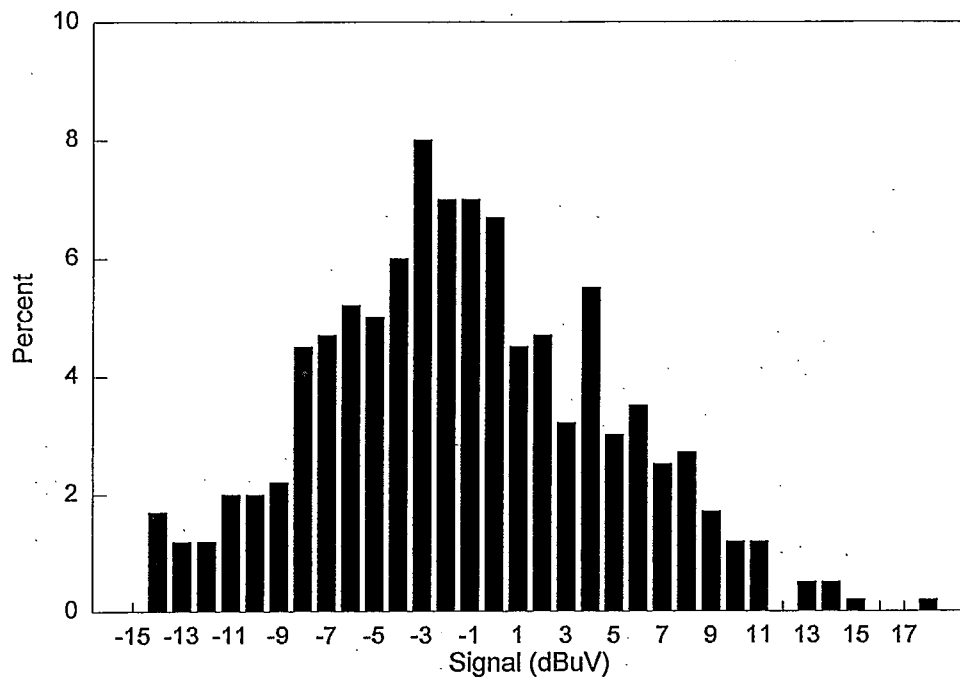
**CHART 6**

Site: Edgar  
Azimuth: 37  
Point #: 101  
# Points: 302  
Avg Signal: -9.9  
Med Signal: -9.9  
StdDev: 3.9



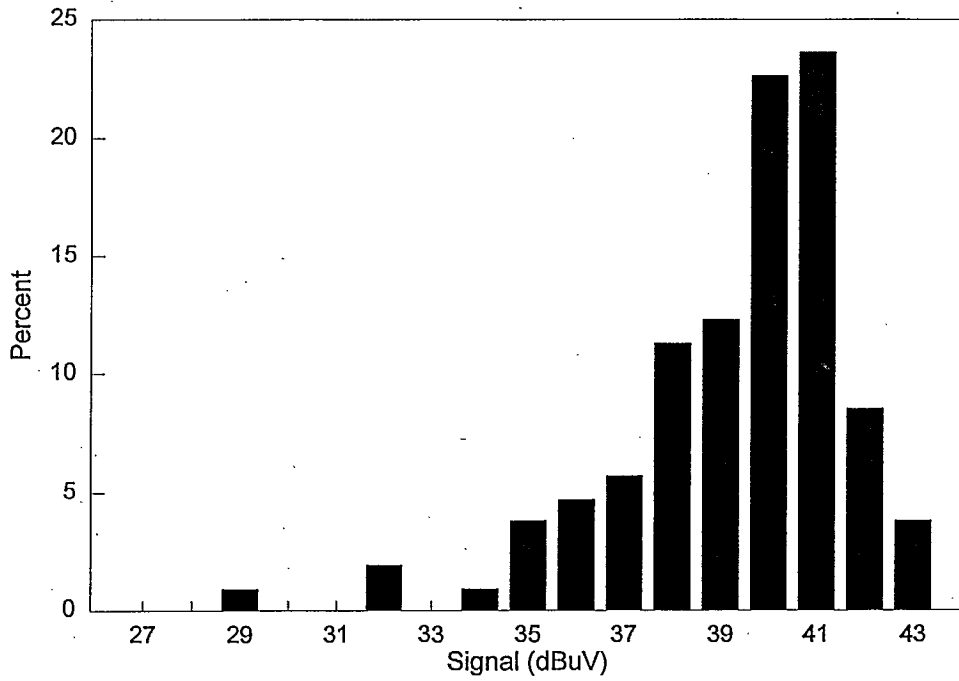
**CHART 6a**

**Site:** Edgar  
**Azimuth:** 37  
**Point #:** 113  
**# Points:** 401  
**Avg Signal:** -1.8  
**Med Signal:** -2.2  
**StdDev:** 6



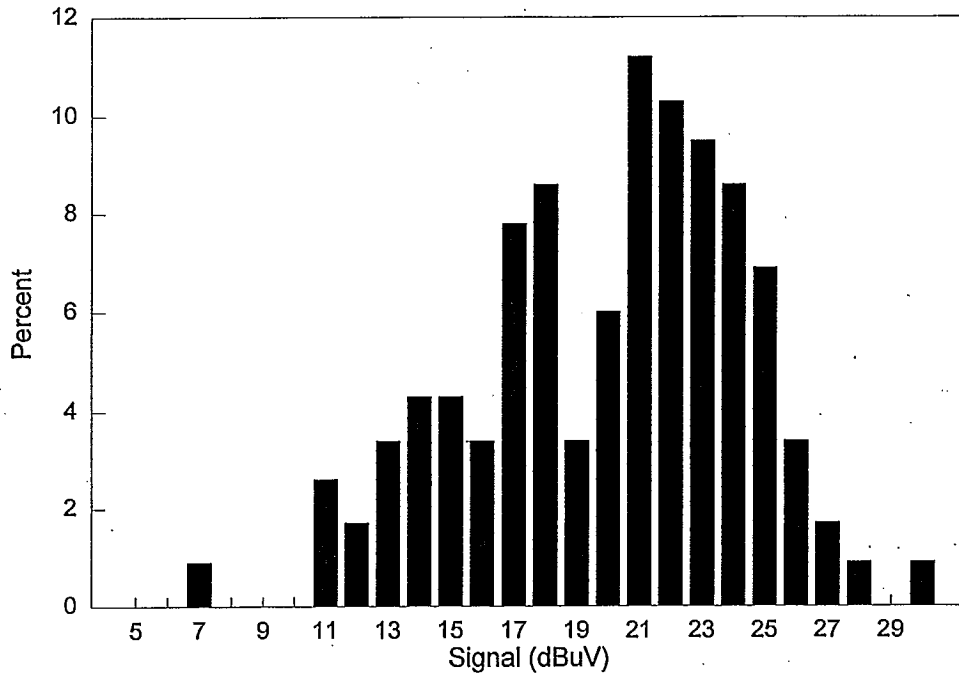
**CHART 7**

**Site:** Edgar  
**Azimuth:** 150  
**Point #:** 8  
**# Points:** 106  
**Avg Signal:** 38.8  
**Med Signal:** 39.3  
**StdDev:** 2.4



**CHART 7a**

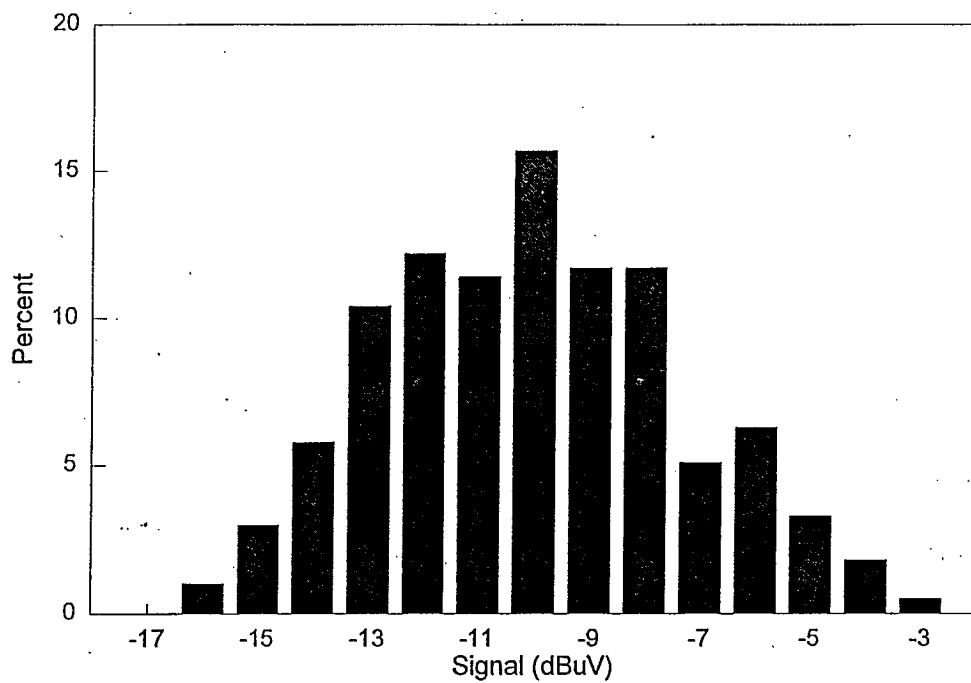
Site: Edgar  
Azimuth: 150  
Point #: 10  
# Points: 116  
Avg Signal: 19.5  
Med Signal: 20.2  
StdDev: 4.3





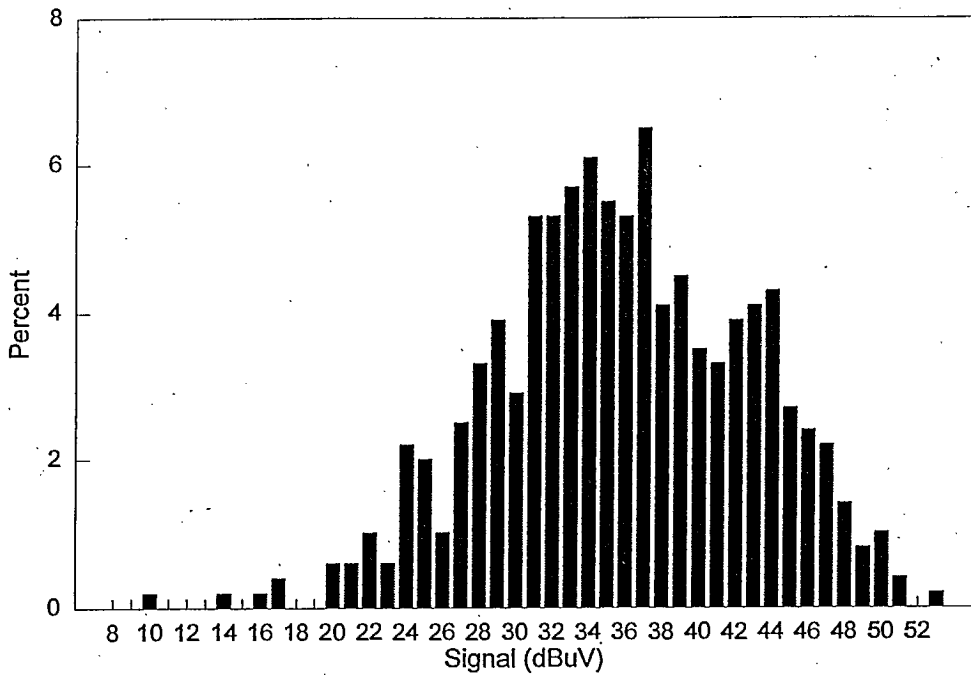
**CHART 8**

Site: St. Catharines  
Azimuth: 209  
Point #: 12  
# Points: 394  
Avg Signal: -10.5  
Med Signal: -10.6  
StdDev: 2.7



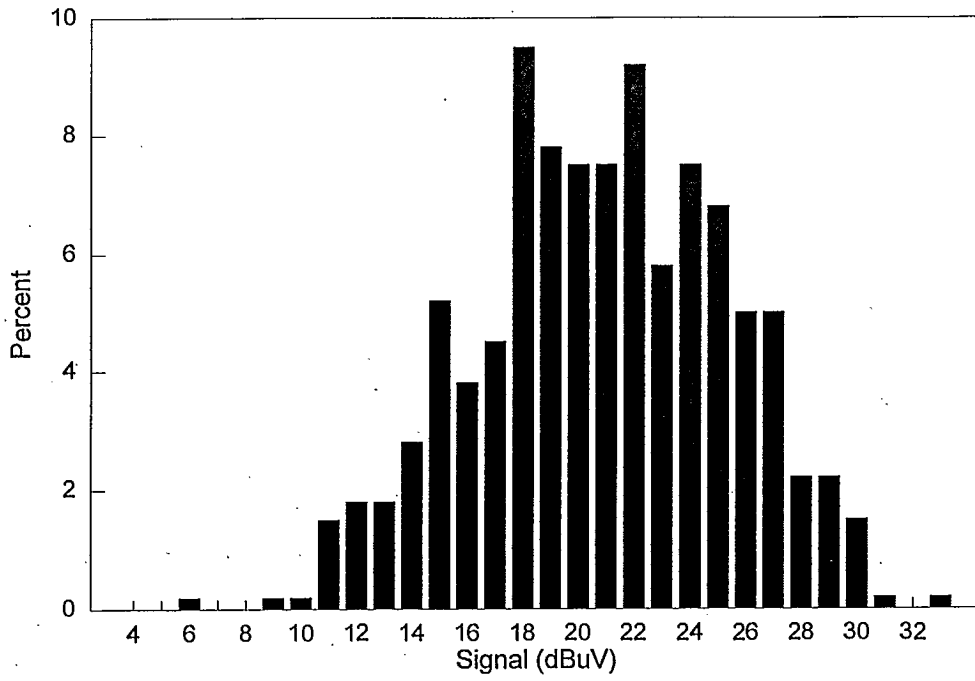
**CHART 8a**

Site: St. Catharines  
Azimuth: 209  
Point #: 11  
# Points: 510  
Avg Signal: 35.2  
Med Signal: 35.2  
StdDev: 7



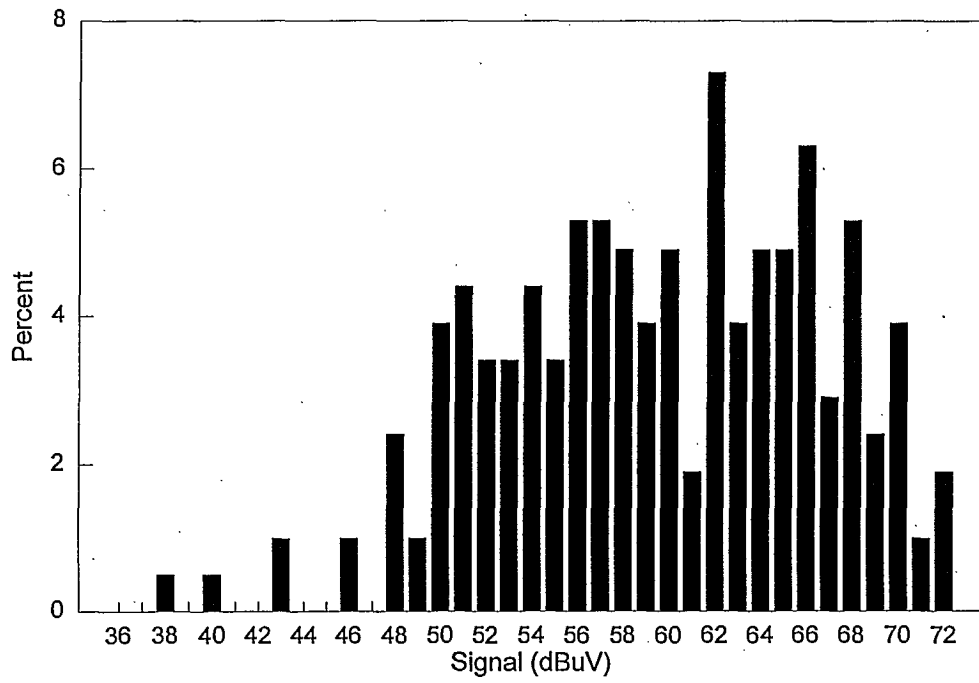
**CHART 9**

Site: St. Catharines  
Azimuth: 252  
Point #: 105  
# Points: 400  
Avg Signal: 20.4  
Med Signal: 20.5  
StdDev: 4.6



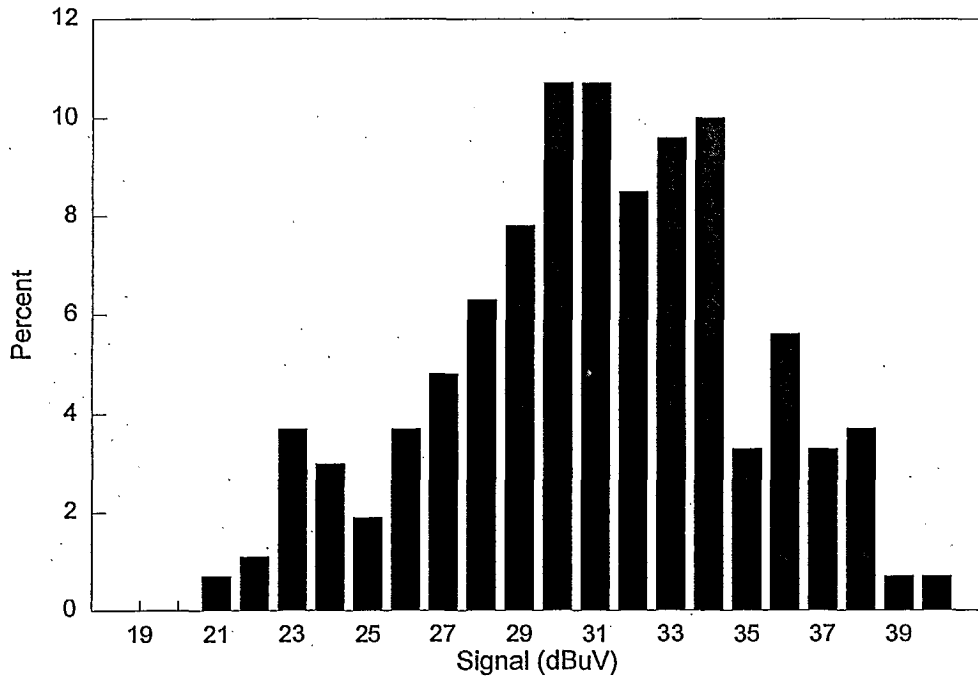
**CHART 9a**

**Site:** St. Catharines  
**Azimuth:** 252  
**Point #:** 117  
**# Points:** 206  
**Avg Signal:** 59.1  
**Med Signal:** 59.5  
**StdDev:** 6.9



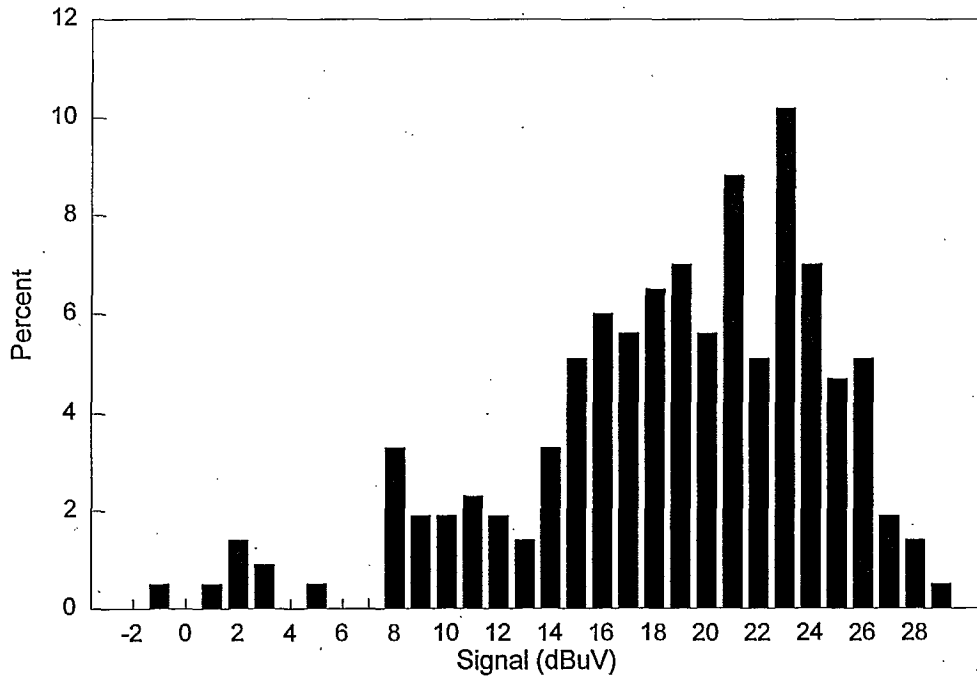
**CHART 10**

**Site:** St. Catharines  
**Azimuth:** 262  
**Point #:** 12  
**# Points:** 270  
**Avg Signal:** 30.5  
**Med Signal:** 30.6  
**StdDev:** 4



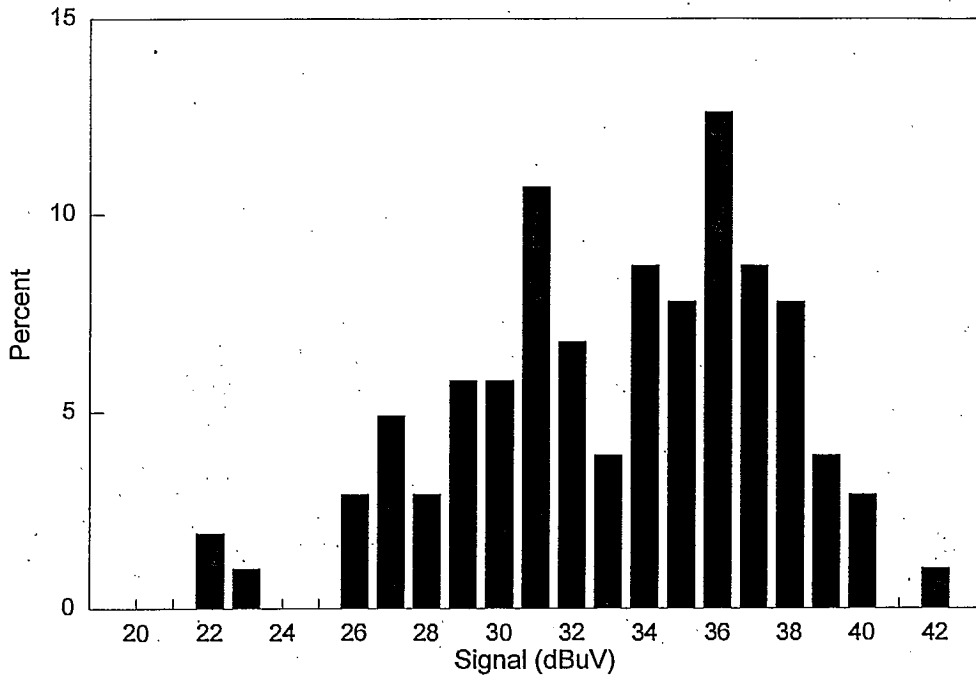
**CHART 10a**

**Site:** St. Catharines  
**Azimuth:** 262  
**Point #:** 3  
**# Points:** 215  
**Avg Signal:** 18.2  
**Med Signal:** 19.2  
**StdDev:** 5.8



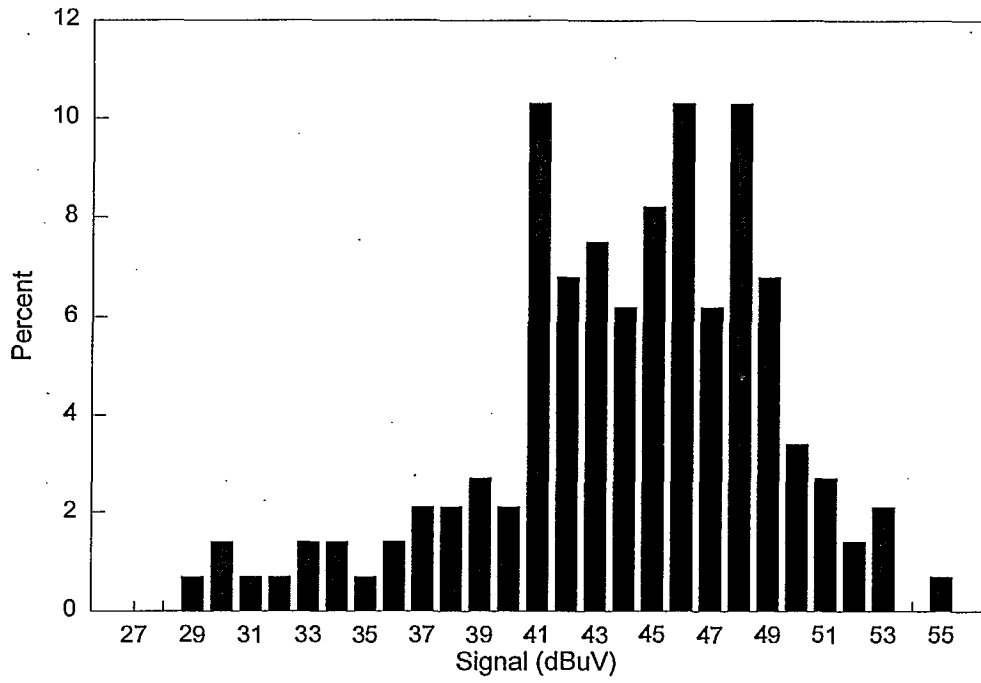
**CHART 11**

Site: St. Catharines  
Azimuth: 358  
Point #: 109  
# Points: 103  
Avg Signal: 32.7  
Med Signal: 33.4  
StdDev: 4.2



**CHART 11a**

**Site:** St. Catharines  
**Azimuth:** 358  
**Point #:** 107  
**# Points:** 146  
**Avg Signal:** 43.5  
**Med Signal:** 44.3  
**StdDev:** 5.1





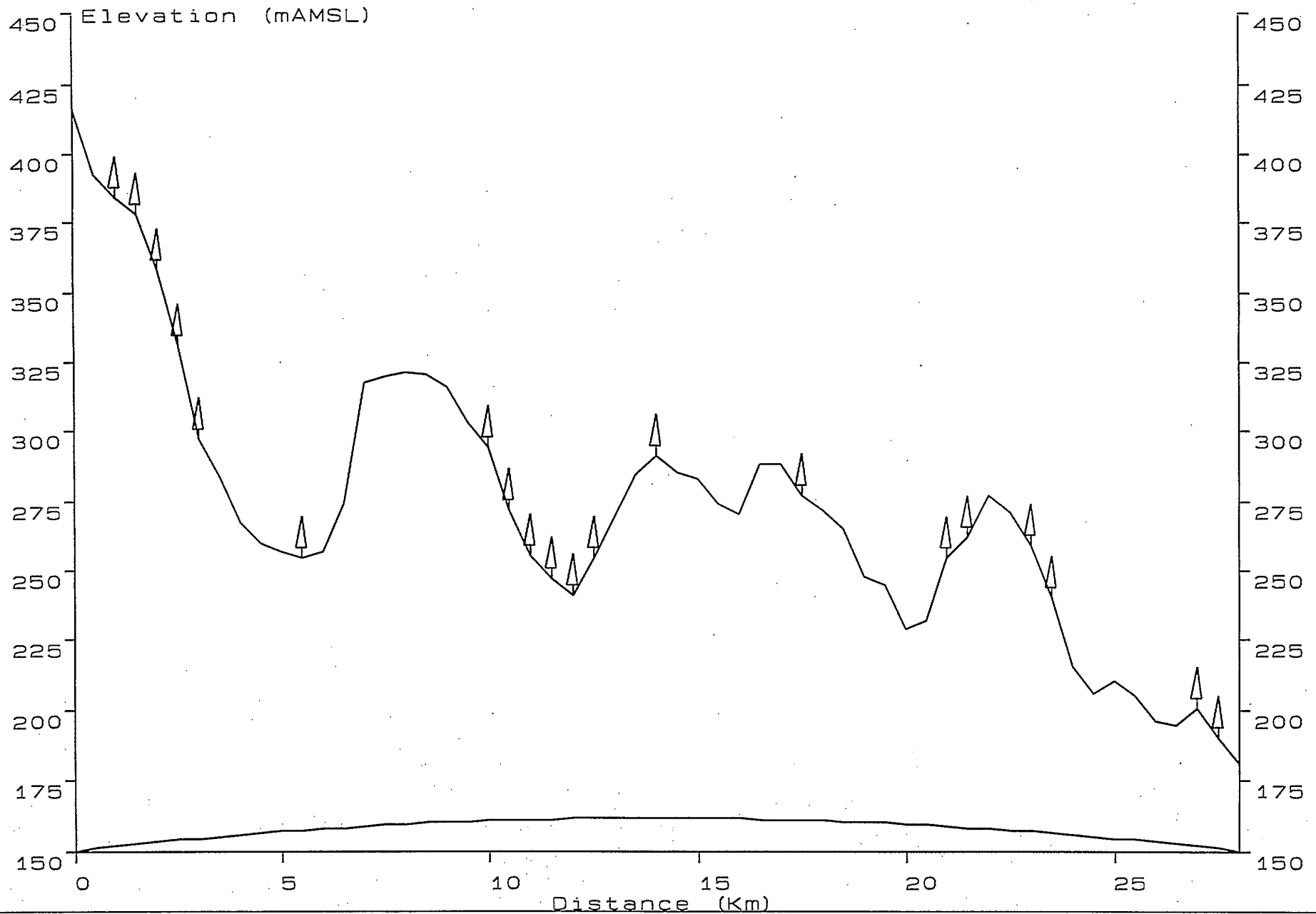
APPENDIX C

TERRAIN PROFILES

Path :Edgar-328  
Freq (MHz):1810  
Dist (Km) :28

Figure-1

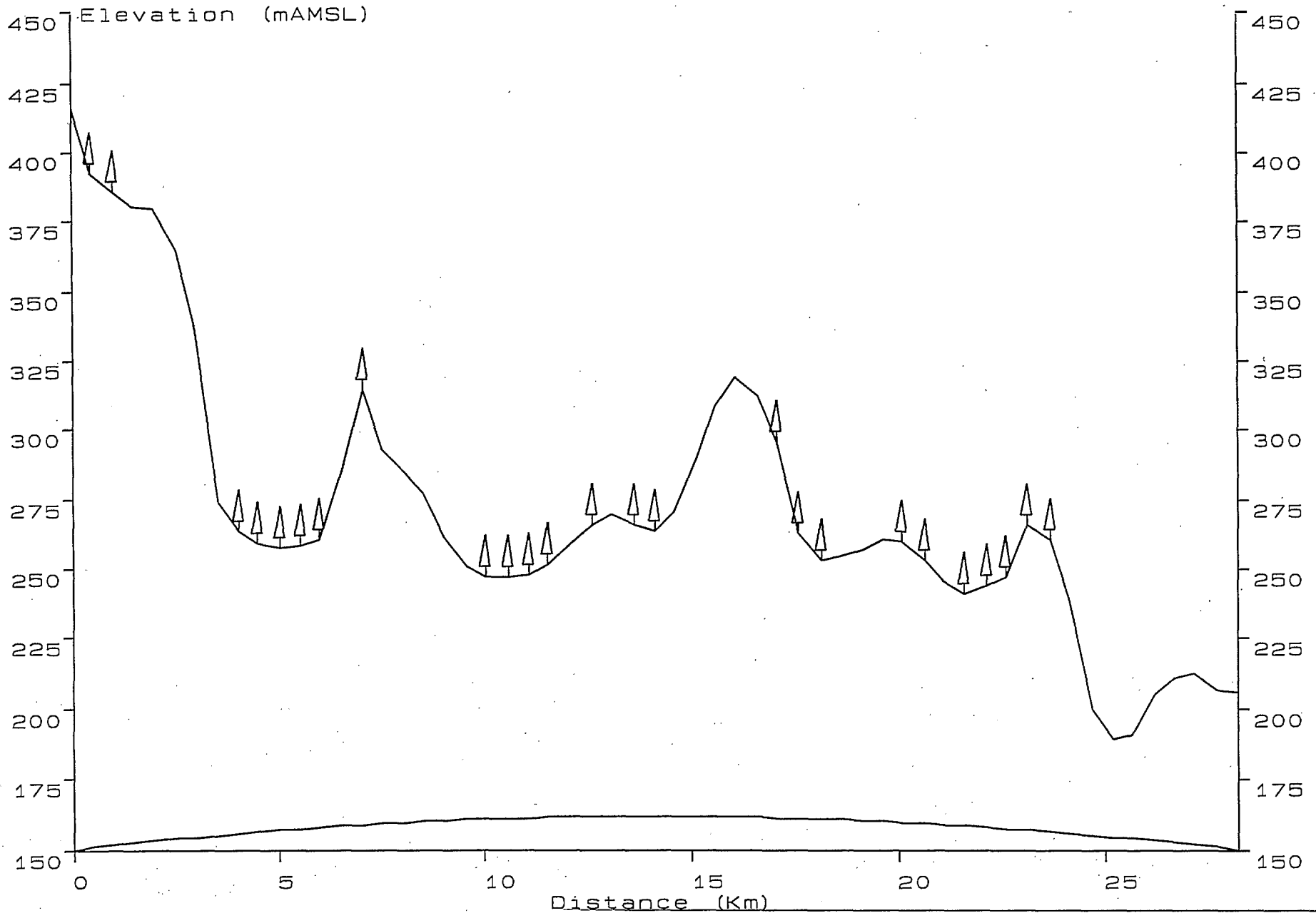
TxAntHt (mAGL): 5  
RxAntHt (mAGL): 2  
K=4/3



Path : Edgar-316  
Freq (MHz) : 1810  
Dist (Km) : 28.2

Figure-2

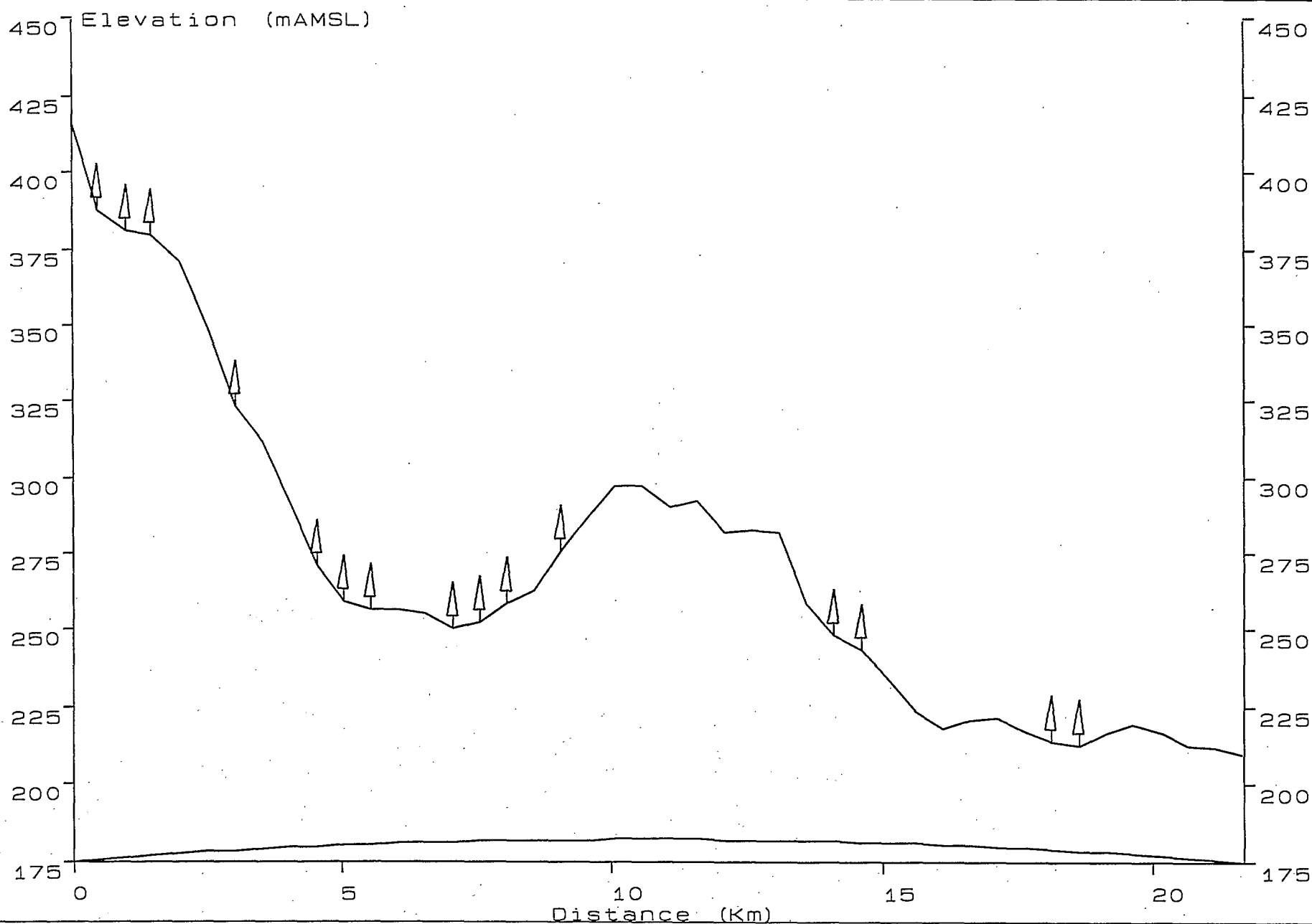
TxAntHt (mAGL) : 5  
RxAntHt (mAGL) : 2  
K=4/3



Path : Edgar-290  
Freq (MHz) : 1810  
Dist (Km) : 21.7

Figure-3

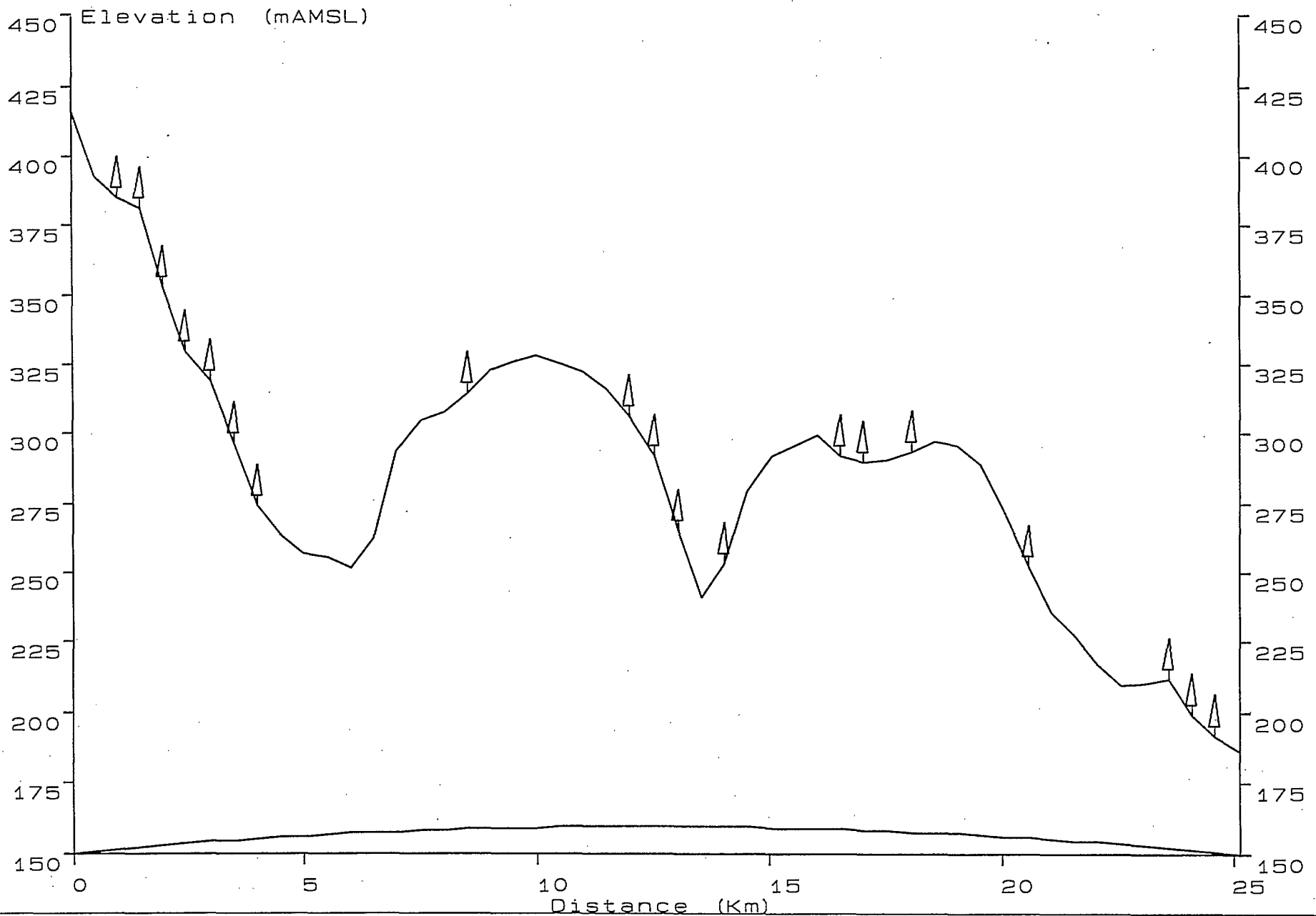
TxAntHt (mAGL) : 5  
RxAntHt (mAGL) : 2  
K=4/3



Path : Edgar-337  
Freq (MHz) : 1810  
Dist (Km) : 25.1

Figure-4

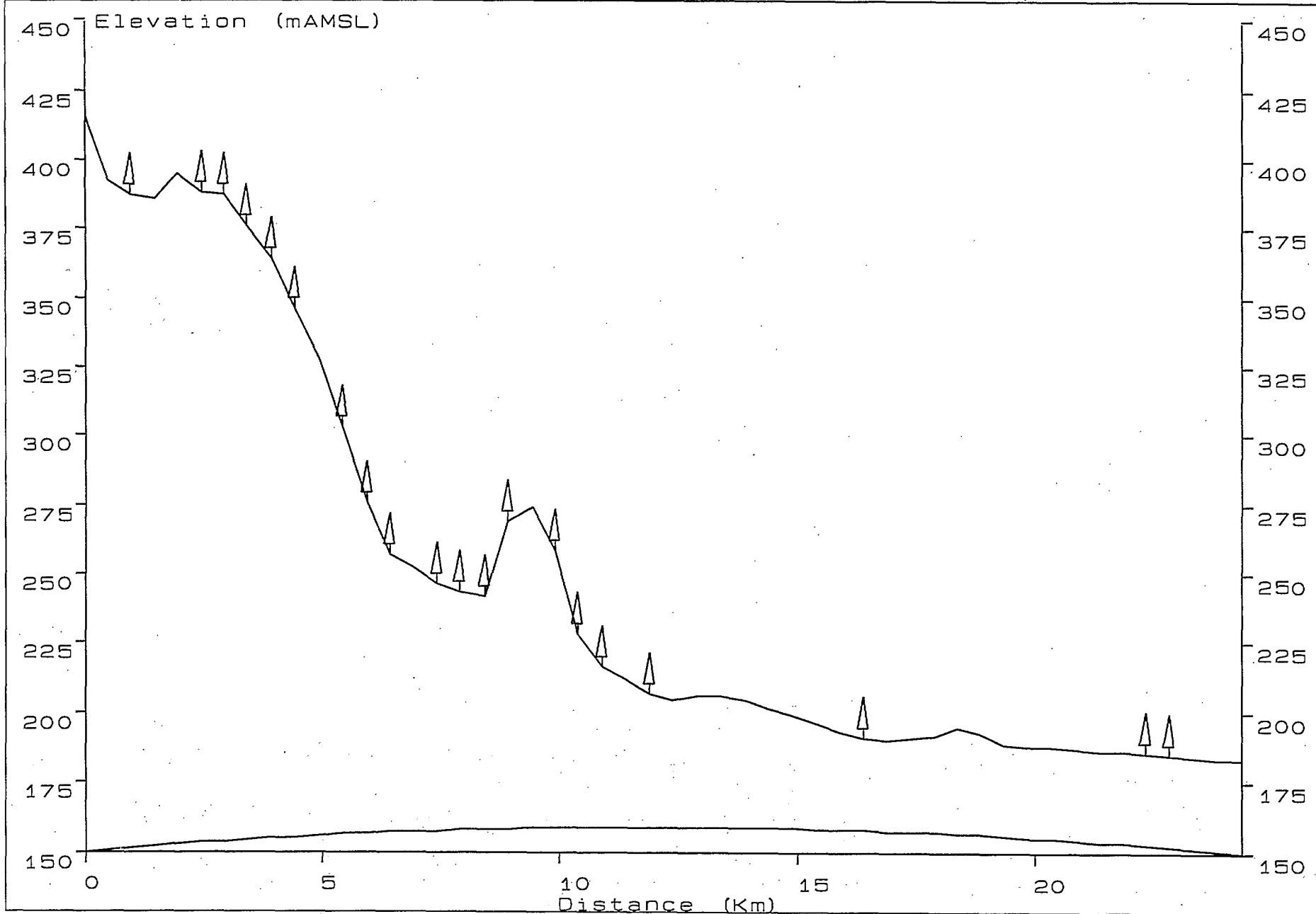
TxAntHt (mAGL) : 5  
RxAntHt (mAGL) : 2  
K=4/3



Path : Edgar-6  
Freq (MHz) : 1810  
Dist (Km) : 24.3

Figure-5

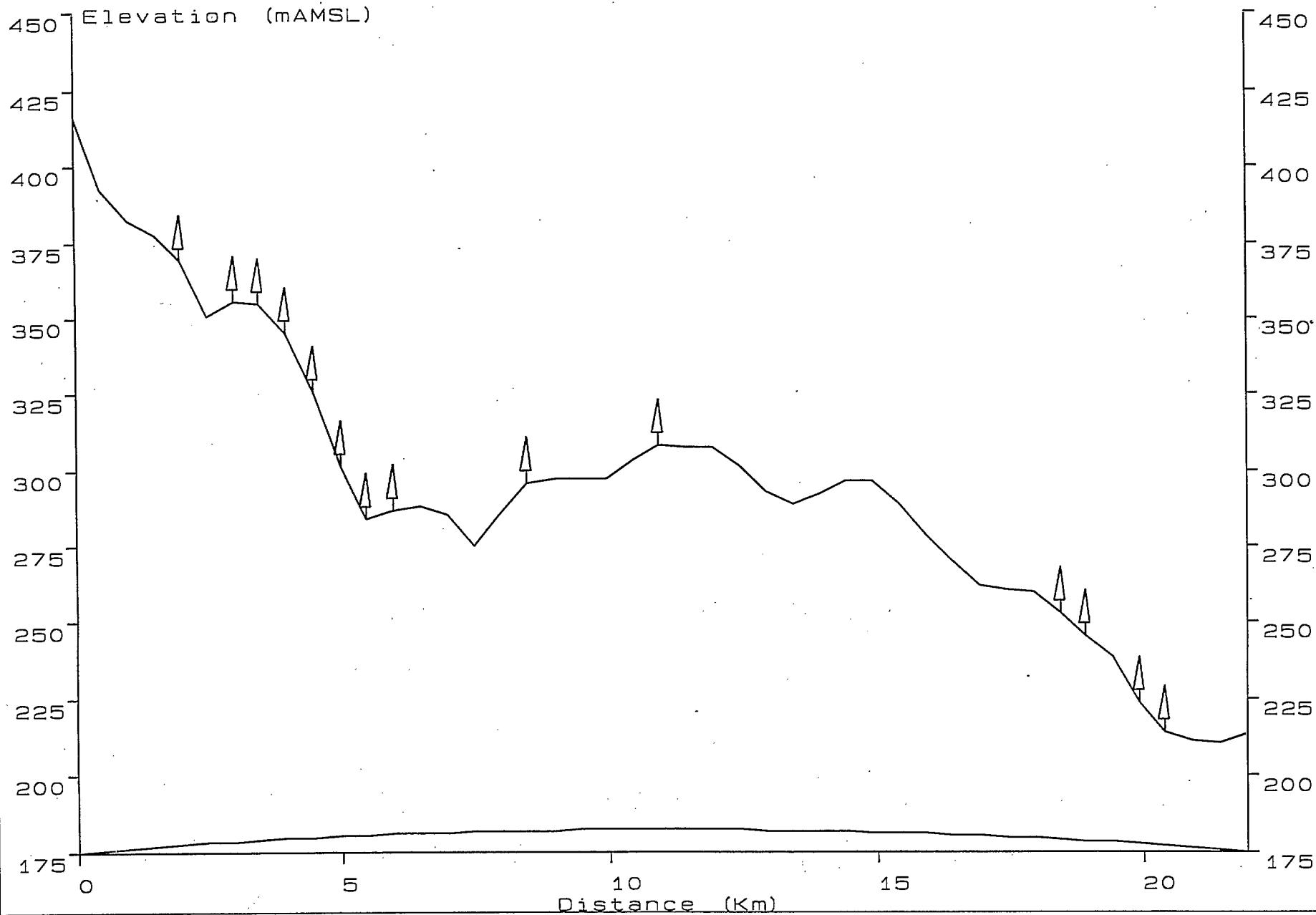
TxAntHt (mAGL) : 5  
RxAntHt (mAGL) : 2  
K=4/3



Path : Edgar-37  
Freq (MHz) : 1810  
Dist (Km) : 21.9

Figure-6

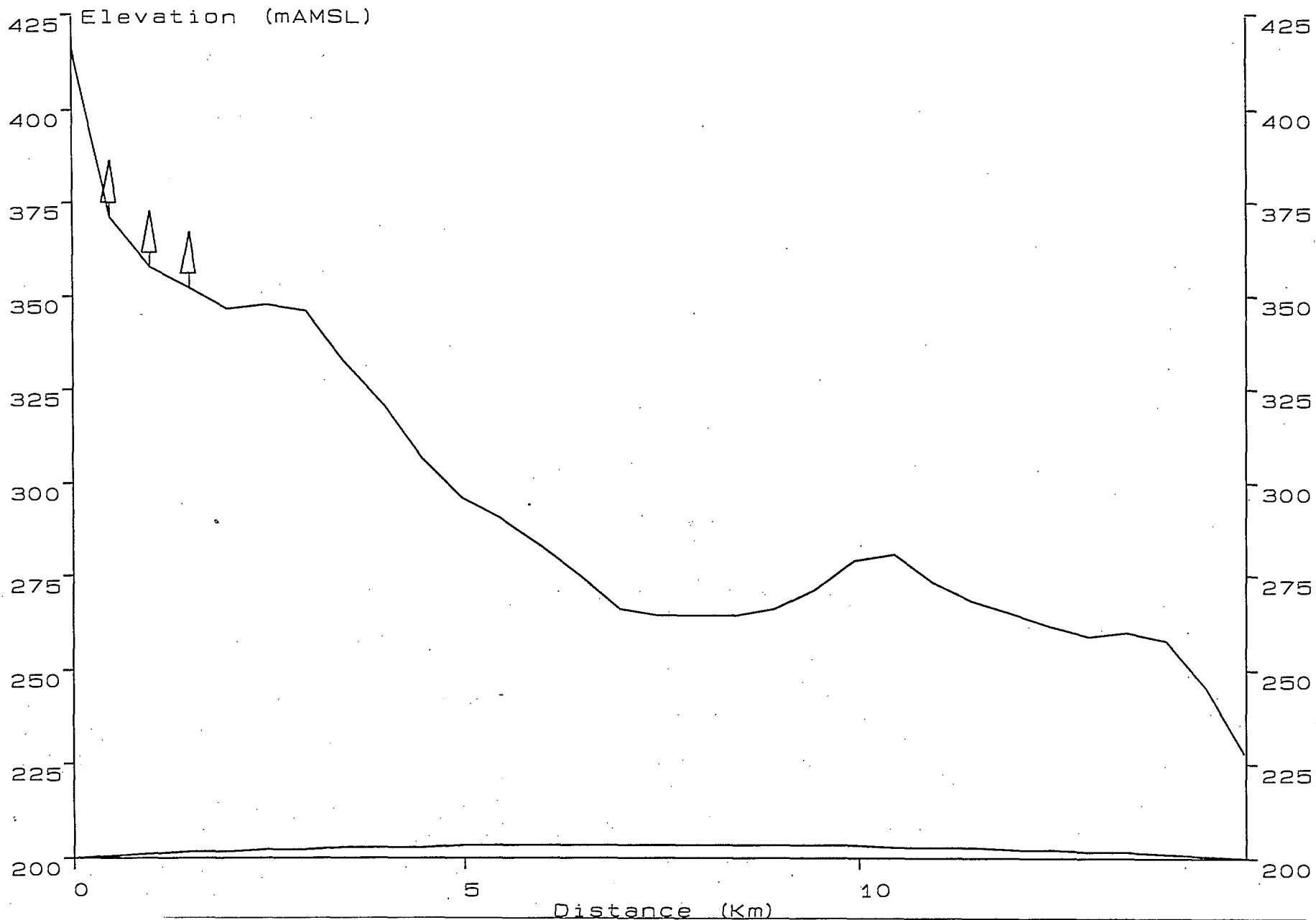
TxAntHt (mAGL) : 5  
RxAntHt (mAGL) : 2  
K=4/3



Path : Edgar-150  
Freq (MHz) : 1810  
Dist (Km) : 14.9

Figure-7

TxAntHt (mAGL) : 5  
RxAntHt (mAGL) : 2  
K=4/3

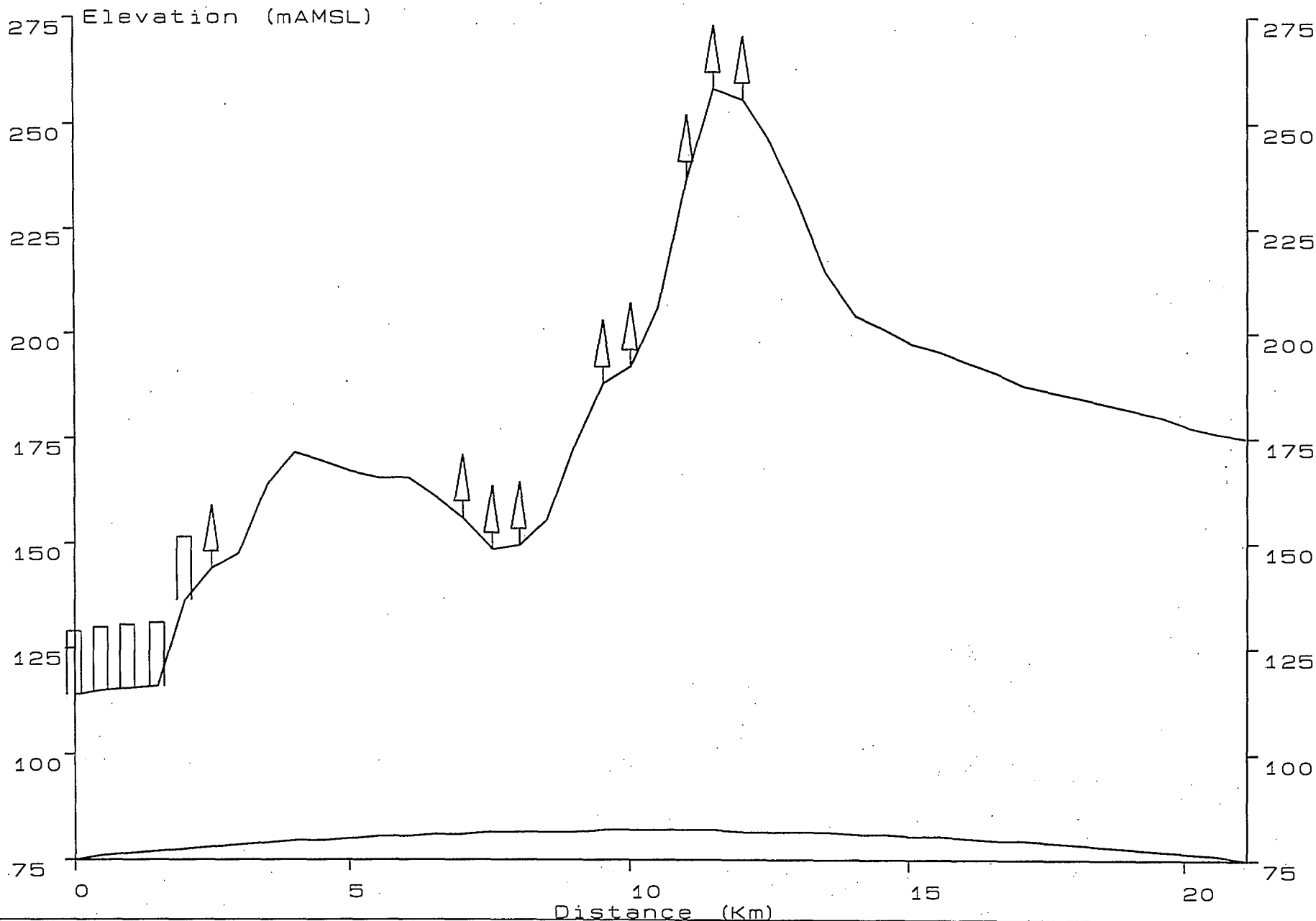




Path : St. Catharines-209  
Freq (MHz) : 1810  
Dist (Km) : 21.1

Figure-8

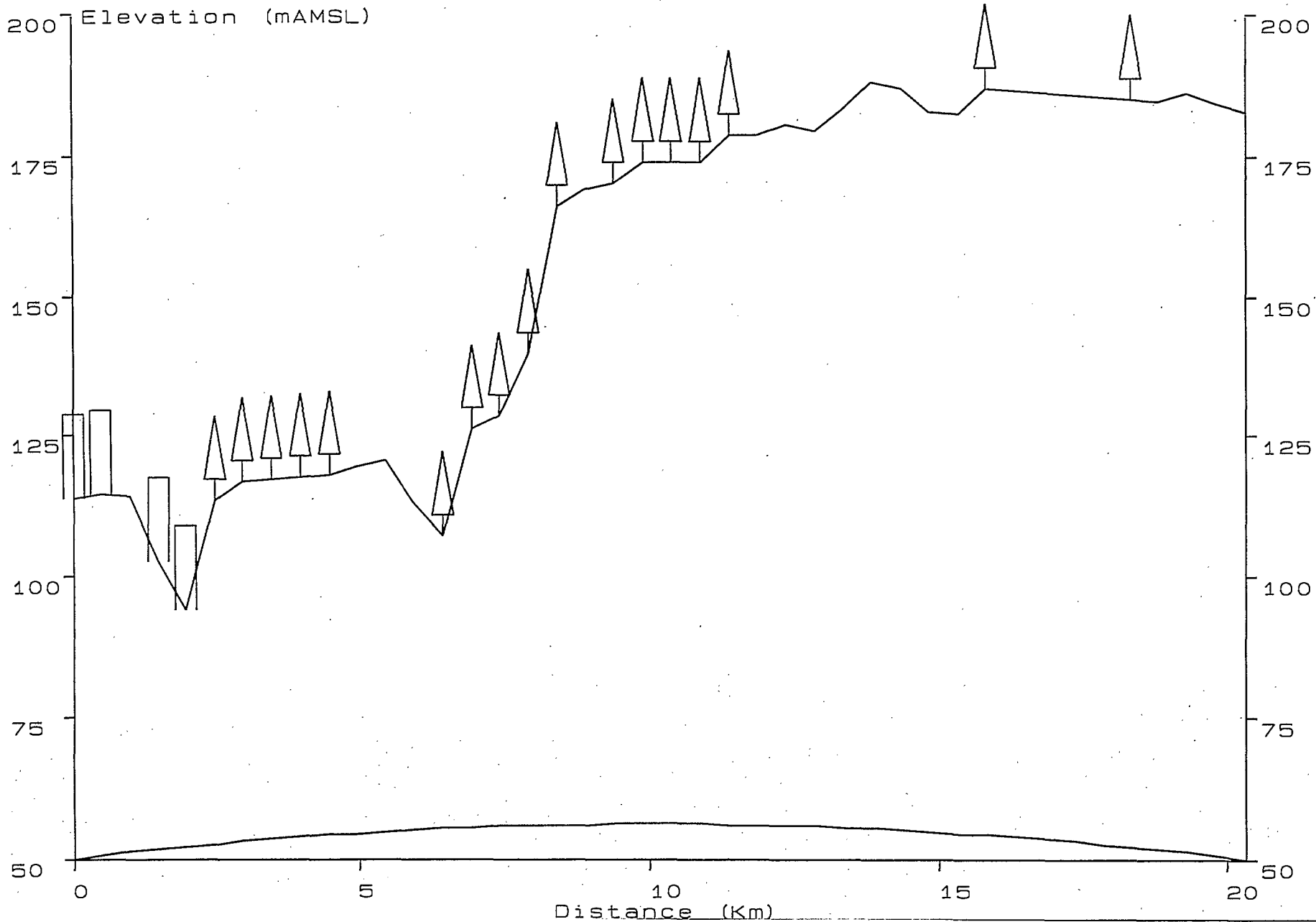
TxAntHt (mAGL) : 65  
RxAntHt (mAGL) : 2  
K=4/3



Path : St. Catharines-252  
Freq (MHz) : 1810  
Dist (Km) : 20.3

Figure-9

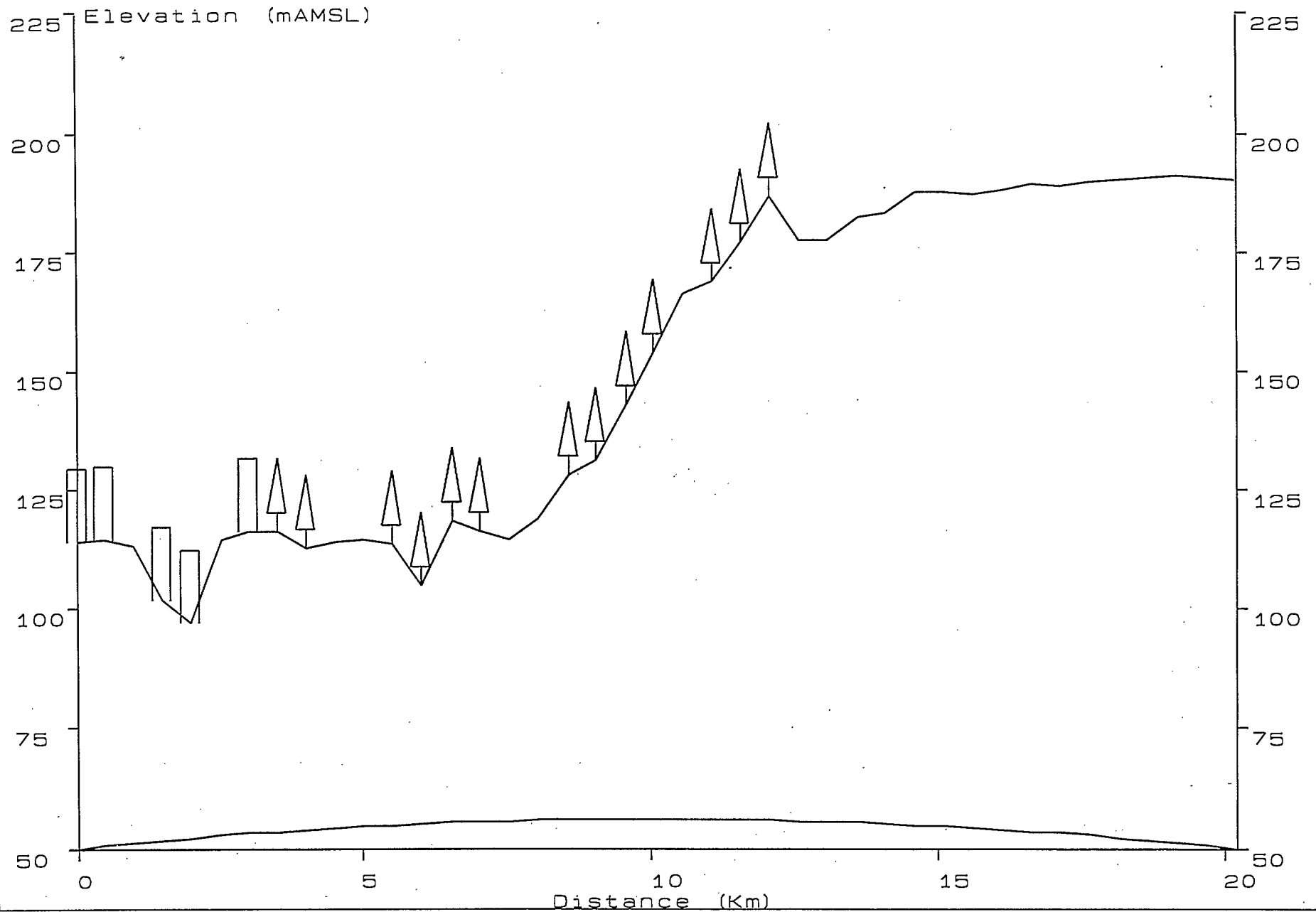
TxAntHt (mAGL) : 65  
RxAntHt (mAGL) : 2  
K=4/3



Path : St. Catharines-262  
Freq (MHz) : 1810  
Dist (Km) : 20.2

Figure-10

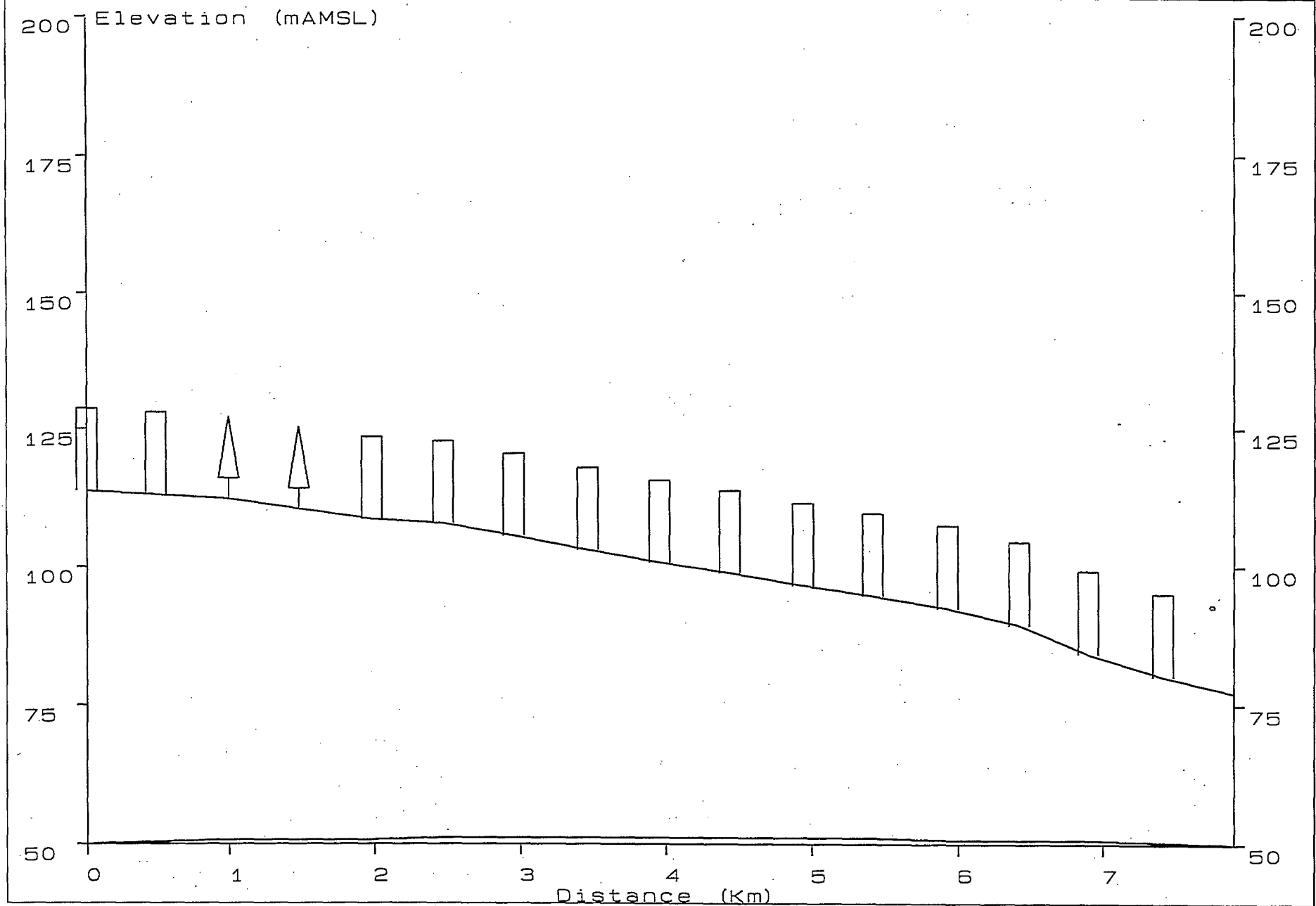
TxAntHt (mAGL) : 65  
RxAntHt (mAGL) : 2  
K=4/3



Path : St. Catharines-358  
Freq (MHz) : 1810  
Dist (Km) : 7.9

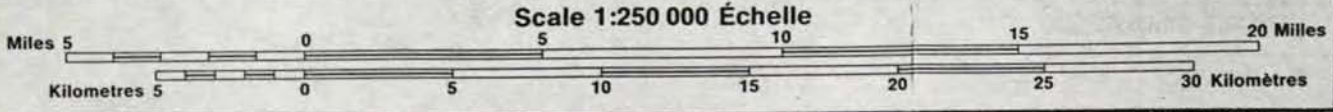
Figure-11

TxAntHt (mAGL) : 65  
RxAntHt (mAGL) : 2  
K=4/3

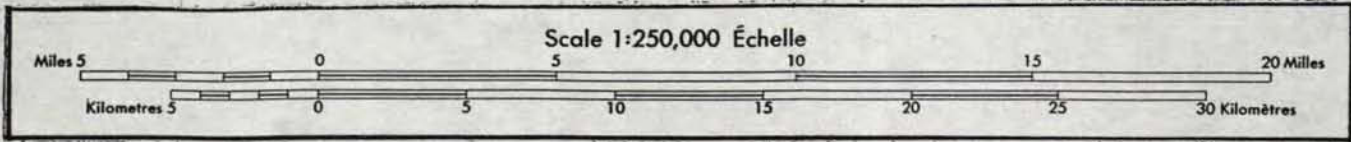


APPENDIX D

RADIAL MAPS



**FIGURE D1**  
**EDGAR RADIALS**



**FIGURE D2**  
**ST. CATHARINES RADIALS**

APPENDIX E

DIRECTIONAL ANTENNA PATTERNS



# FIGURE E1

## Transmitter Antenna Radiation Pattern



# ANDREW

RPE 3480

*Edward Louis Orlutay*  
Approved

8 November 1982

### RADIATION PATTERN ENVELOPE

ANTENNA TYPE NUMBER GP4F-17

4 FOOT ANTENNA

1.7 - 2.11 GHz

PLANE POLARIZED

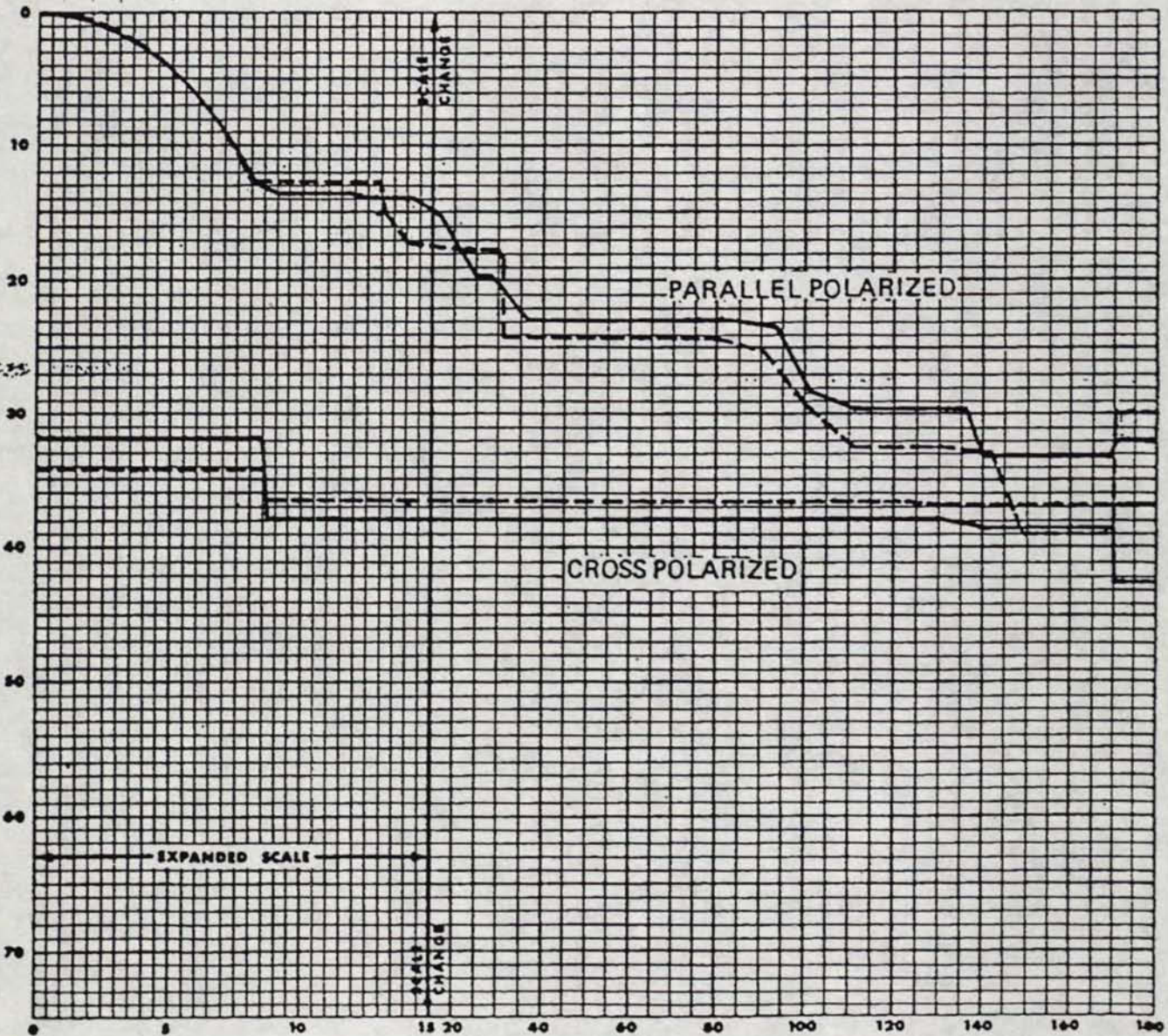
————— Envelope for a Horizontally Polarized Antenna

- - - - - Envelope for a Vertically Polarized Antenna

Gain: 25.3 ± 0.2 dBi at 1.9 GHz

See Andrew Bulletin 1032, "Radiation Pattern Envelopes", for further information.

ANTENNA DIRECTIVITY—dB DOWN FROM MAIN LOBE



AZIMUTH ± DEGREES FROM MAIN LOBE

File: TEST16.DAT  
Date: 06-Feb-95  
Operator: Reed

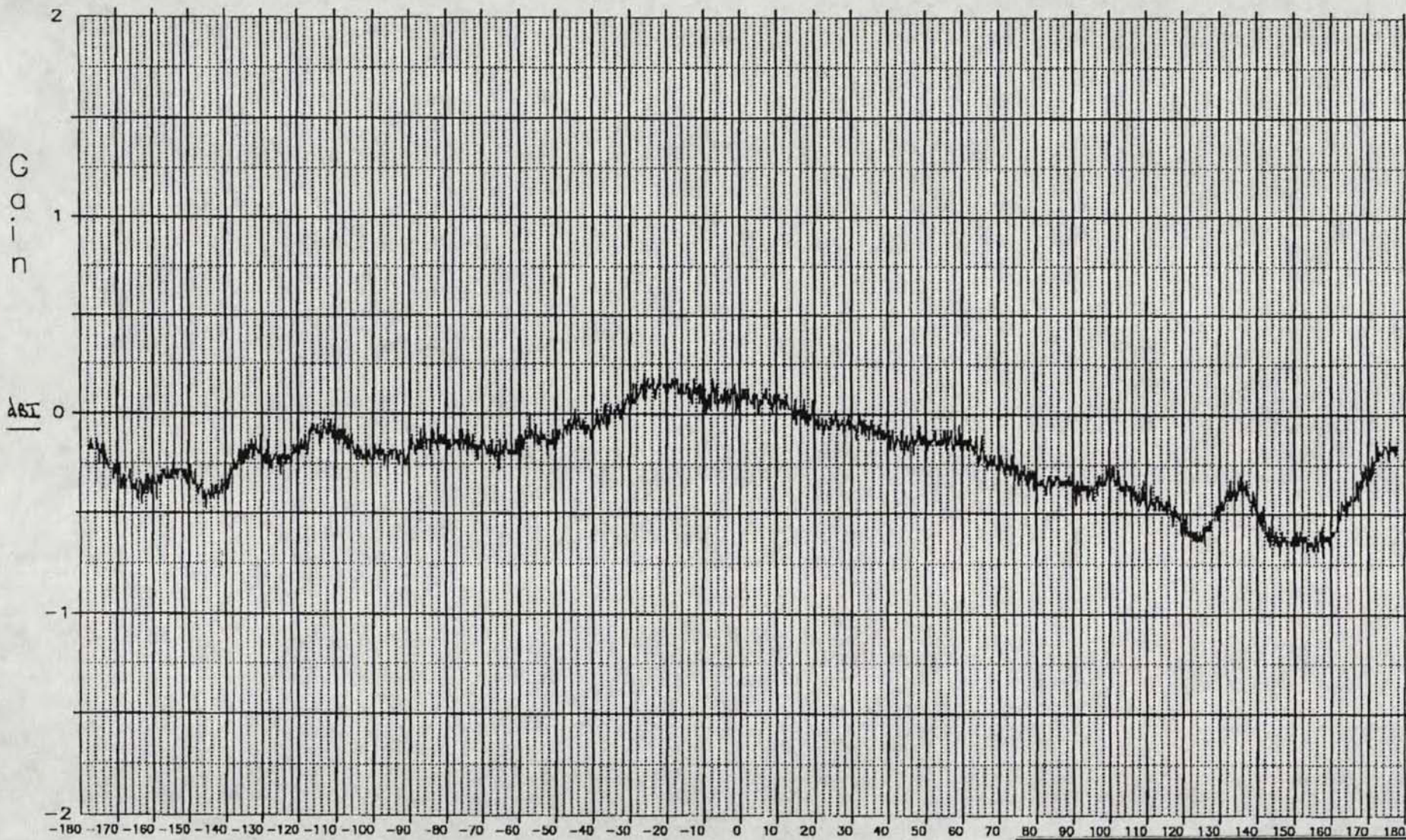
Unclassified  
1.81 GHz Monopole SN 1, H-Plane, Extra absorb Freq: 1.810 GHz  
Antenna rotated 30 deg.

03/20/95

14:50

FAX 613 998 4077

RADIO SCIENCES



1.97 dB

Azimuth

FIGURE E2

Unclassified

Receiver Antenna Radiation Pattern

APPENDIX F

EQUIPMENT LIST

EQUIPMENT LIST

Test Receiver:	Rohde and Schwarz ESVD
GPS Receiver:	Magellan NAV5000 PRO
Transmit Antenna:	Andrew GP4F-17-1
Receive Antenna:	CRC Custom 1/4 wave monopole
Remote Computer:	Toshiba T1910
Local Computer:	Bull 386 SX
Linear Amplifier:	PST AR1929-20
Microwave Synthesizer:	System Donner 1618
Power Meter:	HP 438A
Directional Coupler:	HP 778D
Rotator, Antenna:	CDE HAMII
Power Head:	HP 8481A

LKC  
QC676.7 .T7 R46 1995  
c.2  
Report on path loss  
measurements at 1810 MHz

**DATE DUE**  
DATE DE RETOUR

DATE DUE DATE DE RETOUR	

CARR MCLEAN 38-296

