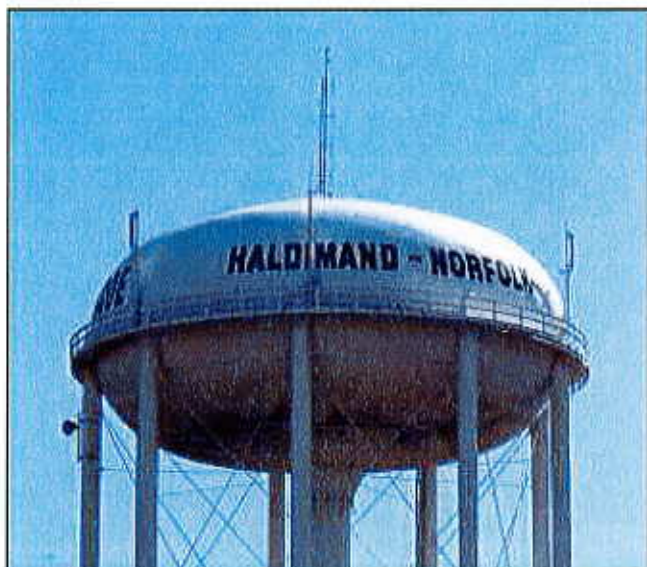




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**Spectrum, Information Technologies and Telecommunications  
Ontario Regional Office**



**Measurement and Analysis of  
Radiofrequency  
Electromagnetic Field Intensity  
in the Vicinity of  
Union Street Water Tower  
Simcoe, Ontario**

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## EXECUTIVE SUMMARY

This radiofrequency survey was conducted in response to a request from Norfolk County, that Industry Canada conduct radiofrequency measurements to address concerns raised by some local residents regarding radiocommunication installations on the Union Street water tower.

Measurements of the radiofrequency electromagnetic field intensity levels were taken at six different locations, selected in consultation with the County, where the public has regular access and in clear view of the water tower. Two measured locations were situated at the playground of the Elgin Avenue Public School, one at the playground of Ecole Sainte-Marie, one at the rear parking lot of the Norfolk General Hospital, and at two residences on Union Street.

The measurements were done in accordance with Health Canada's Safety Code 6 guidelines, "*Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz.*" The electromagnetic field intensity levels in the frequency range from 75 kHz to 18 GHz were sampled and recorded on June 27, 2007 between 9:30 AM to 8:00 PM.

The recorded data was analyzed to determine the cumulative maximum and time-average Safety Code 6 levels, taken over a six-minute sampling period, of all measureable radiofrequency electromagnetic emitting sources with respect to the recommended limits outlined in Safety Code 6.

The measurement results are consistent with previous Departmental surveys and theoretical analysis, which has identified that these types of radiocommunication installation generally comply with Safety Code 6 requirements for the general public by a very wide margin. In this particular situation, the results for the radiofrequency electromagnetic field measurements, in the frequency range between 75 kHz and 18 GHz, **shows that the cumulative radiofrequency levels associated with the operation of radiocommunication facilities located at, or in the immediate vicinity of the Union Street water tower, is only a very small fraction of the general public acceptable exposure limits recommended by Health Canada.**

The highest cumulative time-averaging Safety Code 6 level of all measurable radiofrequency electromagnetic signals was recorded at the upper hillside of the Elgin Avenue Public schoolyard, but it was only 0.01852% of the recommended limits, or more than 5,300 times below the Safety Code 6 limit. At this location, the radio paging service contributed 92% and the personal communication services (PCS) on the water tower contributed 6% of the measurable total energy.

For the remaining five locations, the cumulative time-averaging Safety Code 6 level ranged from 0.00023% to 0.00249% of the Safety Code 6 limit, or from about 40,000 to 426,000 times below the recommended limit.

Among the six locations surveyed, the highest reading for personal communication services (PCS) was 0.00295% of Safety Code 6 limit or about 33,000 times below the recommended limit. This value was recorded at the rear entrance of Norfolk General Hospital.

The survey showed that the 900 MHz paging service was the major radiofrequency energy contributor within the area whenever it was active, and it is **not** located on the water tower.

## **INTRODUCTION**

In March of 2006 both Rogers Wireless and the Haldimand-Norfolk Health Unit informed Industry Canada that some residents in the vicinity of the Union Street water tower had concerns about a PCS<sup>2</sup> radiocommunication facility located on the water tower. The radiocommunication facility is owned by Rogers Wireless Communication Inc. (Rogers).

In order to respond to the local health unit's enquiry Industry Canada conducted a theoretical analysis of the electromagnetic field intensity levels of the radiocommunication stations located in the vicinity of the Union Street water tower to verify Rogers' Safety Code 6 (SC6) compliance assessment. The analysis, which confirmed Rogers' assessment, was shared with the County.

It should also be noted that as a condition of licence, the Department requires all radiocommunication installations comply with the general public requirements outlined in Health Canada's Safety Code 6 guidelines, "*Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz.*"

This field survey was conducted on June 27, 2007 at six different locations near the Union Street water tower in response to a formal request from Norfolk County, that Industry Canada conduct radiofrequency (RF) electromagnetic field measurements. In April 2007, Mayor Travale communicated the County's request for Industry Canada's involvement. It was also noted that some local residents living near the Union Street water tower had come to Council expressing their concerns about the radiocommunication installation on the water tower.

The report consists of two sections: the results and the conclusions.

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<sup>2</sup> 1.9 GHz PCS (Personal Communication Services) radio services, employs a digital exchanging of user data vs. the original cellular telephone's analogue voice communications, which operates in the 800 MHz range. PCS operates similarly as the 800 MHz cellular radio service, only at a higher frequency range of 1830 to 1950 MHz. Thus both radio services are commonly referred to as simply "cellular" by the public.



## RESULTS

The site selection criteria, equipment and methodology used to obtain the data are laid out in Appendix A, while Appendix B describes the data analysis used to arrive at the results presented in Table 1 below.

Both the cumulative maximum and time-averaging radiofrequency electromagnetic field intensity levels, relative to SC6 limits, for each site are listed below. The cumulative time-averaging levels represents a more realistic situation, whereas cumulative maximum levels represent a more conservative scenario.

Site No	Location	Maximum		Time Averaging	
		(%) w.r.t SC6 General Public Limit	No. of Times Below Limit	(%) w.r.t SC6 General Public Limit	No. of Times Below Limit
1	298 Union Street – Front Yard	0.00266849	37,474	0.00182758	54,717
2	Elgin Avenue Public School Playground Area	0.00577680	17,310	0.00249341	40,105
3	Elgin Avenue Public School – Upper Hillside	0.02724464	3,670	0.01851981	5,399
4	294 Union Street – Back Yard	0.00133342	74,995	0.00084634	118,155
5	Norfolk General Hospital – Rear Entrance	0.00323983	30,865	0.00224014	44,640
6	Ecole Sainte-Marie – Playground Area	0.00033066	302,425	0.00023431	426,785

**Table 1: All Stations - Cumulative SC6 Levels at Measured Locations**

For the locations surveyed, the highest cumulative time-averaging SC6 levels of all measurable signals (from 75 kHz to 18 GHz) was 0.01852% or more that 5,300 times below the recommended SC6 limits. This level was recorded at the upper hillside of the Elgin Avenue Public schoolyard in the vicinity of 294 Union Street. The major contributor at this location was a radio paging service. Its time-averaging SC6 level was 0.01702% or about 5,800 times below the recommended limit. While the PCS service was 0.00115% or about 87,000 times below the recommended limit. In other words, the radio paging service contributed 92% while the PCS installation on the water tower only contributed 6% of all measurable radiofrequency electromagnetic energy.

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The second highest cumulative time-averaging SC6 level was recorded at the playground of Elgin Avenue Public School, its level was 0.00249% or about 40,000 times below the recommended limit.

The cumulative time-averaging SC6 level at the rear entrance of Norfolk General Hospital was 0.00224% or about 44,000 times below the recommended limit. The cumulative time-averaging SC6 level at the front yard of 298 Union Street and the backyard of 294 Union Street residences were 0.00183% or about 54,000 times below the limits and 0.00085% or about 118,000 times below the limits, respectively. The cumulative time-averaging SC6 level at the playground of Ecole Sainte-Marie was 0.00023% or about 426,000 times below the recommended limit.

The recorded data indicated that the cumulative time-averaging SC6 level for all stations were thousands of time below the general public recommended limits.

With respect to PCS services, Table 2 shows that during the one-day monitoring period from about 9:00 AM to 7:00 PM, the SC6 levels are well below the recommended limit.

Site No	Location	Maximum		Time Averaging	
		(%) w.r.t SC6 General Public Limit	No. of Times Below Limit	(%) w.r.t SC6 General Public Limit	No. of Times Below Limit
1	298 Union Street – Front Yard	0.00025322	394,914	0.00021008	476,009
2	Elgin Avenue Public School Playground Area	0.00083222	120,161	0.00043293	230,984
3	Elgin Avenue Public School – Upper Hillside	0.00155900	64,144	0.00114935	87,006
4	294 Union Street – Back Yard	0.00055991	178,600	0.00044962	222,410
5	Norfolk General Hospital – Rear Entrance	0.00294510	33,955	0.00208140	48,045
6	Ecole Sainte-Marie – Playground Area	0.00014498	689,750	0.00012122	824,946

**Table 2: PCS - SC6 Levels at Measured Locations**

The frequency range from 3 GHz to 18 GHz was scanned, in both horizontal and vertical polarizations. Due to the height and narrow beamwidth of the transmitting microwave antenna located on the water tower no measurable signal from the 18 GHz microwave antenna was detected. In fact, no measurable signal was observed for this frequency range. This result is consistent with what was expected, since radio services in this frequency range are used for point-to-point systems and low-power licence-exempted wireless radio services.

## CONCLUSIONS

Industry Canada's measurement results indicate that the cumulative radiofrequency levels are well-below the general public exposure limits recommended in Health Canada's Safety Code 6 Guideline. **In fact, the findings conclude that the cumulative radiofrequency levels (between 75 kHz and 18 GHz) associated with the operation of radiocommunication facilities located at, or in the immediate vicinity of the Union Street water tower, is only a very small fraction of the general public acceptable exposure limits recommended by Health Canada.**

These findings are consistent with previous Industry Canada surveys and theoretical analysis, which show that these types of radiocommunication installation generally comply with Safety Code 6 requirements for the general public by a very wide margin.



## **APPENDIX A MEASUREMENT PROCEDURES**

### **Site Selection:**

Six sites within a radius of 400 meters of the Union Street water tower were selected. The sites were chosen in consultation with Norfolk County. The site selection criteria were based upon the possibility of access by the general public, close proximity to the water tower and health concerns to children in the playground nearby. The sites included two residences on Union Street adjacent to the water tower, the playgrounds of Elgin Avenue Elementary School and Ecole Sainte-Marie, and the rear parking lot of the Norfolk General Hospital.

At each site, the receiving antennas were placed at the optimum location to obtain highest signal levels. The selected sites usually were line-of-sight to the water tower with minimal blockage, open-field for good reception of RF signals from all directions, and minimizing the reflections from near by metallic objects.

A site map of the surveyed locations are shown in Appendix C.

### **Equipment Used:**

The survey covers the frequency range extending from 75 kHz to 18 GHz. This frequency range encompasses Maritime, Aeronautical, Two-way, PCS/Cellular, Paging, AM, FM, DAB radio, analogue VHF/UHF Television, Digital Television, Microwave radio relay, etc. Due to operating limitations of equipment used it was not possible to have one omni-directional antenna and a single receiver covering the entire frequency range. Thus, the measurements were divided into three frequency ranges: 75 kHz to 50 MHz; 50 MHz to 3 GHz; and, 3 GHz to 18 GHz.

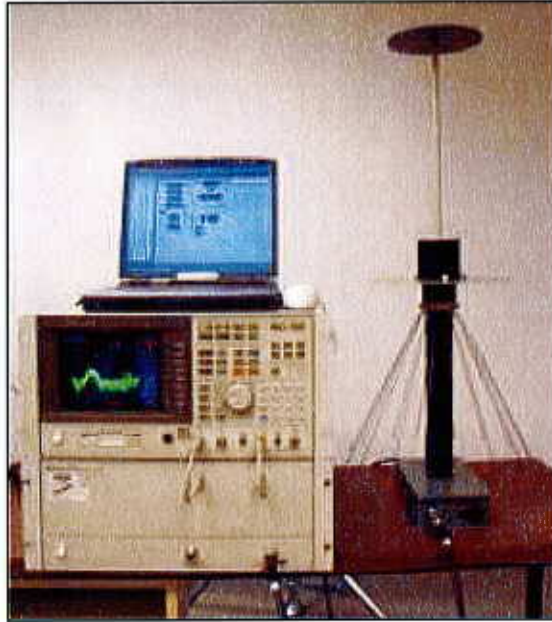
Two measurement methods were employed for the survey: narrowband and wideband methods.

The narrowband method used the Agilent HP89441A Vector Spectrum Analyzer (VSA) and calibrated SAS-2A discone antenna for the frequency range 75 kHz to 50 MHz; and the Rhode & Schwarz FSP-40 Spectrum Analyzer with EM6952 log-periodic antenna for the frequency range 3 GHz to 18 GHz. Band-power technique was used to measure the energy of each channel. The receiving antenna was rotated through three axes to simulate an omni-directional condition.

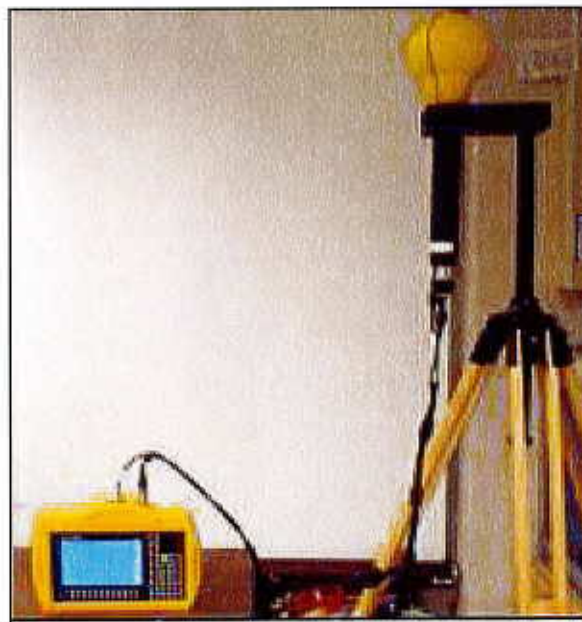
The wideband method used the Narda SRM-3000 Selective Radiation Meter and a three-axis antenna for the frequency range of 50 MHz to 3 GHz. The "Safety Evaluation" feature and a 500 kHz resolution bandwidth were selected. The device is capable of

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displaying the power of individual radio services (or frequency sub-bands) and the cumulative total of all measurable signals from 50 MHz to 3 GHz in various types of units. When “Safety Evaluation” option is selected the device can display energy received in percentage with respect to Safety Code 6 exposure limits.



**Figure 1: Set-up for 75 kHz to 50 MHz**



**Figure 2: Set-up for 50 MHz to 3GHz**



**Figure 3: Typical Set-up for 3 GHz to 18 GHz**

The calibration charts for antennas employed are shown in Appendix E.

### **Methodology:**

Receiving antennas were set at two meters above the ground and mounted on a wooden tripod as shown in the above Figures. Because the exposure limits were derived with the assumption that the incident RF fields were uniform, plane electromagnetic waves, the most appropriate measure of field would be one that is devoid of any perturbations. In this survey, longest permissible transmission lines were used and no observer was present near the receiving antennas during the recording period.

Due to bandwidth limitation of the HP89941A Vector Spectrum Analyzer when operating in digital mode, the frequency range of 75 kHz to 50 MHz was divided into many sub-bands for monitoring purposes as shown in Table 3. Each sub-band was further divided into a number of channels with a specified bandwidth to establish a scan list. The settings of the HP89941A Vector Spectrum Analyzer were optimized for speed and accuracy based on types of services.

In order to get the SC6 contribution levels from each type of radio services, the Narda SRM 3000 meter was programmed with several frequency sub-bands for monitoring purposes as shown in Table 4.

<b>Frequency Sub-Band (MHz)</b>	<b>Major Types of Radio Services</b>	<b>Channel Bandwidth (kHz)</b>
0.075 - 2.0	Maritime Mobile , Aeronautical Mobile, Radiolocation, Radio Navigation & Broadcast (AM Radio), Amateur, International Telegraph Distress	10
2.0 - 8.5	Radiolocation, Maritime Mobile, Land Mobile, Fixed, Aeronautical Mobile, Amateur, Mobile, Broadcasting (shortwave), International Telegraph Distress	500
8.5 – 15.0	Maritime Mobile, Aeronautical Mobile, Fixed, Amateur, Broadcasting, ISM	500
15.0 - 21.5	Space Research, Maritime Mobile, Fixed, Aeronautical Mobile, Broadcasting, Amateur	500
21.5 - 28.0	Maritime Mobile, Fixed, Aeronautical Mobile, Broadcasting, Radio Astronomy, Earth Exploration Satellite	500
28.0 - 34.5	Mobile, Amateur, Fixed, Aeronautical Radionavigation	500
34.5 - 41.0	Fixed, Mobile	500
41.0 - 47.5	Fixed, Mobile	500
47.5 - 50.0	Fixed, Mobile	500

<sup>3</sup>**Table 3: List of Sub-Bands for HP89941A**



<b>Frequency Sub-Band (MHz)</b>	<b>Major Types of Radio Services</b>
50 - 54	Amateur
54 - 72	Broadcasting (Television)
72 - 76	Fixed, Mobile, Radio Astronomy
76 - 88	Broadcasting (Television)
88 - 108	Broadcasting (FM Radio)
108 - 136	Aeronautical
136 - 174	Aeronautical Mobile, Space Operation, Meteorological Satellite, Space Research, Mobile-Satellite, Radiolocation, Amateur, Radionavigation Satellite, Land Mobile Satellite, Maritime Mobile Fixed, Mobile
174 - 216	Broadcasting (Television)
216 - 470	Maritime Mobile, Space Operation, Radio Astronomy, Aeronautical Radionavigation, Radionavigation Satellite, Standard Frequency and Time Signal-Satellite, Meteorological -Satellite, Space Research, Mobile Satellite, Meteorological Aids, Fixed, Mobile, Amateur
470 - 608	Broadcasting (Television)
608 - 614	Radio Astronomy
614 - 806	Broadcasting (Television)
806 - 902	Cellular Telephone, Radio Paging, Fixed, Mobile
902 - 960	Industrial, Scientific and Medical (ISM) Paging, Fixed Links Fixed, Mobile
960 - 1300	Aeronautical Radionavigation
1300 - 1850	Broadcasting (DAB )/MoSAT, Radiolocation, Fixed, Mobile
1850 - 1990	PCS
1990 - 3000	ISM/DTV/Low Power Wireless

<sup>3</sup>**Table 4: List of Sub-Bands for Narda SRM 3000**

<sup>3</sup> Radiocommunication service shown in Table 3 and 4 are the major service in the corresponding frequency band. For detail radiocommunication service at each frequency band, refer to Canadian Table of Frequency Allocation. The internet address is provided at Appendix F.



## APPENDIX B DATA ANALYSIS

For the frequency range of 75 kHz to 50 MHz and 3 GHz to 18 GHz the received band-power of each channel were recorded in dBm. The recorded readings were converted to electric field intensity by taking into account the transmission line loss and antenna factor as shown in the below formula.

$$E_c(dBV/m) = P_r + AF + C_a + A_t - 13$$

Where:  $E_c$  is the channel electric field intensity in dBV/m,  
 $P_r$  is the receiving signal level in dBm,  
AF is the antenna factor in dB,  
 $C_a$  is cable loss in dB, and  
 $A_t$  is external attenuator in dB, if used

The derived electric field intensity (in V/m) was normalized with respect to the recommended Safety Code 6 limit for the corresponding frequency band. The ratio was then squared to obtain SC6 exposure levels for each channel recorded as shown by the equation below:

$$SC6\% = (E_c/L_f)^2$$

Where: SC6% is the value expressed as a percentage of SC6 limit ( $L_f$ )  
 $E_c$  is the measured electric field intensity in V/m, and  
 $L_f$  is the Safety Code 6 electric field limit for the corresponding frequency band

The SC6 exposure levels for the both frequency ranges (75 kHz to 50 MHz and 3 GHz to 18 GHz) per sweep were obtained by summing up the squares of the normalized values as shown below:

$$SC6\% = \sum \left( \frac{E_c}{L_f} \right)^2$$

For frequency range from 50 MHz to 3GHz, no post processing is needed to obtain the SC6 levels of each sub-band record. During a six-minute monitoring period over a hundred records were stored in memory. The recorded readings were transferred from the Narda SRM-3000 meter to a spreadsheet for further analysis. The maximum and time-averaging SC6 levels for each sub-band and for the whole frequency band (50 MHz to 3 GHz) were calculated. Similar process applies to the narrowband method.

The time-averaging SC6 levels of each sub-band was calculated by summing up its SC6 figures and dividing by the number of stored records during a monitoring period (about six minutes).

The maximum SC6 levels of each sub-band was the maximum SC6 figure of all SC6 levels observed during a monitoring period for that sub-band.

The maximum and time-averaging Safety Code 6 exposure levels for each site was obtained by summing up the maximum and time-averaging SC6 levels of all frequency sub-bands, respectively. These figures represent cumulative total measurable RF energy at the location.

Time-averaging SC6 levels represent more realistic situation, whereas maximum SC6 level represent a more conservative scenario. Both the average and maximum SC6 levels for each site are presented in this report.

## APPENDIX C

### SITE MAP OF MEASURED LOCATIONS

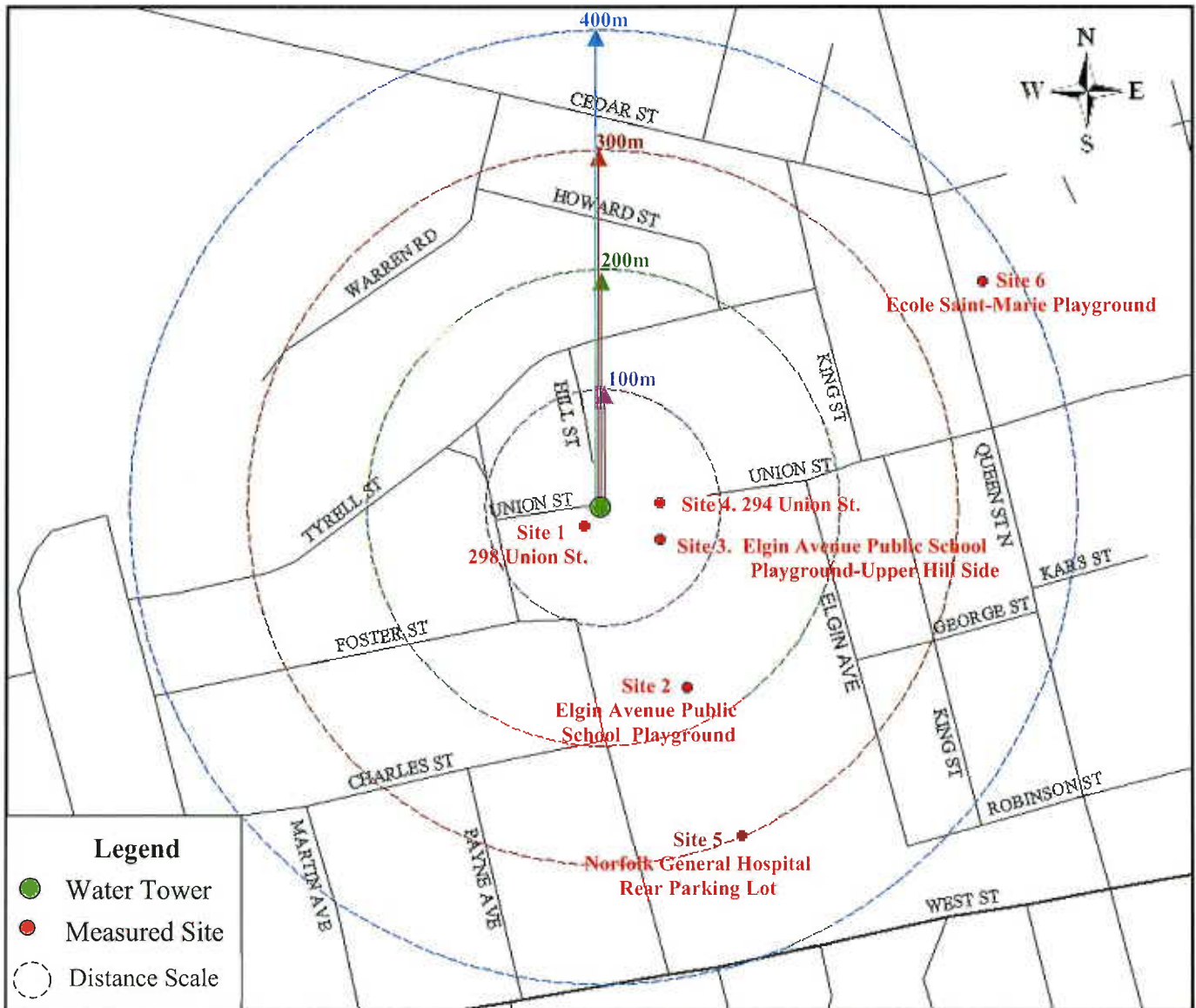


Figure 4

Site Map Showing Measured Locations

## **APPENDIX D**

### **SITE INFORMATION**

#### **Site 1:**

**Geographical Coordinates (GPS reading):** Latitude: 42°50'16" N  
Longitude: 080°19'50" W

**Distance between measured location to the center leg of water tower:** 13 m

	<b>Time-average SC6 Levels (%)</b>	<b>No. of Times below Limits</b>
Overall From 75 kHz to 18 GHz	0.00182758	54,717
SC6 Level Contributed By PCS	0.00021008	476,009



#### **Site 1: Front Yard of 298 Union Street**

- 1). The measurement took place between 08:45 to 10:15 hrs. This measured location is right beside the water tower which is clearly line of sight to the water tower. The main beam of the two closest PCS antenna sector on the tower is facing away from the household unit.
- 2). The ISM mobile and radio paging is the major contributor at this site. Activities from PCS, cellular service and land mobile service at 136 MHz – 174 MHz also detected.
- 3). The frequency range from 3 GHz to 18 GHz was scanned and no measurable RF signals were found.

### Time-averaging SC6 Levels

Frequency Sub-Band (MHz)	<sup>4</sup> Major Types of Services	Percentage w.r.t SC6 Limit	Number of Times below SC6	<sup>5</sup> Power Flux Density ( $\mu\text{W}/\text{m}^2$ )
0.075 - 0.535	Maritime & Aeronautical	0.00000443	22,573,363	9.22
0.535- 1.705	Broadcast ing (AM Radio)	0.00000039	256,410,256	0.79
1.705 - 50	Maritime & Aeronautical Mobile / Radionavigation Amateur, Fixd, Land	0.00000548	18,248,175	0.15
50- 54	Amateur	Below Noise Threshold	-	-
54 - 72	Broadcasting (Television)	"	-	-
72 -76	Mobile, Fixed, Radio	"	-	-
76 - 88	Broadcast ing (Television)	"	-	-
88 - 108	Broadcast ing (FM Radio)	"	-	-
108 - 136	Aeronautical	"	-	-
136 - 174	Land Mobile, Amateur	0.00029843	335,087	5.97
174 - 216	Broadcast ing (Television)	Below Noise Threshold	-	-
216 - 470	Amateur / Land Mobile	"	-	-
470 - 608	Television Broadcast	"	-	-
608 - 614	Radio Astronomy	"	-	-
614 - 806	Television Broadcast	"	-	-
806 - 902	Cellular, Radio Paging, Fixed, Mobile	0.00014098	709,320	8.48
902 - 960	ISM, Trunking, Paging , Fixed Links	0.00116779	85,632	74.74
960 - 1300	Aeronautical	Below Noise Threshold	-	-
1300 - 1850	Broadcasting (DAB) MSAT, Radiolocation	"	-	-
1850 - 1990	PCS	0.00021008	476,009	21.01
1990 - 3000	ISM/DTV/ low power wireless	Below Noise Threshold	-	-
3000 - 18000	Microwave Radio Relay	Not Measurable	-	-
<b>Total SC6 Values:</b>		<b>0.00182758%</b>		

<sup>4</sup> Refer to Canadian Frequency Allocation Table for detail service at each frequency sub-band. The internet link is provided under Appendix F.

<sup>5</sup> Power flux density shown in each frequency sub-band from 75 kHz to 50 MHz is a conversion of the electric field intensity base on the band power measurement. Power flux density shown in each frequency sub band from 50 MHz to 3 GHz is a conversion of the SC6 figures with respected to the highest SC6 limit at the corresponding frequency sub-band.



**Site 2:**

**Geographical Coordinates** (GPS reading): Latitude: 42°50'12" N  
Longitude: 080°18'56" W

Distance between measured location to:

1. Water Tower: 181m
2. Norfolk General Hospital: 134 m
3. School Building: 49 m

	Time-average SC6 Levels (%)	No. of Times below Limits
Overall From 75 kHz to 18 GHz	0.00249341	40,105
SC6 Level Contributed By PCS	0.00043293	230,984



**Site 2: Elgin Avenue Public School Playground**

- 1). The measurement took place between 11:15 to 12:30. It is line of sight to water tower and also line of sight to the Norfolk General Hospital.
- 2). The ISM trunking /radio paging is the major contributor of the site which contribute 61% of the overall measured levels. Activities from PCS and land mobile service at 136 MHz to 174 MHz were also detected.
- 3). The frequency range from 3 GHz to 18 GHz was scanned and no measurable RF signals were found.

### Time-averaging SC6 Levels

Frequency Sub-Band (MHz)	<sup>4</sup> Major Types of Services	Percentage w.r.t SC6 Limit	Number of Times below SC6	<sup>5</sup> Power Flux Density ( $\mu\text{W}/\text{m}^2$ )
0.075 - 0.535	Maritime & Aeronautical	0.00000283	35,335,689	5.89
0.535- 1.705	Broadcast ing (AM Radio)	0.00000073	136,986,301	1.35
1.705 - 50	Maritime & Aeronautical Mobile / Radionavigation Amateur. Fixd. Land Mobile	0.00001965	5,089,059	0.42
50- 54	Amateur	Below Noise Threshold	-	-
54 - 72	Broadcasting (Television)	"	-	-
72 -76	Mobile, Fixed, Radio	"	-	-
76 - 88	Broadcast ing (Television)	"	-	-
88 - 108	Broadcast ing (FM Radio)	"	-	-
108 - 136	Aeronautical	"	-	-
136 - 174	Land Mobile, Amateur	0.00050574	197,730	10.11
174 - 216	Broadcast ing (Television)	Below Noise Threshold	-	-
216 - 470	Amateur / Land Mobile	"	-	-
470 - 608	Television Broadcast	"	-	-
608 - 614	Radio Astronomy	"	-	-
614 - 806	Television Broadcast	"	-	-
806 - 902	Cellular, Radio Paging, Fixed, Mobile	"	-	-
902 - 960	ISM, Trunking, Paging , Fixed Links	0.00153153	65,294	98.02
960 - 1300	Aeronautical	Below Noise Threshold	-	-
1300 - 1850	Broadcasting (DAB) MSAT, Radiolocation	"	-	-
1850 - 1990	PCS	0.00043293	230,984	43.29
1990 - 3000	ISM/DTV/ low power wireless	Below Noise Threshold	-	-
3000 - 18000	Microwave Radio Relay	Not Measurable	-	-
<b>Total SC6 Values:</b>		<b>0.00249341%</b>		

<sup>4</sup> Refer to Canadian Frequency Allocation Table for detail service at each frequency sub-band. The internet link is provided under Appendix F.

<sup>5</sup> Power flux density shown in each frequency sub-band from 75 kHz to 50 MHz is a conversion of the electric field intensity base on the band power measurement. Power flux density shown in each frequency sub band from 50 MHz to 3 GHz is a conversion of the SC6 figures with respected to the highest SC6 limit at the corresponding frequency sub-band.

**Site 3:**

**Geographical Coordinates** (GPS reading): Latitude: 42°50'16" N  
Longitude: 080°18'57" W

Distance between measured location to: 1. Water Tower: 44 m  
2. Norfolk Hospital: 270 m

	Time-average SC6 Levels (%)	No. of Times below Limit
Overall From 75 kHz to 18 GHz	0.01851981	5,399
SC6 Level Contributed By PCS	0.00114935	870,006



**Site 3: Upper Hill from Elgin Avenue Public School**

- 1). The measurement took place between 13:00 to 14:30 hrs. It is line of site to the water tower with partial obstruction from the trees and also line of site to the Norfolk General Hospital.
- 2). The major RF contributor was Radio Paging services that contributed 92% of the total levels. Spectrum analyzer was used to identify the frequency, and it was 929.2875 MHz.
- 3). The frequency range from 3 GHz to 18 GHz was scanned and no measurable RF signals were found.



### Time-averaging SC6 Levels

Frequency Sub-Band (MHz)	<sup>4</sup> Major Types of Services	Percentage w.r.t SC6 Limit	Number of Times below SC6	<sup>5</sup> Power Flux Density ( $\mu\text{W}/\text{m}^2$ )
0.075 - 0.535	Maritime & Aeronautical	0.00000229	43,668,122	4.75
0.535 - 1.705	Broadcast ing (AM Radio)	0.00000021	476,190,476	0.40
1.705 - 50	Maritime & Aeronautical Mobile / Radionavigation Amateur, Fixd, Land Mobile	0.00000828	12,077,295	0.25
50 - 54	Amateur	Below Noise Threshold	-	-
54 - 72	Broadcasting (Television)	"	-	-
72 - 76	Mobile, Fixed, Radio	"	-	-
76 - 88	Broadcast ing (Television)	"	-	-
88 - 108	Broadcast ing (FM Radio)	"	-	-
108 - 136	Aeronautical	"	-	-
136 - 174	Land Mobile, Amateur	0.00033651	297,168	6.73
174 - 216	Broadcast ing (Television)	Below Noise Threshold	-	-
216 - 470	Amateur / Land Mobile	"	-	-
470 - 608	Television Broadcast	"	-	-
608 - 614	Radio Astronomy	"	-	-
614 - 806	Television Broadcast	"	-	-
806 - 902	Cellular, Radio Paging, Fixed, Mobile	"	-	-
902 - 960	ISM, Trunking, Paging , Fixed Links	0.01702317	5,874	1089.48
960 - 1300	Aeronautical	Below Noise Threshold	-	-
1300 - 1850	Broadcasting (DAB) MSAT, Radiolocation	"	-	-
1850 - 1990	PCS	0.00114935	87,006	114.93
1990 - 3000	ISM/DTV/ low power wireless	Below Noise Threshold	-	-
3000 - 18000	Microwave Radio Relay	Not Measurable	-	-
<b>Total SC<sub>6</sub> Values:</b>		<b>0.01851981%</b>		

<sup>4</sup> Refer to Canadian Frequency Allocation Table for detail service at each frequency sub-band. The internet link is provided under Appendix F.

<sup>5</sup> Power flux density shown in each frequency sub-band from 75 kHz to 50 MHz is a conversion of the electric field intensity base on the band power measurement. Power flux density shown in each frequency sub band from 50 MHz to 3 GHz is a conversion of the SC6 figures with respected to the highest SC6 limit at the corresponding frequency sub-band.

**Site 4:**

**Geographical Coordinates** (GPS reading): Latitude: 42°50'17" N  
Longitude: 080°18'58" W

Distance between measured location to: 1. Water Tower: 36 m  
2. Norfolk General Hospital: 306 m

	<b>Time-average SC6 Levels (%)</b>	<b>No. of Times below Limit</b>
Overall From 75 kHz to 18 GHz	0.00084634	118,155
SC6 Level Contributed By PCS	0.00044962	222,410



**Site 4: 294 Union Street Back Yard**

- 1). The measurement took place between 14:45 to 16:00. It is line of sight to the water tower and also line of sight to the Norfolk General Hospital with tree obstruction.
- 2). The frequency range from 3 GHz to 18 GHz was scanned and no measurable RF signals were found.



### Time-averaging SC6 Levels

Frequency Sub-Band (MHz)	<sup>4</sup> Major Types of Services	Percentage w.r.t SC6 Limit	Number Of Times Below SC6	<sup>5</sup> Power Flux Density ( $\mu\text{W}/\text{m}^2$ )
0.075 - 0.535	Maritime & Aeronautical	0.00000181	55,248,619	3.77
0.535- 1.705	Broadcast ing (AM Radio)	0.00000013	769,230,769	0.26
1.705 - 50	Maritime & Aeronautical Mobile / Radionavigation Amateur, Fixd, Land	0.000000405	54,347,826	0.13
50- 54	Amateur	Below Noise Threshold	-	-
54 - 72	Broadcasting (Television)	"	-	-
72 -76	Mobile, Fixed, Radio	"	-	-
76 - 88	Broadcast ing (Television)	"	-	-
88 - 108	Broadcast ing (FM Radio)	"	-	-
108 - 136	Aeronautical	"	-	-
136 - 174	Land Mobile, Amateur	"	-	-
174 - 216	Broadcast ing (Television)	"	-	-
216 - 470	Amateur / Land Mobile	"	-	-
470 - 608	Television Broadcast	"	-	-
608 - 614	Radio Astronomy	"	-	-
614 - 806	Television Broadcast	"	-	-
806 - 902	Cellular, Radio Paging, Fixed, Mobile	"	-	-
902 - 960	ISM, Trunking, Paging , Fixed Links	0.00039073	255,931	25.01
960 - 1300	Aeronautical	Below Noise Threshold	-	-
1300 - 1850	Broadcasting (DAB) MSAT, Radiolocation	"	-	-
1850 - 1990	PCS	0.00044962	222,410	44.96
1990 - 3000	ISM/DTV/ low power wireless	Below Noise Threshold	-	-
3000 - 18000	Microwave Radio Relay	Not Measurable	-	-
<b>Total SC<sub>6</sub> Values:</b>		<b>0.00084634%</b>		

<sup>4</sup> Refer to Canadian Frequency Allocation Table for detail service at each frequency sub-band. The internet link is provided under Appendix F.

<sup>5</sup> Power flux density shown in each frequency sub-band from 75 kHz to 50 MHz is a conversion of the electric field intensity base on the band power measurement. Power flux density shown in each frequency sub band from 50 MHz to 3 GHz is a conversion of the SC6 figures with respected to the highest SC6 limit at the corresponding frequency sub-band.

**Site 5:**

**Geographical Coordinates** (GPS reading): Latitude: 42°50'08" N  
Longitude: 080°18'58" W

Distance between measured location to water tower: 298 m

	<b>Time-average SC6 Levels (%)</b>	<b>No. of Times below Limit</b>
Overall From 75 kHz to 18 GHz	0.00224014	44,640
SC6 Level Contributed By PCS	0.00208140	48,045



**Site 5: Norfolk General Hospital Rear Entrance**

- 1). The measurement took place between 16:30 to 18:00. It is line of sight to water tower.
- 2). PCS was the major contributor to the total SC6 levels. A radio paging service was detected, but the reading was relatively low in comparison to the reading at Site 3.
- 3). The frequency range from 3 GHz to 18 GHz was scanned and no measurable RF signals were found.

**Time-averaging SC6 levels**

<b>Frequency Sub-Band (MHz)</b>	<b><sup>4</sup>Major Types of Services</b>	<b>Percentage w.r.t SC6 Limit</b>	<b>Number of Times below SC6</b>	<b><sup>5</sup>Power Flux Density (<math>\mu\text{W}/\text{m}^2</math>)</b>
0.075 - 0.535	Maritime & Aeronautical	0.00000223	44,843,049	4.65
0.535- 1.705	Broadcast ing (AM Radio)	0.00000079	126,582,278	1.54
1.705 - 50	Maritime & Aeronautical Mobile / Radionavigation Amateur, Fixd, Land Mobile	0.00000551	18,148,820	0.13
50- 54	Amateur	Below Noise Threshold	-	-
54 - 72	Broadcasting (Television)	"	-	-
72 -76	Mobile, Fixed, Radio	"	-	-
76 - 88	Broadcast ing (Television)	"	-	-
88 - 108	Broadcast ing (FM Radio)	"	-	-
108 - 136	Aeronautical	"	-	-
136 - 174	Land Mobile, Amateur	"	-	-
174 - 216	Broadcast ing (Television)	"	-	-
216 - 470	Amateur / Land Mobile	"	-	-
470 - 608	Television Broadcast	"	-	-
608 - 614	Radio Astronomy	"	-	-
614 - 806	Television Broadcast	"	-	-
806 - 902	Cellular, Radio Paging, Fixed, Mobile	"	-	-
902 - 960	ISM, Trunking, Paging , Fixed Links	0.00015021	665,735	9.61
960 - 1300	Aeronautical	Below Noise Threshold	-	-
1300 - 1850	Broadcasting (DAB) MSAT, Radiolocation	"	-	-
1850 - 1990	PCS	0.00208140	48,045	208.14
1990 - 3000	ISM/DTV/ low power wireless	Below Noise Threshold	-	-
3000 - 18000	Microwave Radio Relay	Not Measurable	-	-
<b>Total SC<sub>6</sub> Values:</b>		<b>0.00224014%</b>		

<sup>4</sup> Refer to Canadian Frequency Allocation Table for detail service at each frequency sub-band. The internet link is provided under Appendix F.

<sup>5</sup> Power flux density shown in each frequency sub-band from 75 kHz to 50 MHz is a conversion of the electric field intensity base on the band power measurement. Power flux density shown in each frequency sub band from 50 MHz to 3 GHz is a conversion of the SC6 figures with respected to the highest SC6 limit at the corresponding frequency sub-band.

**Site 6:**

**Geographical Coordinates (GPS Reading):** Latitude: 42°50'23" N  
Longitude: 080°18'45" W

**Distance between measured location to water tower:** 370 m

	<b>Time-average SC6 Levels (%)</b>	<b>No. of Times below Limit</b>
Overall From 75 kHz to 18 GHz	0.00023431	426,785
SC6 Level Contributed By PCS	0.00012122	824,946



**Site 6: Ecole Saint-Marie Playground Area**

- 1). The measurement took place between 18:30 to 20:00. There is **no** direct line of sight to the water tower.
- 2). The PCS was the major contributor. A radio paging service was detected, but the reading was relatively low in comparison with the reading at Site 3.
- 3). The frequency range from 3 GHz to 18 GHz was scanned and no measurable RF signals were found.



### Time-averaging SC6 Levels

Frequency Sub-Band (MHz)	<sup>4</sup> Major Types of Services	Percentage w.r.t SC6 Limit	Number of Times below SC6	<sup>5</sup> Power Flux Density ( $\mu\text{W}/\text{m}^2$ )
0.075 - 0.535	Maritime & Aeronautical	0.00000057	175,438,596	1.19
0.535- 1.705	Broadcast ing (AM Radio)	0.00000025	714,285,714	0.45
1.705 - 50	Maritime & Aeronautical Mobile / Radionavigation Amateur, Fixd, Land Mobile	0.00002248	4,448,399	0.56
50- 54	Amateur	Below Noise Threshold	-	-
54 - 72	Broadcasting (Television)	"	-	-
72 -76	Mobile, Fixed, Radio Astronomy	"	-	-
76 - 88	Broadcast ing (Television)	"	-	-
88 - 108	Broadcast ing (FM Radio)	"	-	-
108 - 136	Aeronautical	"	-	-
136 - 174	Land Mobile, Amateur	"	-	-
174 - 216	Broadcast ing (Television)	"	-	-
216 - 470	Amateur / Land Mobile	"	-	-
470 - 608	Television Broadcast	"	-	-
608 - 614	Radio Astronomy	"	-	-
614 - 806	Television Broadcast	"	-	-
806 - 902	Cellular, Radio Paging, Fixed, Mobile	"	-	-
902 - 960	ISM, Trunking, Paging , Fixed Links	0.00008979	1,113,710	5.75
960 - 1300	Aeronautical	Below Noise Threshold	-	-
1300 - 1850	Broadcasting (DAB) MSAT, Radiolocation	"	-	-
1850 - 1990	PCS	0.00012122	824,946	12.12
1990 - 3000	ISM/DTV/ low power wireless	Below Noise Threshold	-	-
3000 - 18000	Microwave Radio Relay	Not Measurable	-	-
<b>Total SC<sub>6</sub> Values:</b>		<b>0.00023431%</b>		

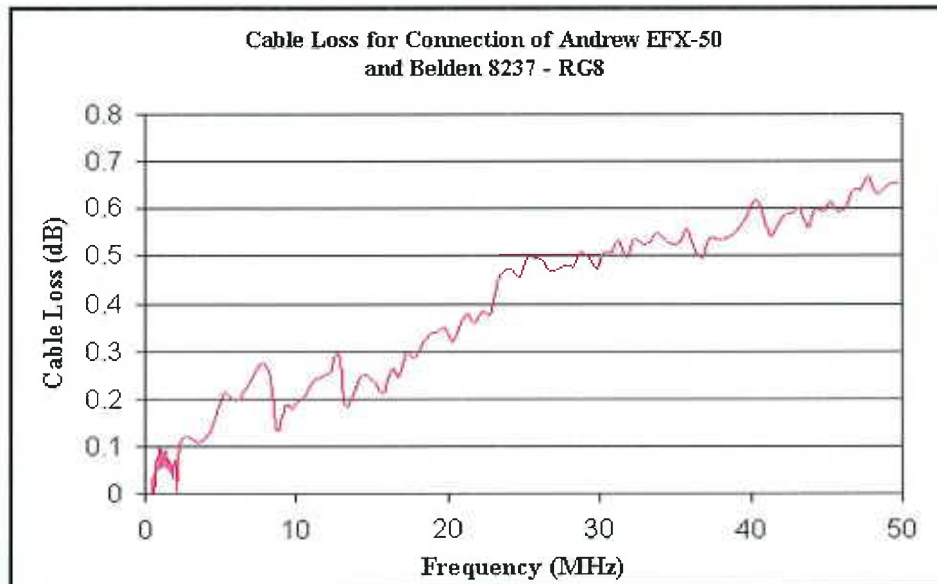
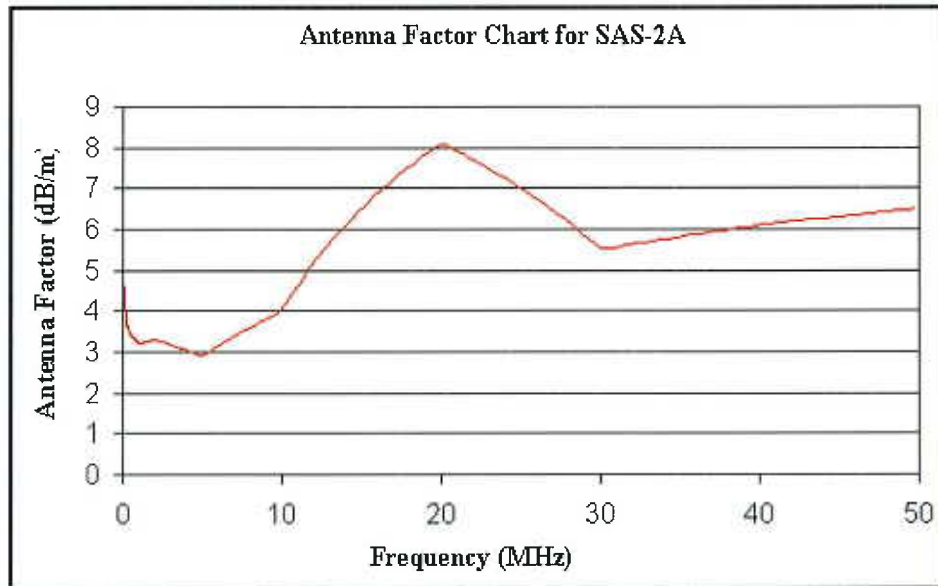
<sup>4</sup> Refer to Canadian Frequency Allocation Table for detail service at each frequency sub-band. The internet link is provided under Appendix F.

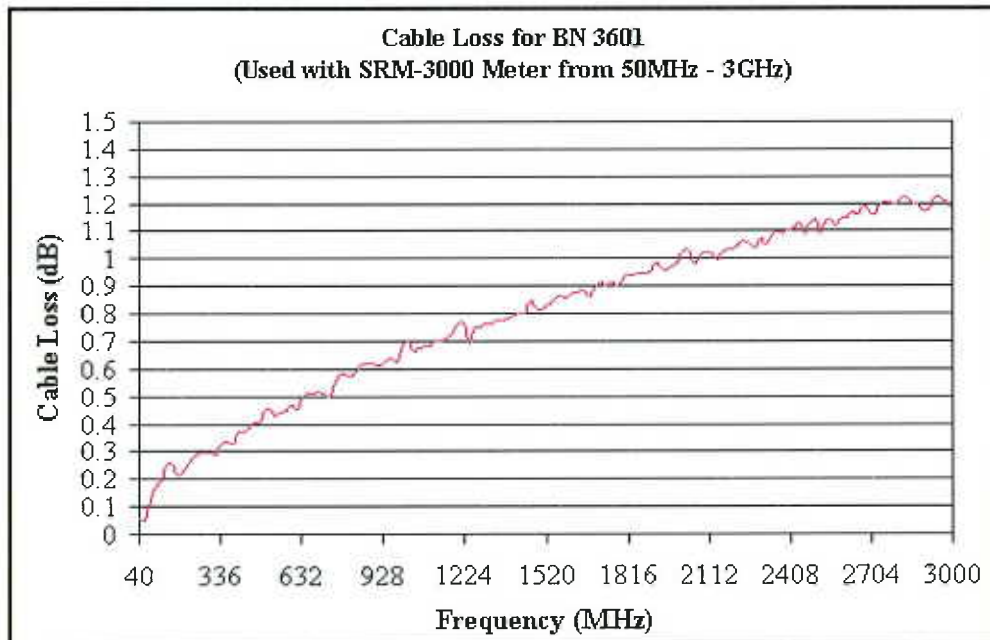
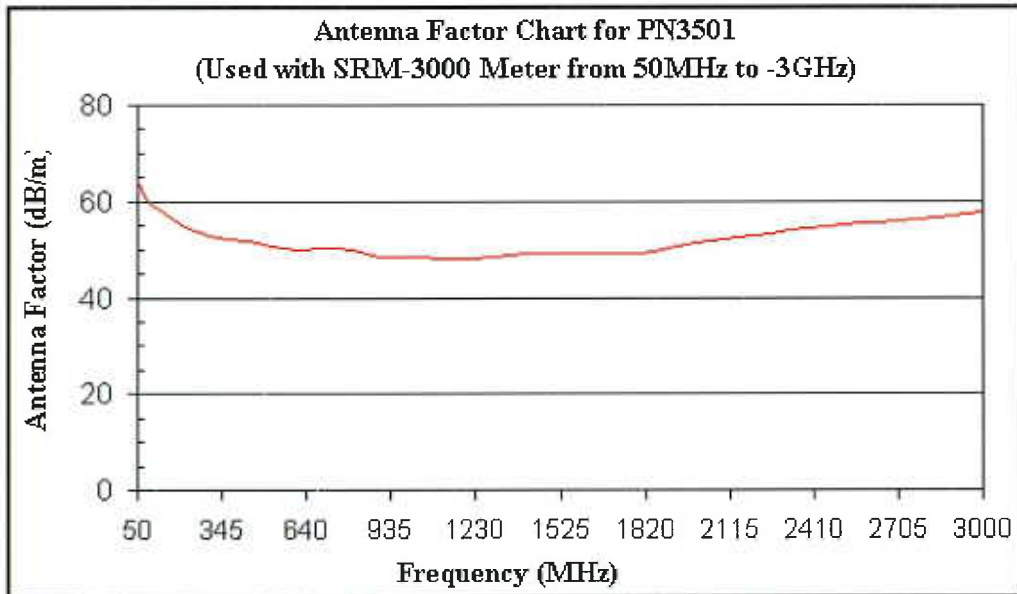
<sup>5</sup> Power flux density shown in each frequency sub-band from 75 kHz to 50 MHz is a conversion of the electric field intensity base on the band power measurement. Power flux density shown in each frequency sub band from 50 MHz to 3 GHz is a conversion of the SC6 figures with respected to the highest SC6 limit at the corresponding frequency sub-band.



## APPENDIX E

### ANTENNA AND CABLE CALIBRATION CHARTS





**APPENDIX F  
SURVEY EQUIPMENT  
AND SOFTWARE**

**Measurement Devices**

**Model Number**

**Calibration Date**

Agilent - Vector Signal Analyzer	HP89441A	June 22,2007 (In House Calibrated)
Narda - Selective Radiation Meter	SRM - 3000	March 15, 2007
Rohde & Schwarz - Spectrum Analyzer	FSP-40	February 15, 2005

**Antennas**

Antenna Research Associates - Discone (20 Hz to 1 GHz)	SAS-2A	March 17 2002
Narda - 3 Axis antenna (50 MHz – 3 GHz)	PN 3501/02	March 15, 2007
Electro Metrics - Log Periodic (1 GHz to 18 GHz)	EM6952	January 29, 2007

**Cables**

Andrew - Super FlexRF Coaxial	EFX2-50	June 22, 2007(In House Calibrated)
Belden - RF Coaxial	8237 RG-8	June 22, 2007(In House Calibrated)
Megaphase - RF Coaxial	EC29-NKNK-197	June 22, 2007(In House Calibrated)
Narda - SRM Cable	BN3601/02	March 14, 2007

**Auxiliary**

Laser Surveillance Equipment	Criterion 400	---
Laptop		
GPS Receiver	eTrex 500	---
Wooden Tripod	---	---
Laser Rangefinder		
GPIB Cable	---	---
RF Connector Kit	---	---
Digital Camera	Kodak DC4800	---

**Software**

HP VEE- Version 5.0 Data Acquisition Software  
SRM Firmware revision 1.5.6  
SRM-Tools revision 1.1.7  
Microsoft Office 2003  
MapInfo 7.5

**Uncertainty**

The total measurement and equipment uncertainty for this study is about  $\pm 3$ dB. This figure includes: receiver uncertainty; antenna gain variation; cable and connectors uncertainties; data truncation; and, other factors relating to measurement procedures.



**HP 89441A Vector Analyzer**



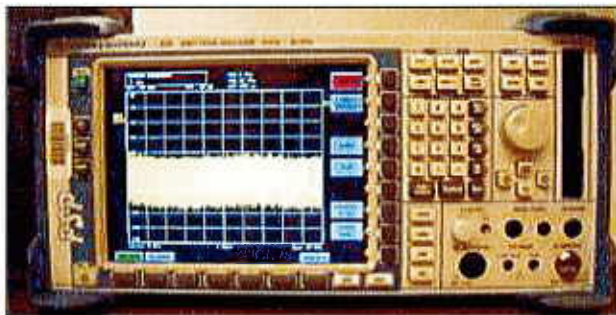
**SAS-2A Discone Antenna**



**SRM 3000 Selective Radiation Meter**



**Criterion 400 Laser Surveillance Equipment**



**FSP 40 Spectrum Analyzer**



**EM6952 Log Periodic Antenna**



## APPENDIX G

### GLOSSARY

#### **Aeronautical Mobile**

A mobile service between aeronautical stations and aircraft stations, or between aircraft stations in which survival craft stations may participate; emergency position-indicating radiobeacon stations may also participate in this service on designated distress and emergency frequencies.

#### **Aeronautical Radionavigation**

A radionavigation service intended for the benefit and for the safe operation of aircraft

#### **Amplitude Modulation (AM) Broadcasting**

AM broadcasting is the process of radio broadcasting using modulation in which the significant conditions are represented by alternating currents of different amplitude.

#### **Amateur**

Often called Ham radio is a service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

#### **Broadcasting**

Broadcasting is the distribution of audio and/or video signals intended for direct reception by the general public.

#### **Cellular**

Communications systems that divide a geographic region into sections, called *cells*. The purpose of this division is to make the most use out of a limited number of transmission frequencies

#### **Digital Audio Broadcasting (DAB)**

Digital Audio Broadcasting, a technology for broadcasting using digital audio transmission.

#### **Electric Field Strength**

The force on a stationary unit positive charge at a point in an electric field measured in volts per meter (V/m).

#### **Electromagnetic Field**

A physical field produced by electrically charged objects. It affects the behaviour of charged objects in the vicinity of the field. The field can be viewed as a combination of an

electric field and a magnetic. The electric field is produced by stationary charges, and the magnetic field by moving charges (currents).

**Fast Fourier Transformation (FFT)**

An algorithm for converting data from the time domain to the frequency domain often used in signal processing.

**Frequency Modulation (FM) Broadcasting**

A broadcast technology that uses frequency modulation (FM) to provide high-fidelity sound over broadcast radio.

**Fixed Service**

A radiocommunication service between specified fixed points

**Industrial, Scientific and Medical (ISM)**

Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications.

**Land Mobile**

A radiocommunication service between base station and mobile station or between land mobile stations.

**Mobility Satellite (MSAT)**

A radiocommunication service between mobile earth stations and one or more space stations, or between space stations used by this service.

**Maritime Mobile**

A mobile service between coast stations and ship stations, or between ship stations, or between associated on-board communication stations; survival craft stations and emergency position-indicating radio beacon stations may also participate in this service.

**Meteorological Satellite**

An earth exploration-satellite service for meteorological purposes.

**Microwatts per meter squared ( $\mu\text{W}/\text{m}^2$ )**

Radiofrequency radiation in terms of power density measured in microwatts per meter and abbreviated ( $\mu\text{W}/\text{m}^2$ ). It is used when talking about emissions from wireless facilities, and when describing ambient RF in the environment.

**Microwave Radio Relay**

A technology for transmitting digital and analog signals between two locations on a line of sight radio path using a directional antenna.

**Mobile**

A radiocommunication service between mobile and land stations, or between mobile stations.

**Radio Astronomy**

Astronomy based on the reception of radio waves of cosmic origin.

**Radiocommunication**

Any transmission, emission or reception of signs, signals, writing, images, sounds or intelligence of any nature by means of electromagnetic waves of frequencies lower than 3 000 GHz propagated in space without artificial guide.

**Radiofrequency (RF)**

Any frequency at which electromagnetic radiation is useful for telecommunication. It usually refers to the frequency range between 9 kHz-300 GHz.

**Radionavigation Satellite**

A radiodetermination-satellite service used for the purpose of radionavigation.

**Radio Paging**

The service provides the subscriber with the facility, by means of portable equipment used in a given area, to receive an alert by radio initiated by any telephone in a public network. The alert can be accompanied by a spoken message or visual coded display either entered by the caller or generated within the network.

**Standard Frequency and Time Signal Service**

A radiocommunication service for scientific, technical and other purposes, providing the transmission of specified frequencies, time signals, or both, of stated high precision intended for general reception

**Trunking**

A trunked radio is one in which the communication traffic may pass through any one of the "trunked group of channels" selected automatically by the systems.

## **APPENDIX H**

### **REFERENCE**

Limits of Human Exposure to Radiofrequency Electromagnetic Fields at Frequency Range from 3kHz - 300GHz, Safety Code 6; Health Canada, Environmental Health Directorate Health Protection Branch, Catalogue No. H46-2/99-237E, 1999

Available on the web at :

[http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/index\\_e.html](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/index_e.html)

The Canadian Table of Frequency Allocations assigns the electromagnetic spectrum between 9 kHz and 275 GHz and establishes the frequency allocations available for radio services in Canada. Available on the web at :

[http://strategis.ic.gc.ca/epic/site/smt-gst.nsf/en/h\\_sf01678e.html](http://strategis.ic.gc.ca/epic/site/smt-gst.nsf/en/h_sf01678e.html)

International Telecommunication Union Database Service: ITU-R / ITU-T Terms and Definitions.