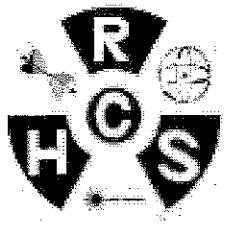

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Summary of RF and Microwave Levels Associated with WiFi Access Points at Oak Ridges Public School and at Dr. Bette Stephenson Centre for Learning Richmond Hill, Ontario

2011 10 04

Carried out for:

York Region District School Board
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1. INTRODUCTION

Concerns about radiofrequency (RF) and microwave health and safety issues within the York Region District School Board (YRDSB) have intensified as implementation of wireless local area network (LAN, also called WiFi) internet access services has increased in recent times. The concerns focus on wireless routers used to provide connections to the Internet for computers on school property and on the exposure of computer (particularly laptop) users, especially children and young adults.

Early in September, 2011 Radiation Health and Safety Consulting (RHSC) was contacted for advice and assistance in addressing concerns about RF and microwave exposures. Although consideration was being given to making measurements on all the installations at all the schools under the YRDSB's jurisdiction it was decided that, as an initial stage, measurements would be carried out at one elementary school and at one secondary school. After some discussion it was decided that the Dr. Bette Stephenson Centre for Learning (BSCL), having the highest level of wireless service with over 60 wireless access points (APs) installed, and which houses an Adult Learning program similar to a secondary school, would be the site representing secondary schools. For the sake of efficiency and convenience Oak Ridges Public School (ORPS) was selected as representative of the elementary schools because of its proximity to BSCL.

On Tuesday, 2011 10 04, between approximately 0900 h and 1030 h, measurements of RF and microwave levels were made near wireless APs throughout ORPS. Measurements were made at BSCL between approximately 1100 h and 1230 h and continued between approximately 1300 h and 1530 h. Both ORPS and BSCL are situated in an urban setting within the town of Richmond Hill surrounded by relatively low density single family residential neighbourhoods with a scattering of small apartments and commercial properties in the immediate vicinity.

At the time the measurements were being carried out ORPS was operating in a normal manner with students, teachers and staff conducting routine activities. The same was true at BSLC. In attendance at ORPS while the measurements were being carried out were Andy Bischoff (Manager, Network Services, YRDSB) who provided floor plans of the school indicating where the APs were located. Barbara Nemoy (Principal), Alexander Pancharovski (Vice-Principal) and Philip Whissell (Technology Lead Teacher) were also in attendance for part of the time. At BSCL, Tom Pawloski (Health and Safety Officer), Kori Zsigmond (Environmental Health and Safety Officer), John Britnell (CUPE 1196 Representative), Colin Whackett (ETFO Representative) and Nicolette Lane (ETFO Representative), all being members of the YRDSB Joint Health and Safety Committee, were in attendance. The author is grateful to all the Board representatives for their assistance in locating and providing access to the various WiFi access points at both locations and for animated discussions of the issues involved in addressing concerns about WiFi, APs and RF and microwave radiation in general.

2. BACKGROUND

The electromagnetic spectrum is a valuable and limited resource, not unlike air and water and land, with ever increasing demands put upon all of them by human activities. As soon as the electromagnetic spectrum began to be utilized during the first part of the last century it rapidly became obvious that one user's activities could adversely affect another user's activities unless certain conditions are met, again not unlike air, water and land use. Consequently national governments around the world have established controls on the use of the electromagnetic spectrum.

The government of Canada is no exception[1]. It allocates specific frequency ranges within the electromagnetic spectrum for various civil and military uses. Most of the allocations provide for exclusive use of a specific range of frequencies and are subject to conditions specified in a licence. There are some ranges called the Industrial, Scientific and Medical (ISM) bands that are not subject to most of the conditions associated with licenced use. The only condition they must meet is that devices operating in the ISM bands must not interfere in any way with users outside the ISM bands. Two ISM bands, at 2.45 GHz and 5.8 GHz, are currently in use for unlicensed applications such as microwave ovens, residential portable (wireless) telephones and (wireless) routers for localized computer networks (wireless LANs or WiFi systems).

It is important to note that unlicensed does not mean unregulated. All installations and devices are subject to the limits specified in Health Canada SC-6. Furthermore all installations and devices take into account and meet local standards and guidelines to limit occupational and general public exposure.

AM and FM Radio, TV, police and emergency communications, air traffic control systems including radars, cellular telephone, pager and commercial data transmission systems all operate in specifically allocated and licenced bands. Their operating frequencies are spread over the whole spectrum and with the advent of lasers and fibre optics corresponding radio communications applications are moving to frequencies beyond the microwave range, into the infrared and visible regions of the spectrum. Towers scattered throughout the countryside accommodate one or many different antennas or dishes to serve the many needs of the communities.

It is also to be noted that the study and use of electricity, magnetism and the electromagnetic spectrum in general is not at all "new" as is so often claimed. Among the earliest work was that of Galvani and Volta in the late 1700s followed by Gauss, Maxwell, Hertz and Roentgen in the 1800s and then Einstein, Tesla, Townes and Schawlow and Gould in the 1900s. Each and every one of the associated advances in physics led to advances in engineering and technology to bring useful, truly "new," applications into existence including advances in medical diagnosis and therapy which

1 See <http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01678.html>

inherently involve determination of mechanisms of action and of biological effects. However, it seems that each innovation, regardless of its provenance, also spawned its own wave of alarm and quackery (the proverbial purveyors of bear grease and snake oil, magic crystals, pyramid power, etc.) that, with the passage of time, in **almost all** cases is dispelled and discredited by results arising from more detailed scientific investigations the history of tobacco, CFCs, asbestos, etc. notwithstanding.

3. MEASUREMENT RESULTS

Measurements were carried out with a Holaday Industries Broadband RF Field Strength Meter Model HI 4012. It provides a calibrated response to electric field levels over the frequency range of 500 kHz to 5 GHz. The meter was set to display far field equivalent power density. The smallest value that the meter can display is 0.001 mW/cm^2 which normally implies a detection limit of 0.0005 mW/cm^2. However, the manufacturer's specifications state that its calibrated detection limit is 0.040 mW/cm^2. Therefore recorded values of less than the manufacturer's stated detection limit are only to be interpreted as the barest indication of the presence of emissions from a source and not to be taken as precise or calibrated readings. Values recorded as N.D. or N.D.x indicate that there was not even an approximate indication of emissions detected, i.e. the display did not deviate from 0.000 mW/cm^2 (see also Section 4.2 below).

The probe incorporates an integral spacer such that the detector assembly cannot be placed closer than 5 cm from any source or other object.

Attention was focused on the APs themselves since it was anticipated that, even with the probe in contact, the emissions would be near the limits of detectability of the measurement system. The APs are typically mounted on the actual ceiling some 50 cm or so above the typical suspended ceiling. Unless otherwise indicated a measurement of 10 to 15 s duration was taken at the suspended ceiling for each mapped AP location plus several locations where there were other indications that an AP might be located. If any emission was detected another reading was taken at head level and repeated at waist level if any emission was detected.

For ease of reading, the meter, being digital, only updates its display approximately twice each second. However, it actually samples the field approximately twenty times each second. If the display were to show every reading it would usually be changing so rapidly as to be unintelligible. In order to ensure that short duration high readings are not missed the meter's MAX HOLD feature displays the highest detected value during a given time period at a fixed location or while the probe is moving along a certain path between two points, say walking along a corridor or scanning around an AP or over the surface of a microwave oven, computer or monitor. Such highest detected values are designated with an "x" in the tables of measured values below.

A total of 170 measurements were recorded at 101 locations in the two facilities, 44 measurements at 32 locations in ORPS and 126 measurements at 69 locations in BSCL. Some (most) locations were chosen specifically because there was, or was supposed to be (according to the maps provided), an AP in proximity. However a number of locations were chosen because of the presence of some other feature of interest, specifically a microwave oven, or to evaluate maximum levels along corridors when moving between other selected measurement locations. For reference purposes the locations are numbered sequentially from 1 to 32 at ORPS and 33 to 101 at BSCL. The reference number for each measurement location is shown on the floor plans of ORPS (in Figures 1 and 2) and BSCL (Figures 3 and 4), respectively.

Table 1. Measured Power Densities, Oak Ridges PS

Location Ref. No.	Power Density mW/cm^2
1	0.003 N.D.
2	0.001x
3	0.001 N.D.
4	N.D.
5	0.001x
6	0.003x
7	0.021x
8	0.001 N.D.
9	0.011x
10	0.006 N.D.
11	0.007x
12	0.002 N.D.
13	0.009 N.D.
14	0.007x
15	N.D.
16	0.009x

Location Ref. No.	Power Density mW/cm^2
17	N.D. 0.059x 0.133x
18	N.D.
19	N.D.
20	0.005x
21	0.041x
22	0.001 N.D.
23	0.004x
24	N.D.
25	0.005x
26	0.001 N.D.
27	0.003x
28	0.002 N.D.
29	0.001x
30	N.D.
31	N.D.
32	0.001 N.D.

Table 2. Measured Power Densities, BSCL

Location Ref. No.	Power Density mW/cm^2
33	N.D. 0.001 0.003 0.088x 0.084x 0.158x
34	0.001 0.003 N.D.
35	0.001 N.D.
36	0.004 N.D.
37	0.002 N.D.
38	N.D.
39	0.012x
40	N.D.
41	N.D. 0.004 N.D.
42	N.D.
43	0.015x
44	0.003 N.D.
45	0.004 N.D.
46	0.003 N.D.
47	0.001 N.D.

Location Ref. No.	Power Density mW/cm^2
48	0.003 N.D.
49	N.D.
50	0.005 N.D.
51 51A	0.001 N.D. 0.021 N.D.
52	N.D.
53	N.D.
54	N.D. N.D.
55 55A	N.D. 0.001 0.002 0.001
56	0.015x
57	0.002 N.D.
58	0.003x
59	N.D.
60	0.006 0.001 N.D.
61	0.003 0.001 N.D.
62	0.001 N.D.
63	N.D.
64	0.004 N.D.

Location Ref. No.	Power Density mW/cm^2
65	0.001 N.D.
66	N.D.
67	N.D.
68	N.D.
69	0.004 0.001 N.D.
70	0.001 0.001 N.D.
71	0.003 0.003 N.D.
72	0.005 N.D.
73	N.D.
74	N.D.
75	0.003 N.D.
76	N.D.
77	N.D.
78	0.003 N.D.
79	N.D.
80	N.D.
81	N.D.
82	N.D.
83	0.001x
84	0.003 0.003 N.D.

Location Ref. No.	Power Density mW/cm^2
85	0.008 N.D.
86	N.D.
87	0.003 0.008 N.D.
88	N.D.
89	0.003 N.D.
90	0.004 N.D.
91	N.D.
92	N.D.
93	N.D.
94 94A	N.D. 0.004 N.D.
95	N.D.
96	N.D.
97	N.D.
98	N.D.
99	0.001 N.D. N.D.
100	0.002 N.D. 0.198x 0.045x
101	N.D. N.D.

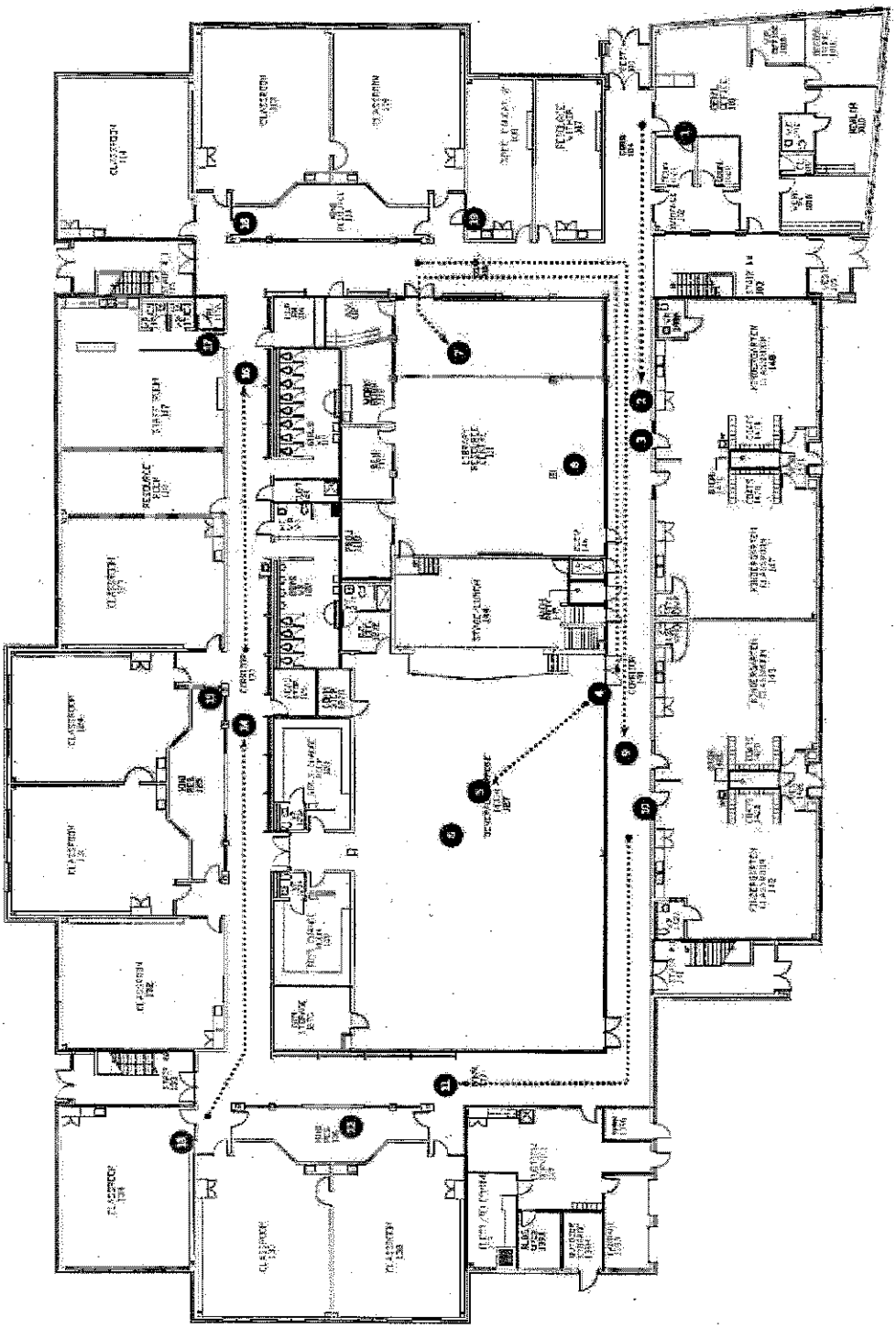


Figure 1. Measurement Locations, Oak Ridges Public School, Ground Floor

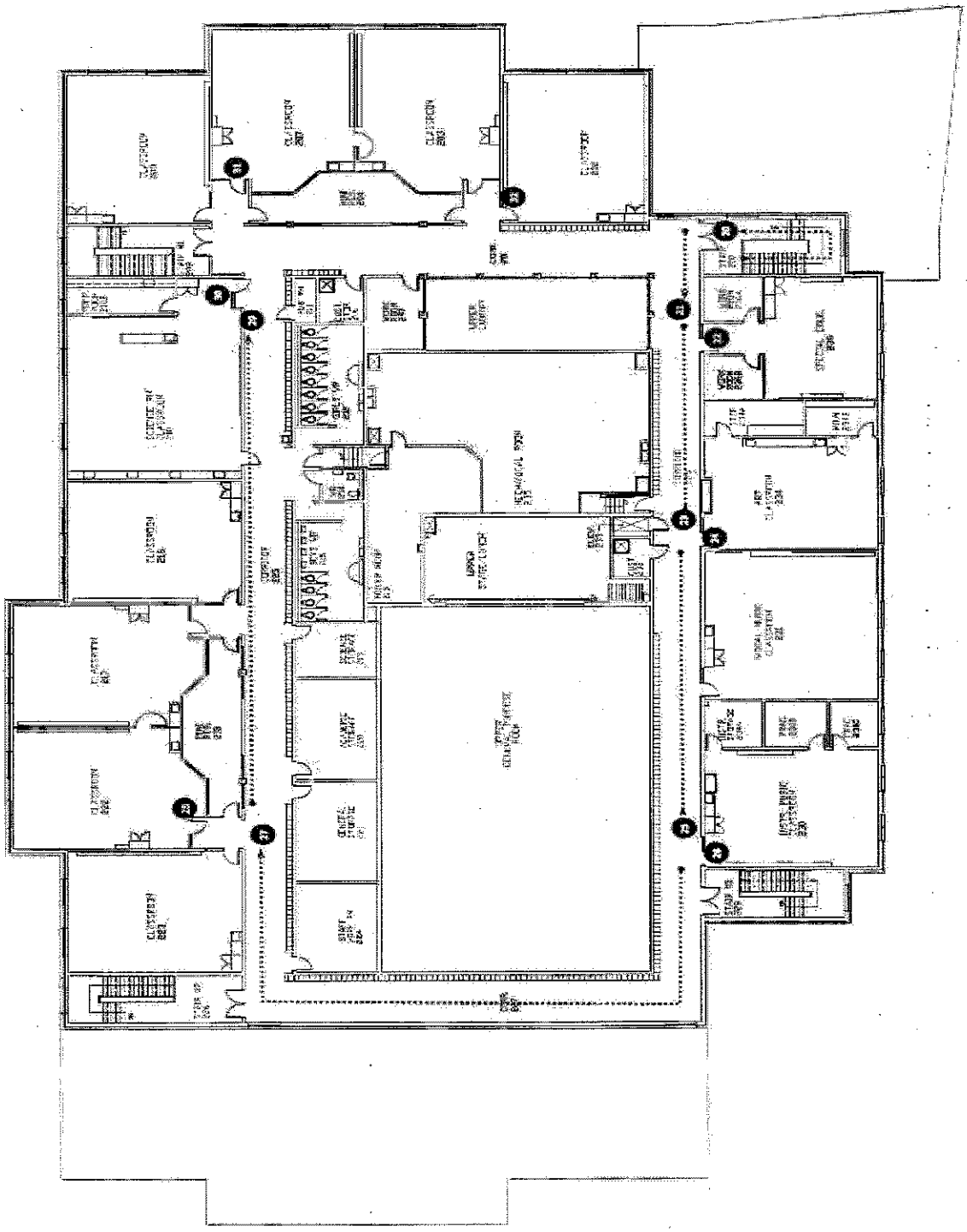


Figure 2. Measurement Locations, Oak Ridges Public School, Second Floor

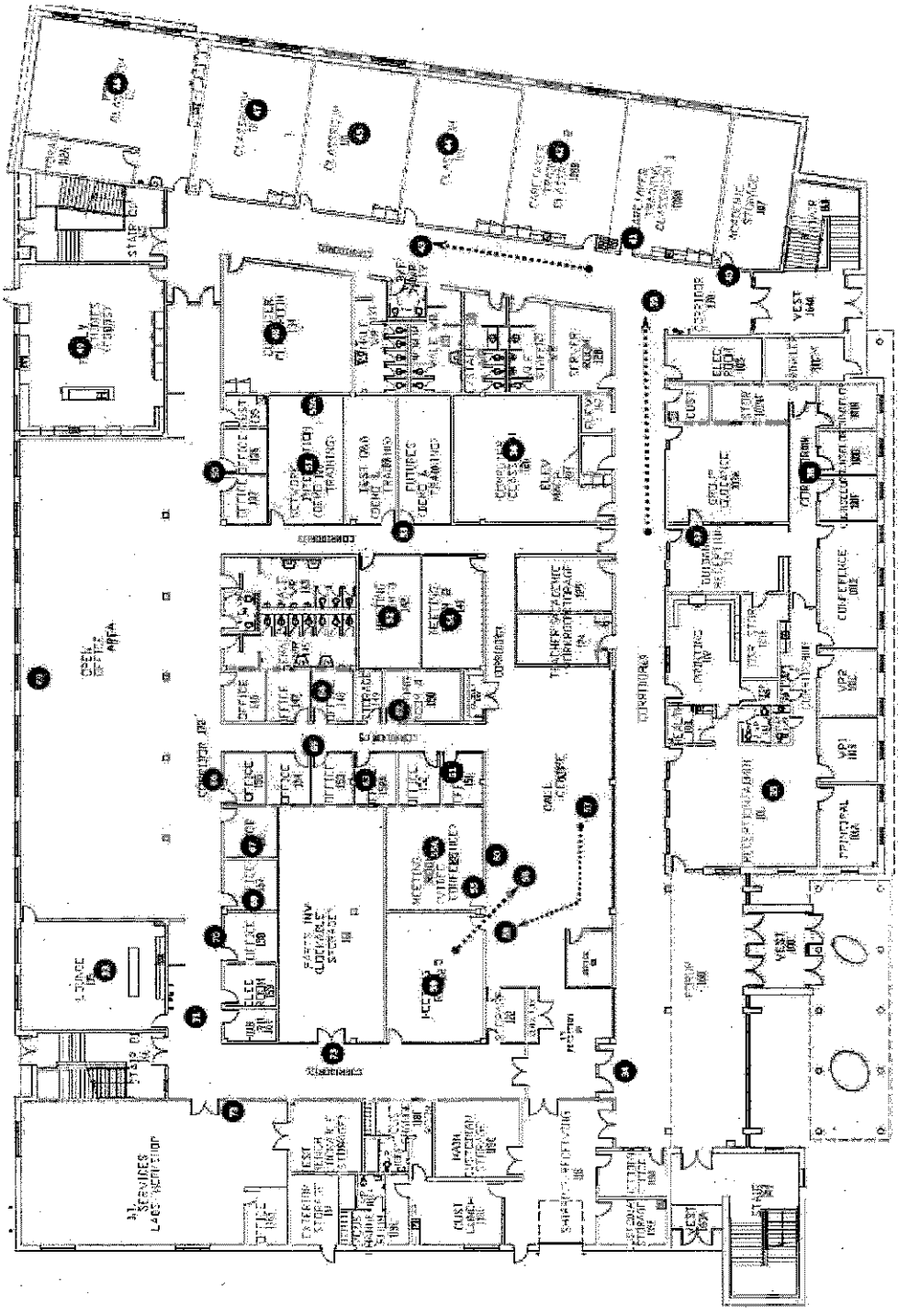


Figure 3. Measurement Locations, Bette Stephenson Centre for Learning, Ground Floor

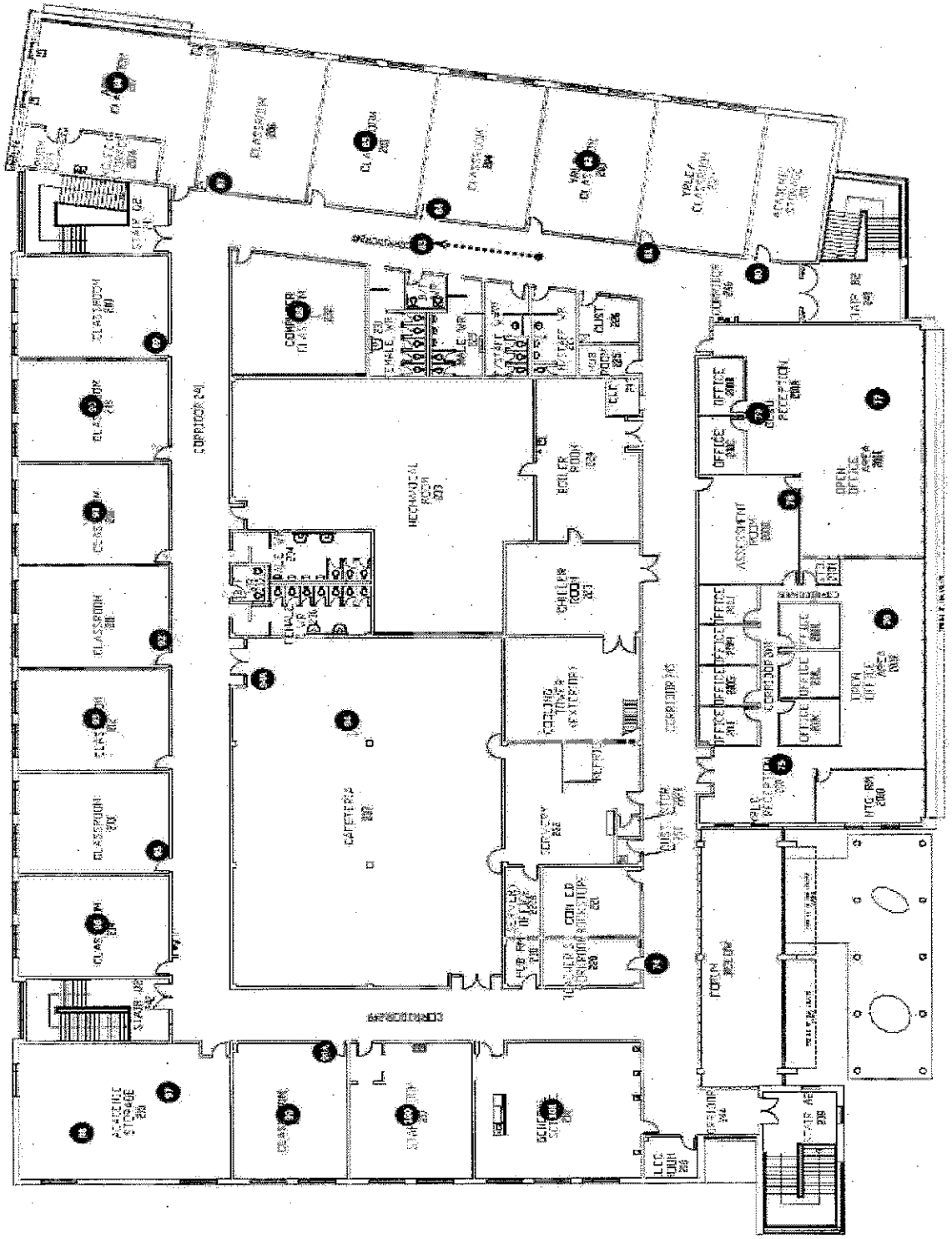


Figure 4. Measurement Locations, Bette Stephenson Centre for Learning, Second Floor

4. DISCUSSION

4.1 The Sources

The APs being used in YRDSB schools are Aruba Networks Model AP-125 units designed to operate in one or both of the 2.4 GHz and 5 GHz ISM bands. The number and location of the APs at any given site depends on the expected volume of data, number of users anticipated, reliability and coverage requirements that the APs are intended to meet. At any given time only selected bands and selected channels within the bands are active in accordance with the needs of the users. Since the measurements were carried out with a broadband meter the reported values cannot be directly attributed to any specific band or channel and represent a total level arising from both the school and neighbouring areas. Of course when the probe is physically in contact with, or very close to, a specific source, one of the APs, a laptop or a microwave oven it is to be assumed (quite reasonably) that virtually all of the indicated emission level is attributable to that closest source.

4.2 The Locations Chosen for Measurements

Since the APs are, for the most part, installed above the suspended ceilings, a member of the Board's IT Services staff provided guidance as to their specific locations at both facilities. A number of locations were also chosen "at random" and were not specifically associated with the location of an AP. A number of locations were chosen because of some other feature of interest such as a microwave oven or other installation.

4.3 The Measured Values

The underlined insertions (Ref. NN) below refer to the Reference Numbers for the locations identified in the first column of Tables 1 and 2 and shown in Figures 1, 2, 3 and 4.

The 7 highest levels recorded anywhere within the two facilities visited were all observed near microwave ovens (Ref. 17, 33, 100). All 7 were greater than the highest level observed at any other location and the highest was 0.198 mW/cm^2.

The highest level observed at locations not specifically associated with a microwave oven was 0.041 mW/cm^2 (Ref. 21). This is well above the detection threshold and just above the calibrated detection limit.

Of the remaining 93 readings the highest was 0.021 mW/cm^2 observed in contact with a testing AP (Ref. 51A) in a room used for training IT staff at BSCL. 55 of the remaining measurements indicated levels of less than 0.010 mW/cm^2. While all these measured values indicate the presence of emissions, none of them exceeds the meter's calibrated

measurement limit of 0.040 mW/cm^2. 88 of the measurements were recorded as N.D. indicating that the level at such locations was below the limit of detection.

It is important to note that values reported as N.D. do not mean levels are absolutely 'zero' but rather that they are not only below the calibrated detection limit of the meter but also below its limit to display any reading at all. Clearly there is sufficient signal for the WiFi equipment to operate successfully and reliably. That is because, within their specific channels, the WiFi receivers are designed to be extremely sensitive and can work with levels many, many times (factors of thousands to millions) lower than the detection limit of the Holaday meter or the limits specified in Safety Code 6.

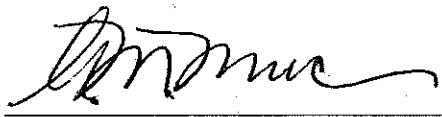
4.4 Limits for Exposure to RF and Microwave Fields

According to Health Canada Safety Code 6, for the frequency range from 1.5 GHz to 15 GHz, which includes the APs used in YRDSB Schools and facilities, levels less than 1 mW/cm^2 are considered acceptable "for Persons Not Classed as RF and Microwave Exposed Workers (Including the General Public)" regardless of exposure duration.

In the U.S., limits specified in the standards established by the American National Standards Institute (ANSI) in association with the Institute of Electrical and Electronic Engineers (IEEE) and the the Food and Drug Administration's Center for Devices and Radiological Health (USFDA – CDRH) are very similar (although not totally identical) to those of Health Canada Safety Code 6. The same can be said for the limits specified by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) which has brought together experts from across Europe and provides guidance to the European Economic Community (EEC). On the broadest front, such a general consensus on limits flows from the EMF Project established by the World Health Organization (WHO) which has been working and continues to work toward global harmonization of exposure standards and guidelines by promoting and facilitating interchange of the results of research among all the member nations.

5. CONCLUSIONS

The RF and microwave electromagnetic field levels associated with WiFi APs in a representative sample of areas normally accessed by students and staff at both ORPS and BSCL are a factor of at least 25 below the exposure limits specified in Health Canada Safety Code 6 for "Persons Not Classed as RF and Microwave Exposed Workers (Including the General Public)." All the observed levels are far below exposure limits currently established or proposed by major international or national agencies or organizations for public (including children) or occupational exposures.



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