

Armitage Systems Limited

Auckland Viaduct Harbour RF Survey

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1. Introduction

There have been a couple of strange incidents in the vicinity of Halsey Street in Auckland's Viaduct Harbour involving perceived radio interference. Firstly a helicopter in the process of landing lost its radio communication and then an operator of a remote drone lost control of the device which then crashed into a building window. Close to where both of these incidents occurred is a particularly prominent cell site located on the roof of a building at 132 Halsey Street. There is concern that radio emissions emanating from this site may be of the cause of the suspected interference and represents a hazard for radio communications in the area. This report contains the results of an RF survey conducted in the area, and discusses whether any transmissions identified in the survey are likely to be a source of interference to other radio communications users.



Fig 1 No 132 Halsey Street – Wynyard Quarter, Viaduct Harbour Auckland.

The exact channel / frequency being used by the helicopter and drone are unknown, but in the case of the helicopter it is likely to be either a UHF channel designated for aircraft use (118 to 137 MHz) or a public mobile radio channel in either the UHF or VHF bands. Model aircraft have traditionally used a number of narrow band VHF channels between 26 and 73MHz that have been reserved exclusively for their use. However the bulk of the drones currently available on the market don't use these exclusive channels, but use broadband channels at 2.4GHz and 5GHz, as typically used by other WiFi devices. They use the WiFi channels as they need the extra bandwidth to support video transmissions from the drone and also as it allows a smart phone to be used as the controller saving the cost of a separate controller.

2. Licensed Radio Transmitters

A search of the Radio Licence Register showed forty plus licensed radio transmitters in the vicinity of Halsey Street, refer to Appendix A for a full listing. Figure 2 shows the locations for each of these transmitters as recorded on the license. The coordinates for the location recorded in the register as ‘Wynyard Central’ are those for the building at 132 Halsey Street.

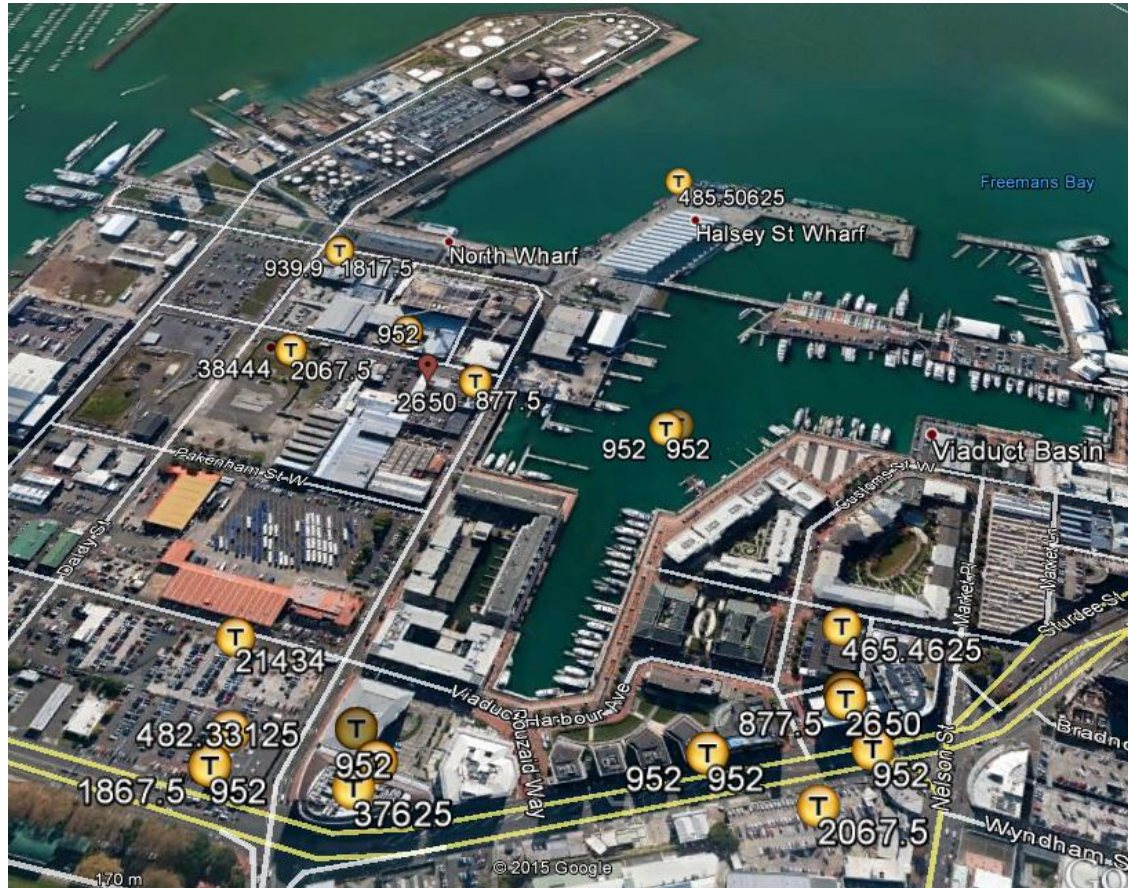


Fig 2 Licensed Radio Transmitters in the vicinity of Halsey Street.

All of the licences for radio transmitters at the Wynyard Central location are recorded against either Spark New Zealand or Telecom Leasing as the licence holder. In this case there are four separate licences for this location covering different radio frequency bands:

1. 850 Cellular Band (870 MHz to 885 MHz)
2. 1800 Cellular Band (1830 MHz to 1855 MHz)
3. 2100 Cellular Band (2140 MHz to 2155 MHz)
4. 2.6 GHz Band – Private Spectrum (2640 MHz to 2660 MHz)

A sweep of the radio spectrum within each of these bands was completed using a Rohde & Schwarz FSH6 Spectrum Analyser. The measurements were taken from the roof of the building at 132 Halsey Street at a distance of approximately 30 metres from the cell site antennas.

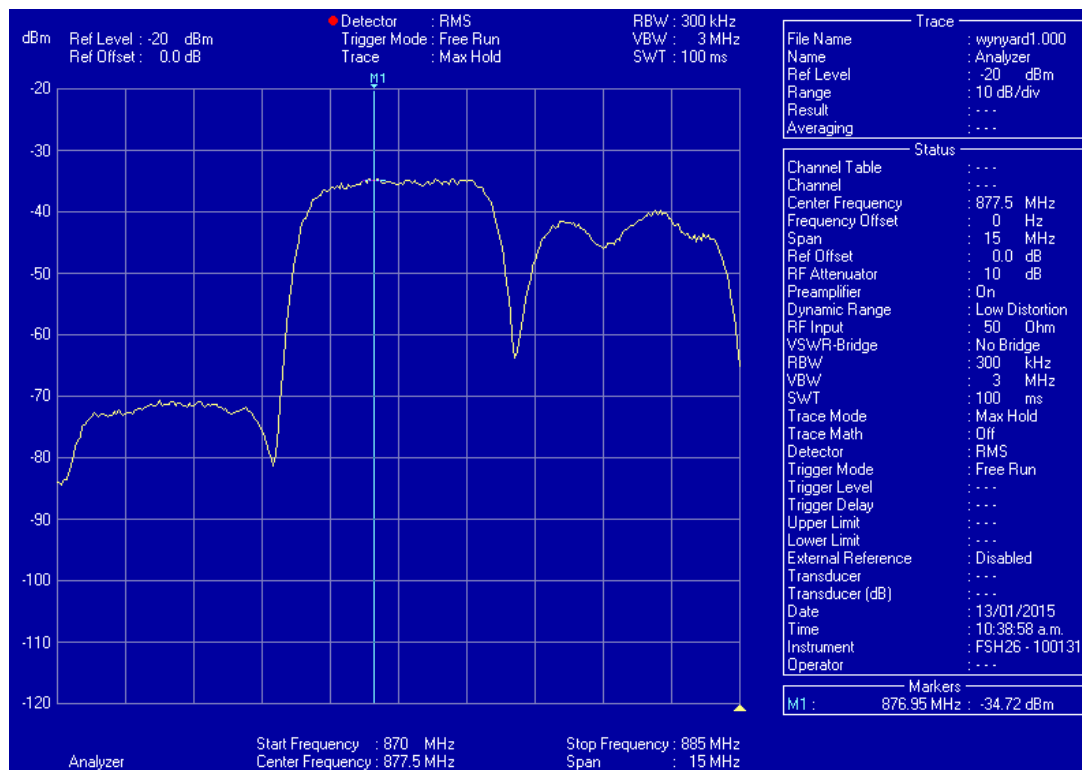


Fig 3 Wynyard Central 850 Cellular Band

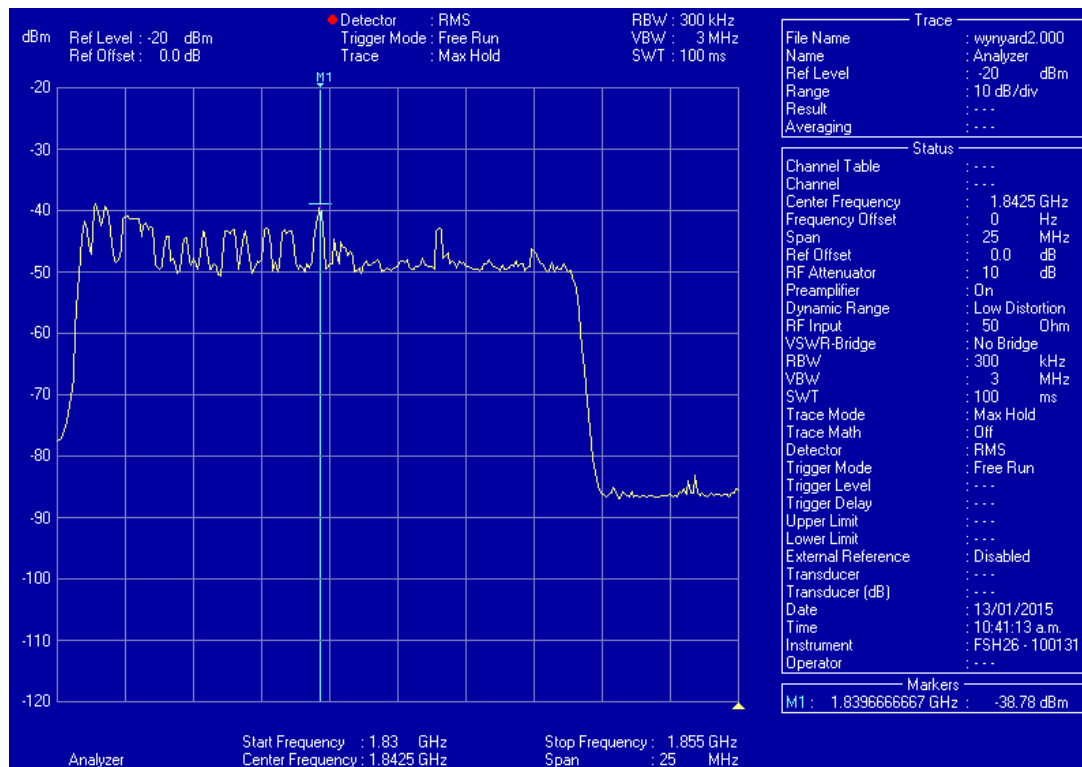


Fig 4 Wynyard Central 1800 Cellular Band

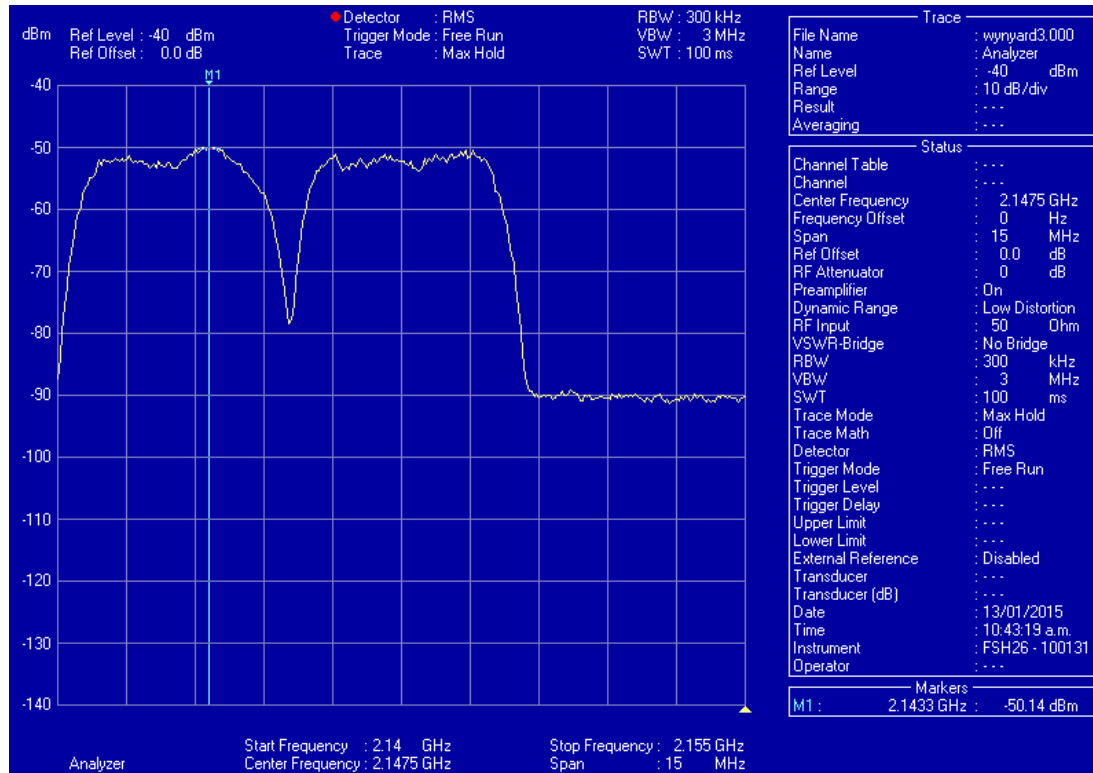


Fig 5 Wynyard Central 2100 Cellular Band

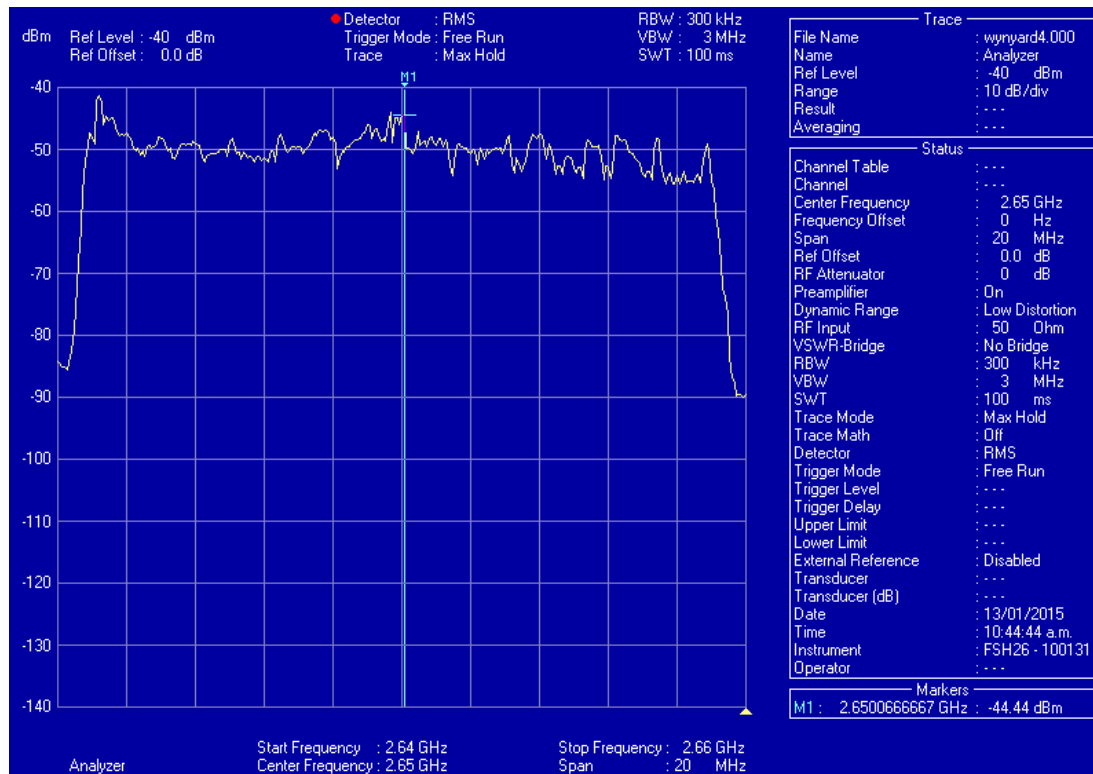


Fig 6 Wynyard Central 2.6GHz Private Spectrum

While the measured signal in each of these bands was reasonably strong, ranging from -35dBm for the 850 Band down to -50dBm in the 2100 Band, they are still within levels that could reasonably be expected within such close proximity to the transmitter. Each of these transmitters is licensed for a radiated power level of 40dBW (10kW or +70dBm) which constitutes a high powered transmitter, even at licensed levels.

Spark uses these frequency bands to operate its 'XT Mobile Network'. This network includes a 3G mobile service which operates nationwide in the WCDMA/UMTS 850 MHz band, with 2100 MHz band operation for infill in major urban areas. Spark also offers a 4G (LTE) service which operates in the 1800 MHz Band (LTE Band 3). Spark combines this with the 2600 MHz band for its LTE service (LTE band 7), and with a compatible handset band 3 (1800 MHz) and band 7 (2600 MHz) can be used simultaneously to speed up data access.

It can be deduced from the radio licensing information and the spectrum analyser plots, that the radio installation at 132 Halsey Street is a combined 3G / 4G cell site operated by Spark New Zealand.

3. General User Radio Licence Transmitters

All radio transmitters in New Zealand need to operate in accordance with a radio licence. Where a specific site licence hasn't issued, then the radio transmitter would need to comply with a General User Radio Licence (GURL) that allows operation in commonly used shared spectrum bands. GURLs have been issued for use by 'short range devices' which includes the 2.4GHz and 5GHz bands used by WiFi devices and cordless phones. Separate GURLs have also been issued for commercial and private aircraft use, 'citizen band'/'personal radio service' mobile radio operation, and also for specific use by model aircraft.

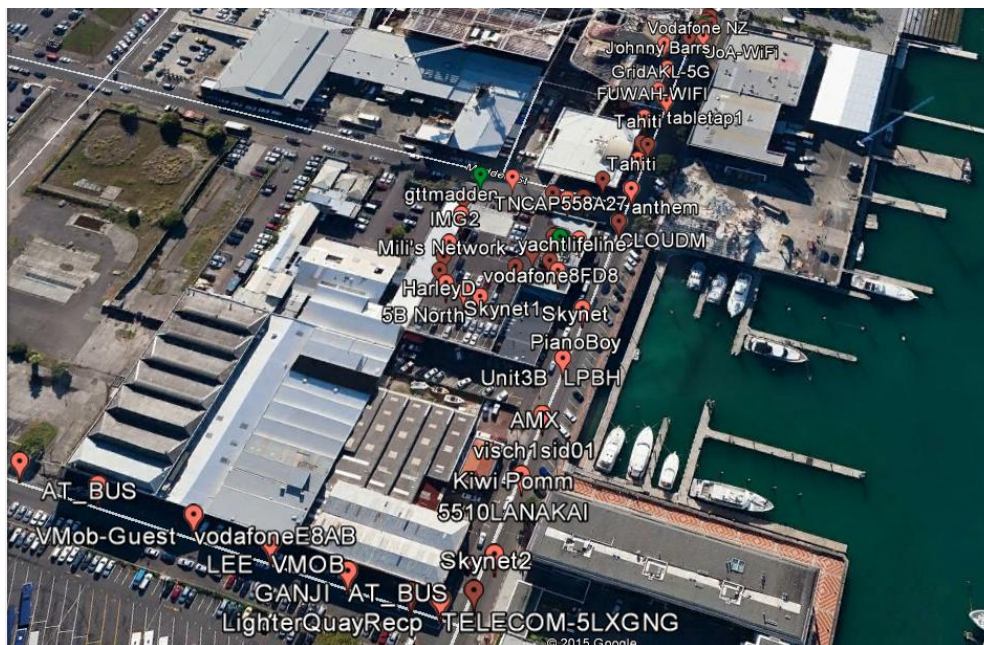


Fig 7 WiFi Networks detected near Halsey Street

A survey was completed of the WiFi networks in the vicinity of Halsey Street and a significant number of Access Points were detected, see figure 7 and Appendix B for a list of the Access Points detected close to 132 Halsey Street. The significant number is not unexpected given the dense urban environment. Most of those detected operated in 2.4GHz Band (802.11 'b', 'g' and 'n'), but signals were also detected in the 5GHz band (802.11 'a' and 'n').

A sweep of the RF spectrum in the 2.4GHz band and the 5.8 GHz band saw more activity in the 2.4GHz band, but no very high powered transmitters likely to prohibit the use of the band by other users or potentially operating outside the constraints of the GURL for short range devices, see figures 8 and 9 below:

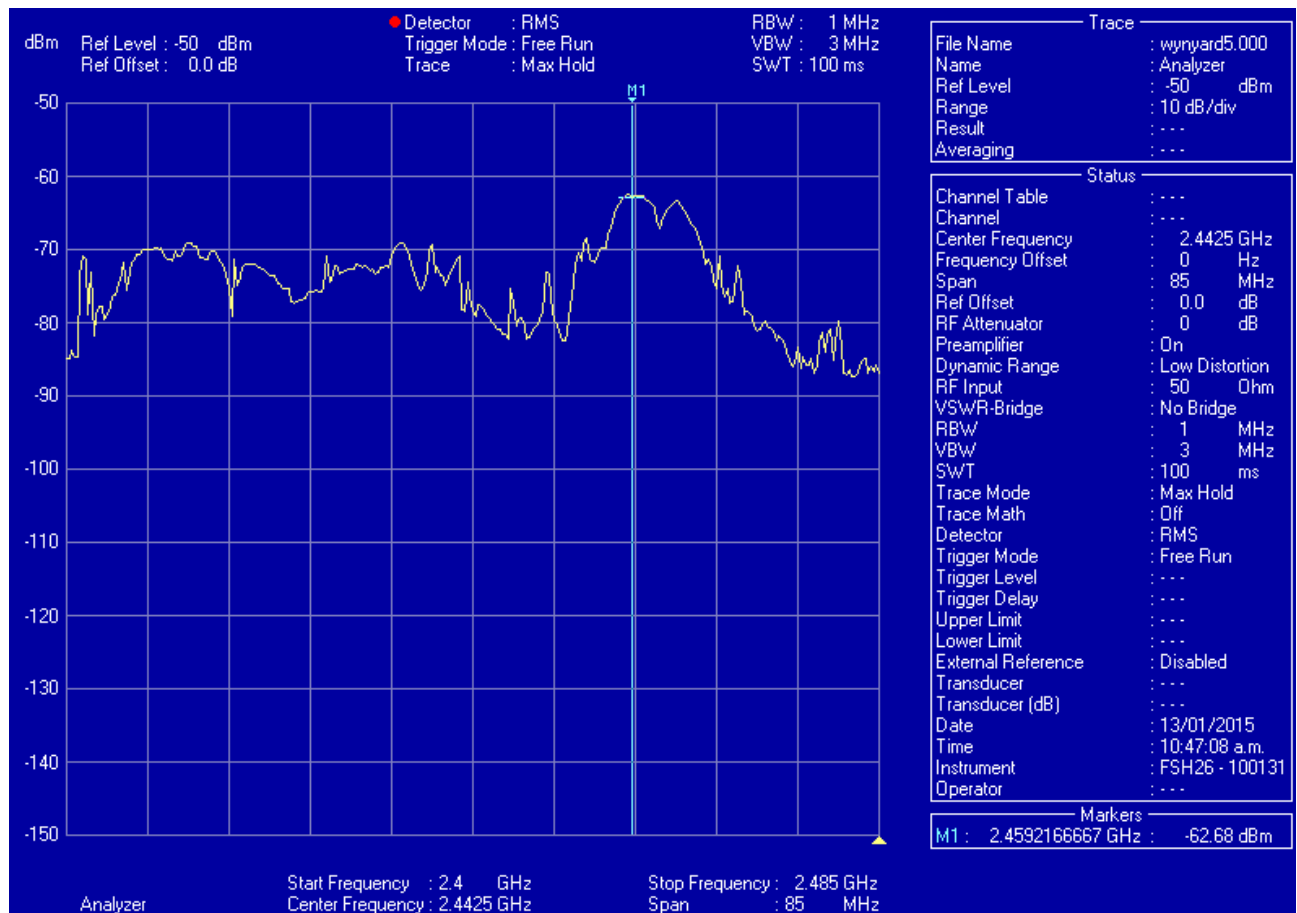


Fig 8 2.4GHz Band at 132 Halsey Street



Fig 9 5.8GHz Band at 132 Halsey Street

In addition to the 2.4 GHz and 5 GHz bands used by short range devices, a sweep was also conducted of the GURL bands used for VHF aircraft communications and also for public mobile radio channels at both VHF and UHF frequencies as used by commonly available mobile radio products.

The GURL for aircraft communications covers the frequency range from 118 MHz up to 137 MHz, with the frequency at 134 MHz specifically reserved for general air-to-ground and air-to-air communications. A sweep of this band showed no activity at the time the measurements were taken, see figure 10. This isn't unexpected given no aircraft were operating in the area at the time, but the sweep also didn't show any significant noise of a persistent nature in the band. Radio noise levels, in addition to background thermal noise, can potentially be affected by spurious out-of-band transmissions generated directly by other transmitters or as a result of intermodulation (intermod) products being generated by a combination of other transmitters operating outside of the band in question and close proximity to each other.

In the case of the public mobile radio channels in the VHF band, again no activity was detected at the time the sweep was conducted, see figure 11. As with the aircraft communications channels, no significant persistent noise source was detected in the VHF public mobile radio band. For the UHF public mobile radio band, one signal was detected at 477.14 MHz at signal strength of -65dBm, see figure 12. This signal was temporary in nature and had the expected radio spectrum profile of a typical narrowband FM transmitter at a signal level that is not excessively high. It therefore isn't considered to be a likely source of interference that could have caused the issues experienced by the helicopter and drone.

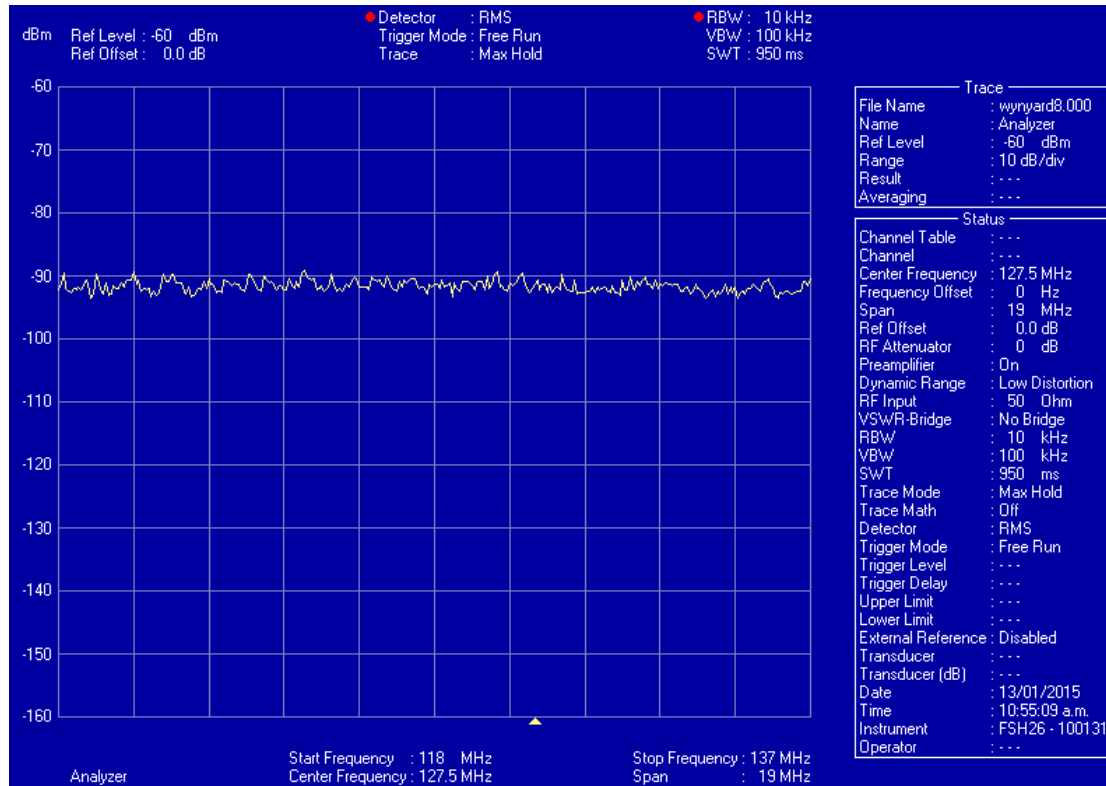


Fig 10 VHF Aircraft Communications Band – 132 Halsey Street

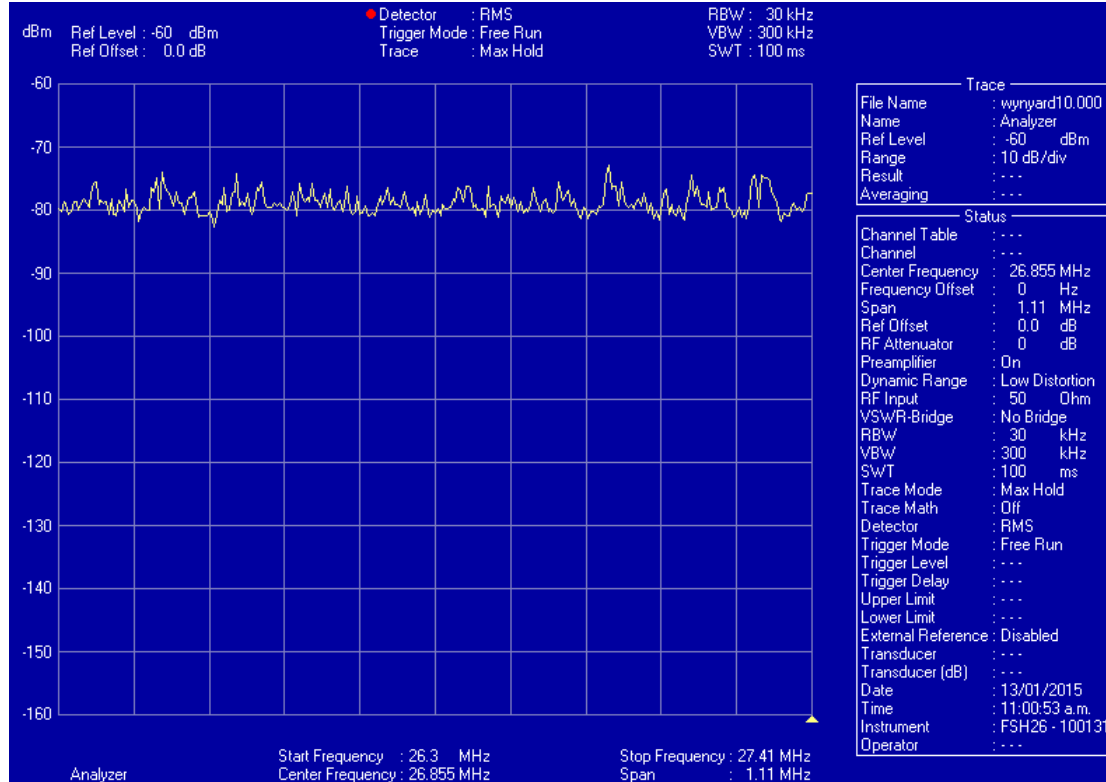


Fig 11 VHF Citizen Band – 132 Halsey Street

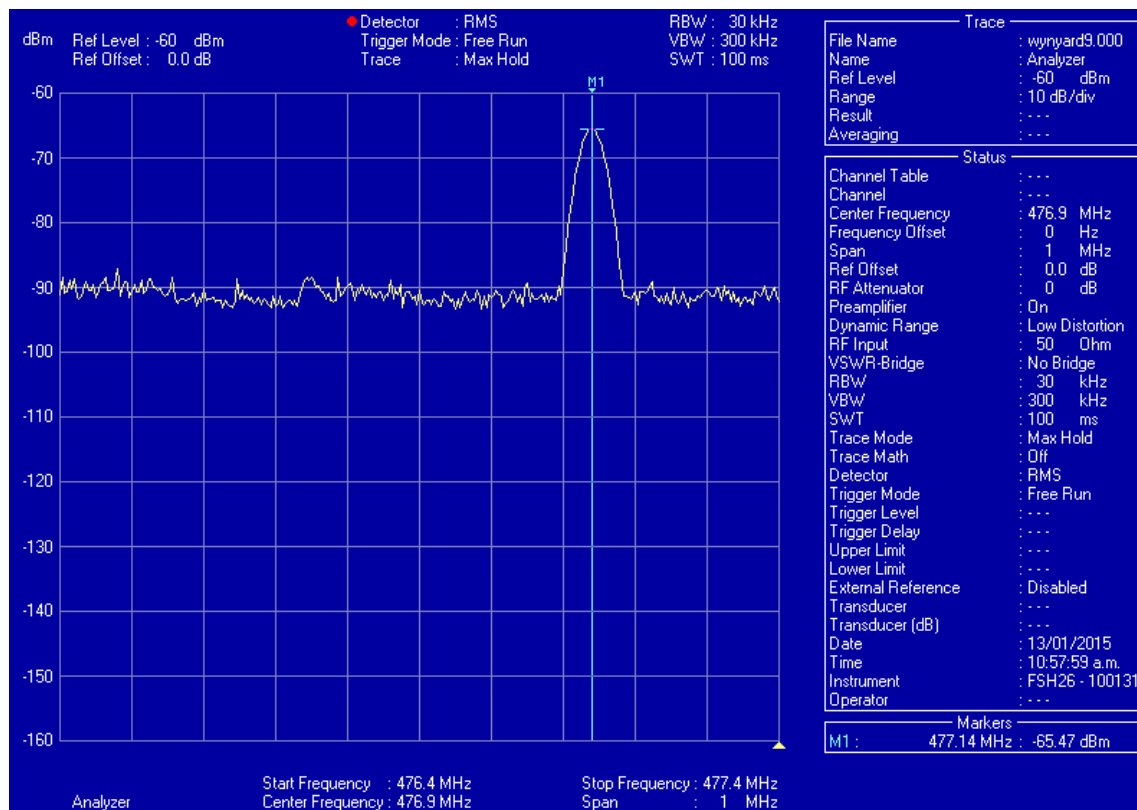


Fig 12 UHF 'Personal Radio Service' Band – 132 Halsey Street

4. Conclusion

The Spark cell site at 132 Halsey Street, although prominent is actually only one of a number in the vicinity, with Vodafone, Two Degrees Mobile and Woosh Wireless also having sites around the Viaduct Harbour. While supporting a number of high powered transmitters, the Spark cell site only operates in privately held cellular bands that are separated significantly in terms of frequency with the likely channels used by the helicopter and drone. Consequently this site is not considered to be the primary cause of the interference issues experienced. Potentially intermodulation products resulting from the combination of these and other legitimate sources in the area may have inadvertently created a source of interference in the bands of interest. However no persistent source of unidentified interference was detected in any of the bands likely to be used by the helicopter or drone. It is also likely that Spark and other commercial cellular operators would employ filtering on both the transmit and receive sides of their radios to minimise the risk of intermodulation interference.

The use of the 2.4GHz and 5GHz WiFi bands for the control of drone aircraft has a number of benefits and had become the de facto standard for these devices. There are unfortunately a number of downsides to using these frequencies, particularly in dense urban environments. Firstly as it is shared spectrum the drone must compete with other WiFi devices in the area of which there are many. This

is mitigated partially by the WiFi protocol employing 'Carrier Sense Multiple Access with Collision Avoidance' (CSMA/CA) which is a technique by which multiple WiFi devices manage shared access to a radio channel. It results in reduced throughput during times of congestion, which could potentially result in data rates below that needed by the drone to be effectively controlled.

The use of CSMA/CA also doesn't address the issue of devices that use WiMax or other proprietary protocols other than the WiFi protocol, but operate in the same bands of the WiFi devices. Signals from these devices will be seen purely as noise by a WiFi device. When the signals from these other sources raises the noise floor such that the signal to noise ratio drops below a minimum threshold, the WiFi radios used by the drone will progressively drop down its modulation rate to maintain communications. The effect is the same as for WiFi traffic congestion, in that it results in reduced throughput and can potentially lead to the sudden loss of all communications.

In addition to interference issues, radios operating at frequencies at 2.4GHz and above typically require line of sight or near line of sight to operate. Advanced radio techniques including the use of 'Multiple Input Multiple Output' (MIMO) do allow for some non line of sight operation at close range. If a smart phone was being used as the controller it may not possess the multiple antenna arrays used by MIMO and other smart antenna techniques and therefore not have this capability.

It is generally advisable that drones using WiFi as a means of communication for control, particularly in a dense and built up urban environments, either be operated at relatively close range or only with direct line of sight between the controller and the drone in the air.

In the case of the helicopter that lost communications during landing, with the passing of time and unless the exact channel of operation is known it is difficult to determine whether interference issues were the cause of the break in communications. It can be concluded with reasonable confidence that the Spark cell site located at 132 Halsey Street was not the direct source of any interference and no significant source of interference can now be detected in any of the band that the helicopter is likely to have used. It can only be concluded that any potential source of interference that might have affected the helicopter, was temporal in nature and is no longer present.

Appendix A – Licensed Radio Transmitters in the vicinity of Viaduct Harbour

Licence Id	Licence Number	Status	Org Name	Spectrum Low	Ref Freq	Spectrum High	Emission	Power	Channel	Polarisation	Tx Loc Name
79291	175369	Current	WATTS AND HUGHES CONSTRUCTION LTD	461.6625	461.66875	461.675	10K0F3EJN	14	DNX36	Vertical	MARITIME PROJ VIADICT BASIN AK
10153	52676	Current	NZME, RADIO LIMITED	465.44	465.4625	465.485	45K0F3EGN	-13.6		Horizontal	CALTEX HOUSE
168569	242598	Current	FLETCHER CONSTRUCTION BUILDING AUCKLAND	482.325	482.33125	482.3375	10K0F3EJN	14	FNX528	Vertical	CNR HALSEY AND FANSHAWE STREETS AUCKLA
160725	237024	Current	AOTEA CENTRE TRUST BOARD	485.5	485.50625	485.5125	10K0F3EJN	17	FN442	Vertical	VIADUCT EVENTS CENTRE AUCKLAND
145986	227534	Current	SPARK NEW ZEALAND TRADING LIMITED	870.015	877.5	885	15M0W7W	40		Mixed	FANSHAWE STREET
151638	232393	Current	SPARK NEW ZEALAND TRADING LIMITED	870.015	877.5	885	15M0W7W	40		Mixed	WYNYARD CENTRAL
127964	217861	Current	TWO DEGREES MOBILE LIMITED	935	939.9	944.8	9M80X7W	38		Mixed	7 FANSHAWE STREET (AKL-007-024-D)
153439	233579	Current	TWO DEGREES MOBILE LIMITED	935	939.9	944.8	9M80X7W	38		Mixed	22 JELlicoe ST AUCKLAND CBD HALSEY STREET
127078	217228	Current	VODAFONE NEW ZEALAND LIMITED	944.9	951.95	959.9	15M0XXX	40		Mixed	VNUE BUILDING
116145	210701	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	AMERICANS CUP VILLAGE ANTENNA-1
69308	10468	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	AMERICANS CUP VILLAGE ANTENNA-4
114509	209800	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	COMPAQ A
114510	209801	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	COMPAQ B
114520	209811	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	FANSHAWE STREET MICROCELL
117103	211007	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	SEAMART
117435	211035	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	VNUE BUILDING INDOOR
113040	208684	Current	VODAFONE NEW ZEALAND LIMITED	944.9	952	959.9	15M0XXX	40		Mixed	TANK FARM
114695	209853	Current	TWO DEGREES MOBILE LIMITED	1805	1817.5	1830	25M0W7W	40		Mixed	7 FANSHAWE STREET (AKL-007-024-D)
173885	245795	Current	TWO DEGREES MOBILE LIMITED	1805	1817.5	1830	25M0W7W	40		Mixed	22 JELlicoe ST AUCKLAND CBD HALSEY STREET
165107	239654	Current	SPARK NEW ZEALAND TRADING LIMITED	1830	1842.5	1855	5M00VXW	40		Mixed	FANSHAWE STREET
165374	239908	Current	SPARK NEW ZEALAND TRADING LIMITED	1830	1842.5	1855	5M00VXW	40		Mixed	WYNYARD CENTRAL
159310	236332	Current	VODAFONE NEW ZEALAND LIMITED	1855	1867.5	1880	25M0XXX	40		Mixed	VNUE BUILDING
159597	236620	Current	VODAFONE NEW ZEALAND LIMITED	1855	1867.5	1880	25M0XXX	45		Mixed	VNUE BUILDING
159595	236618	Current	VODAFONE NEW ZEALAND LIMITED	1855	1867.5	1880	25M0XXX	45		Mixed	VNUE BUILDING INDOOR
159304	236326	Current	VODAFONE NEW ZEALAND LIMITED	1855	1867.5	1880	25M0XXX	40		Mixed	TANK FARM
68468	10336	Current	WOOSH WIRELESS (NZ) LIMITED	2054.76	2067.5	2080.24	7M68D7WWN	13		Mixed	NELSON STREET (A1NEL)
112307	208221	Current	WOOSH WIRELESS (NZ) LIMITED	2053	2067.5	2082	7M68D7WWN	10		Mixed	VIADUCT BASIN (AIVDB)
108419	205371	Current	VODAFONE NEW ZEALAND LIMITED	2110	2122.5	2135	25M0XXX	45		Mixed	AMERICAS CUP VILLAGE
134651	221872	Current	VODAFONE NEW ZEALAND LIMITED	2110	2122.5	2135	25M0XXX	45		Mixed	VNUE BUILDING
82898	13859	Current	VODAFONE NEW ZEALAND LIMITED	2110	2122.5	2135	25M0XXX	45		Mixed	VNUE BUILDING INDOOR
82868	13831	Current	VODAFONE NEW ZEALAND LIMITED	2110	2122.5	2135	25M0XXX	45		Mixed	TANK FARM
145970	227529	Current	SPARK NEW ZEALAND TRADING LIMITED	2140	2147.5	2155	15M0X9W	40		Mixed	FANSHAWE STREET
151635	232390	Current	SPARK NEW ZEALAND TRADING LIMITED	2140	2147.5	2155	15M0X9W	40		Mixed	WYNYARD CENTRAL
134256	221608	Current	TWO DEGREES MOBILE LIMITED	2155	2162.5	2170	15M0W9WWC	40		Mixed	7 FANSHAWE STREET (AKL-007-024-D)
160749	237080	Current	TWO DEGREES MOBILE LIMITED	2155	2162.5	2170	15M0W9WWC	40		Mixed	22 JELlicoe ST AUCKLAND CBD HALSEY STREET
171649	244186	Current	TELECOM LEASING LIMITED	2640	2650	2660	20M0VXW	40		Mixed	FANSHAWE STREET
171647	244184	Current	TELECOM LEASING LIMITED	2640	2650	2660	20M0VXW	40		Mixed	WYNYARD CENTRAL
161000	237120	Current	Araneo Ltd	21420	21434	21448	28M0G7WWX	15	23G2B4	Horizontal	GAUNT ST WESTHAVEN
144494	226560	Current	TWO DEGREES MOBILE LIMITED	21896	21910	21924	28M0D7WWX	8.4	23G7B1	Horizontal	7 FANSHAWE STREET (AKL-007-024-D)
117464	211133	Current	VODAFONE NEW ZEALAND LIMITED	37618	37625	37632	14M0D7WWX	24.4	38G41A	Vertical	VNUE 85 FANSHAWE STREET
81580	177012	Current	WOOSH WIRELESS (NZ) LIMITED	38430	38444	38458	28M0G1DET	33.5	38G5#	Vertical	VIADUCT BASIN (AIVDB)
102278	201413	Current	VODAFONE NEW ZEALAND LIMITED	38948	38955	38962	7M00D7WWX	24.4	38G46A#	Vertical	TANK FARM
144203	226191	Current	TWO DEGREES MOBILE LIMITED	39382	39396	39410	28M0D7WWX	19.7	38G39#	Vertical	7 FANSHAWE STREET (AKL-007-024-D)

Appendix B – WiFi Access Points in the vicinity of 132 Halsey Street

MAC	SSID	Channel	RSSI	CurrentLatitude	CurrentLongitude	AltitudeMeters	AccuracyMeters	Type	
53001_1901_63689354	Vodafone NZ	0	-113	-36.84246446	174.7575819	46.69996838	10	GSM	
9a:1f:a1:3f:e6:ae	Mili's Guest Network	1	-100	-36.84254354	174.757137	43.599965	15	WIFI	
20:08:ed:02:0a:90	vodafone0A89	3	-100	-36.84264427	174.7571551	45.40006986	15	WIFI	
c0:c1:c0:58:f6:da	KX-2.4G	6	-100	-36.84258112	174.7574139	45.20001574	15	WIFI	
92:fe:ce:10:40:70	Mili's Guest Network	1	-98	-36.84248708	174.7571516	43.19998494	15	WIFI	
2c:b0:5d:4b:2d:ff	Skynet1	1	-98	-36.84267098	174.7572232	45.90007415	15	WIFI	
00:0e:8f:bd:96:da	vodafoneRSG2	11	-98	-36.84269531	174.7572879	46.0000308	15	WIFI	
00:27:22:84:79:d5	FreedomInternet@Wiltshire-Lv19	9	-98	-36.84269531	174.7572879	46.0000308	15	WIFI	
88:1f:a1:3f:e6:ae	Mili's Network	1	-97	-36.84264427	174.7571551	45.40006986	15	WIFI	
00:0e:8f:c1:65:1c	vodafone42MA	1	-97	-36.84267098	174.7572232	45.90007415	15	WIFI	
44:94:fc:29:bd:4e	NETGEAR98	11	-97	-36.84269531	174.7572879	46.0000308	15	WIFI	
e8:fc:af:f7:28:27		501	12	-97	-36.84252349	174.7574761	45.40000065	15	WIFI
00:14:f1:62:bd:f0	yachtlifeline	5	-97	-36.84247381	174.7576559	46.89999926	10	WIFI	
90:72:40:10:ce:fe	Mili's Network	1	-96	-36.84248708	174.7571516	43.19998494	15	WIFI	
84:18:3a:10:d5:98	Arbitrage	6	-96	-36.84264427	174.7571551	45.40006986	15	WIFI	
00:1d:aa:c5:60:78	IMG2	6	-95	-36.84237047	174.7571886	44.99998645	15	WIFI	
c0:4a:00:43:12:70	Unit 3	1	-95	-36.84237047	174.7571886	44.99998645	15	WIFI	
06:27:22:cf:63:c4	HarleyD	10	-95	-36.84264427	174.7571551	45.40006986	15	WIFI	
c6:9f:db:1c:e7:96	IPFX	8	-95	-36.84255877	174.7575447	46.99996073	15	WIFI	
3e:19:be:00:18:00	Skype WiFi by Tomizone	6	-94	-36.84269531	174.7572879	46.0000308	15	WIFI	
0e:19:be:30:49:ca	eduroam	1	-93	-36.84230558	174.757193	46.59999636	15	WIFI	
0a:19:be:30:49:ca	UoA-WiFi	1	-93	-36.84230558	174.757193	46.59999636	15	WIFI	
00:15:6d:5e:a5:db	myfi.co.nz - VA ROOF Hotspot	2	-93	-36.84267098	174.7572232	45.90007415	15	WIFI	
fc:75:16:7f:0d:6e	5B North	1	-93	-36.84269531	174.7572879	46.0000308	15	WIFI	
d4:ca:6d:2f:27:53	Courtyard	11	-92	-36.84259616	174.7571259	44.79998012	15	WIFI	
0a:19:be:30:4a:d7	UoA-WiFi	11	-92	-36.84246156	174.757556	46.79993015	10	WIFI	
20:08:ed:02:0a:94	vodafone0A89	44	-91	-36.84269531	174.7572879	46.0000308	15	WIFI	
3c:df:bd:10:4c:f4	vodafone4CE9	100	-91	-36.8425964	174.7575763	47.09997453	15	WIFI	
06:19:be:30:49:ca	Auckland Wi-Fi @ Tomizone	1	-90	-36.84230558	174.757193	46.59999636	15	WIFI	
62:a8:e4:50:8f:d8	vodafone8FD8	10	-89	-36.8425964	174.7575763	47.09997453	15	WIFI	
0e:19:be:30:4a:d7	Skype WiFi by Tomizone	11	-89	-36.8425964	174.7575763	47.09997453	15	WIFI	
e8:94:f6:5c:9e:11	access1	6	-76	-36.84237047	174.7571886	44.99998645	15	WIFI	

Appendix C - WiFi Channel Numbering

CHANNEL NUMBER	LOWER FREQUENCY MHZ	CENTER FREQUENCY MHZ	UPPER FREQUENCY MHZ
1	2401	2412	2423
2	2404	2417	2428
3	2411	2422	2433
4	2416	2427	2438
5	2421	2432	2443
6	2426	2437	2448
7	2431	2442	2453
8	2436	2447	2458
9	2441	2452	2463
10	2451	2457	2468
11	2451	2462	2473
12	2456	2467	2478
13	2461	2472	2483
14	2473	2484	2495

CHANNEL NUMBER	FREQUENCY MHZ	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
36	5180	Indoors	✓	✓
40	5200	Indoors	✓	✓
44	5220	Indoors	✓	✓
48	5240	Indoors	✓	✓
52	5260	Indoors / DFS / TPC	DFS	DFS / TPC
56	5280	Indoors / DFS / TPC	DFS	DFS / TPC
60	5300	Indoors / DFS / TPC	DFS	DFS / TPC
64	5320	Indoors / DFS / TPC	DFS	DFS / TPC
100	5500	DFS / TPC	DFS	DFS / TPC
104	5520	DFS / TPC	DFS	DFS / TPC
108	5540	DFS / TPC	DFS	DFS / TPC
112	5560	DFS / TPC	DFS	DFS / TPC
116	5580	DFS / TPC	DFS	DFS / TPC
120	5600	DFS / TPC	No Access	DFS / TPC
124	5620	DFS / TPC	No Access	DFS / TPC
128	5640	DFS / TPC	No Access	DFS / TPC
132	5660	DFS / TPC	DFS	DFS / TPC
136	5680	DFS / TPC	DFS	DFS / TPC
140	5700	DFS / TPC	DFS	DFS / TPC
149	5745	SRD	✓	No Access
153	5765	SRD	✓	No Access
157	5785	SRD	✓	No Access
161	5805	SRD	✓	No Access
165	5825	SRD	✓	No Access

Note 1: there are additional regional variations for countries including Australia, Brazil, China, Israel, Korea, Singapore, South Africa, Turkey, etc. Additionally Japan has access to some channels below 5180 MHz.

Note 2: DFS = Dynamic Frequency Selection; TPC = Transmit Power Control; SRD = Short Range Devices 25 mW max power.