

Desktop Assessment of Electromagnetic Interference

Collgar Wind Farm

Prepared for: Investec Bank (Australia) Ltd

July 2008

1 EXECUTIVE SUMMARY

This report details the findings of a desktop assessment of licensed telecommunications services and television reception that may be at risk from the proposed Collgar wind farm development near Merredin, Western Australia. This report has been commissioned by Investec Bank (Australia) Ltd (“Investec”).

One radio communications tower was identified within the boundary of the proposed wind farm according to the Australian Communications and Media Authority (ACMA) RADCOM database at the time of this report. Only one radio frequency license associated with this tower was identified in the RADCOM database, that being a Telstra microwave link between Burracoppin South and Dulebanyundy Hill. Another licence is associated with the same tower that being a Telstra microwave link to the Telstra exchange at Merredin. This link was not identified in the RADCOM database.

Wind turbines can degrade the performance of fixed radio links through three principle mechanisms for introducing electromagnetic interference (EMI) – near field effects, diffraction and reflection/scattering. An analysis of the wind turbine layout of the proposed farm was undertaken to determine whether the wind turbine locations would cause unacceptable EMI to the fixed radio links.

The analysis determined that no turbines within the proposed wind turbine layout (Rev H) are likely to cause unacceptable interference to fixed radio links operating in the vicinity of the proposed wind farm. Television reception at some residences may be affected.

The analysis also determined that the proposed wind farm would not have any detrimental impact on aviation communications or navigation aids.

2 INTRODUCTION

Obstruction or reflection of radio waves by a wind turbine can degrade the performance of fixed radio links due to the effect of the rotating blades. The three principal mechanisms for introducing electromagnetic interference are near field effects, diffraction and reflection/scattering. The level of interference caused by a wind turbine depends on:

- The location of the wind turbine relative to the transmitter and receiver;
- Frequency of the radio transmission;
- Characteristics of the wind turbine blades;
- Antenna characteristics; and
- Radio propagation characteristics.

2.1 Assumptions

The boundary of the proposed wind farm development site and the location of the wind turbines used in this report were assumed to be as shown at Appendix 1 (revision H).

All coordinates are referenced to Australian Map Grid zone 50 unless otherwise stated.

3 LICENSED RADIOCOMMUNICATIONS SERVICES

The Australian Communications and Media Authority (ACMA) issues radio communications licences under the Commonwealth *Radiocommunications Act 1992*. The ACMA issues licences to use specific segments of the radio frequency spectrum for different purposes and maintains a register of all the licenses issued (RADCOM).

The ACMA classifies geographic regions of Australia according to the demand for spectrum. The Collgar wind farm area is classified as a “Low Density Area”.

Radiocommunications licences may be apparatus licences or spectrum licences. Apparatus licences are issued on a “per site or system” basis for a defined purpose. Spectrum licences are a tradeable, technology neutral spectrum access right for a fixed non-renewable term. This means that the licence is not limited to any particular technology, system or service. Instead of authorising the use of a specific radiocommunications device at a fixed site, spectrum licences give licensees the freedom to deploy devices anywhere within their licence area, provided that the devices are compatible with the core conditions of the licence and the technical framework for the bands.

Spectrum licences have been issued by the ACMA for spectrum in the 500 MHz, 800MHz, 1800 MHz, 2000 MHz, 2300 MHz, 3400 MHz, 27 GHz, 28 GHz and 31 GHz bands. The spectrum at 500 MHz, 800 Mhz, 1800 MHz and 2000 MHz are in general used for trunked mobile radio and mobile telephone services. The spectrum at 2300 MHz and 3400 MHz are generally used for point-to-multipoint services such as

broadband wireless internet and pay TV services. The 27 GHz, 28 GHz and 31 GHz spectrum is used for Local Multipoint Distribution Services (LMDS).

Telecommunications services most likely to be affected by wind turbines are of the FIXED license type and include microwave links, UHF telemetry links and point-to-multipoint fixed wireless access. The proposed wind farm falls within the spectrum licence areas owned by AKAL Pty Ltd (3400 MHz), AAPT (28 GHz,31 GHz), XY ZED-LMDS Pty Ltd (27 GHz) and Shin Satellite Public Co Ltd (27 GHz).

A check of the ACMA website for device registrations by the licensees of the 2300 MHz, 3400 Mhz, 27 GHz, 28 GHz and 31 GHz showed that no device registrations exist within the vicinity of the proposed wind farm.

Spectrum licence services in the 500 MHz, 800 MHz, 1800 MHz and 2000 MHz services are not considered to be affected by the proposed wind farm as they are used primarily for mobile communications.

According to the ACMA RADCOM database, at the date of this report, 40 radio communications sites were within a 25km radius of the proposed wind farm. No fixed links were identified as crossing the proposed wind farm. An image showing the location of fixed radio links surrounding the proposed wind farm is shown at Appendix 2.

One radio communications tower is located within the boundary of the proposed wind farm (Telstra).

The following table provide details of the telecommunications services at the site as recorded in the RADCOM database. The term 'Azimuth' refers to the direction of the antenna/link relative to North.

Telstra Site Telstra Site Dulebanyundy Hill MERREDIN				
50 639730 6508150 AGD66				
Licensee	Frequency Band	Azimuth (°)	Endpoint	Link Length
Telstra Corporation	1.8 GHz	90	Telstra Site Burracoppin South MERREDIN	13.85 km

In addition to the above microwave link, an inspection of the tower revealed that a second dish is installed. Following an enquiry to Telstra, Telstra confirmed that two microwave links are associated with this site; with the other link being to the Telstra exchange in Merredin. Furthermore, the coordinates of the site recorded in the RADCOM database are incorrect. Telstra advised that the AMG94 coordinates of the tower was 639871E and 6508287N (same as RADCOM when converted to AGD66). The Telstra correspondence is attached at Appendix 3.

Staff from Investec Bank recorded the GPS position of the Telstra tower on site. The recorded position was 639986E and 6508051N. This position has subsequently been verified by aerial photography and has been used for the purposes of this report.

The criteria for the wind turbine blades to be outside of the 2nd Fresnel Zone of the fixed link path is consistent with the approach stated by D.F. Bacon in a paper titled “A proposed method for establishing an exclusion zone around a terrestrial fixed radio link outside of which a wind turbine will cause negligible degradation of the radio link performance” (available via the UK Office of Communications website)

Near field effects refers to the potential of a wind turbine to cause interference to radio signals due to electromagnetic fields emitted by the generator and switching components in the turbine nacelle. The magnitude of an exclusion zone to minimise near field effects increases with increasing antenna diameter and also increases with link operating frequency. The near field exclusion zone refers to the radius of an area surrounding the tower where a wind turbine should not be located.

The Fresnel zone defines an area around a radio link within which a structure, such as a wind turbine, could cause interference through diffraction of the radio waves. The magnitude of an exclusion zone to minimise diffraction increases with decreasing link operating frequency. The Fresnel Exclusion Zone refers to a distance either side of the radio link path that should be free of obstructions, including wind turbines.

According to Bacon, the Near Field exclusion zone is calculated using the following formula:

$$D_{nf} = 0.1 * 10^{0.1 * G} / f$$

G = maximum (boresight) antenna gain (dBi)

f = frequency (GHz)

Using frequency data from the ACMA website for the fixed link at the Telstra site, the following near field exclusion zone has been calculated using the above formula:

Frequency (GHz)	Max Gain (dBi)	D_{nf} (m)	Exclusion Zone
1.8395	33	110.37	160.37

The coordinates of the turbines listed in Appendix 1 are for the centre of the turbine. Based on a 50m blade length, the centre of the turbine must be located a further 50m outside the near field. The exclusion zone distance shown above includes the blade length and therefore is the distance between the turbine position and the radiocommunications tower position.

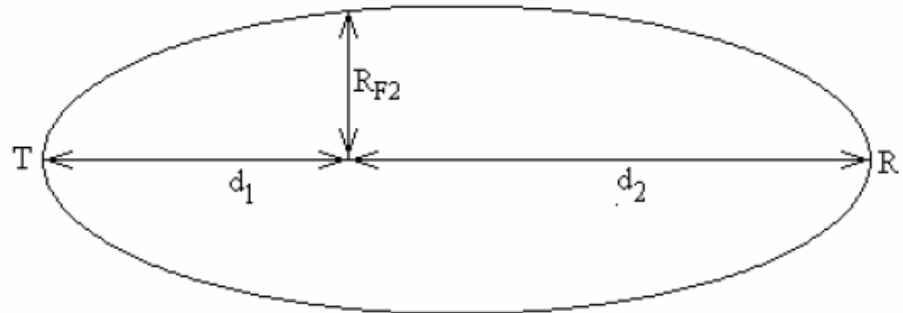
The nearest wind turbines are WTG 46 and WTG 47 which are approximately 276 and 165 metres from the Telstra site respectively. These turbines are located outside of the near field exclusion zone.

The 2nd Fresnel Zone is determined using the following formula:

$$R_{F2} = \sqrt{\frac{2 \lambda d_1 d_2}{d_1 + d_2}}$$

where:

d_1, d_2 = distances from each end of the radio path.



R_{F2} is at a maximum when $d_1 = d_2$.

Endpoint	Bearing	Lowest Frequency	Link Length (km)	2 nd Fresnel Zone (m)	Exclusion Zone (m)
Telstra Site Burracoppin South MERREDIN	93	1.7205000 GHz	13.85	34.5	84.5
Telstra Exchange MERREDIN	294	1.7205000 GHz	20.15	42	92

The coordinates of the turbines listed in Appendix 1 are for the centre of the turbine. Based on a 50m blade length, the centre of the turbine must be located a further 50m outside the 2nd Fresnel zone. The exclusion zone distance shown above includes the blade length and therefore is the distance between the turbine position and the radiocommunications tower position. No turbines are required to be relocated to avoid the 2nd Fresnel Zone exclusion zone.

The third mechanism for EMI is scattering/reflection which is primarily influenced by the directivity of the transmitting and receiving antennas of the fixed links and the turbine Radar Cross Section (RCS). The RCS of the wind turbines will vary in time due to the varying geometry, but for the purposes of the assessment, the maximum RCS of the wind turbines is assumed to be 150 m².

No turbines fail this criterion.

4 TELEVISION RECEPTION

The form of interference if experienced will depend on the relative positions of the wind farm, the transmitting station and the receiver.

In practice the tower or nacelle rarely has any effect on TV reception; the impact on TV reception is solely on account of the rotating turbine blades. As the blades are moving objects, in terms of their rotation speed and orientation, their effect is variable and hard to predict. The result is more difficult to predict when considering the combined effect of all turbines in the proposed wind farm.

The two mechanisms responsible for interference are shadowing effects and reflection effects. The size of the shadow zone is dependent on the orientation of the blades and is at a maximum when the axis of the rotor is in line with the direction of the transmitted signal. The received signal strength varies in a cyclic manner, in time with the blade rotation. Reflection effects vary with the rotation of the blades, the orientation of the nacelle and the area of the metallic components inside the blades.

The affected area around the turbine is a combination of the shadow zone and the reflection zone and is roughly shaped like a keyhole. The actual shape and size is dependent on the type of turbine and the topography. For the purposes of assessing the likelihood of interference, the shadow zone is considered to be a sector with a radius up to 5km and the reflection zone a circle of radius of 500m.

Interference to television caused by the operation of wind turbines is characterised by degradation to the video signal, whilst the audio component of the signal is not affected. Television signals can be affected by reflection and forward scattering.

Reflection or backward scatter of the signal results in the receiver picking up an interference signal as well as the direct signal from the transmitter. This type of interference is usually manifested by a fluctuating “ghost” image in analogue TV systems. Reflection of signals in digital TV systems does not result in ghosting but may still cause errors in the digital signal.

Forward scatter occurs when one or more wind turbines physically obstructs the path of the signal to the TV receiver. This can result in a degradation of the signal and consequently fluctuations in the intensity of the picture. In severe cases there will be insufficient signal strength to provide a picture.

4.1 Existing Environment

According to the ACMA, the television broadcast transmitter site that serves the area around the proposed wind farm is located at the Telstra Exchange at 106 Barrack Street, Merredin. The ACMA details for the Merredin broadcast site are shown on the next page.

Site ID	Site Name	Easting	Northing
29232	Telstra Exchange 106 Barrack Street Merredin WA	621609	6516297

Details of Television Channels – Mt Mowbullan

Broadcaster	Channel	Analog/Digital
Kalgoorlie TV1	6	Analog
ABC	32	Analog

Thirty eight residences have been identified by Investec within the vicinity of the proposed wind farm. The location of each residence is provided at Appendix 4.

The International telecommunications Union Recommendation ITU-R BT.805 states that impacts beyond 5 kilometres are unlikely. However, it also indicates that interference may extend beyond 5km where the receiver location is shielded from the direct signal, but in direct line-of-sight to the turbine. In such cases the reception even without any wind farm interference is likely to be poor.

A review of the above residences surrounding the proposed wind farm indicates that a number of them are at a location with some potential for interference.

Most residences have no wind turbines within 500m of the residence and have no turbines between the TV transmitter at Mt Mowbullan and the residence. These residences are therefore a low probability of interference to TV signals.

Residence #11 will potentially be impacted, as the residence is located less than 500m from WTG57. However the house is derelict, as confirmed by the owner, and as such is not an issue.

Residence #12 will potentially be impacted, as the residence is located less than 500m from WTG56. However the house is derelict, as confirmed by the owner, and as such is not an issue.

Residence #15 will potentially be impacted, as the residence is located less than 5km behind WTG121 and WTG121 is approximately 80m from the direct path between the transmitter site and the residence.

Residence #16 will potentially be impacted, as the residence is located less than 5km behind WTG48 and WTG48 is approximately 60m from the direct path between the transmitter site and the residence. WTG54 is also approximately 40m from the direct path between the transmitter site and the residence.

Residence #17 will potentially be impacted, as the residence is located less than 5km behind WTG59 and WTG59 is approximately 80m from the direct path between the

transmitter site and the residence. WTG66, WTG83 and WTG89 are also less than 200m from the direct path between the transmitter site and the residence.

Residence #18 will potentially be impacted, as the residence is located less than 5km behind WTG94 and WTG94 is approximately 170m from the direct path between the transmitter site and the residence. WTG91, WTG92 and WTG61 are also less than 200m from the direct path between the transmitter site and the residence.

Residence #19 will potentially be impacted, as the residence is located less than 5km behind WTG5 and WTG5 is approximately 130m from the direct path between the transmitter site and the residence. WTG6 is also less than 150m from the direct path between the transmitter site and the residence.

Residence #20 will potentially be impacted, as the residence is located less than 5km behind WTG80 and WTG80 is approximately 130m from the direct path between the transmitter site and the residence.

Residence #38 will potentially be impacted, as the residence is located approximately 500m from WTG4. WTG2 is also on the direct path between the transmitter site and the residence, and less than 2km from the residence.

Residence #41 will potentially be impacted, as the residence is located less than 500m from WTG38.

The actual impact on television reception will depend on the final location of the wind turbines.

Mitigation Measures

The following mitigation measures are proposed in respect of interference to television reception:

- Recommend that Investec investigate and rectify any interference to television reception caused by the development that occurs during construction or following commissioning of the wind farm.
- Rectification of television reception could initially include modifications to or replacement of antennas being used or replacement with digital television (set top box or new television sets). Experience with existing wind farms demonstrates that significant improvements can be achieved by providing a more directional antenna and/or converting to digital TV reception (although no terrestrial digital channels are available within the area at this time).
- In the event that replacement of the receiving antenna or conversion to digital TV reception are ineffective, other measures can be implemented to restore reception to a standard no worse than that which existed prior to the development of the wind farm:
 - The installation of a TV antenna in an area of good television reception connected to the affected residence via coaxial cable, or

- The installation and maintenance of a satellite television system.

5 AVIATION COMMUNICATIONS AND NAVIGATION AIDS

5.1 Location of Airport

Merredin Airport is located approximately 9.5 km from the nearest wind turbine in the proposed wind farm.

5.2 Aviation Communications

According to the Airservices Australia AIP, the only ATS communications facility in use at Merredin Airport is FIA at Melbourne Centre on 123.4 MHz. This radio facility is located at Yerbillon, approximately 40km from the airport. Although the proposed windfarm is located between the airport and radio transmitter/receiver site, the wind turbines are unlikely to cause interference to the VHF signals.

5.3 Navigation Aids

The siting of wind turbines in close proximity aviation navigation aids may result in an effect on the coverage of the radiated signals.

Navigation aids that employ ground based components are:

- Non-Directional Beacons (NDB)
- Distance Measuring Equipment (DME)
- Instrument Landing System (ILS)
- Microwave Landing System (MLS)
- VHF Omni-directional Radio Range (VOR)
- satellite based navigation systems (GPS)

According to the ACMA RADCOM database, none of the above navigation aids are currently installed at or near Merredin Airport. Furthermore, neither Airservices Australia nor the Department of Defence have a radar located at or near this airport.

5.4 Navaid Siting Criteria

According to Airservices Australia navigation aid siting restrictions, large obstructions should not be located within 1.5 km of a DME installation. The wind farm is located well outside this distance.

Instrument Landing Systems have two protective zones for correct and safe operation. These are critical areas and sensitive areas surrounding the localiser and glide path antennas. These areas are located within the boundary of the airport and therefore the proposed wind farm will not interfere with the operation of an ILS. Furthermore, the

location of ILS markers can be accommodated within the 9.5km distance between the airport and the proposed wind farm for the approach to Runway 28.

No MLS operate in Australia today. The beam shape of an MLS can be made very narrow and avoid airport structures. The proposed windfarm is unlikely to effect an MLS installation.

The site of an NDB should keep towers, masts and high voltage transmission lines as distant as possible and no closer than 500m. The proposed windfarm is unlikely to effect an NDB installation at the airport.

The site of a VOR should ensure that VHF coverage from the site should be available down to 0.75° elevation angle on all bearings from the proposed location. The angle of elevation from the airport to the wind turbines is less than 0.75° . Installation of a Doppler VOR (DVOR) is less susceptible to scalloping effects caused by reflective objects in its vicinity.

GPS receivers require visibility to a minimum of four satellites to determine position. At least 8 GPS satellites are visible to any point on Earth at any point of time (subject to local obstruction). It is therefore highly unlikely that the wind turbines will obstruct the view of four satellites at any point in time from the ground. Use of GPS by aircraft whilst airborne is also unlikely to be effected, as the aircraft will quickly be above the height of the wind turbines.

Appendix 1 – Turbine Layout

ID	Easting	Northing	MGA Zone 50
1	639344	6517093	
2	639081	6516678	
3	639863	6516421	
5	639171	6516214	
7	638508	6515800	
6	639101	6515891	
13	639076	6515422	
12	641977	6515380	
14	639065	6515079	
4	640579	6516401	
11	641936	6514909	
9	640717	6514808	
10	641356	6514756	
15	639034	6514726	
16	639010	6514397	
17	638940	6514069	
18	638773	6513701	
19	638352	6513307	
25	639394	6513421	
20	637934	6512930	
26	639114	6513152	
22	637311	6512684	
27	638921	6512846	
23	636441	6512582	
28	638964	6512518	
24	636069	6512183	
30	639550	6511921	
31	639553	6511575	
41	644608	6511422	
40	644045	6511376	
39	643430	6511288	
32	639545	6511149	
38	643246	6510861	
33	639545	6510822	
35	640954	6510522	
36	641483	6510377	
37	642199	6510296	
42	640224	6509559	

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ID	Easting	Northing	MGA Zone 50
43	640210	6509195	
44	640045	6508877	
45	639898	6508572	
61	635804	6506107	
47	639973	6507887	
57	636592	6507601	
49	640162	6507267	
48	640117	6507587	
58	636382	6507247	
63	637079	6507192	
50	640231	6506939	
59	636031	6506850	
64	637363	6506791	
70	638763	6506796	
69	638066	6506705	
51	640368	6506603	
75	641511	6506420	
65	637363	6506430	
71	638534	6506287	
60	635995	6506450	
72	639257	6506186	
73	639699	6506414	
52	640613	6506252	
76	641649	6506094	
66	637061	6506050	
62	635590	6505789	
77	641707	6505768	
67	636939	6505686	
78	641745	6505402	
68	636717	6505243	
79	641663	6505056	
80	641577	6504745	
81	641205	6504501	
83	640106	6504135	
82	640778	6504221	
84	639321	6504179	
87	641572	6504140	
88	641216	6503845	
85	638855	6503829	
86	638415	6503606	

EMI Assessment – Collgar Wind Farm

ID	Easting	Northing	MGA Zone 50
89	641099	6503545	
90	641005	6503122	
91	641079	6502720	
92	641546	6502446	
93	642115	6502136	
94	641975	6501713	
95	642062	6501336	
99	644901	6501141	
115	641009	6501127	
96	642121	6500947	
116	641014	6500731	
100	644736	6500608	
97	642047	6500580	
117	640542	6500349	
101	644794	6500189	
98	643898	6500142	
118	640154	6499993	
102	644780	6499815	
119	640245	6499654	
120	639850	6499456	
128	638245	6499236	
121	639220	6499214	
108	644451	6497032	
103	644398	6499117	
109	645344	6499094	
129	637592	6499013	
127	638380	6498780	
110	645169	6498734	
122	639164	6498694	
104	644420	6498673	
123	639164	6498372	
111	645220	6498283	
105	644430	6498191	
124	639164	6497975	
112	645556	6497910	
106	644512	6497791	
125	639186	6497653	
107	644481	6497370	
113	645834	6497513	
126	639223	6497234	

EMI Assessment – Collgar Wind Farm

ID	Easting	Northing	MGA Zone 50
114	645852	6497042	
34	639012	6510550	
29	639162	6512175	
54	637346	6508995	
55	637334	6508654	
56	637310	6508314	
53	640519	6505876	
46	639796	6508251	
74	641230	6506730	

Appendix 2 – Location of Licensed Fixed Links



Appendix 3 – Telstra Email

Date: Fri, 11 Jul 2008 12:08:48 +1000

From: "Remigio, Bruno P" <Bruno.P.Remigio@team.telstra.com>  

[l](#)

To: "les.kelly@availservices.com.au" <les.kelly@availservices.com.au>

CC: "Priest, Barbara" <Barbara.Priest@team.telstra.com>

Subject: RE: Investec Wind Farm

Les,

Telstra operate an 1800MHz radio link from Merredin Exchange via an RF repeater at Dulebanyundy Hill to Burracoppin South Exchange.

Co-ords

Merredin exchange - Z50 621609mE, 6516315mN

Dulebanyundy Hill - Z50 639871mE, 6508287mN

Burracoppin South - Z50 653587mE, 6507325mN

Dulebanyundy Hill has two 1.8m dish antennas (293degT and 93degT) - both in use.

Regards,

Bruno

Bruno Remigio

Radio Systems Designer

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the sender of its incorrect delivery, and then delete both it and your reply. Thank you.

Appendix 4 – Location of Residences

House Number	X (l)	Y (l)	Participating	Name	Status
1	631855	650821 0	Yes	Crees	Occupied
3	631982	650427 3	No	Unknown	Unoccupied
4	632038	650046 9	No	Unknown	Unoccupied
5	632188	650050 7	No	Unknown	Unoccupied
6	632309	651362 7	No	Unknown	Unknown
7	632604	649929 8	No	Unknown	Occupied
8	633599	649574 3	No	Unknown	Unknown
9	635297	651232 9	Yes	Franklin	Occupied
10	635899	650145 3	No	Unknown	Unknown
11	636641	650793 8	Yes	Giles	Unoccupied (derelict)
12	636975	650811 3	Yes	Crees	Unoccupied(derelict)
13	638894	650203 0	Yes	Unknown	Unknown
15	641321	649703 5	No	Unknown	Unknown
16	642635	650647 8	Yes	Davies	Occupied
17	643156	650231 7	No	Unknown	Shed
18	643226	650102 8	Yes	Unknown	Unoccupied
19	643714	651600 9	Yes	Johnston	Occupied
20	644425	650326 1	Yes	Unknown	Occupied
22	646452	651732 6	Yes	Crees	Occupied
23	646753	650806 8	Yes	Edgecomb	Occupied
24	647310	650436 2	No	Unknown	Unknown
25	647765	651761 8	No	Unknown	Unknown
26	625209	651131 2	No	Unknown	Occupied
27	626232. 7	650982 8	No	Ferrier	Occupied

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28	626746. 1	650939 1	No	Fiegert	Occupied
29	627666. 9	650772 5	No	Unknown	Occupied
30	627749. 4	650587 3	No	Hillview Pk	Occupied
33	629791. 2	649935 3	No	Hooper	Occupied
32	629259	650841 2	No	Unknown	Occupied
31	628530. 2	650820 8	No	for sale	Occupied
38	641033	651671 0	Yes	Johnston	Unoccupied
34	631576	651183 8	No	Unknown	Unknown
39	642020. 5	649273 1	No	Unknown	Unknown
41	642909	651089 2	Yes		Shed
35	633499. 2	652036 7	No	Unknown	Occupied
36	634401. 9	652129 5	No	Unknown	Unknown
37	634584. 2	652095 6	No	Unknown	Unknown
40	642800. 1	651985 3	Yes		