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Television Post-Construction Survey

Crown Street Developments 1

Crown Street Phase 01

October, 2020



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EXECUTIVE SUMMARY

Overview

Pager Power has been engaged to undertake a post-construction terrestrial television reception survey for the Crown Street Phase 01 development located in Manchester City Centre, UK. The building comprises 21 storeys and measures 99.5m above mean sea level (amsl). The Crown Street Phase 01 (known as 'C1') building development has introduced an additional new tall structure into the urban environment which consequently interacts with wireless terrestrial television signals and could cause interference in the surrounding area.

Report Purpose

This report presents the results of the original Television Baseline Reception Survey (completed in November 2017) and the Post-Construction Reception Survey completed in October 2020. The post-construction survey was completed so that comparisons between the old and new baseline could be made to determine whether there has been a significant impact upon terrestrial television signals in the surrounding area. Survey measurements were taken in the development's shadow zone and the original locations were revisited as best as possible. This assessment has been undertaken based on guidance produced by Ofcom.

Survey Results

Signal strength appears to have decreased in the immediate shadow of the development (within 400m) however there are no dwellings within this distance and all main multiplexes remain available. It is possible that this decrease is due to C1 or the adjacent Crown Street tower under construction. Beyond this distance no significant variation to the terrestrial television signal was observed.

Other new tall buildings in the vicinity of the Crown Street development are unlikely to have any affect within the shadow zone of C1[1] where effects are most likely to occur (400m of C1).

[1] Excluding the adjacent Crown Street tower under construction where cumulative effects are possible.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 48 countries within Europe, Africa, America, Asia and Australia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 BACKGROUND

1.1 Introduction

Pager Power has been engaged to undertake a post-construction terrestrial television reception survey for the Crown Street Phase 01 development located in Manchester City Centre, UK. The building comprises 21 storeys and measures 99.5m above mean sea level (amsl). The Crown Street Phase 01 (known as 'C1') building development has introduced an additional new tall structure into the urban environment which consequently interacts with wireless terrestrial television signals and could cause interference in the surrounding area. The Crown Street Phase 01 building development is referred to as 'the development' or 'C1' throughout this report.

This report presents the results of the original Television Baseline Reception Survey (completed in November 2017) and the Post-Construction Reception Survey completed in October 2020. The post-construction survey was completed so that comparisons between the old and new baseline could be made to determine whether there has been a significant impact upon terrestrial television signals in the surrounding area. Survey measurements were taken in the development's shadow zone consisting of the wider development within Phase 1 of Crown Street. The original locations have been revisited as best as possible however adjustments have been made where required to account for the shadow zone of C1 specifically. This assessment has been undertaken based on guidance produced by Ofcom.

1.2 Coordinate System

Unless otherwise stated all coordinates used within this report are in British National Grid (OSGB36 datum).

2 DEVELOPMENT DETAILS

2.1 Development Boundary

The development boundary is shown in Figure 1[2] below (red line). C1 is shown on the right-hand side and is illustrated by the blue square.

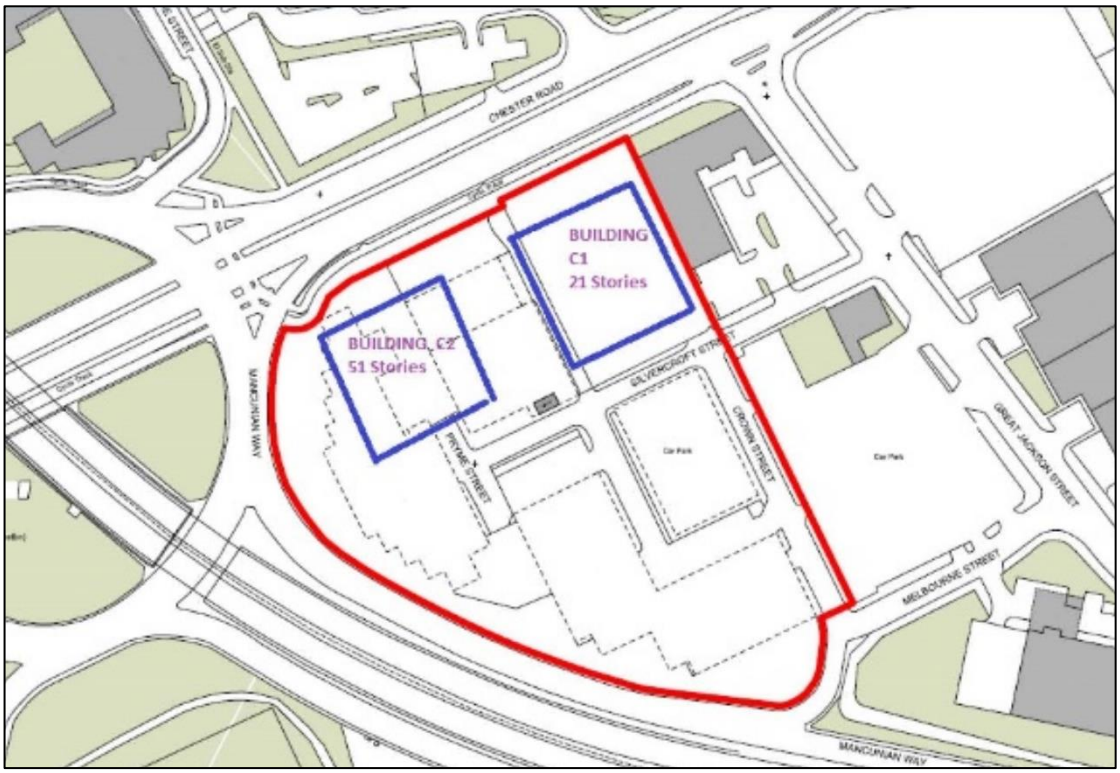

Figure 1 *Development boundary*

[2] Source: Renaker (edited).

2.2 Development Elevations and CGIs

Figure 2[3] below shows the south elevation (left image) and a CGI of C1.



Figure 2 *Southern elevation and CGI*

[3] Source: Renaker (edited).

Figure 3[4] below is a CGI of the development as a whole with C1 highlighted.

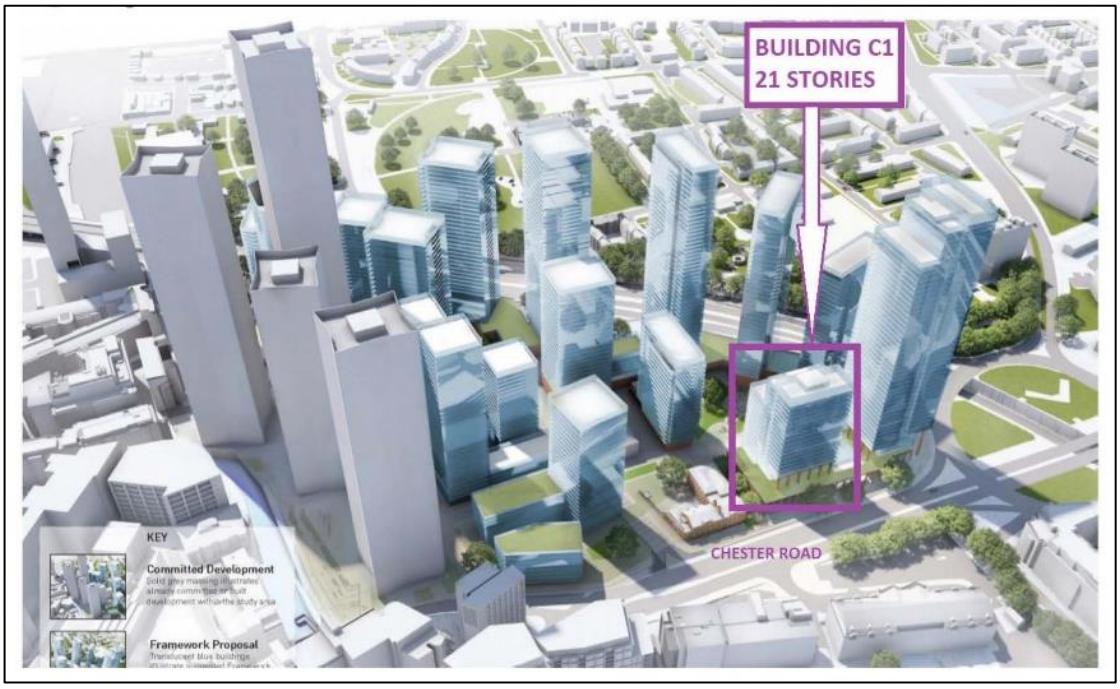

Figure 3 *CGI of whole Crown Street development with C1*

[4] Source: Simpsonhaugh (edited).

3 TELEVISION TRANSMITTER DETAILS

3.1 Relevant Transmitter

A comprehensive search of transmitter and coverage maps as well as the baseline survey, confirmed that the Winter Hill transmitter serves the area around the development.

Digital television services are broadcast via Ultra High Frequency (UHF) signals; no analogue television signals are broadcast. The transmitter information is presented below[5].

3.2 Winter Hill Main Transmitter

Winter Hill is one of the UK's main television transmitters located approximately 24.3km northwest of the development (published coordinates SD66051446). The main digital services provided are shown in the sub-sections below. Note that the channels broadcast by Winter Hill changed between the two surveys.

3.2.1 Baseline Survey Channels

The channels broadcast by Winter Hill during the baseline survey are presented in the tables below.

	Public (PSB)			Commercial (COM)		
Service	BBC A	Digital 3&4	BBC B	SDN	Arqiva A	Arqiva B
Channel	50	59	54-	58	49	55
Power	100 kilo-Watts (kW)					

Table 1 *Winter Hill main transmissions*

Additional Winter Hill transmissions are shown in Table 2 below.

	Local Multiplexes			
Service	COM 7	COM8	LM/LL/LPR	GIM
Channel	31	37	56	57
Power	25.7 kW	22.6kW	2 kW	1 kW

Table 2 *Winter Hill additional transmissions*

[5] Source: Ofcom

3.2.1 Post-Construction Survey Channels

The channels broadcast by Winter Hill during the post-construction survey are presented in the tables below.

	Public (PSB)			Commercial (COM)		
Service	BBC A	Digital 3&4	BBC B	SDN	Arqiva A	Arqiva B
Channel	32	34	35	29	31	37
Power	100 kilo-Watts (kW)					

Table 3 *Winter Hill main transmissions*

Additional Winter Hill transmissions are shown in Table 3 below.

	Local Multiplexes/Other				
Service	COM 7	LM/LL/LPR	GIM	-	-
Channel	55	56	57	24	27
Power	25.7 kW	1kW	1 kW	-	-

Table 4 *Winter Hill additional transmissions*

3.3 Television Transmitter Location

The location of the transmitter relative to the development is shown in Figure 4[6] below.

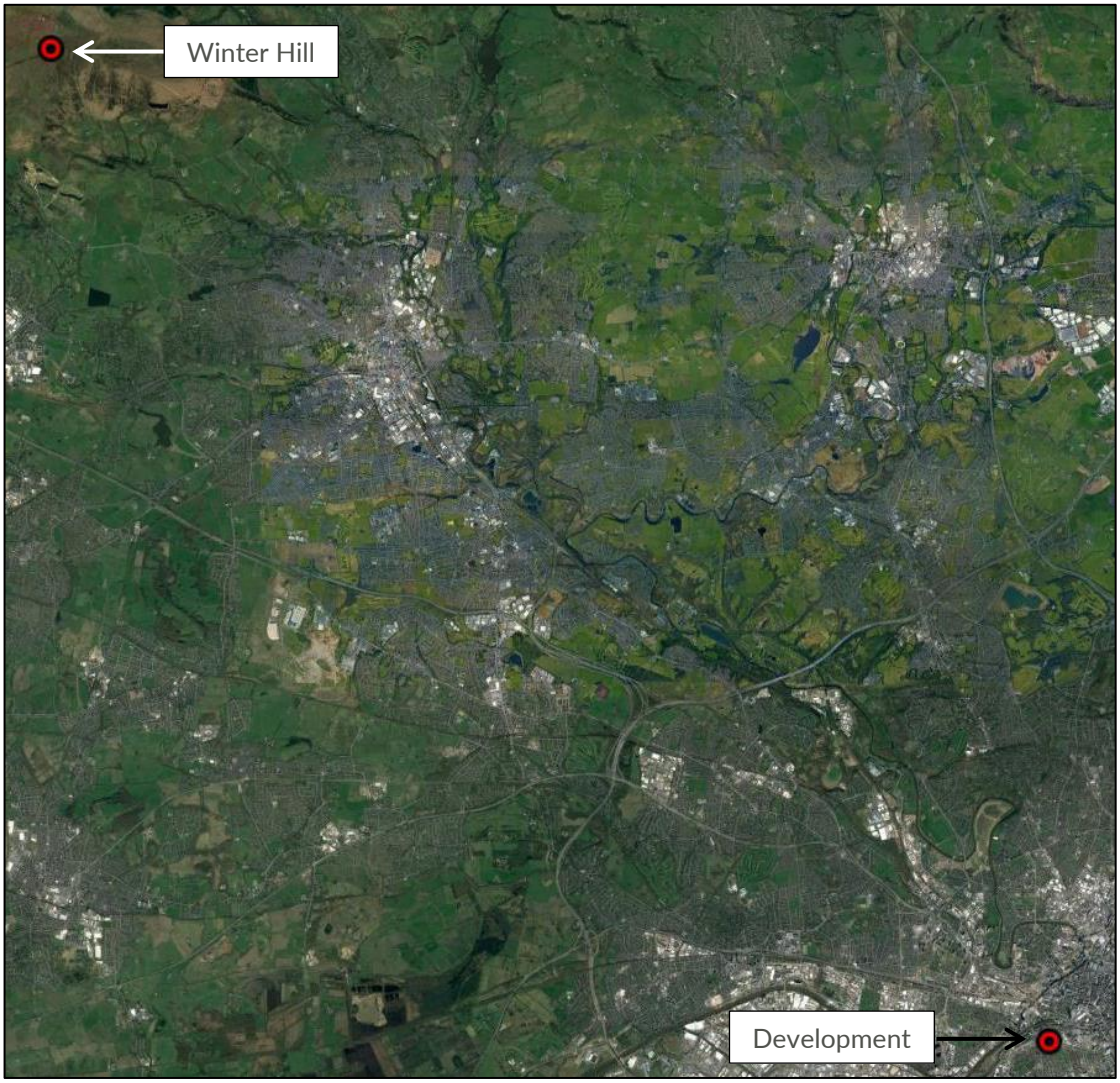

Figure 4 *Television transmitter and development relative location*

[6] Source: © 2017 Google.

4 BUILDINGS AND INTERFERENCE MECHANISMS

4.1 Technical Overview

Terrestrial television services are provided by means of electromagnetic waves in the Ultra High Frequency (UHF) range which propagate from land-based transmitters to receiving aerials.

The quality of the image and sound on a television set is dependent on both the strength of the signal received directly from the transmitter (carrier signal) and the strength of any interference signals from other sources.

To achieve good quality reception an aerial must receive a strong carrier signal but weak interference signals.

There are two ways that buildings can cause interference to television reception, these are described below.

4.2 Obstruction of the Signal

This is caused by the building physically blocking the transmitted signal, reducing the strength of the carrier signal in the shadow of the building. In the case of Winter Hill transmissions, this would affect residences to the south-southwest of the development. The following is true for television signals:

- The highest losses (greatest interference) will be located immediately behind the building relative to the transmitter i.e. in the shadow zone;
- Losses near the edge of the shadow zone will be less significant due to diffraction effects (bending of the signal).

Ofcom has produced a document[7] offering guidance on this issue. Relevant extracts from the documents are presented below.

"In general, there will be three 'zones' behind the structure:

Zone A - close behind the structure (typically a few tens of metres) there may be a large reduction in signal level with a possible complete loss of reception

Zone B - further away (typically a few hundred metres) the signal reduction is less severe and the shadow will be smaller as diffraction effects partially fill in the shadow. Depending on the size of the structure, some locations could still lose reception completely

Zone C - some distance away (1-5km) the shadow will effectively have disappeared."

[7] Ofcom (2009): Tall Structures and their impact on broadcast and other wireless services

The zones mentioned are illustrated in Figure 5[8] below, taken from Section 3.2 of the Ofcom guidance regarding the impact of buildings on broadcast signals.

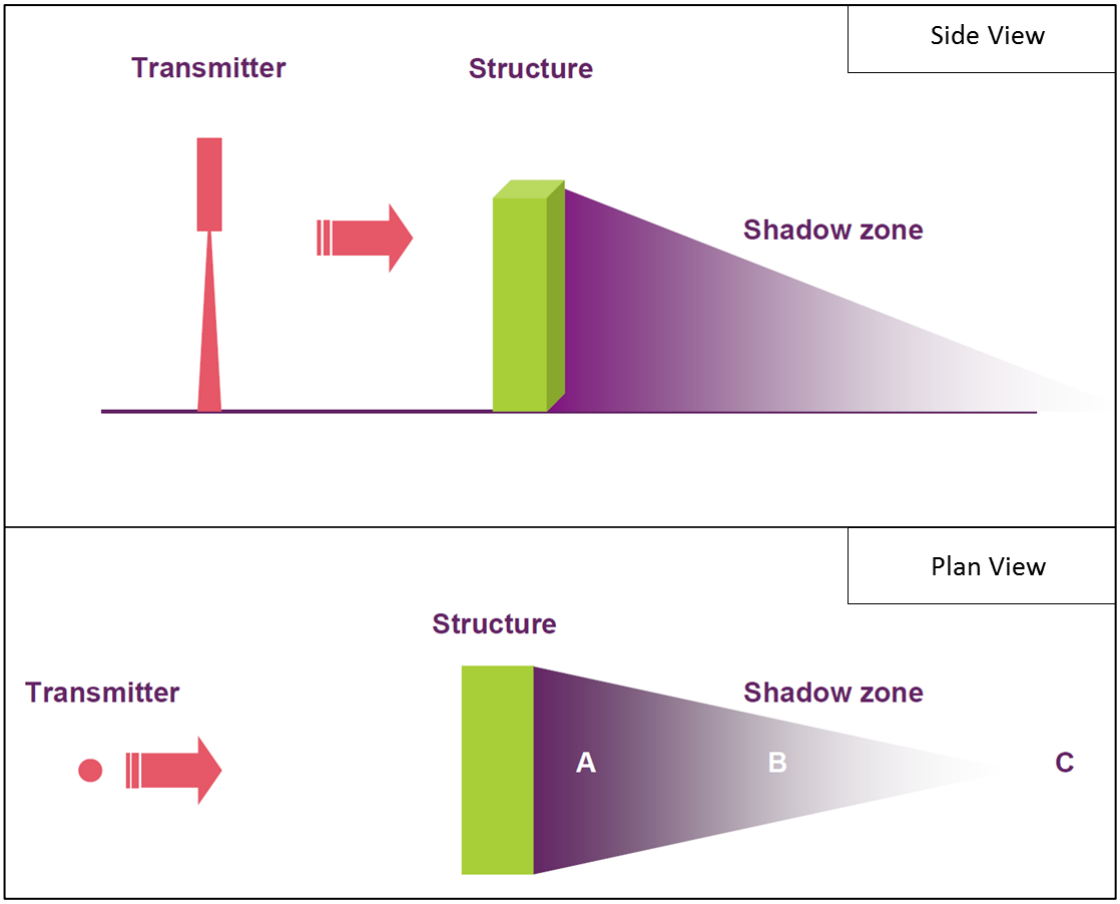

Figure 5 *Diffraction loss zones*

[8] Source: Ofcom publication

4.3 Reflection of the Signal

For large developments with straight edges, the transmitted signal can be reflected by the building itself. This causes an effect known as 'multipath interference' whereby the signal is received twice by an aerial at different times. The direct signal arrives first because it has a shorter distance to travel.

Figure 6[9] below (taken from Section 3.3 of the Ofcom guidance referenced above) illustrates this effect.

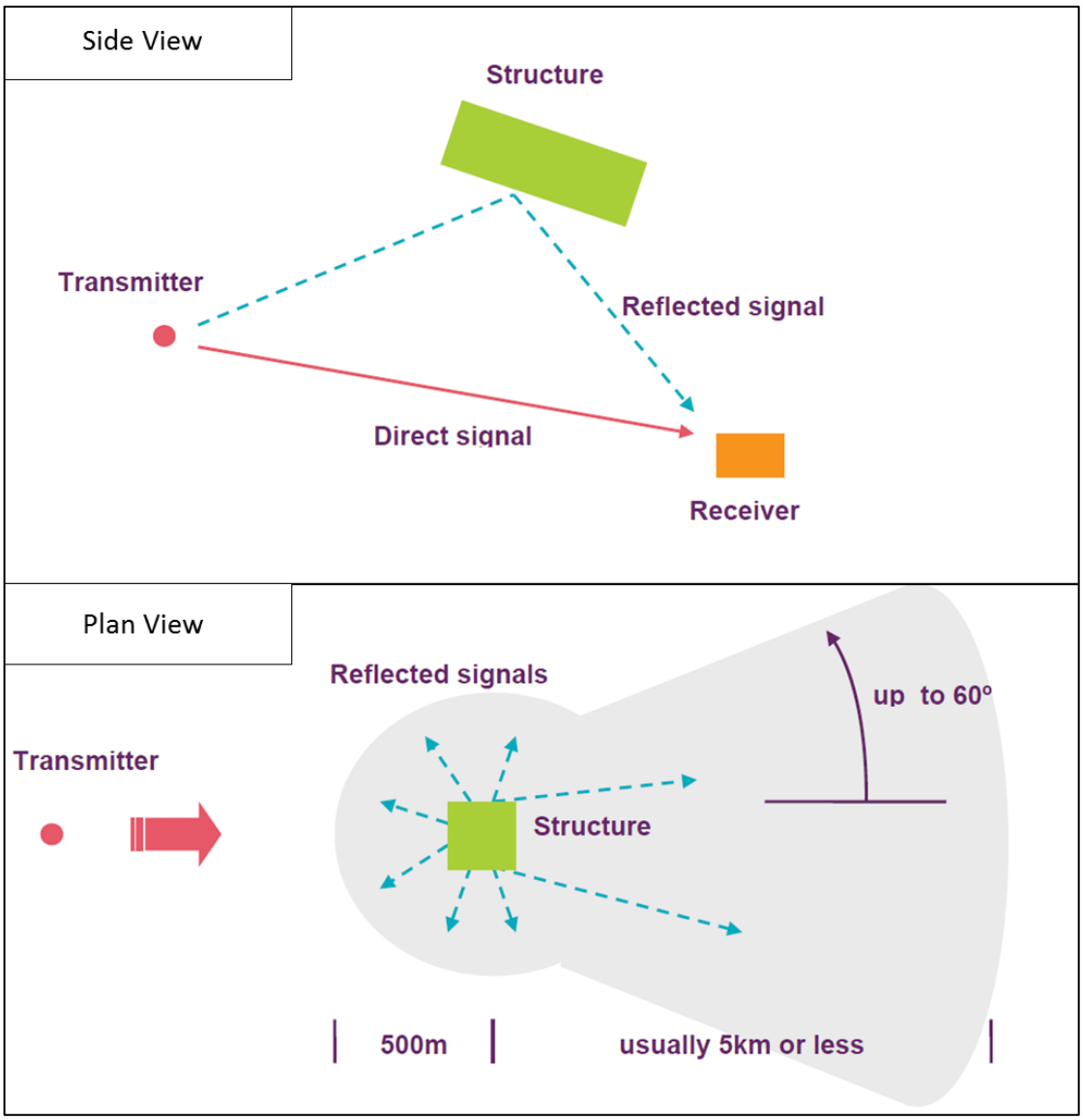

Figure 6 *Reflection* zones

[9] Source: Ofcom publication

In practice, it is considered highly unlikely that reflections will have an effect for receivers in front of the building or on either side when viewed from the location of the transmitter. For digital transmissions in particular, it is unlikely that issues will occur if the angle between the direct signal and the reflected signal is more than 30 degrees[10] .

The reflection zone has been constructed in accordance with the Ofcom approach, however the angle considered is 30 degrees rather than 60 degrees. This is in order to represent a more realistic scenario for digital transmissions.

Reflection issues are most likely to cause a noticeable impact if:

- The direct signal from transmitter to receiver is weak (e.g. obstructed by terrain or buildings);
- The reflected signal from the building is strong (e.g. clear radio line of sight from the transmitter to the building and the building to the receiver).

The worst-case scenario is for both of the above conditions to be satisfied. The best-case scenario is for neither of the above conditions to be satisfied.

[10] This is known to be the angle that Arqiva considers when safeguarding its Television Re-Broadcast Links with regard to reflections from wind turbines – whilst wind turbines cause issues that are different to buildings this particular issue is similar for the two.

5 TECHNICAL ASSESSMENT

5.1 Potential Interference Areas

Figure 7 below shows the potential interference areas associated with the development. The shadow associated with C1 is the top half of the red shadow zone i.e. the north eastern side.

The shadow and reflection zone have been defined based on the geometry of the potential interference zones as set out in the previous section. Both zones extend to a distance of 5km beyond the building in accordance with the Ofcom guidance.

In the case of the shadow zone, this has been modelled as having straight sides in order to be conservative. In actuality due to diffraction effects the zone would have a more triangular shape as shown in Figure 5 in the previous section.

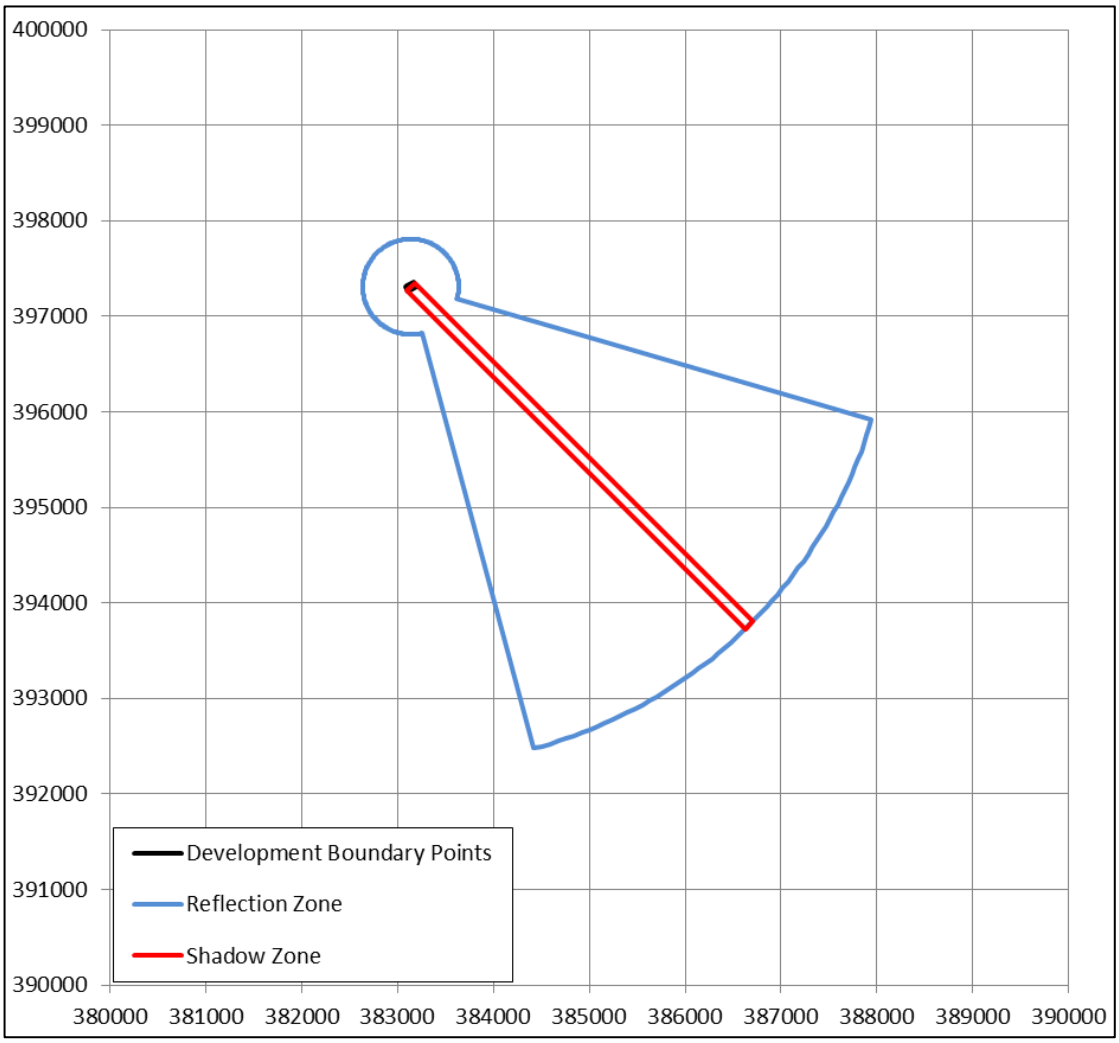

Figure 7 *Interference areas*

Figure 8[11] below shows the interference zones overlaid onto mapping of the area.

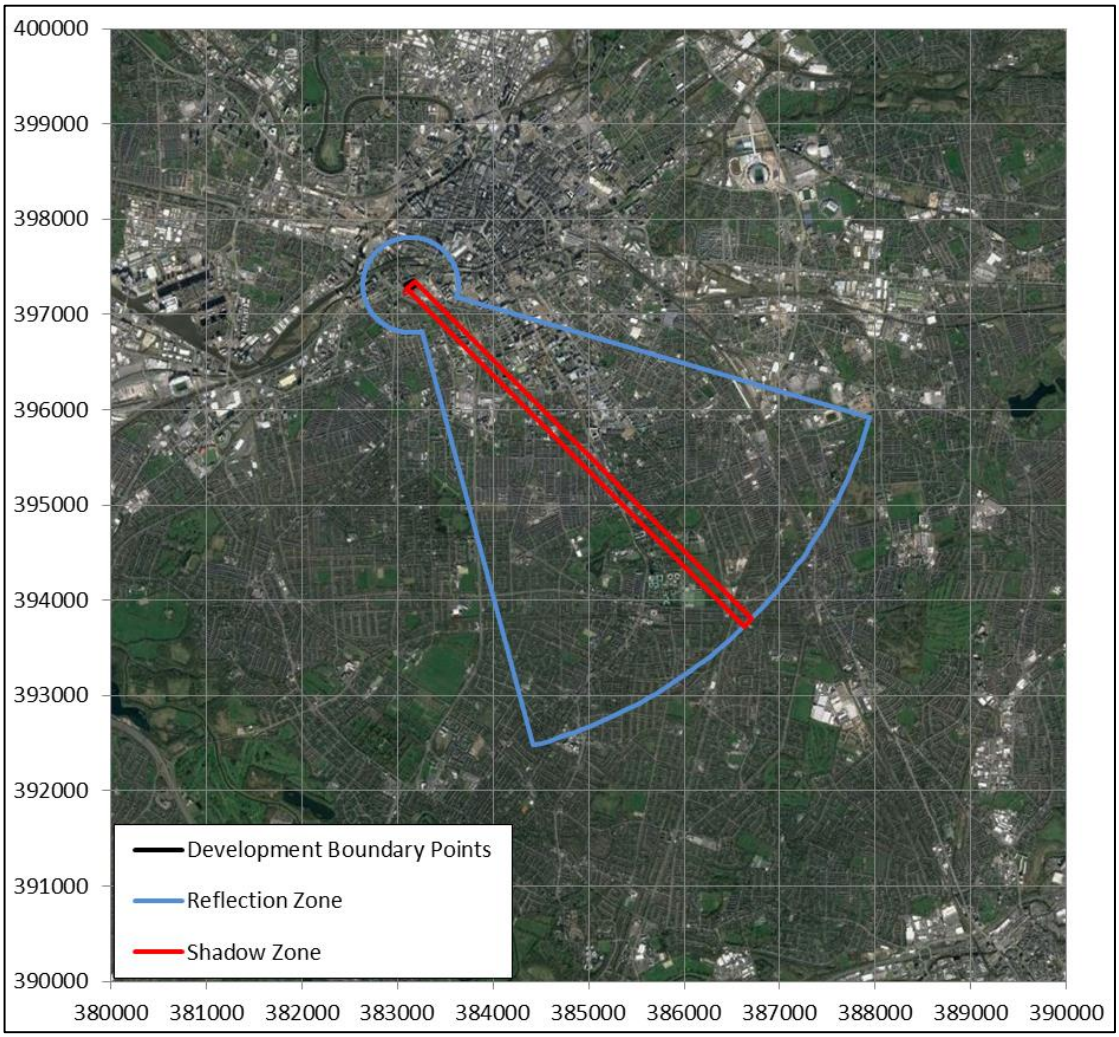

Figure 8 *Interference zones map*

5.2 Potential Diffraction Issues – Terrestrial Television

It can be seen that the shadow zone passes over both urban and industrial buildings. Areas closest to the development are generally[12] at the highest risk of experiencing television interference.

[11] Source: map - © 2017 Infoterra Ltd and Bluesky. © 2017 Google

[12] Under some circumstances, this is not the case e.g. if the pre-existing signal quality was exceptional at close range but borderline at longer range.

5.3 Potential Reflection Issues – Terrestrial Television

Reflection effects are most likely if the transmitter does not have direct radio line of sight to the receiving aerial.

Based on bare-earth terrain, the Winter Hill transmitter has coverage below ten metres for the populated areas within the reflection zone. This means that any receivers that have a low signal strength are likely to be affected by existing obstructions.

For interference to occur due to reflections, the following criteria would need to be met:

- The receiving aerial would not be already obstructed by a building or other existing obstacle;
- The reflected signal path via the development would have to be relatively unobstructed;
- The angle between the reflected signal via the development and the direct signal would have to be small.

In practice it is unlikely that all of the above criteria would be met. Impacts due to reflections are considered unlikely.

6 TERRESTRIAL TELEVISION SURVEYS

6.1 Overview

The purpose of a baseline survey was to establish existing television signal strength and quality in the area. The baseline survey served three purposes, these are:

1. It confirmed which transmitter is serving most homes in the areas surveyed;
2. It provided an indicator regarding the likelihood of interference. If current signals are of good quality, minor degradation is less likely to have a noticeable effect; and
3. It allowed a 'before and after' comparison to be made in the event that a complaint is received.

The purpose of a post-construction survey is as follows:

1. To establish the reception quality post-construction;
2. To determine the variation to television signal strength and quality from baseline to post-construction;
3. To determine whether significant interference (reported or otherwise) is occurring and to identify the specific development to which the interference is attributable

6.2 Survey Locations

Figure 9[13] below shows the survey locations (baseline and post-construction) overlaid onto aerial photography with the icons showing where television measurements were taken. The whole Crown Street site outline is shown in the top left. The survey locations chosen for the baseline survey were revisited as best as possible for the post-construction survey[14]. The orange squares show the post-construction survey locations and the red circles show the baseline survey locations. Where they are closely located, only the post-construction icon is shown. The post-construction survey locations concentrated on the northern side of the shadow zone (defined by the red central line) to account for the shadow zone of C1 specifically however location 3 was surveyed outside of the shadow zone due to access on the day.

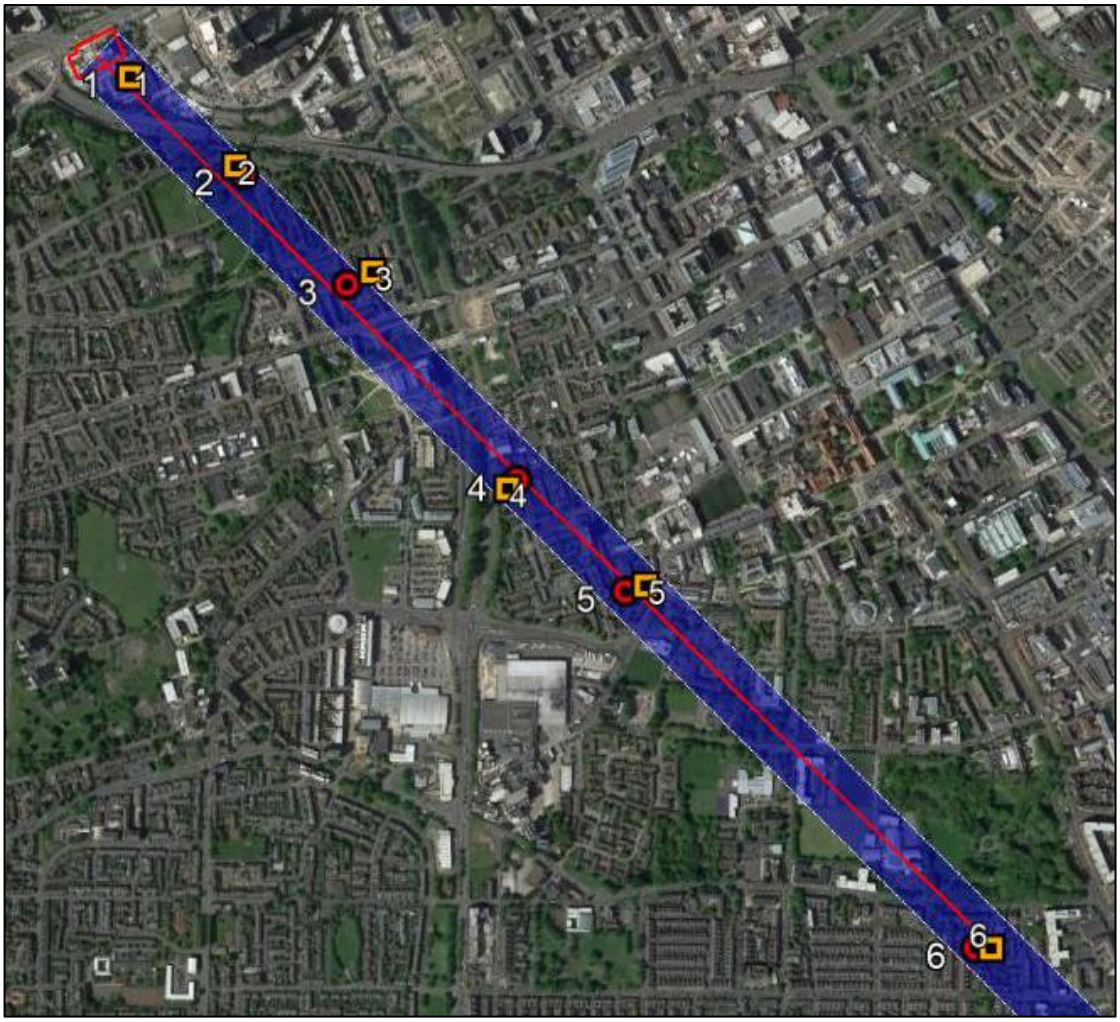

Figure 9 *Survey locations*

[13] Source: Copyright © 2020.
[14] Safe and available access influenced the specific position on the day.

6.3 Survey Results

The baseline reception survey was undertaken for the development in November 2017. The post-construction survey was completed in October 2020.

Survey measurements were taken using Pager Power's custom survey vehicle with a wideband UHF aerial extended to a height of 10 metres above ground level. This was connected to television analyser to record the signal strength and stability.

The strength of the recorded television signals is categorised in accordance within Table 5 below.

Average Signal Strength (dB)	Subjective Signal Strength Definition
<35	Low
35-45	Moderate
45-55	Good
55+	Very Good

Table 5 *Television signal strength categories*

The surveys confirmed that the Winter Hill transmitter served the surveyed area within the shadow zone.

6.4 Baseline and Post-Construction Results

Table 6 on the following page summarises the results of the baseline and post-construction reception surveys.

The average signal strength is given for the baseline and post-construction surveys to show the average change. A number of factors, including variable weather and foliage conditions, can lead to minor fluctuations of signal strength.

Detailed survey results are shown in Appendices A and B. Survey photographs are shown in Appendices C and D.

Location	Average Measured Signal Strength (dB)	Distance from development	Remarks	Conclusion
1	Baseline = 49.2 (Good) Post-construction[15] = 43.1 (Moderate)	0.06km Within the development's shadow zone.	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality however one main multiplex stuttered when it initially decoded but eventually stabilised. Two channels of lower power did not decode. No HP[16] UHF aerials or satellite dishes observed.	The signal strength was good at this location and it has reduced to moderate for the post-construction survey. The specific survey location was within its shadow. It is unlikely that the tall buildings to the east (Owen Street – approximately 150m from C1) will be having any effect at this survey location. Therefore, any signal strength reduction is likely to be attributable to C1 and the adjacent Crown Street tower under construction, at this location. There are however no dwellings currently present at this location and therefore it is unlikely that terrestrial television interference will be experienced. Because of this, any interference that may occur is deemed immaterial at this location.

[15] Because channels 24 and 27 are not known Winter Hill channels, they have not been included in the average.
[16] Horizontally polarised. This means the aerial is orientated towards a main television transmitter rather than a relay television transmitter.

Location	Average Measured Signal Strength (dB)	Distance from development	Remarks	Conclusion
2	Baseline = 59.0 (Very Good) Post-construction = 48.1 (Good)	0.33km Within the development's shadow zone.	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 6 of 9 channels decoded with fine picture and sound quality. Three did not decode – all lower power channels. HP UHF aerials observed directed towards Winter Hill. No satellite dishes observed.	The signal strength was very good at this location and it has reduced to good for the post-construction survey. The specific survey location was within its shadow. It is likely that a reduction of this size is attributable to the C1 and the adjacent Crown Street tower under construction however all main multiplexes decoded. Just south east of this location, a number of dwellings are present which are circa two storeys in height however, considering the results for main multiplexes, it is unlikely that interference would be significant. Significant interference is deemed unlikely to materialise and be caused by C1.

Location	Average Measured Signal Strength (dB)	Distance from development	Remarks	Conclusion
3	Baseline = 58.6 (Very Good) Post-construction = 53.3 (Very Good)	0.60km Within the development's shadow zone	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – all lower power channels. HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.	The signal strength was very good at this location and it has remained very good with only a minor variation. Based on the reasons listed above, effects are deemed unlikely at this location.

Location	Average Measured Signal Strength (dB)	Distance from development	Remarks	Conclusion
4	Baseline = 44.2 (Moderate) Post-construction = 42.4 (Moderate)	1.10km Within the development's shadow zone.	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – all lower power channels. HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.	The signal strength was moderate at this location and it has remained moderate with only a minor variation. Based on Pager Power experience, the likelihood of experiencing interference decreases with distance from a development. At this location buildings in the surrounding area are significantly smaller compared to those in the city centre. Therefore it is considered unlikely that C1 would have any significant impact upon the television signal at this location.

Location	Average Measured Signal Strength (dB)	Distance from development	Remarks	Conclusion
5	Baseline = 46.9 (Good) Post-construction = 47.8 (Good)	1.39km Within the development's shadow zone.	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – all lower power channels. HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.	The signal strength was moderate at this location and it has remained moderate with only a minor variation. At 1.4km beyond the development, considering the signal strength and distance from the development, no significant interference is expected.

Location	Average Measured Signal Strength (dB)	Distance from development	Remarks	Conclusion
6	45.5 (Good) Post-construction = 48.1 (Good)	2.34km Within the development's shadow zone.	Baseline: All channels decoded with fine picture and sound quality. Post-Construction: 7 of 9 channels decoded with fine picture and sound quality. Two did not decode – all lower power channels. HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.	The signal strength was moderate at this location and it has remained moderate with only a minor variation. Considering the size of C1 and the current signal strength and quality, no significant interference is expected at 2.3km.

Table 6 *Baseline and post-construction survey results*

7 CONCLUSIONS

7.1 Findings

Signal strength appears to have decreased in the immediate shadow of the development (within 400m) however there are no dwellings within this distance and all main multiplexes remain available. It is possible that this decrease is due to C1 or the adjacent Crown Street tower under construction. Beyond this distance no significant variation to the terrestrial television signal was observed.

Other new tall buildings in the vicinity of the Crown Street development are unlikely to have any affect within the shadow zone of C1[17] where effects are most likely to occur (400m of C1).

[17] Excluding the adjacent Crown Street tower under construction where cumulative effects are possible.

APPENDIX A – BASELINE SURVEY RESULTS

Baseline reception survey results are presented in the following section.

Location 1 (GPS coordinates: SJ 83861 97627 +/- 16 ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER[18]**	**Picture**	**Sound**
31	COM7	45.0-45.3	0%	Fine	Fine
37	COM8	41.8-42.0	0%	Fine	Fine
49	Arqiva A	54.4-54.6	1x10-8	Fine	Fine
50	BBC A	55.1-55.9	1x10-7	Fine	Fine
54-	BBC B	55.7-56.1	0%	Fine	Fine
55	Arqiva B	56.1-56.3	1x10-8	Fine	Fine
56	LM/LL/LPR	37.4-37.6	1x10-7	Fine	Fine
57	GIM	31.6-62.0	1.2x10-8	Fine	Fine
58	SDN	49.7-50.0	6.4x10-8	Fine	Fine
59	Digital 3&4	48.9-49.2	1x10-8	Fine	Fine

Notes: No HP UHF aerials or satellite dishes observed.

[18] Bit Error Rate.

Location 2 (GPS coordinates: SJ 83421 97086 +/- 15ft)					
Channel	Service	Signal Strength (dBµV)	BER	Picture	Sound
31	COM7	57.6-57.7	0%	Fine	Fine
37	COM8	55.7-55.8	0%	Fine	Fine
49	Arqiva A	69.7-69.9	1x10-7	Fine	Fine
50	BBC A	70.0-70.2	1x10-6	Fine	Fine
54-	BBC B	66.0-66.2	0%	Fine	Fine
55	Arqiva B	65.8-65.9	1x10-7	Fine	Fine
56	LM/LL/LPR	44.4-44.6	1x10-7	Fine	Fine
57	GIM	36.7-36.8	2.3x10-8	Fine	Fine
58	SDN	63.5-63.6	1x10-8	Fine	Fine
59	Digital 3&4	60.0-60.2	1x10-8	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. No satellite dishes observed.

Location 3 (GPS coordinates: SJ 83937 96503 +/- 12ft)					
Channel	Service	Signal Strength (dBµV)	BER	Picture	Sound
31	COM7	54.0-54.2	0%	Fine	Fine
37	COM8	56.0-56.2	0%	Fine	Fine
49	Arqiva A	67.5-67.6	1x10-7	Fine	Fine
50	BBC A	68.7-68.8	1x10-7	Fine	Fine
54-	BBC B	66.0-66.1	0%	Fine	Fine
55	Arqiva B	66.0-66.2	1x10-8	Fine	Fine
56	LM/LL/LPR	45.0-45.1	1x10-8	Fine	Fine
57	GIM	38.5-38.6	1x10-8	Fine	Fine
58	SDN	62.9-63.0	1x10-7	Fine	Fine
59	Digital 3&4	60.5-60.6	1x10-7	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

Location 4 (GPS coordinates: SJ 83937 96503 +/- 12ft)					
Channel	Service	Signal Strength (dBµV)	BER	Picture	Sound
31	COM7	44.4-44.8	0%	Fine	Fine
37	COM8	45.7-45.9	0%	Fine	Fine
49	Arqiva A	49.5-49.7	1x10-7	Fine	Fine
50	BBC A	52.6-52.8	1x10-7	Fine	Fine
54-	BBC B	47.6-47.7	0%	Fine	Fine
55	Arqiva B	48.6-48.7	3.3x10-8	Fine	Fine
56	LM/LL/LPR	33.1-33.3	1x10-7	Fine	Fine
57	GIM	31.1-31.1	6.7x10-4	Fine	Fine
58	SDN	44.7-44.9	5.4x10-7	Fine	Fine
59	Digital 3&4	43.7-44.0	1x10-7	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

Location 5 (GPS coordinates: SJ 84150 96292+/- 9ft)					
Channel	Service	Signal Strength (dBµV)	BER	Picture	Sound
31	COM7	50.7-51.0	0%	Fine	Fine
37	COM8	42.9-43.0	0%	Fine	Fine
49	Arqiva A	53.3-53.4	1x10-7	Fine	Fine
50	BBC A	56.7-56.8	1x10-7	Fine	Fine
54-	BBC B	55.4-55.6	0%	Fine	Fine
55	Arqiva B	52.3-52.4	1x10-8	Fine	Fine
56	LM/LL/LPR	31.9-32.0	1x10-7	Fine	Fine
57	GIM	31.4-31.6	2x10-6	Fine	Fine
58	SDN	47.3-47.6	1x10-8	Fine	Fine
59	Digital 3&4	46.6-46.8	1x10-8	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

Location 6 (GPS coordinates: SJ 84809 95617 +/- 20ft)					
Channel	Service	Signal Strength (dBµV)	BER	Picture	Sound
31	COM7	46.2-46.4	0%	Fine	Fine
37	COM8	52.8-52.9	0%	Fine	Fine
49	Arqiva A	63.3-63.4	1x10-7	Fine	Fine
50	BBC A	64.9-65.1	1x10-8	Fine	Fine
54-	BBC B	62.0-62.2	0%	Fine	Fine
55	Arqiva B	61.9-62.1	1x10-7	Fine	Fine
56	LM/LL/LPR	42.0-42.1	1x10-7	Fine	Fine
57	GIM	37.1-37.2	1x10-7	Fine	Fine
58	SDN	58.0-58.1	1x10-8	Fine	Fine
59	Digital 3&4	55.9-56.0	1x10-8	Fine	Fine

Notes: HP UHF aerials observed directed towards Winter Hill. Satellite dishes observed.

APPENDIX B – POST-CONSTRUCTION SURVEY RESULTS

Post-construction reception survey results are presented in the following section.

Location 1 (GPS coordinates: SJ 83219 97256 +/- 23ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER[19]**	**Picture Quality**	**Audio Quality**
24	That's TV (COM6) Tiny Pop	37.3 +/- 0.3	9e-8	Fine	Fine
27	POP Max	36.3 +/- 0.2	1.1e-4	Fine	Fine
29	5Star	51.7 +/- 0.2	7.4e-8	Fine	Fine
31	Sky Arts	51.9 +/- 0.2	8.8e-9	Fine	Fine
32	BBC One NW (BBC A)	51.1 +/- 0.1	1e-7	Fine	Fine
34	ITV+1	48.4 +/- 0.2	8e-3	Fine but with some stuttering on the image	Fine some stuttering to begin
35	BBC One HD	48.3 +/- 0.3	1e-7	Fine	Fine
37	Ideal World (COM8) Yesterday	47.6 +/- 0.2	5.2e-7	Fine	Fine
55	BBC News HD (COM7)	37.4 +/- 0.2	1e-7	Fine	Fine

[19] $e = x10^{-x}$

Location 1 (GPS coordinates: SJ 83219 97256 +/- 23ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER[19]**	**Picture Quality**	**Audio Quality**
56	QVC (LM) CBeebies HD	25.6 +/- 0.1	DND[20]	n/a	
57	Sony Channel +1	25.6 +/- 0.1	DND	n/a	

Notes: Located within the building site, within 40m of C1.

[20] Did not decode.

Location 2 (GPS coordinates: SJ 83410 97095 +/- 19ft)					
Channel	Service	Signal Strength (dBµV)	BER	Picture Quality	Audio Quality
24	That's TV (COM6) Tiny Pop	37.5 +/- 0.2	1.1e-8	Fine	Fine
27	POP Max	36.4 +/- 0.2	3.3e-8	Fine	Fine
29	5Star	57.0 +/- 0.1	7e-5	Fine	Fine
31	Sky Arts	56.9 +/- 0.1	2.4e-4	Fine	Fine
32	BBC One NW (BBC A)	54.4 +/- 0.2	3.6e-4	Fine	Fine
34	ITV+1	54.1 +/- 0.2	5.9e-5	Fine	Fine
35	BBC One HD	56.8 +/- 0.2	1e-8	Fine	Fine
37	Ideal World (COM8) Yesterday	55.4 +/- 0.1	8e-5	Fine	Fine
55	BBC News HD (COM7)	45.2 +/- 0.2	DND	n/a	
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: Lo

Location 3 (GPS coordinates: SJ 8366 96902 +/- 29ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER**	**Picture Quality**	**Audio Quality**
24	That's TV (COM6) Tiny Pop	44.8 +/- 0.2	1e-8	Fine	Fine
27	POP Max	38.7 +/- 0.1	1e-8	Fine	Fine
29	5Star	62.9 +/- 0.2	1e-8	Fine	Fine
31	Sky Arts	64.6 +/- 0.2	1e-8	Fine	Fine
32	BBC One NW (BBC A)	62.7 +/- 0.1	1e-8	Fine	Fine
34	ITV+1	60.6 +/- 0.1	1e-7	Fine	Fine
35	BBC One HD	61.9 +/- 0.1	1e-7	Fine	Fine
37	Ideal World (COM8) Yesterday	62.8 +/- 0.2	1e-8	Fine	Fine
55	BBC News HD (COM7)	51.3 +/- 0.1	1e-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: Located near terraced housing and apartments ranging from 2-7 storeys. HP aerials observed and satellite dishes.

Location 4 (GPS coordinates: SJ 83922 96489 +/- 27ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER**	**Picture Quality**	**Audio Quality**
24	That's TV (COM6) Tiny Pop	37.5 +/- 0.1	8e-9	Fine	Fine
27	POP Max	32.9 +/- 0.2	4e-4	Fine	Fine
29	5Star	46.8 +/- 0.2	2e-7	Fine	Fine
31	Sky Arts	48.4 +/- 0.2	8e-7	Fine	Fine
32	BBC One NW (BBC A)	48.9 +/- 0.2	1e-8	Fine	Fine
34	ITV+1	47.5 +/- 1.2	3e-8	Fine	Fine
35	BBC One HD	48.9 +/- 0.2	1e-8	Fine	Fine
37	Ideal World (COM8) Yesterday	50.6 +/- 0.1	2e-7	Fine	Fine
55	BBC News HD (COM7)	37.6 +/- 0.2	1e-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: ina large cr par surrounded by two storey terraced housing. All aerials hp towards winter hill and satellite dieshes observed on south face of dwellings.

Location 5 (GPS coordinates: SJ 84177 96302 +/- 16ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER**	**Picture Quality**	**Audio Quality**
24	That's TV (COM6) Tiny Pop	35.4 +/- 0.2	1E-8	Fine	Fine
27	POP Max	30.2 +/- 0.2	2 to 8e-3	Fine	Fine
29	5Star	55.6 +/- 0.2	1e-8	Fine	Fine
31	Sky Arts	55.7 +/- 0.2	1e-8	Fine	Fine
32	BBC One NW (BBC A)	55.3 +/- 0.2	1e-8	Fine	Fine
34	ITV+1	55.1 +/- 0.2	1e-8	Fine	Fine
35	BBC One HD	56.5 +/- 0.1	1e-8	Fine	Fine
37	Ideal World (COM8) Yesterday	55.2 +/- 0.1	1e-8	Fine	Fine
55	BBC News HD (COM7)	43.8 +/- 0.2	1e-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.5 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.5 +/- 0.1	DND	n/a	

Notes: surrounded by two and three storey terraced homes and flats. HP aeirials orientated towards winter hill. Satellite deishes observed on south face of dwellings.

Location 6 (GPS coordinates: SJ 84835 95613 +/- 17ft)					
Channel	**Service**	**Signal Strength (dBµV)**	**BER**	**Picture Quality**	**Audio Quality**
24	That's TV (COM6) Tiny Pop	34.7 +/- 0.3	1e-8	Fine	Fine
27	POP Max	32.0 +/- 0.2	Fluctuations from in the e-2-e-3 range	Fine but came in and out	Fine but came in and out
29	5Star	54.3 +/- 0.3	1e-8	Fine	Fine
31	Sky Arts	54.8 +/- 0.2	1e-8	Fine	Fine
32	BBC One NW (BBC A)	54.7 +/- 0.3	1E-8	Fine	Fine
34	ITV+1	54.9 +/- 0.2	1E-8	Fine	Fine
35	BBC One HD	58.2 +/- 0.1	1E-8	Fine	Fine
37	Ideal World (COM8) Yesterday	58.2 +/- 0.2	1E-8	Fine	Fine
55	BBC News HD (COM7)	45.8 +/- 0.2	1E-8	Fine	Fine
56	QVC (LM) CBeebies HD	26.1 +/- 0.1	DND	n/a	
57	Sony Channel +1	26.1 +/- 0.1	DND	n/a	

Notes: Surrounded by two storey dwellings in the suburbs. All dwellings had HP aerials orientated north west towards Winter Hill. Satellite dishes observed on the south face of dwellings.

APPENDIX C – BASELINE SURVEY PHOTOGRAPHS

Location 1




PAGERPOWER
E015 OEY
WWW.PAGERPOWER.COM

Location 2




npower
AV17 BRF
PAGERPOWER
SURVEYING
www.pagerpower.com
SURVEYING

Location 3




Let's work together
PAGERPOWER
E015 OEY
SURVEYING
CITY LIVING
LET BY

Location 4




RAGLAN WALK
's work together
ER POWER
Worldwide Planning Solutions- Aeronautics, Glint & Glare
UAV Risk, Wind Turbines, Radar & RadioCommunications
ower.com

Location 5




Let's work together
PAGERPOWER
E015 OEY

Location 6





APPENDIX D – POST-CONSTRUCTION SURVEY PHOTOGRAPHS

Location 1




NO PARKING
PAGERPOW
Urban & Renev
E015

Location 2




PAGERPOWER
Urban & Renewables
E015 OEY

Location 3

No survey photo taken. Street view image of survey location shown for reference. The silver car is located at the survey location.



Location 4


PAGERPOWER
Urban & Renewables
E015 OEY
SURVEYING
PAGERPOWER
Urban & Renewables
SURVEYING
www.pagerpower.com


PAGERPOWER
Urban & Renewables
E015 OEY

Location 5




PAGERPOWER
Urban & Renewables
E015 OEY

Location 6




PAGERPOWER
Urban & Renewables
FO15 OEY

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