


Birmingham Eastside Extension

Environmental Statement Volume 2 Technical Appendix M1: Noise and Vibration Technical Information

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West Midlands Combined Authority

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Issue and revision record

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Contents

1. Noise and Vibration

1.1 Introduction

1.1.1 This appendix should be read in conjunction with Chapter 10 Noise and Vibration of ES Volume 1: Main Statement. It includes technical details and supporting information including:

- Noise important areas;
- Conversion between metrics;
- Construction noise and vibration;
- Measurements and predictions of noise and vibration during tram pass-bys;
- Background noise survey details; and
- Contour maps of noise levels and differences.

1.1.2 All noise indices in this appendix are A-weighted with a fast time constant unless stated otherwise.

1.2 Noise important areas

1.2.1 Noise important areas are noise 'hotspots' identified by DEFRA and correspond to areas where the population is exposed to some of the highest noise levels due to roads and railways. They may be seen on an interactive map1. Although there are no noise important areas due to roads along the BEE route, there is one noise important area due to railways: this is where the mainline into Birmingham New Street crosses New Canal Street. The DEFRA Noise Action Plan2 states "For each Important Area, DfT and the rail industry will identify proposed actions that will meet the vision and aims set out in the Government's policy on noise, or state why, in their view, no further action can or needs to be taken in order to meet this objective."

1.2.2 There are no known action plans currently in place that address the noise important area on the BEE route but any such action plan would likely seek to reduce noise from the mainline railway thereby reducing background noise levels in the immediate vicinity of the mainline tracks.

1.3 Conversion between metrics

1.3.1 Section 10.4 of the main chapter discussed the noise metrics used in the assessment and explained that these include the L10 index (the A-weighted sound level that is exceeded 10% of the time and used as the standard index for road traffic noise) and the Leq (the equivalent continuous sound level that has the same A-weighted acoustic energy as fluctuating noise and which is used for tram and rail noise).

[1] http://www.extrium.co.uk/noiseviewer.html

[2] Noise Action Plan: Railways (Including Major Railways) Environmental Noise (England) Regulations 2006, as amended January 2014

1.3.2 Since noise sources within the assessment include trams and trains in addition to road traffic it is necessary to convert the calculated traffic L10 values to appropriate Leq values so that composite noise levels from all sources may be determined and compared with the assessment criteria set out in the main chapter.

1.3.3 The formulae used for this conversion are given by TRL3 as follows:

- For traffic flows > 200 vehicles/hr L_{eq}=0.94L_{10}+0.77dB, otherwise;
- L_{eq}=0.57L_{10}+24.46dB.

1.4 Construction noise and vibration

Construction noise

1.4.1 The construction noise calculations were carried out using a spreadsheet applying the methodology set out in BS 5228-1[4].

1.4.2 The plant and equipment required for each of the construction activities given in Table 10-14 of the main chapter is set out below based on the Construction Strategy in ES Volume 2 Technical Appendix D1. Noise levels for construction plant and equipment have been determined from the reference tables provided in Annex C of BS5228-1 that give noise levels 10m from the plant. The calculations also include an estimate of the time for which each plant item will be active during the construction day.

Table 1.1: Plant used in BS5228 assessment of construction noise

Activity phase	Operations	Plant items	BS5228 Reference numbers	Sound pressure level L_{eq} at 10m	On-time %
Road Surface Works	Upgrades to highway including: Site preparation, Surface breaking, concreting, rolling and compaction	Hand-held Pneumatic Breaker	C.1.6	83	50
		Compressor for hand-held pneumatic breaker	C.5.5	65	50
		Mini Road Planer	C.5.9	68	25
		Vibratory Plate	C.2.41	80	50
		Vibratory Roller	C.5.27	67	50
		Asphalt Paver	C.5.30	75	50
		Mini Tracked Excavator	C.3.20	68	50
Footway	Realignment,	Vibratory Roller	C.5.27	67	50

[3] Converting the UK traffic noise index L10,18h to EU noise indices for noise mapping, 2002, P G Abbot and P M Nelson, Transport Research Laboratory

[4] British Standards Institution, 2014, British Standard BS 5228 Code of practice for noise and vibration control on construction and open sites - Part 1 noise

Activity phase	Operations	Plant Items	BS5228 Reference numbers	Sound pressure level L_{eq} at 10m	On-time %
Alterations	resurfacing and arrangement of footways	Asphalt Paver	C.5.30	75	30
		Wheeled Loader	C.2.28	76	25
		Vibratory Plate	C.2.41	80	50
Moving Pedestrian Crossing	Removing and reinstalling pedestrian crossings	Small Cement Mixer	C.4.23	61	75
		Lorry with Lifting Boom Amr	C.4.53	77	25
		Road Breaker (Hand-held pneumatic breaker)	C.5.3	82	50
		Compressor for Hand-held breaker	C5.5	65	50
Material Excavation for Track Formation	Removing pre-existing concrete and tarmac, ready for track foundations to be laid.	Breaker mounted on Excavator	C.1.9	90	25
		Dumper (Idling)	C.4.5	63	25
		Hand-held Circular Saw	C4.72	79	20
		Diesel Generator	C.4.86	65	100
Track Foundations	Preparation of ground for track installation	Vibratory Plate	C.2.41	80	50
		Dumper (Idling)	C.4.5	63	25
		Lorry with Lifting Boom Arm	C4.53	77	25
		Vibratory Roller	C5.27	67	50
Track Installation	Track cutting, laying and fixing	Angle Grinder	C.4.93	80	25
		Vibratory Roller	C.5.27	67	25
		Cement Mixer Truck (Discharging)	C.4.18	75	50
		Core Drill (Electric)	C.4.69	85	10
OLE (Over-head Line Equipment)	OLE Base installation – piling and concreting in place	CFA (Continuous Flight Auger) Crawler Rig	C.3.21	79	25
		CFA Concrete Pump	C.2.26	75	25
		Hand-held Cordless Nail gun	C.4.95	73	50
Substation Works	Excavation and foundations	Breaker Mounted on an Excavator	C.1.9	90	25
		Vibratory Plate	C.2.41	80	50
		Lorry with Lifting Boom Arm	C.4.53	77	25
Demolition	Demolition of buildings for track alignment and	Pulveriser Mounted on an Excavator	C.1.5	72	25
		Tracked Excavator	C.1.12	82	25

Activity phase	Operations	Plant items	BS5228 Reference numbers	Sound pressure level L_{eq} at 10m	On-time %
	substation	Breaker Mounted on a Wheeled Backhoe	C.1.1	92	25
		Hand-held Pneumatic Breaker	C.1.6	83	25
		Hydraulic Breaker Power Pack	C.1.8	74	25
		Gas Cutter	C.1.18	790	10

Construction vibration

1.4.3 The Transport Research Laboratory (TRL) has published the results of a series of measurements of vibration levels at distances from a range of construction works[5]. The ground conditions in the area of the source and receiver position and of the intervening ground are not specified in that report, however it is considered to be sufficiently representative for the purposes of this assessment. The data is reproduced in Table 1.2 with vibration levels expressed as peak particle velocity (PPV) for construction traffic and heavy lorries on poor surfaces.

Table 1.2: Estimated peak particle velocities at distances between construction vehicles and vibration measurement positions

Construction plant	Distance between construction Site and vibration measurement position [m]	Peak particle velocity at measurement position [mm/s]
General construction traffic including haul routes	1	0.60
	2	0.24
	4	0.14
	6	0.10
	≥8	<0.10
Heavy lorry on poor road surface	1	2.20
	2	0.80
	4	0.24
	6	0.16
	8	0.10
	≥10	<0.10

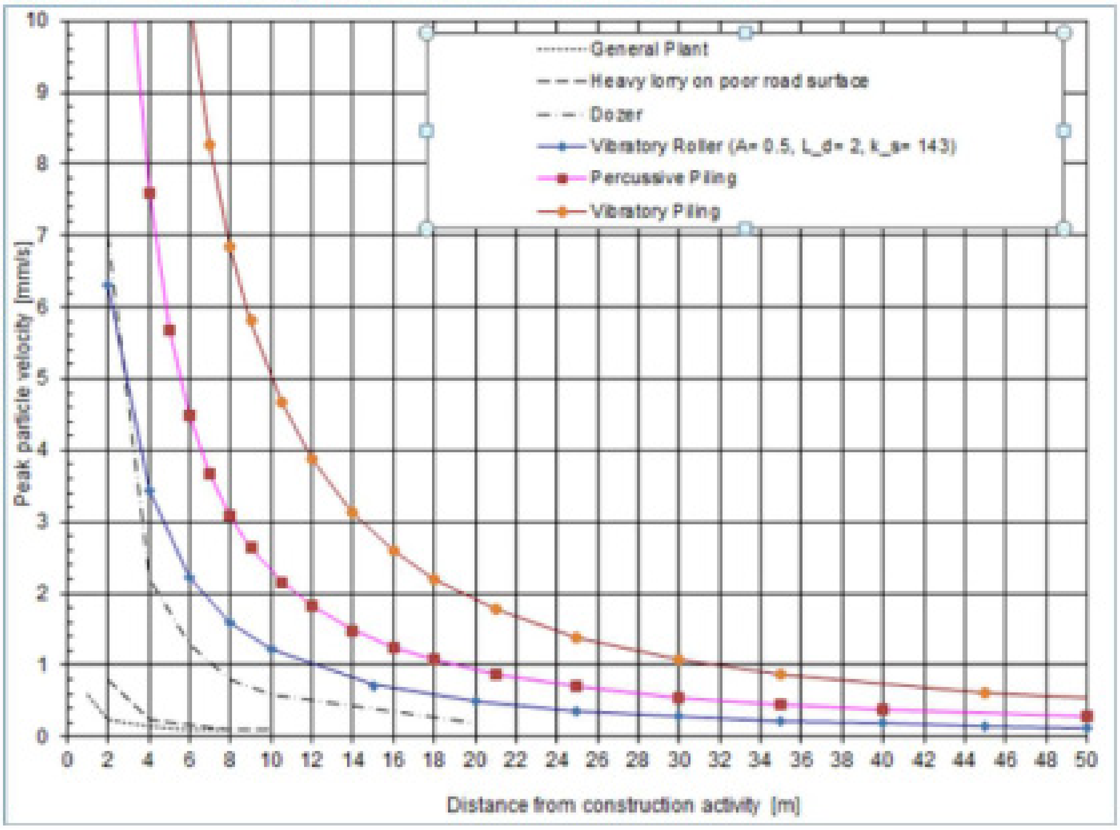
1.4.4 It will be noted that construction vibration levels are below the SOAEL criterion (main chapter Table 10-10) of 1.0 mm/s at all distances >2m and above the LOAEL (main chapter Table 10-10) criterion of 0.3 mm/s at all distances >4m. The shortest distance from sensitive receptors

5 DoT (1986) Transport and Road Research Laboratory Report 53. Ground Vibration Caused by Civil Engineering Works.

to the BEE (main chapter Table 10-4) is 6m and there is therefore a low probability that construction vehicles will exceed either SOAEL or LOAEL.

1.4.5 BS 5228-2[6] provides empirical relationships for ground-borne vibration arising from a range of mechanised construction activities including vibratory compaction. Figure 1.1 below shows the level of vibration from typical construction plant expressed as a PPV as a function of distance from the works.

Figure 1.1: Construction generated vibration based on BS5228 Part 2



1.4.6 Figure 1.1 shows that vibratory rollers produce a PPV of 0.3 mm/s (LOAEL – main chapter Table 10-10) at a distance of approximately 25m and PPV of 1.0 mm/s (SOAEL – main chapter Table 10-10) at a distance of approximately 12m.

1.4.7 The table of receptors in the main chapter (Table 10-4) included 6 receptors at distances of less than 12m which are therefore likely to be subject to significant adverse effects (vibration above SOAEL) and a further 12 at distances from 12m to 25m which are likely to be subject to adverse effects (vibration above LOAEL but below SOAEL).

[6] BSI, 2009, amended 2014. British Standard BS 5228 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

1.4.8 The closest receptor is 6m from the works where Figure 1.1 shows a vibration level of 2.1 mm/s. This is greater than SOAEL but considerably below the value of 10 mm/s which BS 5228-2 describes as "*likely to be intolerable for any more than a very brief exposure*".

1.4.9 The vibration level at the closest receptor is also below the threshold value of 15mm/s at 4Hz rising to 20mm/s at 15Hz which BS5228-2[7] provides as a guide value for cosmetic damage in buildings and below 12.5 mm/s at which BS 7385-2 notes the probability of structural damage tends towards zero unless a building is already structurally unsound.

1.5 Trams Operational noise

Pass-by noise

1.5.1 Section 10.3 of the main chapter sets out the West Midlands Combined Authority criteria for maximum noise levels at night of $L_{max,\ slow}$ of 82 dB up to six times per hour night (23:00 – 07:00 hours)

1.5.2 During a noise survey carried out by Mott MacDonald in July 2016, the value of $L_{max,\ slow}$ was measured from passing trams on a section of track on Bilston Road, Wolverhampton, part of the existing Midland Metro Line One between Birmingham Snow Hill and Wolverhampton. Table 1.3 presents the measured airborne $L_{max,\ slow}$ noise levels obtained at varying distances from the tram track centre line.

Table 1.3: Noise monitoring results indicating $L_{max,\ slow}$ due to tram pass by events

Date and start time	Distance from track [m]	$L_{eq,T}$	$L_{max,slow}$ dB
13/07/2016 11:35	5	74.7	80.2
13/07/2016 11:43	5	73.9	78.5
13/07/2016 11:51	5	73.9	79.9
13/07/2016 11:59	5	73.2	76.9
13/07/2016 12:23	5	72.6	76.7
13/07/2016 14:56	5	77.4	81.0
13/07/2016 12:31	5	75.3	80.8
13/07/2016 12:39	7.5	70.1	73.7
13/07/2016 15:03	7.5	74.6	80.2
13/07/2016 15:35	7.5	71.4	76.9

1.5.3 The measurements indicate that airborne $L_{max,\ slow}$ noise levels generated during a passing tram event are between 73 to 81 dB depending on the measurement distance and with some variability between individual trams. These levels are likely to be higher than the levels that

[7] British Standards Institution, 2014, British Standard BS 5228 Code of practice for noise and vibration control on construction and open sites - Part 2 vibration

will be encountered on the BEE extension where speeds will be lower than the 40km/h speeds at which the trams were operating during the measurements. The measurements indicate that at a distance of 5m or more it is unlikely that the 82 dB $L_{max, slow}$ criteria will be exceeded. The scheme drawings[8] show that the shortest distance from the proposed track centre line to any noise sensitive receptor is greater than 5m. The results given in Table 1.3 indicate that 82 dB $L_{max, slow}$ is therefore unlikely to be exceeded and therefore no mitigation is required to meet the West Midlands Combined Authority criteria for maximum noise levels at night.

Ground-borne noise

1.5.4 Section 10.3 of the main chapter sets the West Midlands Combined Authority criteria for ground-borne noise levels in terms of $L_{max,slow}$ inside different building types.

1.5.5 The US Federal Transit Administration (FTA) published a procedure for predicting ground-borne vibration from railways in 2006[9] which can be extended to estimate ground-borne noise levels for the BEE extension.

1.5.6 The procedure described in Section 11.2 of the FTA report has been used to predict ground-borne noise using parameters for light rail, which is considered to most closely represent the tramway. The predictions use representative values for:

- force density applied by the tram to the tracks at the upper end, typical, and lower end of the range presented in the FTA report for light rail vehicles at 40 mph;
- foundation response of a large masonry building on piles; and
- vibration to sound pressure level conversion that is typical for residential rooms.

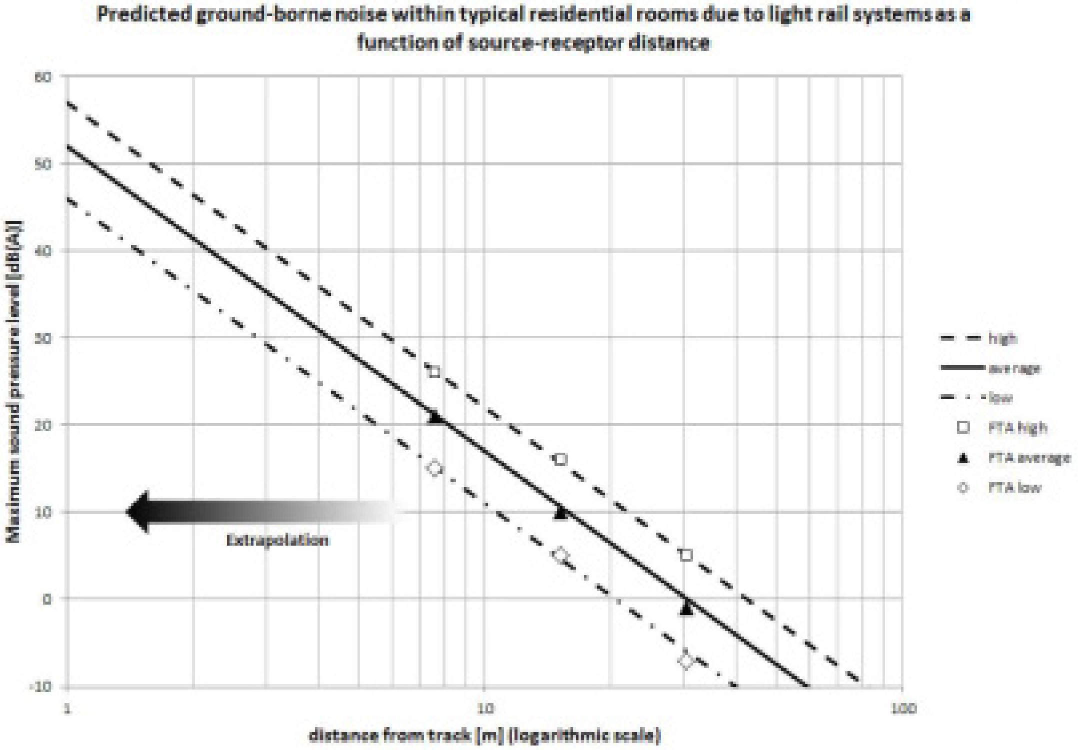
1.5.7 The calculations have been carried out for source-receptor distances of 25 feet (7.6m), 50 feet (15.2m), 100 feet (30.5m) and 150 feet (45.7m). The noise levels at these distances have been interpolated and extrapolated in Figure 1.2 to show predicted noise level a function of source-receptor distance on a logarithmic scale.

1.5.8 The chart in Figure 1.2 was used to estimate ground-borne noise levels in terms of $L_{max,slow}$ for the receptors given in Table 10.4 of the main chapter using the distances given in Table 10.4. These values were then compared with the building-type ground-borne noise criteria given in paragraph 10.3.62 to determine the likelihood of non-compliance with the results shown in Table 10.21 of the main chapter.

8 MMD-300207-HS29-DRA-0000-0010 – 00117 Rev 2

9 Carl E Hanson, David A Towers and Lance D Meister (2006), Transit Noise and Vibration Impact Assessment, Office of Planning and Environment Federal Transit Administration (2006)

Figure 1.2: Chart showing calculated ground-borne noise as a function of distance from the tramway



1.5.9 For example, 81 Digbeth (R28) is 20m from the BEE extension. Figure 1.2 indicates that the $L_{max,slow}$ level at 20m is approximately 0dB for trams with a low force density, 7dB for trams with an average force density and 12dB for trams with a high force density. Dwellings such as 81 Digbeth have an $L_{max,slow}$ criterion of 40dB so there is a low risk of non-compliance, whatever average force density is used in the computation.

Pass-by vibration

1.5.10 The Birmingham Eastside Extension will operate Urbos 3 trams similar to those currently in operation along the existing Midland Metro tram line which runs between Wolverhampton and Birmingham City Centre. Vibration measurements have been carried out by Mott Macdonald along sections of the existing Midland Metro Line One tram route to provide an indication of potential vibration impacts along the extension route. Vibration surveys were undertaken in July 2016 along a section of track on Bilston Road Wolverhampton under normal tram operating conditions. The measurements which included PPV and vibration dose value (VDV) are presented in Table 1.4 below.

Table 1.4: Measured maximum vibration levels from the existing Birmingham Tram line – typical tram line operational condition

Distance to the nearest track C/L	Measured peak particle velocity (mm/s)	Measured vibration dose value ($ms^{-1.75}$)
3m	1.22	0.072
5m		0.069
6m	0.66	0.047
7m		0.024
8m	0.39	0.022
9m		0.017

Source: Mott MacDonald

1.5.11 These values have been used to estimate the vibration levels during operation of the extension for the receptors given in Table 10-4 of the main chapter and hence the likelihood of adverse impacts.

1.5.12 No specific criterion is given for the PPV of an individual tram pass-by. Instead the LOAEL and SOAEL criteria for operational vibration are specified in terms of the cumulative vibration dose, VDV. It is nevertheless instructive to compare the PPV values with the BS5228-2 (1.5.3) criteria on the effects of vibration for construction. In particular, the standard states that

- At a vibration level of 0.3mm/s "*vibration might be just perceptible in residential environments*";
- At a vibration level of 1.0mm/s "*it is likely that vibration in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents*"; and
- At a vibration level of 10mm/s "*vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.*"

1.5.13 The measurements in Table 1.4 and these criteria indicate that for receptors within approximately 10m of the track it is possible that vibration might be just perceptible but that receptors would need to be significantly less than 6m from the track for vibration to cause complaint. The minimum receptor distance given in Table 10-4 of the main chapter is 6m so complaints due the pass-by of individual trams are unlikely.

1.5.14 The LOAEL and SOAEL thresholds and criteria for operational vibration are given in terms of VDV in the main chapter. This is a cumulative dose for vibration which increases with the passage of each tram and for N trams that each produce the same dose V, the total dose is given by $N^{1/4}V$. The VDV for the daytime and night-time derived from the tram frequency values in Table 10.5 of the main chapter and the individual pass-by values given in Table 1.4, above are given in Table 1.5 (using worst-case volumes for night-time at the week-ends).

Table 1.5: Predicted vibration dose values for day and night

Distance to the nearest track C/L	Vibration Dose Value Day (18hr) VDV ($ms^{-1.75}$)	Vibration Dose Value Night (6hr) VDV ($ms^{-1.75}$)
3m	0.30	0.16
5m	0.29	0.15
6m	0.20	0.10
7m	0.10	0.05
8m	0.09	0.05
9m	0.07	0.04

Source: Mott MacDonald

1.5.15 The LOAEL and SOAEL criteria given in Table 10.12 of the main chapter are not exceeded for the daytime or the night-time at any of the distances given in Table 1.5 so there are unlikely to be any adverse effects due to vibration from the trams.

Baseline survey methodology

1.5.16 Background noise surveys were carried out in November 2015, and January, April and June 2016 at locations identified as sensitive receptors in the vicinity of the BEE corridor. The surveys comprised three long-term unattended measurements (LT1, LT2 and LT3) and short-term, attended measurements at eleven positions (ST1 to ST11) in the vicinity of the Scheme. Survey locations are shown in Figure 1.3 and are summarised below:

- Position LT1: Hotel La Tour first floor roof terrace - Albert Street;
- Position LT2: Hennessey's Bar first floor roof - 30-31 Allison Street, Digbeth;
- Position LT3: Irish Centre first floor window - Plunkett Room, 14-20 High Street;
- Position ST1: New Meeting Street - outside Travelodge;
- Position ST2: New Meeting Street - outside offices
- Position ST3: Hotel La Tour - south west façade extent;
- Position ST4: Hotel La Tour – south east façade extent;
- Position ST5: City Park;
- Positon ST6: New Canal Street/Meriden Street – outside residential property;
- Position ST7: Meriden Street - outside garage/residential property;
- Position ST8: Corner of High Street Deritend and Meriden Street - outside South and City College Birmingham – Fusion Centre;
- Position ST9: High Street Deritend - outside Birmingham Coach Station;
- Position ST10: High Street Deritend - outside Subway; and
- Positon ST11: High Street Deritend - outside Irish Centre.

1.5.17 Positions were selected both with regard to their proximity to sensitive receptors and their ability to give a general indication of the ambient noise climate. Measurements at the short-term positions were each carried out three times to ensure that they were both representative and adequately captured the existing noise climate in the area.

1.5.18 All measurements were undertaken by engineers who are competent in environmental noise monitoring, and completed in accordance with the principles of BS 7445:2003. The sound level meters were all Rion Type ML-52 and are designed to be in conformance with the IEC 61672:2003 to the requirements of the Class 1 standard. Further details for the sound meters are provided in the table below.

1.5.19 All meters and field calibrators used held current calibration certificates obtained under laboratory conditions traceable to UK and International Standards. Before and after the measurement session the reference calibration level of the sound level meter was checked using a field calibrator. Variation of no more than 0.3 dB in the reference level was identified over any measurement session.

Table 1.6: Rion type NL-52 sound level meter details

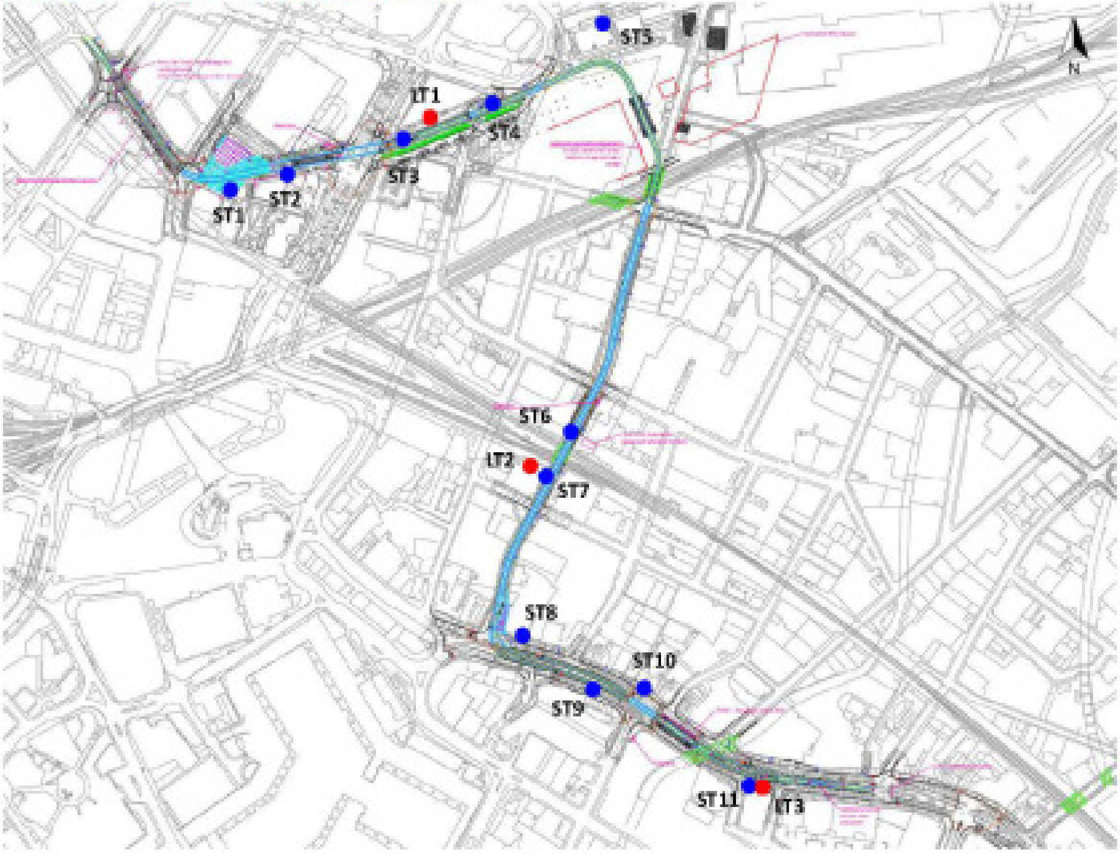
Serial number	Date of calibration preceding measurements	Locations used
231672	14 Oct 15	ST2, ST3, ST5 (some), ST6, ST8, ST9 (some), ST10
743137	8 Oct 14	LT1
1143538	20 Mar 15	LT2, LT3, ST1, ST4, ST5 (some), ST7,ST9 (some), ST11

1.5.20 At each position the microphone was supported using a tripod and was fitted with a windshield suitable for outdoor use. The attended sound level meter was positioned at ground floor level with the microphone at a height of 1.5m above local ground level. The unattended meters were positioned at locations where there was low risk of tampering with weather-protected microphones placed on poles as illustrated in the photographs below. The weather conditions were suitable for all surveys with no precipitation and wind speeds below 5 m/s.

1.5.21 The sound level meters were configured to record the equivalent continuous noise level ($L_{eq,T}$), statistical noise level indicators such as the background noise level (L_{90}), ten-percentile statistical noise level (L_{10}) and maximum noise level with fast time weighting ($L_{max,fast}$). For the attended sound measurements, the measurement interval used was 15 minutes and all measurements were free-field – the position of the noise measurements was more than 3.5m away from any walls or vertical reflecting other than the ground. Exceptionally ST7 was only approximately free-field as the microphone was approximately 2m from the nearest building façade and LT2 was at the end of the valley in a roof as Figure 1.4 illustrates.

1.5.22 The noise climate during the daytime at the various short-term monitoring positions was typically dominated by road traffic noise (RTN). In particular High Street Deritend, Digbeth (B4100) and B4114 were the most significant contributors within the BEE corridor. Other contributing noise sources observed during the surveys included pedestrians, fixed plant noise, commercial/industrial noise and emergency vehicle sirens. At measurement positions near railway lines, train noise was also audible. Details of the survey locations and results at each measurement position are given below.

Figure 1.3: Noise monitoring location map



Source: Mott MacDonald

Baseline Noise Survey Results

1.5.23 A summary of the noise baseline survey results at all locations is given in Table 1.7. The summary shows the daytime, evening and night-time levels for the unattended measurements and daytime values only for the attended measurements (which were made during the daytime only.).

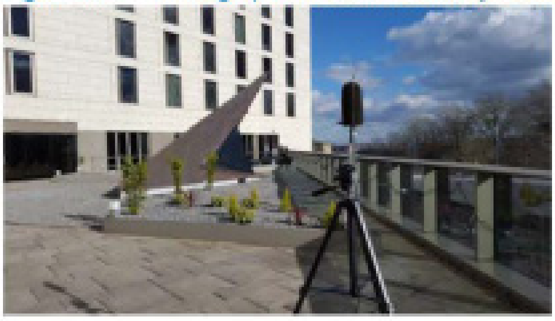
1.5.24 For the long-term measurement positions the daytime L_{eq} values are given for 07:00 to 19:00 (12-hour day), 19:00 to 23:00 (evening) and 23:00 to 07:00 (8-hour night), they are also given for 07:00 to 23:00 (16-hour day) and for 06:00 to midnight (18-hour day) and midnight to 06:00 (6- hour night). It will be noted that the period selected for the daytime (or night-time) does not affect the Leq value with variations of only 1dB at any given location.

Table 1.7: Summary noise survey results in 2015 and 2016

Location	Reference	Baseline noise level dB L_{eq}		
		Daytime	Evening	Night time
Hotel La Tour, Albert Street B5 5JE	LT1	(07:00-19:00) 57	(19:00-23:00) 55	(23:00-07:00) 53
		(07:00-23:00) 57		
		(06:00-24:00) 58		(00:00-06:00) 52
Substation, Meriden Street	LT2	(07:00-19:00) 58	(19:00-23:00) 59	(23:00-07:00) 49
		(07:00-23:00) 58		
		(06:00-24:00) 58		(00:00-06:00) 48
Irish centre, 14-20 High street Deritend B12 0LN	LT3	(07:00-19:00) 70	(19:00-23:00) 69	(23:00-07:00) 65
		(07:00-23:00) 70		
		(06:00-24:00) 70		(00:00-06:00) 64
New Meeting Street (back of Travelodge)	ST1	60	-	-
Albert Street corner New Meeting Street	ST2	66	-	-
Pedestrian area in front of hotel La Tour on B4100 side	ST3	63	-	-
Pedestrian area in front of hotel La Tour entrance on B4114	ST4	67	-	-
Park between New Canal Street and Fox Street	ST5	60	-	-
Meriden Street (railway bridge - Chicken)	ST6	70	-	-
Meriden Street (railway bridge - Hennessey's)	ST7	68	-	-
B4100 Digbeth (South and City College Birmingham - Fusion Centre)	ST8	73	-	-
B4100 Digbeth (Birmingham Coach Station)	ST9	73	-	-
B4100 Digbeth (The institute/Subway)	ST10	73	-	-
B4100 High Street Deritend (Irish centre)	ST11	72	-	-

Photographs of baseline survey locations

Figure 1.4: Photographs of baseline survey locations

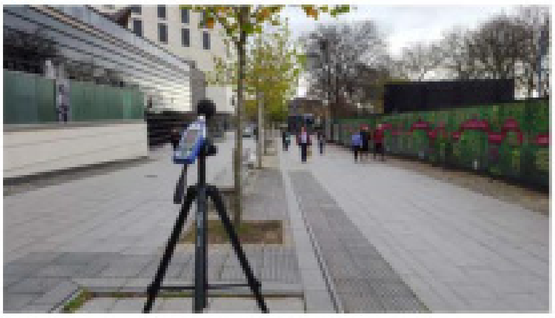

LT1


LT2


LT3

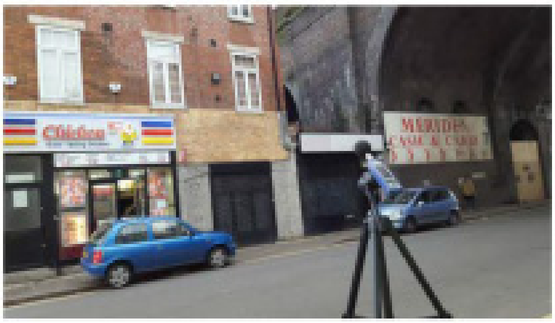
ST1


ST2

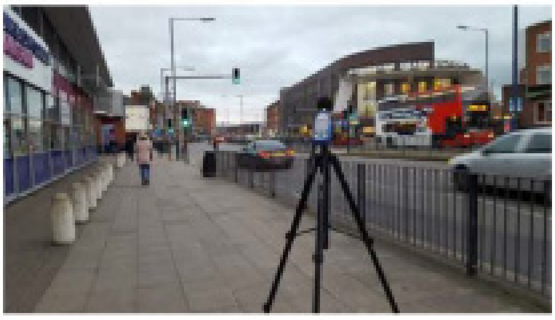

ST3

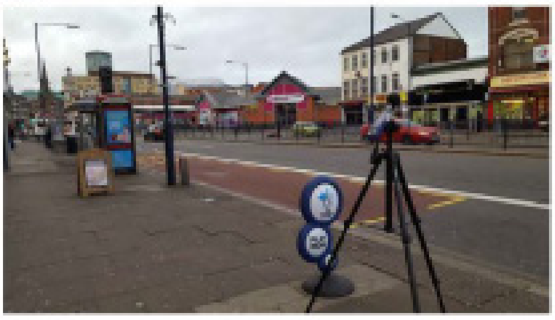

ST4


ST5


ST6


ST7


ST8


ST9


ST10


ST11

Details of noise baseline survey results for LT1-LT3 and ST1 to ST11

1.5.25 More detailed results from the noise survey are shown in Table 1.8 which shows the Leq, L10 and L90 statitisical parameters in addition to the maximum sound level Lmax,fast. The comments record details of the sound sources that were audible at the time of the attended surveys including road traffic noise (RTN).

Table 1.8: Details of baseline noise survey results

Location	Date and start time	L_{eq} dB	L_{10} dB	L_{90} dB	$L_{max,fast}$ dB	Comments
LT1	Day (06:00-24:00)	57	58	51	83	Continuous monitoring on 18-19 February 2016
	Day (07:00-23:00)	57	59	51	83	

Location	Date and start time	L_{eq} dB	L_{10} dB	L_{90} dB	$L_{max,fast}$ dB	Comments
	Night (00:00-06:00)	52	55	45	73	
	Night (23:00-07:00)	53	56	50	76	
LT2	Day (06:00-24:00)	58	57	52	92	Continuous monitoring on 7-8 June 2016
	Day (07:00-23:00)	58	57	52	92	
	Night (00:00-06:00)	48	49	47	71	
	Night (23:00-07:00)	49	49	47	71	
LT3	Day (06:00-24:00)	70	73	62	101	Continuous monitoring on 3-4 March 2016
	Day (07:00-23:00)	70	73	62	101	
	Night (00:00-06:00)	64	67	47	87	
	Night (23:00-07:00)	65	68	52	87	
ST1	11 November 2015 at 13:00	59	60	56	72	Plant noise (on McDonald's roof). Occasional Road Traffic Noise (RTN) in car park on New Meeting Street, pedestrian passing by and talking.
	12 November 2015 at 8:19	61	63	56	86	Plant noise (on McDonald's roof). Unloading van, occasional RTN in car park on New Meeting Street.
	12 November 2015 at 11:26	59	61	55	80	Plant noise (on McDonald's roof). RTN in car park on New Meeting Street, pedestrian passing by and talking.
ST2	11 November 2015 at 13.00	66	70	59	82	RTN on Albert Street from/to B4100. Pedestrian passing by and talking, reversing lorry, RTN B4100, birds.
	12 November 2015 at 8:20	66	70	57	81	RTN on Albert Street from/to B4100. RTN B4100, RTN in the multistore car park (opposite side of the road), pedestrian passing by and talking, birds.
	12 November 2015 at 11:26	67	70	59	88	RTN on Albert Street from/to B4100. Pedestrian passing by and talking, reversing lorry, RTN B4100, construction site between multi-storey car park and B4100.
ST3	11 November 2015 at 13:27	62	65	58	77	RTN B4100. Pedestrian passing by and talking, RTN

Location	Date and start time	L_{eq} dB	L_{10} dB	L_{90} dB	$L_{max,fast}$ dB	Comments
						Park Street, train.
	12 November 2015 at 8:40	62	64	59	74	RTN B4100. Pedestrian passing by and talking, RTN Park Street, birds, train.
	12 November 2015 at 11:48	64	66	59	80	RTN B4100. Pedestrian passing by and talking, helicopters, RTN Park Street, construction site between B4100 and multi-storey car park, trains.
ST4	11 November 2015 at 13:26	67	71	59	82	RTN B4114. Pedestrian passing by and talking and in/out Hotel La Tour.
	12 November 2015 at 8:41	66	69	59	80	RTN B4114. Pedestrian passing by and talking and in/out Hotel La Tour.
	12 November 2015 at 11:48	67	70	60	78	RTN B4114. Pedestrian passing by and talking and in/out Hotel La Tour, helicopters.
ST5	11 November 2015 at 13:52	61	62	56	85	RTN B4114. Trains in/out Birmingham New Street station, pedestrian passing by and talking.
	12 November 2015 at 9:01	58	60	55	69	RTN B4114. Trains in/out Birmingham New Street station, pedestrian passing by and talking.
	12 November 2015 at 12:09	60	61	56	84	RTN B4114. Trains in/out Birmingham New Street station, pedestrian passing by and talking, wind in trees.
ST6	11 November 2015 at 15:06	70	74	53	89	RTN Meriden Street. construction site (approx. 60m N of SLM), trains on bridge, pedestrian passing by and talking, shop's door bell, vehicles door open/close.
	12 November 2015 at 9:25	70	74	54	87	RTN Meriden Street. Trains on bridge, construction site (approx. 60m N of SLM), birds, pedestrian passing by and talking
	12 November 2015 at 12:34	68	72	55	81	RTN Meriden Street. Trains on bridge, pedestrian passing by and talking, birds.
ST7	11 November 2015 at 15:07	67	70	54	85	RTN Meriden Street. Trains on bridge (slow), indoor construction noise (*Hennessey's*).

Location	Date and start time	L_{eq} dB	L_{10} dB	L_{90} dB	$L_{max,fast}$ dB	Comments
	12 November 2015 at 9:25	69	73	56	93	RTN Meriden Street. Pedestrian passing by and talking.
	12 November 2015 at 12:34	66	70	56	86	RTN Meriden Street. Car repair in garage, car washing (high pressure water).
ST8	11 November 2015 at 16:08	75	76	66	97	RTN B4100. Pedestrian passing by and talking, music form cars, ambulance siren.
	12 November 2015 at 10:12	72	76	65	89	RTN B4100. Pedestrian passing by and talking, music form cars.
	12 November 2015 at 13:20	73	76	64	92	RTN B4100. Pedestrian passing by and talking, music form cars, car horn.
ST9	11 November 2015 at 16:04	73	77	64	89	RTN B4100. Pedestrian passing by and talking, birds.
	12 November 2015 at 10:12	72	76	63	83	RTN B4100. Pedestrian passing by and talking, dog barking.
	12 November 2015 at 13:19	73	77	64	87	RTN B4100. Pedestrian passing by and talking.
ST10	11 November 2015 at 15:40	73	76	64	92	RTN B4100. Pedestrian passing by and talking, birds, alarm pedestrian traffic lights.
	12 November 2015 at 9:50	73	75	64	94	RTN B4100. Pedestrian passing by and talking, alarm pedestrian traffic lights.
	12 November 2015 at 12:57	72	75	65	89	RTN B4100. Pedestrian passing by and talking, alarm pedestrian traffic lights, ambulance siren.
ST11	11 November 2015 at 15:32	71	74	60	97	RTN B4100 - High Street Deritend. Pedestrian passing by and talking.
	12 November 2015 at 9:50	72	76	61	88	RTN B4100 - High Street Deritend. Pedestrian passing by and talking.
	12 November 2015 at 13:00	70	74	61	86	RTN B4100 - High Street Deritend. Unloading van, pedestrian passing by and talking.

1.6 Noise contour maps

1.6.1 Noise contour maps of tram and road traffic noise produced using the acoustic model are shown in figures 1.5 to 1.20. Figures 1.5 to 1.14 show absolute noise levels under a range of conditions whereas figures 15 to show changes in noise levels. These are all described more fully below.

1.6.2 Figures 1.5 and 1.6 show absolute noise levels (L_{eq}) under the Do Minimum scenarios for day and night in the opening year respectively.

1.6.3 Figures 1.7 and 1.8 show absolute noise levels (L_{eq}) under the Do Something scenarios for day and night in the opening year respectively.

1.6.4 Figures 1.9 and 1.10 show absolute noise levels (L_{eq}) under the Do Minimum scenarios for day and night in the design year respectively.

1.6.5 Figures 1.11 and 1.12 show absolute noise levels (L_{eq}) under the Do Something scenarios for day and night in the design year respectively.

1.6.6 Figures 1.13 and 1.14 show absolute noise levels (L_{eq}) under the Do Minimum scenarios for day and night in the opening year but with the addition of tram noise – this is not the same as Do Something for the opening year because the only additional noise source compared with the Do Minimum opening year (figures1. 5 and 1.6) is tram noise whereas the Do Something scenarios for the opening year (in figures 1.7 and 1.8) also incorporates changes due to road traffic for Do Something case.

1.6.7 Figures 1.15 and 1.16 show the change in noise levels between Do Something and Do Minimum for the opening year for day and night respectively.

1.6.8 Figures 1.17 and 1.18 show the change in noise levels between Do Something for the design year and Do Minimum for the opening year for day and night respectively.

1.6.9 Figures 1.19 and 1.20 show the changes in noise levels due to the tram for the opening year for day and night respectively.

1.6.10 The contour maps corresponding to the daytime show in $L_{eq,18h}$ noise levels and for the night-time show in $L_{eq,6h}$ noise levels. All levels are shown with coloured bands covering a 5dB range and with 1dB contours shown within the coloured bands. The same scales and mapped area are used on all the figures to facilitate comparison between them. The tram extension route is shown in light blue and larger buildings are shown as white patches. The boundary for the area shown by the coloured contours is defined by the study area described in the main chapter. It will be noted that the highest noise levels correspond to the heavily trafficked routes and areas close to the mainline railways. The contours were calculated by interpolation between noise calculations at 10m intervals.

1.6.11 The larger white patch in front of Hotel LaTour (approximately one third of the way along the blue line north east to south west for the design year is the proposed HS2 terminal.

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http://pims01/pims/llisapi.dll?func=ll&objid=2093546393&objAction=browse&sort=name

1.6.12 Noise levels are generally higher in the daytime than in the night-time as may be seen by comparing, for example, figures for the do-something-opening-year for the day and night.

Figure 1.5: DMOY Leq Day

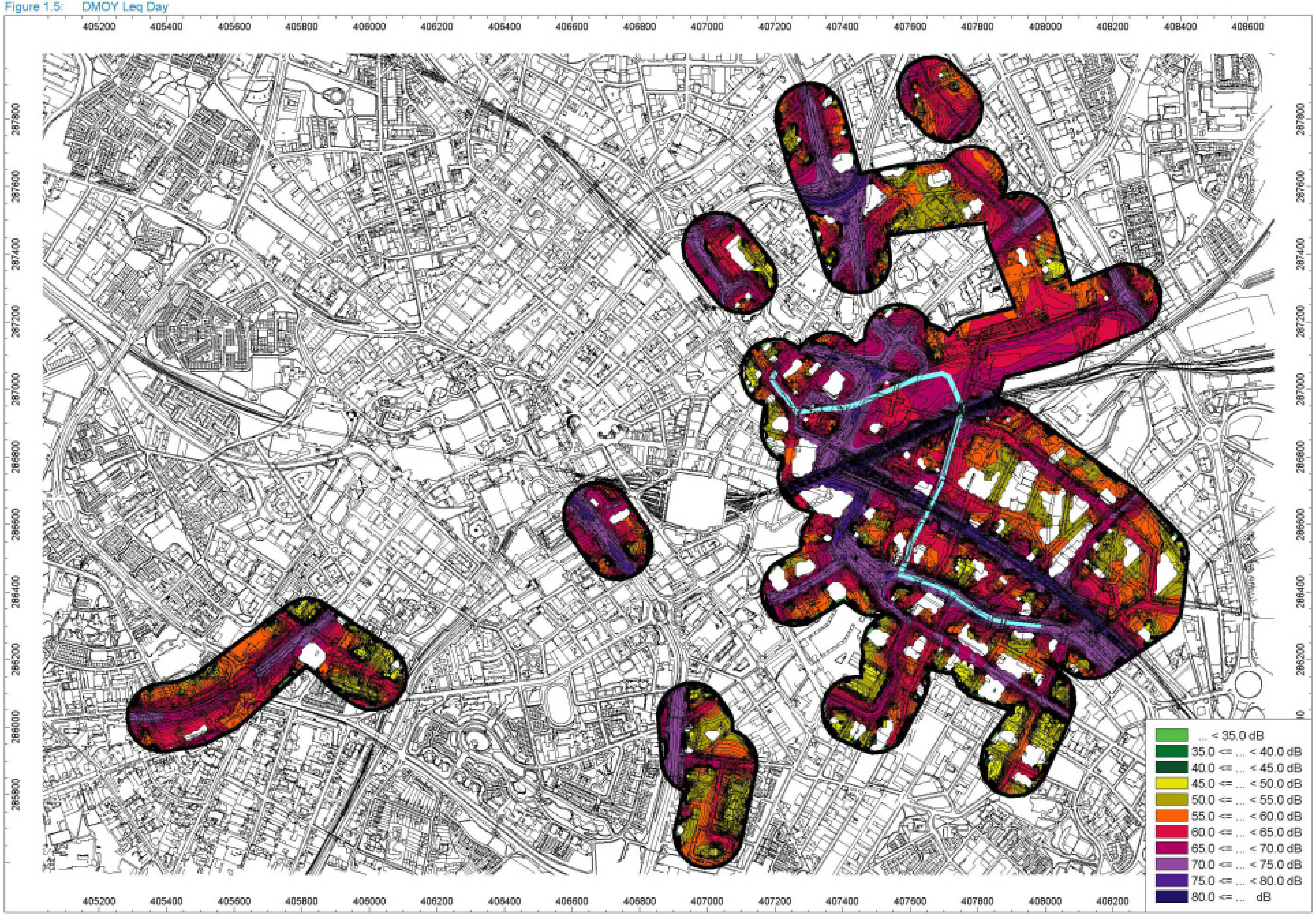
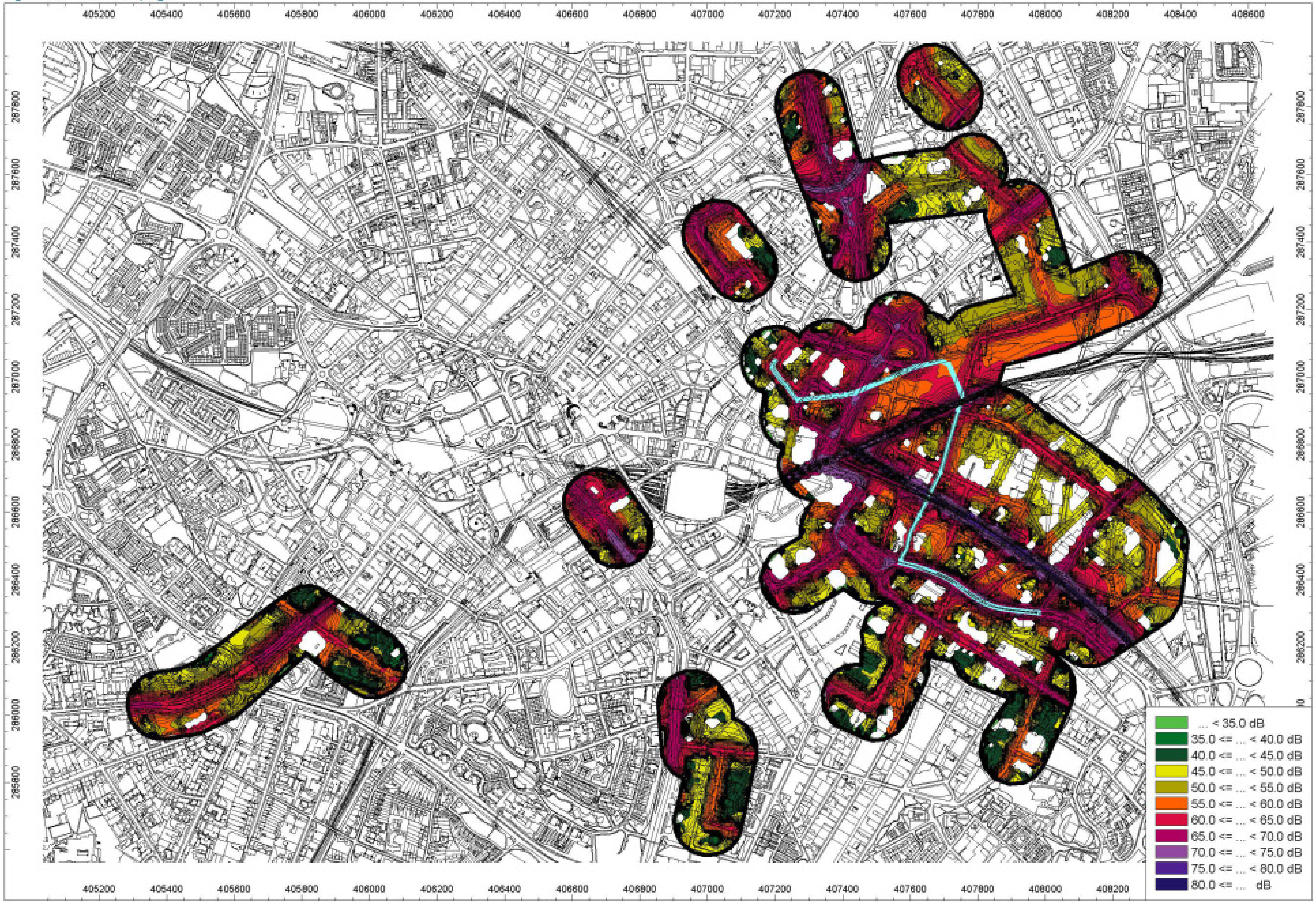


Figure 1.6: DMOY Leq Night



MMD/300207/HS30/DOC/0000/1035/A October 2016
http://pims01/pims/llisapi.dll?func=ll&objid=2093546393&objAction=browse&sort=name

Figure 1.7: DSOY Leq Day

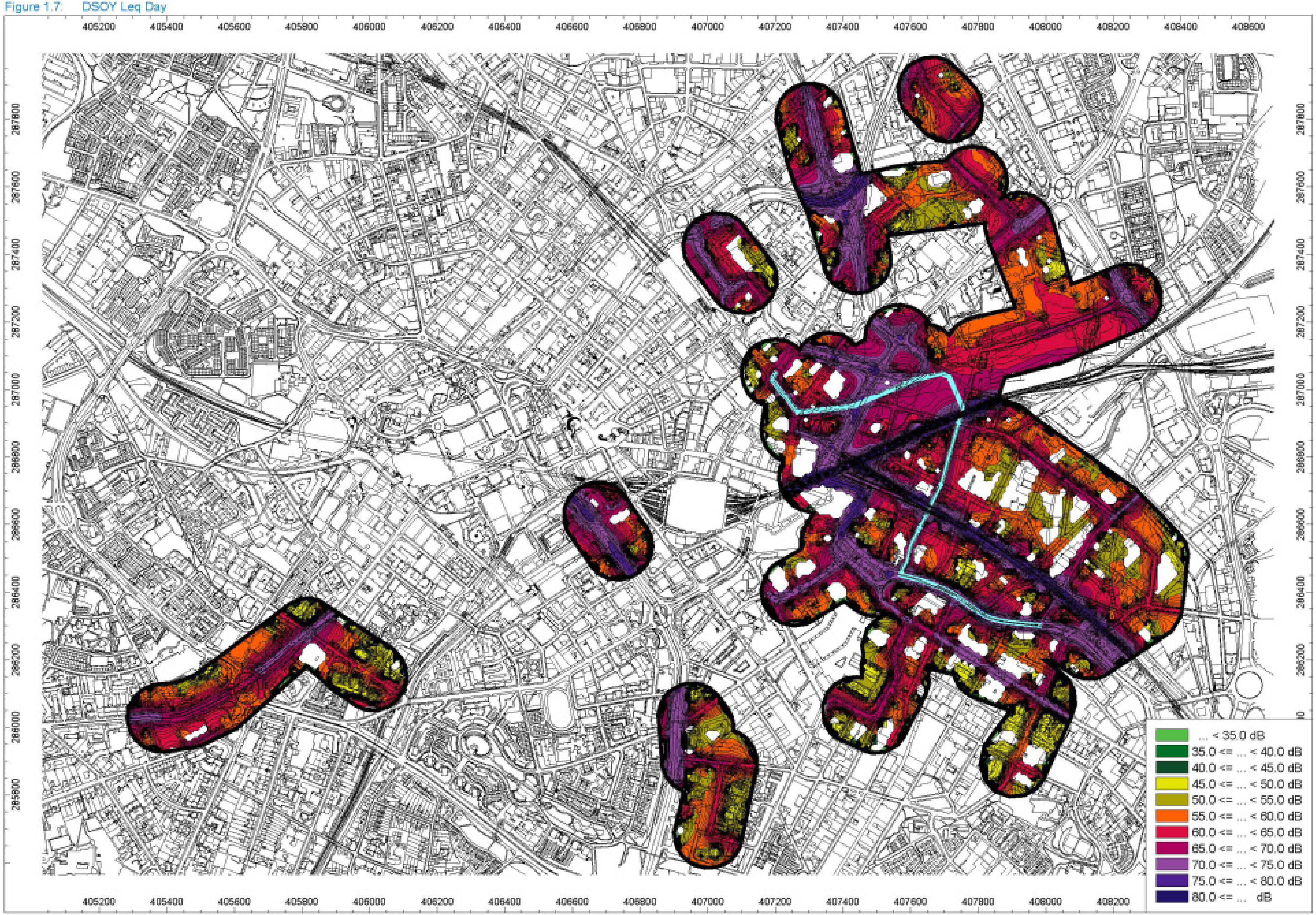


Figure 1.8: DSOY Leq Night

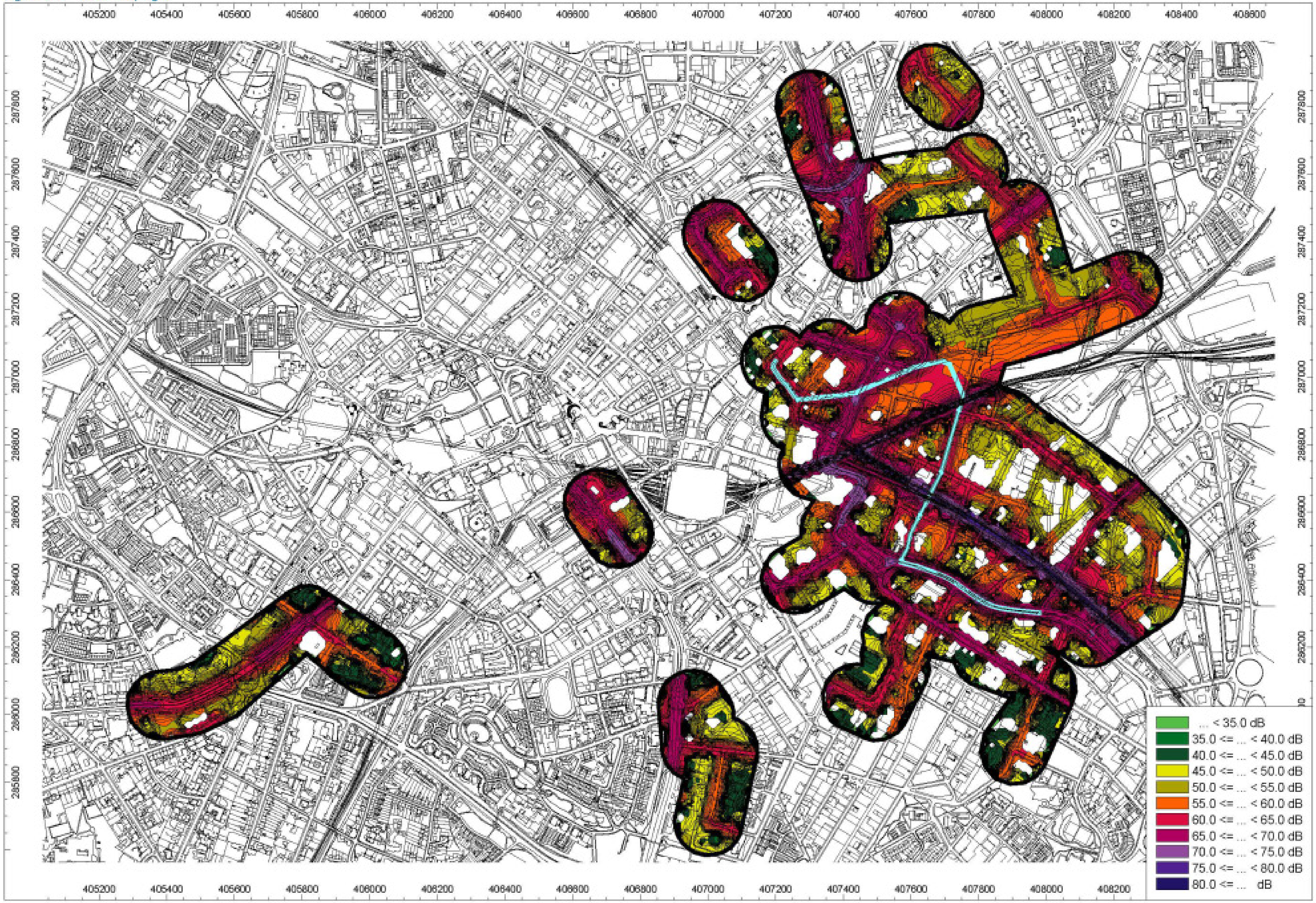
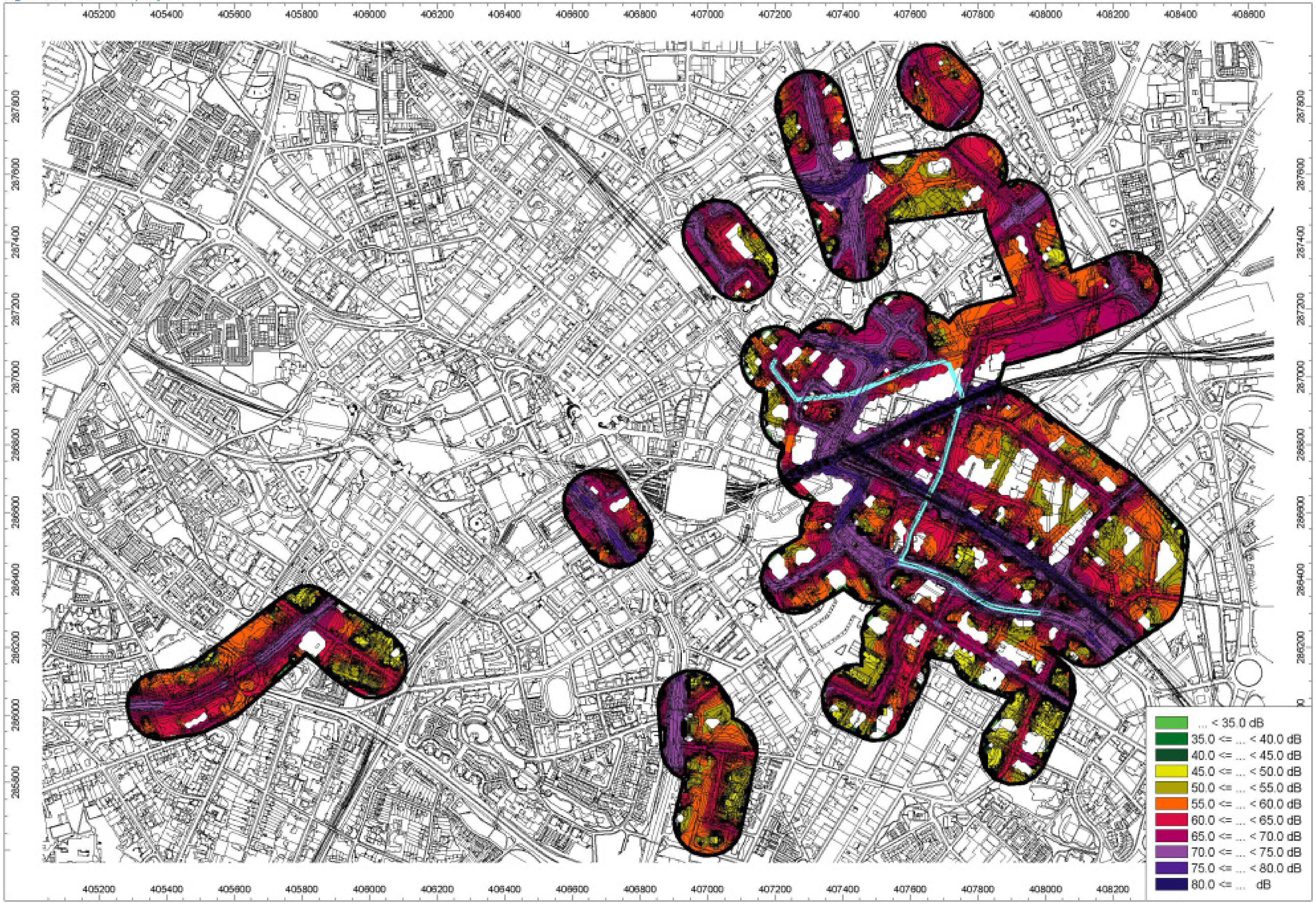


Figure 1.9: DMDY Leq Day



MMD/300207/HS30/DOC/0000/1035/A October 2016
http://pims01/pims/llisapi.dll?func=ll&objid=2093546393&objAction=browse&sort=name

Figure 1.10: DMDY Leq Night

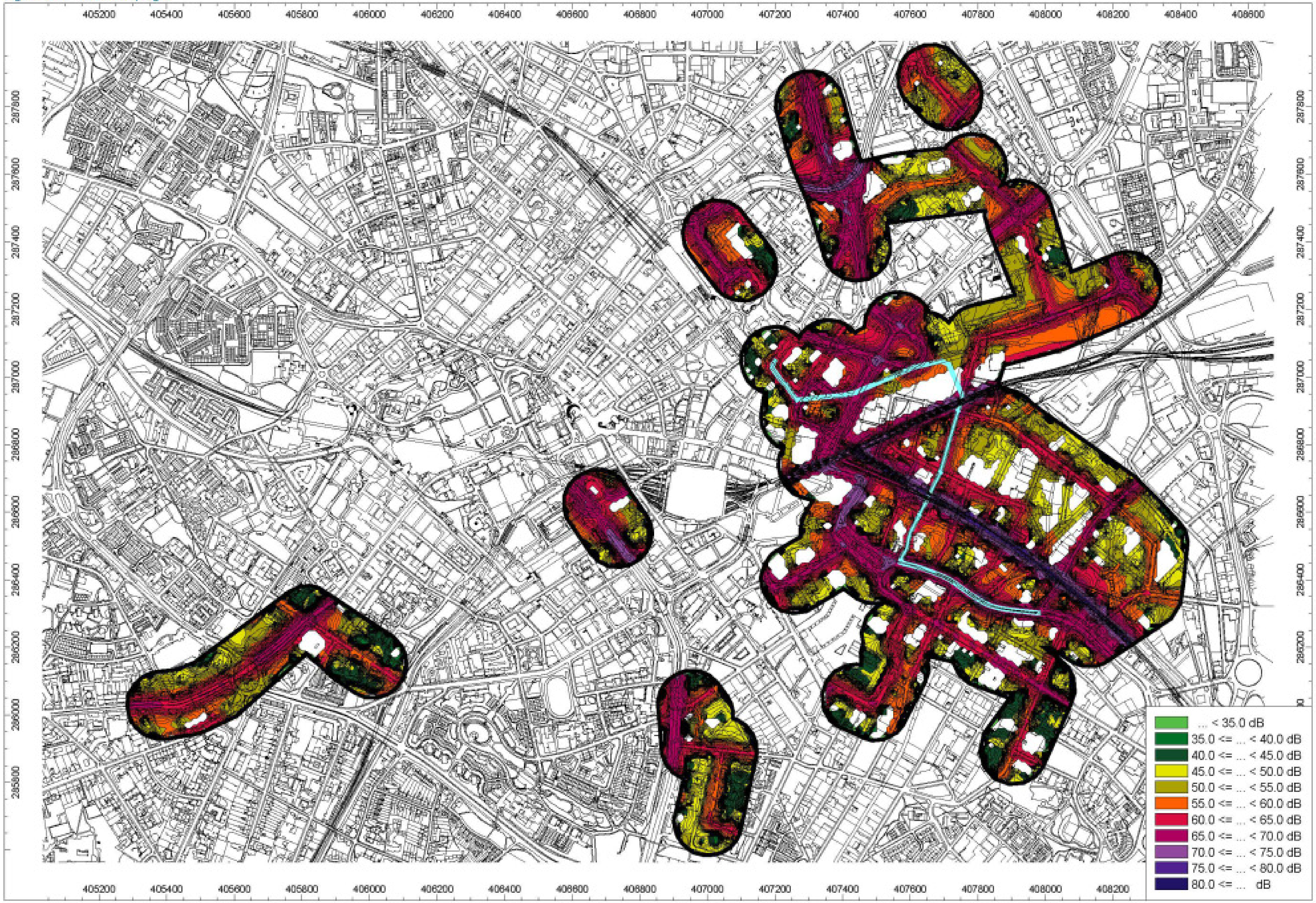


Figure 1.11: DSDY Leq Day

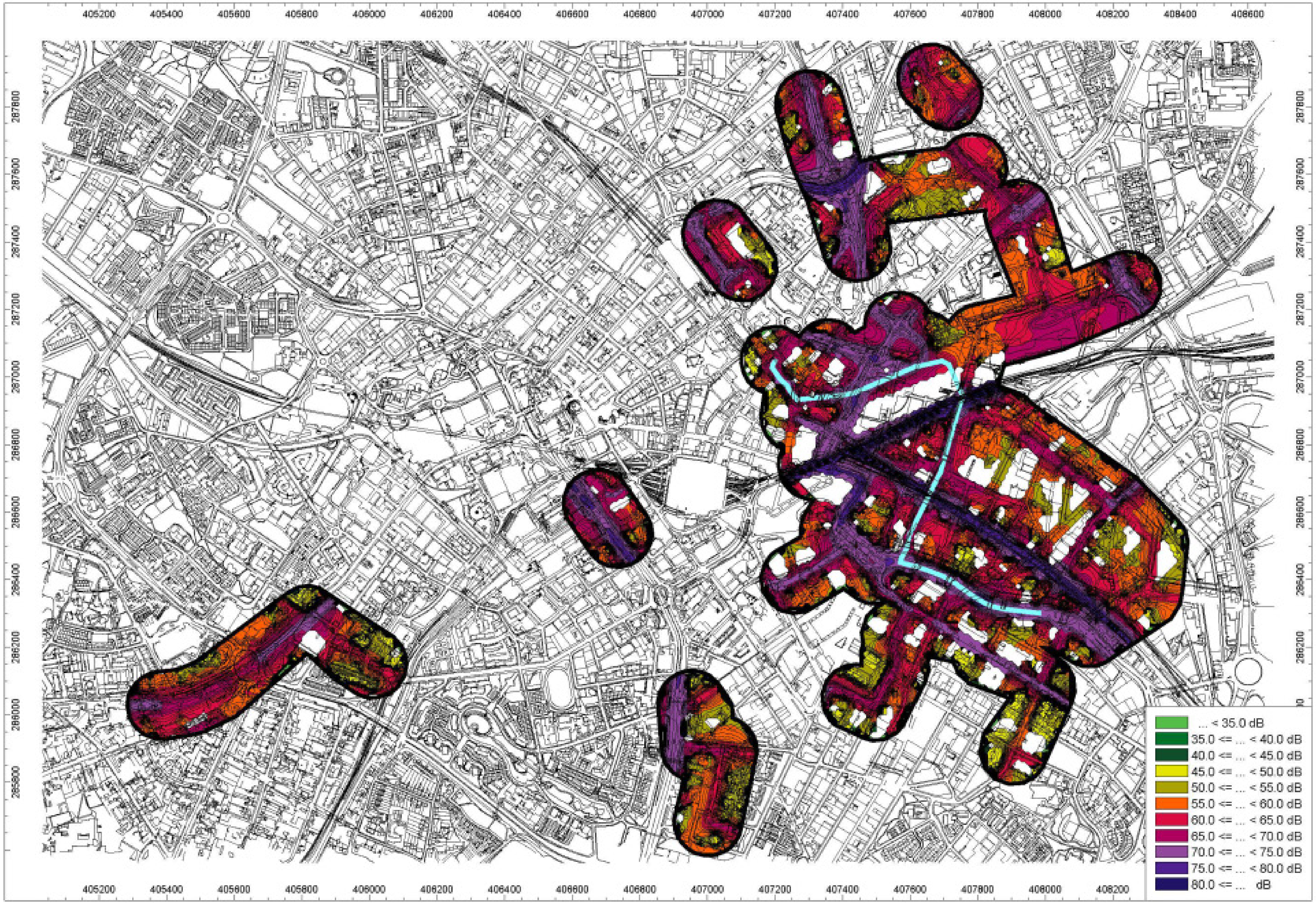
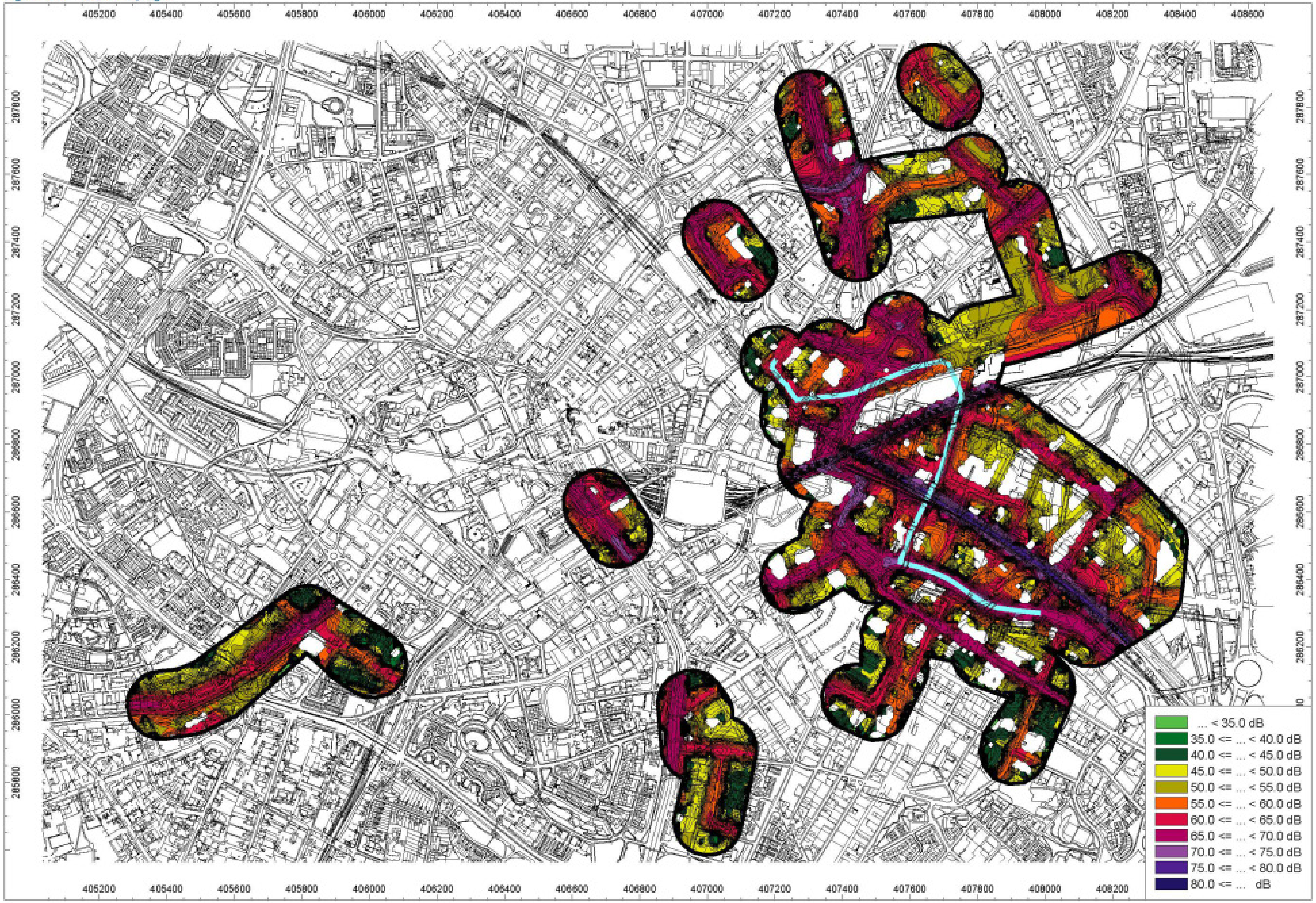


Figure 1.12: DSDY Leq Night



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http://pims01/pims/llisapi.dll?func=ll&objid=2093546393&objAction=browse&sort=name

Figure 1.13: DMOY (+tram) Leq Day

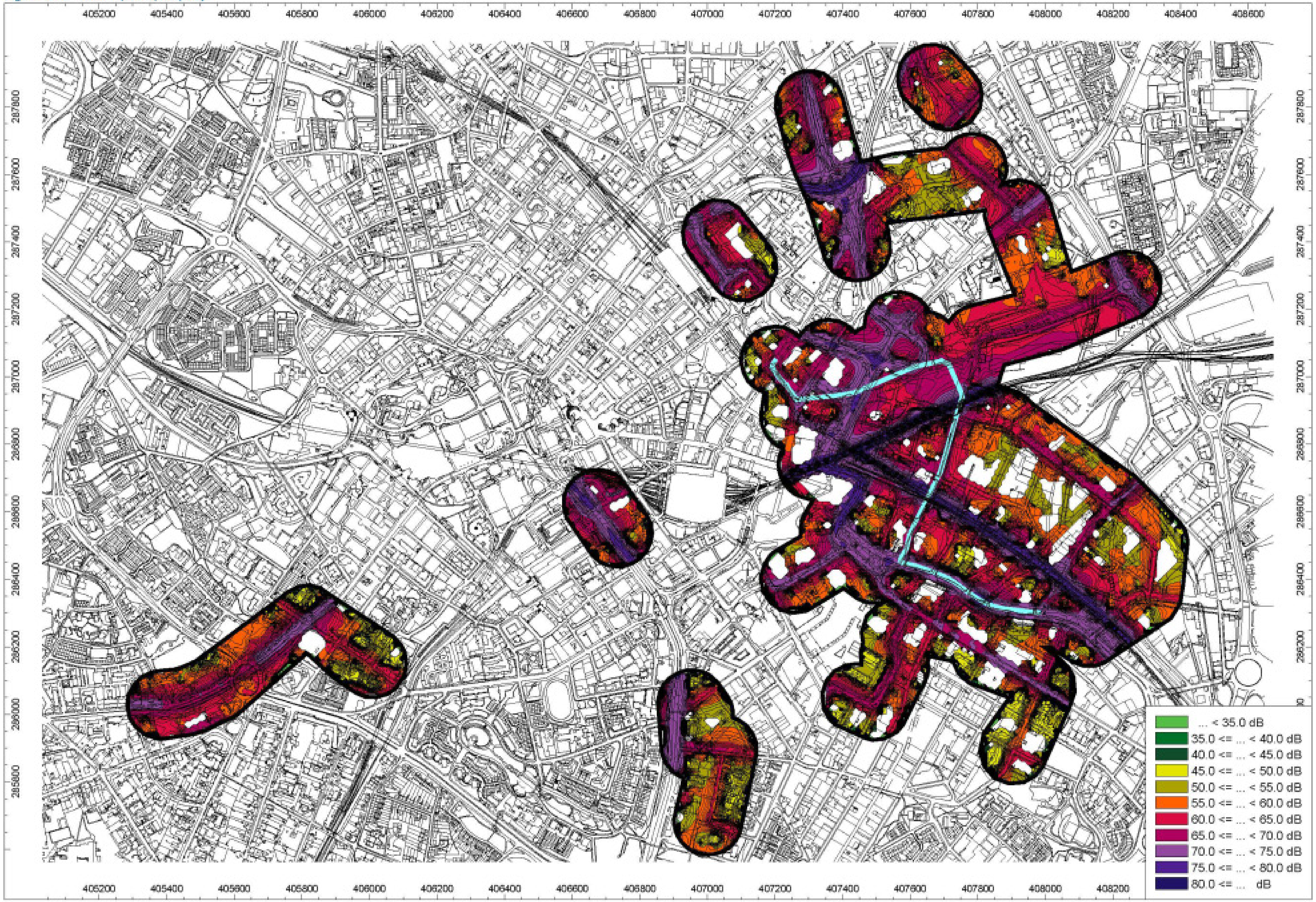
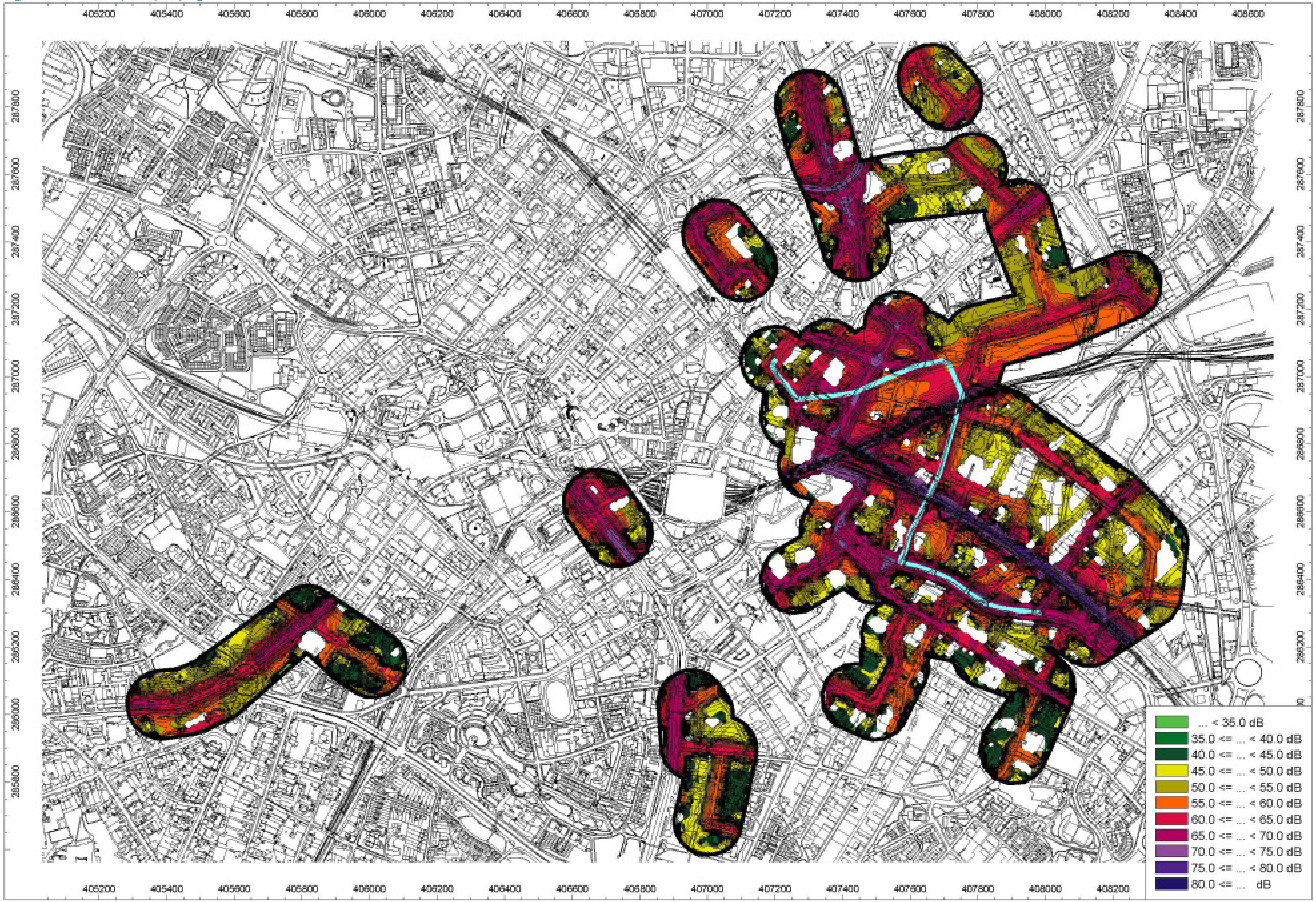


Figure 1.14: DMOY (+tram) Leq Night



MMD/300207/HS30/DOC/0000/1035/A October 2016
http://pims01/pims/llisapi.dll?func=ll&objid=2093546393&objAction=browse&sort=name

Figure 1.15: DSOY - DMOY difference Leq Day

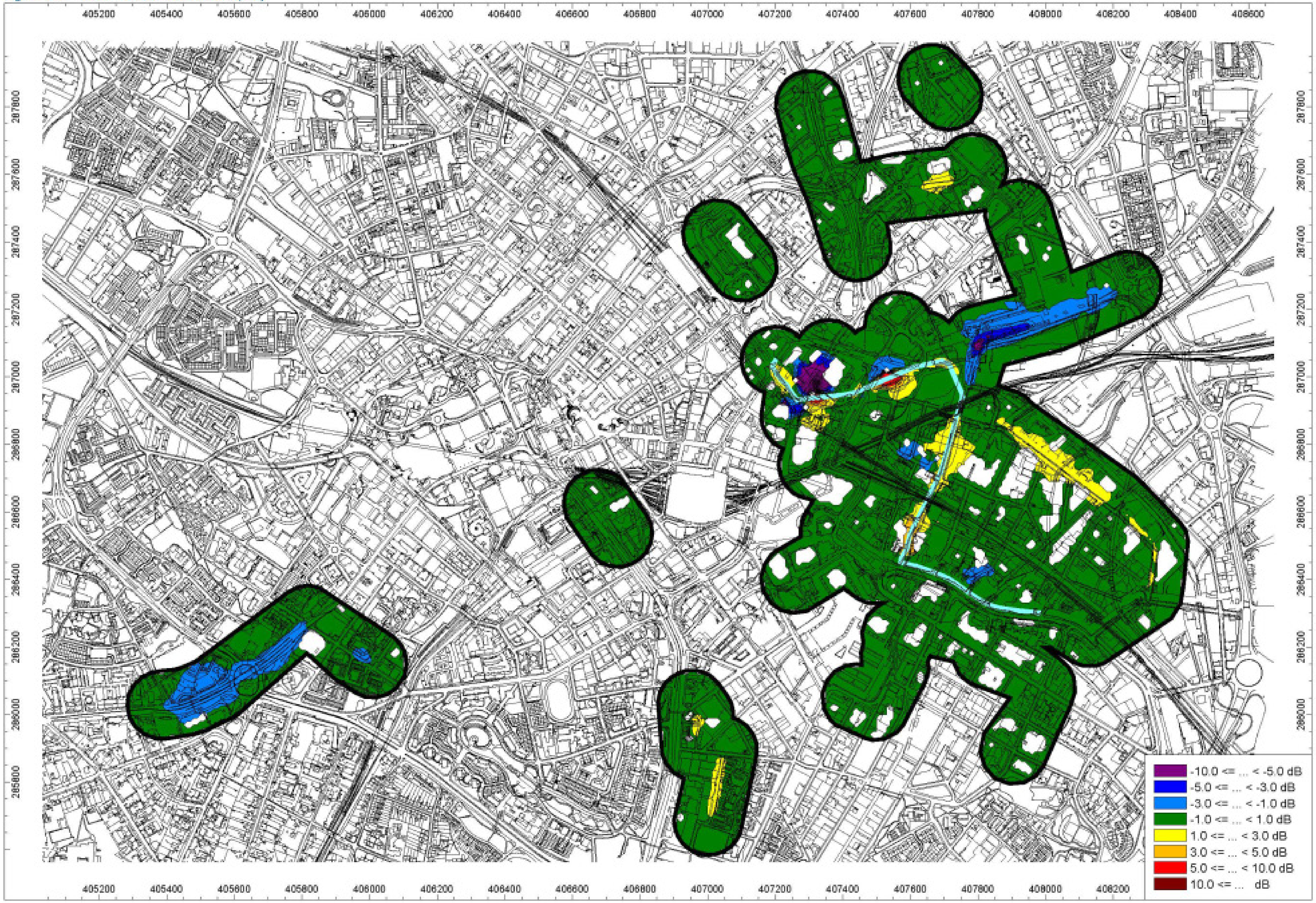


Figure 1.16: DSOY - DMOY difference Leq Night

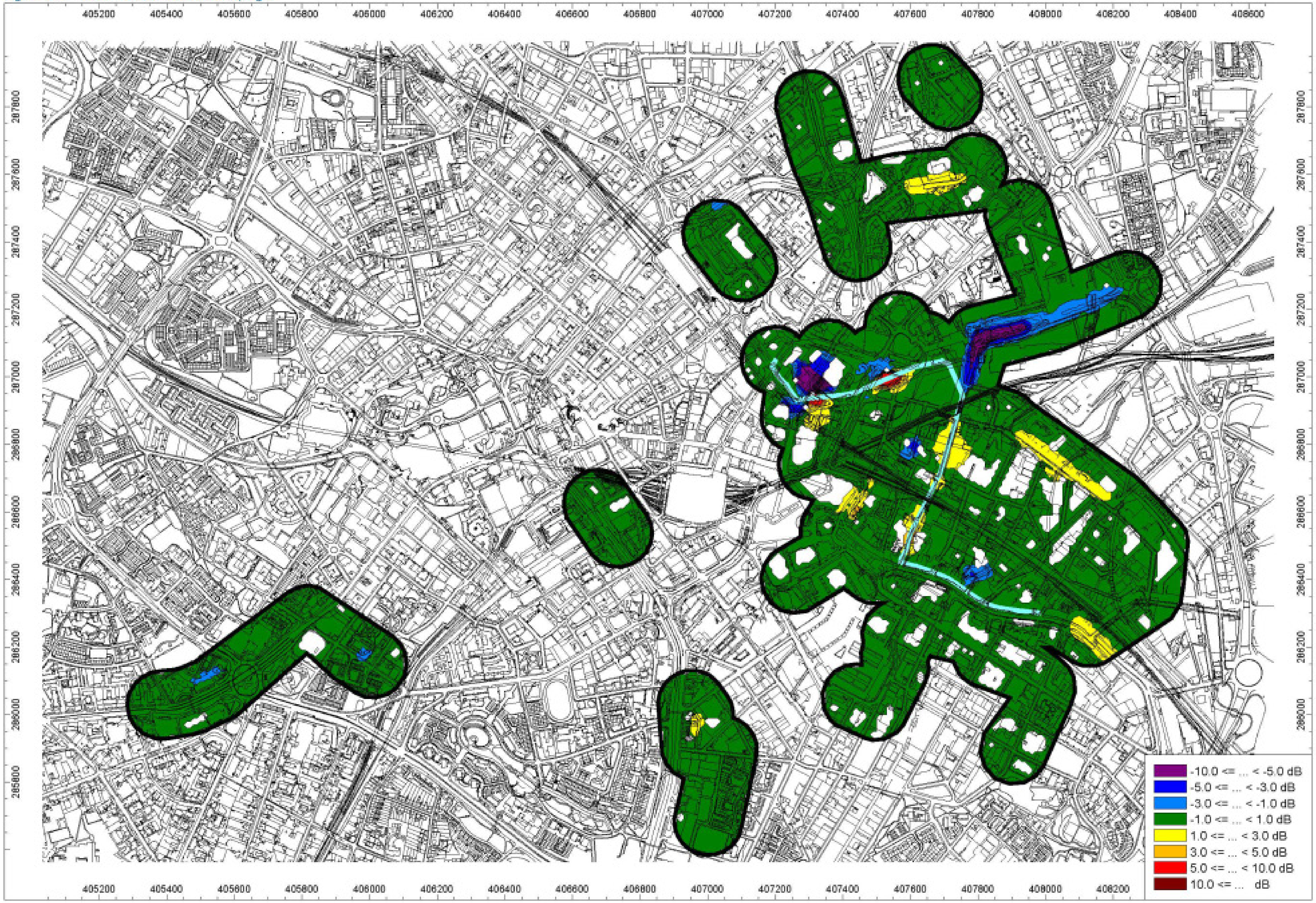


Figure 1.17: DSDY - DMOY difference Leq Day

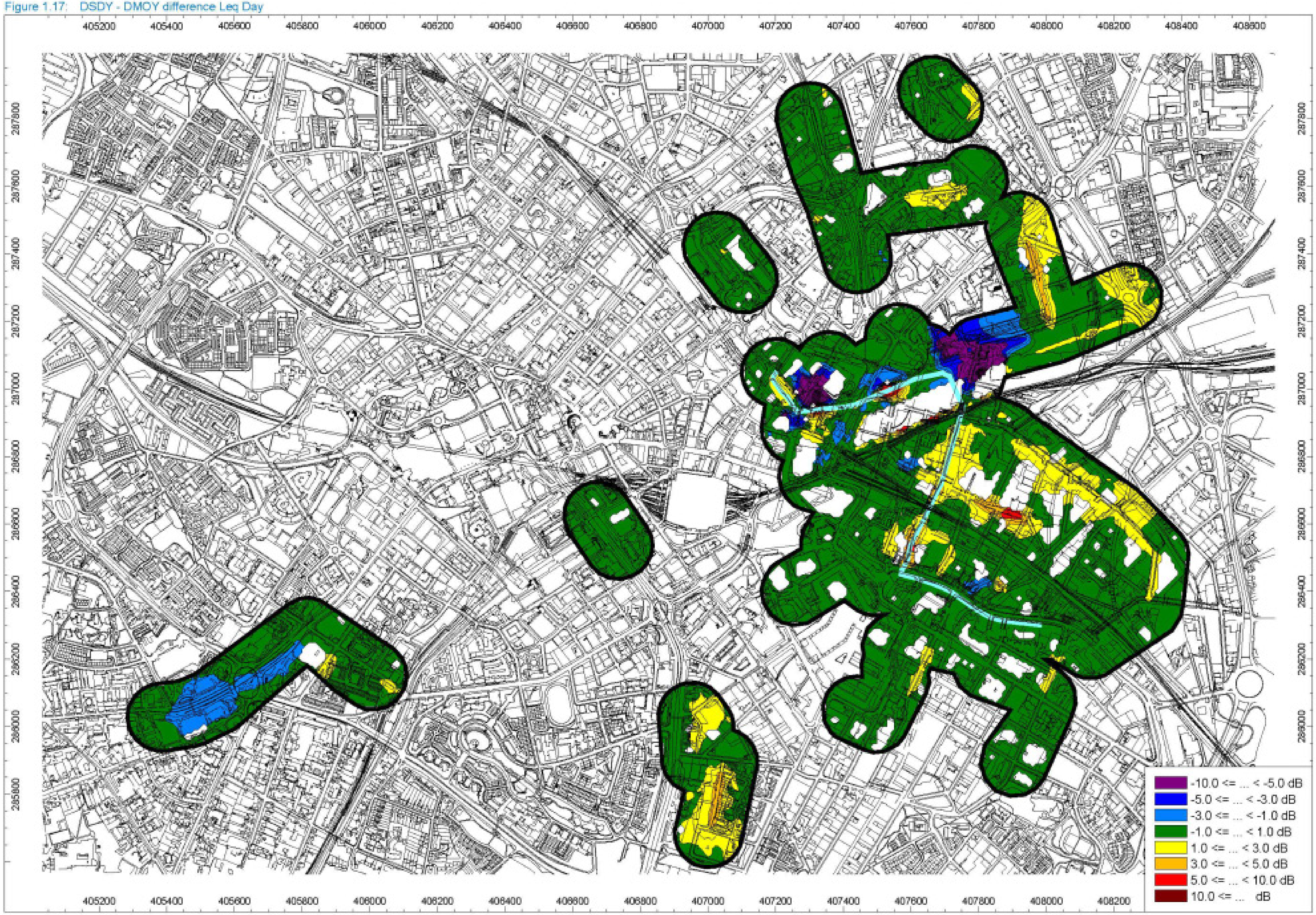
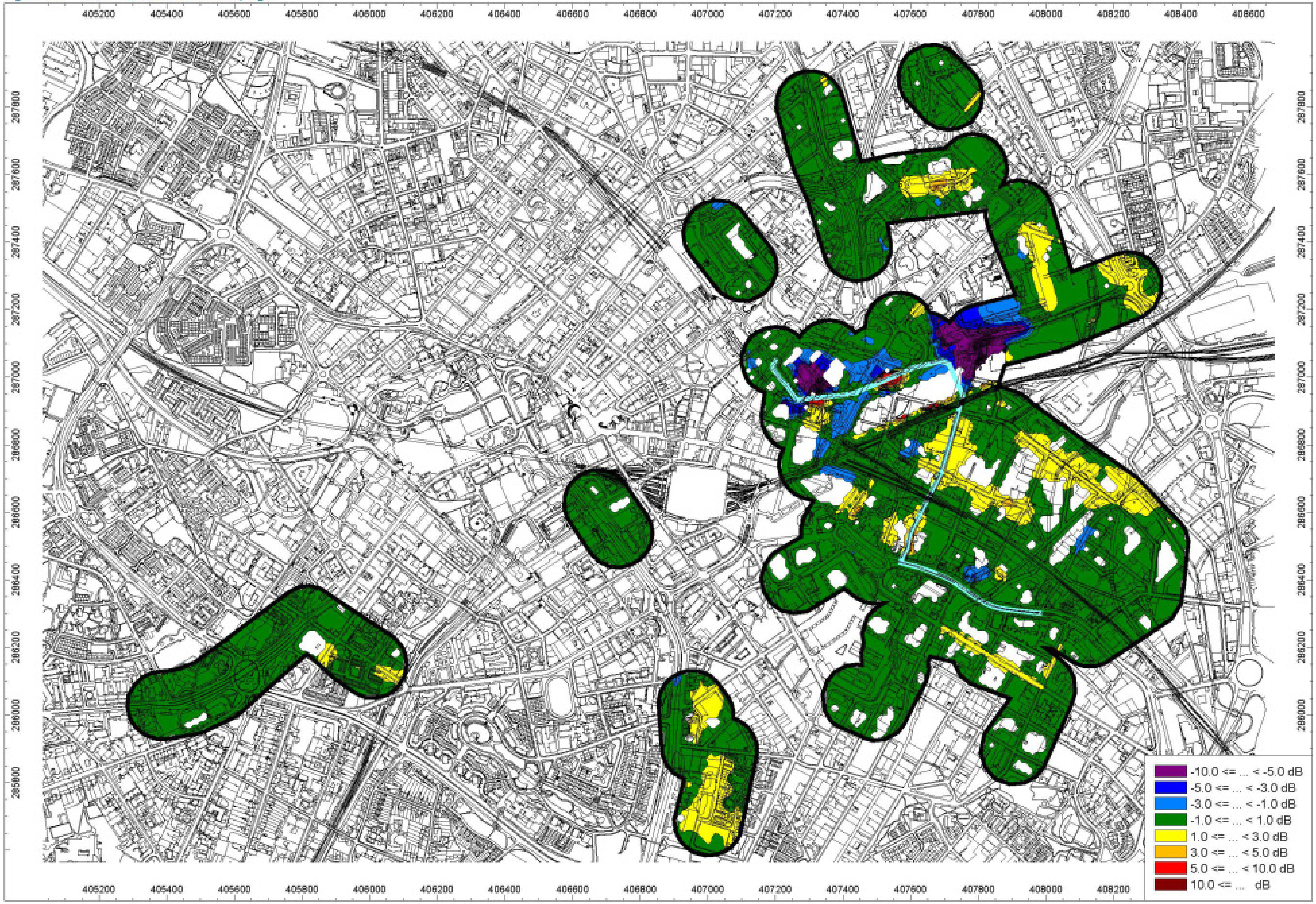


Figure 1.18: DSDY - DMOY difference Leq Night



MMD/300207/HS30/DOC/0000/1035/A October 2016
http://pims01/pims/llisapi.dll?func=ll&objid=20935463938&objAction=browse&sort=name

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Figure 1.19: DMOY (+tram) - DMOY difference Leq Day

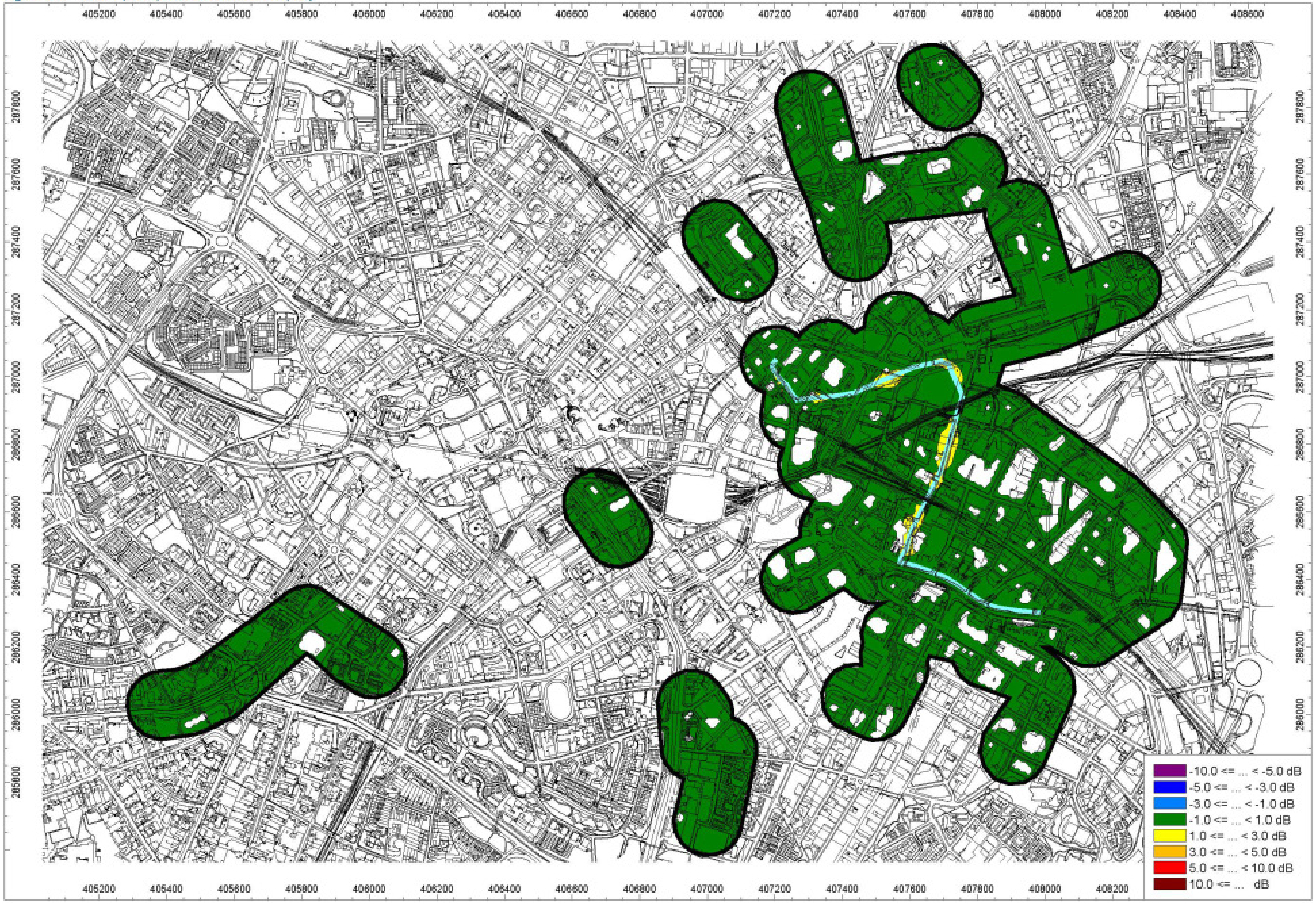
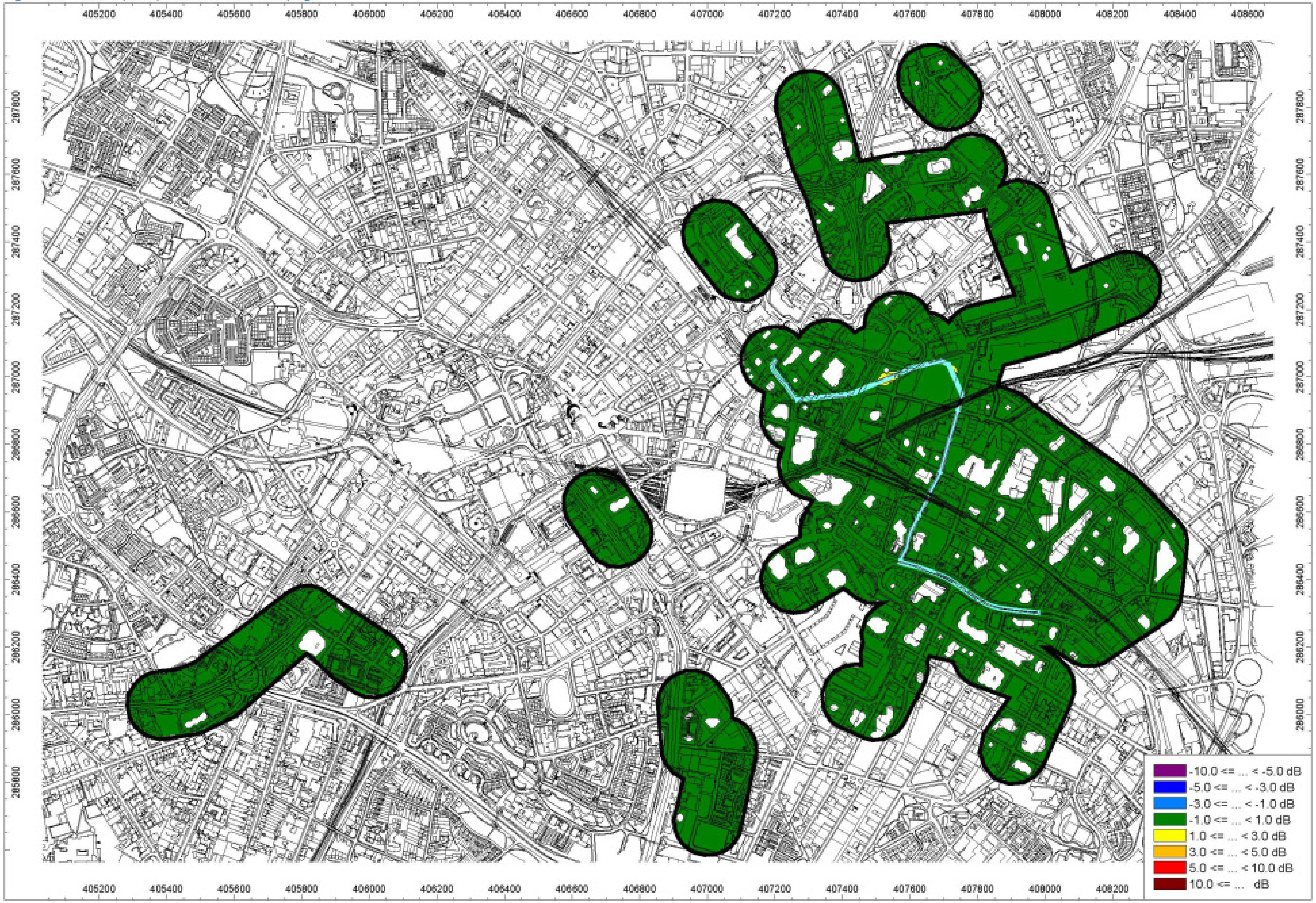


Figure 1.20: DMOY (+tram) - DMOY difference Leq Night



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