A Second Runway for Gatwick

Appendix

A8

Ground Noise

YOUR LONDON AIRPORT
Gatwick

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Gatwick Runway II

1BGround noise

Report HM: 2717/R3

8th May 2014

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GATWICK RUNWAY II,

GROUND NOISE

Report HM: 2717/R3,

8th May 2014

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1. EXECUTIVE SUMMARY

1.1 Ian Flindell & Associates were commissioned by Gatwick Airport Limited to assess ground noise (road traffic noise, aircraft ground noise and construction noise) associated with the proposed second runway development (R2) at Gatwick in support of its Updated Scheme Design submission to the Airports Commission (the Commission). Road traffic noise and aircraft ground noise have been modelled by Hayes McKenzie Partnership Ltd using CADNA-A sound level modelling software. This report compares modelled road traffic and aircraft ground noise average sound levels for R2 in 2040 and 2050 cases (R2-2040 and R2-2050) with a Base Case in 2040 (Base Case) which assumes projected traffic continues to increase into the future but only up to the capacity limits of the airport with its existing single runway.

1.2 **The road traffic noise assessment** shows differences in $L_{A10,18hr}$ calculated road traffic noise sound levels between the 2040 Base Case and the R2 2040 and R2 2050 development cases which exceed the 3dB threshold for moderate short-term and minor long-term impacts (according to the DMRB) out to around 400m from the line of the A23 diversion for the R2 development cases. Allowing for the increased landtake of properties from the R2 development, we estimate that less than 50 properties would be included within this boundary. Many, if not all, of these properties will have qualified for the additional noise insulation and financial compensation schemes that form part of Gatwick's proposed mitigation.

1.3 **The aircraft ground noise assessment** shows that in many areas to the northwest of the airport, aircraft ground noise is predicted to be significantly less for the R2 cases than for the 2040 Base Case. In many areas to the south of the airport, aircraft ground noise is predicted to be significantly higher under the R2 cases. However, most (if not all) of the properties in these areas will benefit from the embedded mitigation provided by the proposed noise bunds around the western end of the airport and the noise wall around the south eastern corner of the airport in addition to the enhanced noise insulation and additional financial compensation schemes proposed by Gatwick.

1.4 **The qualitative construction noise assessment** shows that while it is too early in the design process to permit quantitative assessment of construction noise, there is no reason why any noise issues arising could not be managed satisfactorily by following the methods summarised in the text.

1.5 Considered overall, while it must be acknowledged that the development and bringing into use of a new second runway at Gatwick will unavoidably increase the numbers of properties to the south of the airport exposed to ground noise as compared to the existing single runway airport, it would also lead to reductions in ground noise impacts on properties to the north of the airport. The number of properties to the south is, however, limited by the surrounding character of built development, with much of the developed land immediately to the south of the airport being industrial development within Manor Royal Business District, with only limited areas of residential properties in close proximity to the expanded airport.

1.6 A range of mitigation measures are proposed that will minimise and reduce the number of properties and residents likely to be exposed to increases in ground noise. These include engineering features such as noise barriers, walls and bunds; aircraft ground noise controls on aircraft taxiing and APU use; and other operational restrictions that will limit both air and ground noise. In addition Gatwick's recently extended single runway Noise Insulation Scheme, which is based on the 60dBA$_{Leq}$ air noise contour, would be extended further with R2 and the area it would encompass would also benefit properties that are subject to increased ground noise. Gatwick has also announced a Council Tax Initiative that will provide compensation to those most affected by the R2 development. The area of the scheme (based on the 57dBA$_{Leq}$ air noise contour) would also cover those adversely affected by ground noise. The Noise Insulation Scheme and Council Tax Initiative would be the most generous package currently offered at any other airport in England, and as far as is known, anywhere else in the world.

2. INTRODUCTION

2.1 Ian Flindell & Associates were commissioned by Gatwick Airport Limited (Gatwick) to assess ground noise associated with the proposed second runway development (R2) at Gatwick in support of its Updated Scheme Design submission to the Commission (the Commission). This report sets out the results of assessment work that has been undertaken on the impacts that R2 would have on road traffic noise, aircraft ground noise and construction noise.

2.2 In the final version of the Appraisal Framework published in April 2014, in paragraph 5.15, second bullet point, the Commission specifies '*for the local assessment, a high level consideration of changes to **surface access noise**, modelled where a 25% or greater change in traffic flow is expected*'. In paragraph 5.8, the Commission specifies '*In addition, specific nuances of noise impacts will be assessed at a local level, considering **background noise levels**. As well as air noise (take off and departure, approach and landing), an assessment of **ground noise** (including contributions from reverse thrust, taxi-ing, hold, APU use and engine testing) will be included*'. The Commission has not set out any requirements for ***construction noise*** assessment, and construction noise is only assessed qualitatively in this report.

2.3 ***Road traffic noise*** and ***aircraft ground noise*** have been modelled by Hayes McKenzie Partnership Ltd using CADNA-A sound level modelling software. This report compares modelled road traffic and aircraft ground noise average sound levels for R2 in 2040 and 2050 cases (R2-2040 and R2-2050) with a Base Case in 2040 (Base Case) which assumes projected traffic continues to increase into the future but only up to the capacity limits of the airport with its existing single runway.

2.4 The aircraft ground noise assessment in this report covers taxiing, holding and APU noise but does not cover reverse thrust or engine testing. Reverse thrust is not covered in this assessment because it is already covered in the air noise assessment and to include it in the ground noise assessment as well would be double counting. Engine testing at idle power on aircraft stands immediately prior to departure as part of normal operations is subsumed within normal taxiing operations and not separately identifiable at receiver locations outside the airport boundary. High power engine testing in defined maintenance areas is strictly controlled under airport director's instructions and there is at present no information which could support any quantitative comparison between the R2 2040 and R2 2050 development cases and the corresponding 2040 Base Case. The additional mitigation proposed for R2 includes a commitment that Gatwick will work with the members of GATCOM to explore the possibility of including a ground run pen.

2.5 The road traffic and aircraft ground noise contours presented in this report are based on road traffic and air traffic data provided by Gatwick to represent each of the modelled scenarios.

2.6 The assessment described in this report assumes that aircraft taxiing from the north apron to the mid-field terminals or to the south runway and vice versa would have to cross the north runway. Gatwick's Masterplan submission also identifies a possible alternative solution which includes End Around Taxiways (EATs) around each end of the existing north runway which would reduce or eliminate the need for these runway crossings. This alternative option is included in the Runway Options Consultation document published by Gatwick in April 2014 (see Appendix 2). Appendix A of this report summarises how the alternative option with end around taxiways would affect the results of this assessment.

2.7 This report is structured as follows: Chapter 3 describes the modelled noise sources; Chapter 4 describes the methodology used to calculate sound level contours and sound levels at defined locations; Chapter 5 sets out the results of the assessment; Chapter 6 discusses embedded and additional mitigation; and Chapter 7 sets out the conclusions. All figures are included in Appendix B at the end of the report.

3. NOISE SOURCES

3.1 Operational noise from airports is considered either as ***air noise*** (aircraft taking off, in flight, or landing) or ***ground noise*** (anything which does not come under the heading of air noise). Except in areas off to either side of the airport which are not under flight tracks but are relatively close to aprons and taxiways, aircraft ground noise is generally less significant than air noise, although it can continue for extended periods of time in between time-separated air noise events.

3.2 The most significant sources of aircraft ground noise are:

a. aircraft taxiing under their own power from the arrivals runway to the designated parking stands and then back to the departures runway prior to take-off.
b. Aircraft auxiliary power units (APUs) can also be significant at times when the airport is

otherwise quiet.

c. Road traffic noise can be significant in areas close to main roads.

3.3 Construction noise can also be significant for periods of time. However, construction noise is considered separately from operational noise because it is essentially temporary in nature. Construction noise is generated by construction plant and machinery operating during the construction phase of a project, including the supply and delivery of construction materials onto a site and the removal of waste products from it. It is generally not possible to assess construction noise quantitatively until a project is relatively close to the construction phase when more details about construction equipment would be available.

3.4 Other types of mobile and fixed ground support equipment and fixed plant, while they may be significant at short distances, are not generally significant at receiver locations outside the airport boundary, and can be regulated and controlled if they contribute to any specific noise problems.

3.5 Other sources of general neighbourhood and background noise are not considered in this report except in so far as they establish a baseline below which many types of airport ground noise would not be heard.

4. METHODOLOGY AND ASSUMPTIONS FOR SOUND LEVEL CALCULATIONS

4.1 All noise modelling techniques generally take into account the sound power, operating times, and directivity of the sources, the geographical distributions of those sources in relation to distant receiver locations and the attenuation of sound with distance from each source to each receiver location around the airport. Noise contours are produced by interpolation between calculated sound levels at spot locations distributed over a regularly spaced grid. The main benefits of computer modelling are that it can support complex models with large numbers of sources (or source positions) and large grids of receiver locations and can also be adapted to deal with alternative layouts and operating assumptions relatively quickly.

Road Traffic Noise

4.2 The standard method for modelling road traffic noise is set out in the Department of Transport/Welsh Office Memorandum - Calculation of Road Traffic Noise (CRTN) (Department of Transport, 1998). This memorandum sets out the precise procedures to be used to determine statutory entitlement to noise insulation provided in mitigation of increased road traffic noise arising from new road schemes and is typically used for all kinds of road traffic noise assessment in England and Wales. The specified noise metric is the $L_{A10,18hr}$, which is defined as the average of the A-weighted sound levels exceeded for 10% of the time in each hour of the 18 hours from 0600 am to 2400 pm on an average day and calculated (or measured in the case of existing roads) according to CRTN. The implementation of CRTN within CADNA-A noise modelling software was used for this assessment. It should be noted that the $L_{A10,18hr}$ noise metric used for road traffic noise assessment is not strictly comparable with the LAeq-based noise metrics used for most other types of noise assessment in the UK, although, and depending on the specific circumstances at the time, the numeric values are often not greatly different. The $L_{A10,18hr}$ noise metric is not suitable for the assessment of intermittent noise sources such as air noise, particularly if noise events are only present for less than 10% of the time.

4.3 Road traffic sound levels across the study area have been calculated based on projected traffic flows for the 2040 Base Case and also for the R2 development in both 2040 and 2050. Predictions are limited to traffic data that has been supplied for the main routes around the airport. It is not expected that traffic on local roads would be significantly different between the modelled cases. For the high level consideration of changes in road traffic noise specified by the Commission, the differences between the predicted road traffic sound levels have been used to show the effect of the R2 development. It should be noted that the road traffic noise assessment carried out for this report takes into account both the changes in road traffic flows and the changes in road layouts arising under the R2 development. The road traffic flow data and road layouts were provided by Gatwick. The 2040 Base Case road traffic flow data was provided as 24 hour road traffic flows, rather than the 18 hour road traffic flows required for CRTN assessment and was therefore converted to the equivalent 18 hour flows by multiplying by 0.75. This is likely to marginally underestimate actual 18 hour flows and therefore represents a worse case when compared against the R2 2040 and 2050 cases for which the required 18 hour flows were provided directly. The difference when translated into equivalent $L_{A10,18hrs}$ sound levels is, however, likely to be completely negligible.

4.4 The input data provided by Gatwick does not extend down to the level of granularity required to estimate road traffic sound levels in the vicinity of road junctions where detailed and to some extent unpredictable differences in driver behaviour can affect actual sound levels both above and below those calculated according to the standard CRTN methodology. This simplification is perfectly acceptable for a high level assessment such as required by the Commission. Table 1 below (as provided within the DMRB[1]) shows suggested criteria for assessing road traffic noise impact based on the calculated difference between the Do-mimimum (ie 2040 Base Case) and Do-Something (R2 2040 and R2 2050) cases. Note that DMRB specifies lower criteria for short term than for long term impacts, presumably to account for an assumed effect of reducing sensitivity to increased noise after longer time exposure. It is assumed that residents who are more sensitive to the increased noise may have moved away over the longer term while new residents who are presumably less sensitive to absolute levels of noise may have moved in, and long term residents may have become more acclimatised to the noise. In addition, DRMB states that *'In terms of road traffic noise, a methodology has not yet been developed to assign a significance according to both the value of a resource and the magnitude of an impact'*. This statement is presumably intended as recognition that noise disturbance and annoyance depend on many other so-called non-acoustic variables in addition to sound levels alone.

Table 1: DMRB Classification of Magnitude of Noise Impacts

Magnitude of Impact	Noise Change (dB, Short Term)	Noise Change (dB, Long Term)
No Change	0	0
Negligible	0.1 – 0.9	0.1 – 2.9
Minor	1 – 2.9	3 – 4.9
Moderate	3 – 4.9	5 – 9.9
Major	5 +	10 +

Aircraft Ground Noise

4.5 The aircraft ground noise assessment in this report is based on modelled aircraft ground noise LAeq contours for daytime (0700 hrs to 1900 hrs), evening (1900 hrs to 2300 hrs), and night-time (2300 hrs to 0700 hrs) time periods for both easterly and westerly operations separately for the three cases that have been assessed. The modelled data is tabulated for 14 representative receiver locations distributed in different directions around the airport and

[1] Highways Agency, November 2011, *The design manual for roads and bridges (DMRB)*, Vol 11, Sec 3, Part 7.

indicated on each noise contour plot. The same methods were used as in previous assessments of aircraft ground noise at Gatwick.

4.6 For the purposes of the aircraft ground noise model, the many different aircraft types predicted to use each modelled option in future scenario years have been categorised as either ‘large’ or ‘small’ generic types. The first generic type is representative of the 'jumbo' size aircraft taxiing and APU sound levels as first measured for the Heathrow Terminal 5 Public Inquiry. The second generic type is representative of the majority of small stand size category twin-jet aircraft currently operating at Gatwick and is based on measurements of an Airbus A319 aircraft carried out at Stansted Airport on 29 January 2007. The extent to which newer aircraft types may be quieter than those actually measured for the ground noise calculation model contributes to uncertainties arising from this cause. Because of progress made in engineering noise control generally, it is unlikely that any more recent and future types of aircraft introduced since the original measurements were made would be any noisier.

4.7 The APU sound levels were measured at 150m radius under loading conditions which were assumed to be representative of the maximum loading likely to occur under normal operations, with ancillary equipment such as air conditioning systems operating normally. Actual sound levels could be lower than those measured under different conditions where, for example, the APU might be running at idle power without supplying any load.

4.8 The taxiing noise sound levels were also measured at 150m radius for both idle and breakaway thrust settings which were assumed to be typical for normal taxiing. There is sufficient residual thrust even at idle power settings to maintain forward motion during normal taxiing, but pilots can choose to use higher breakaway thrust settings for a few seconds to assist the aircraft to accelerate rapidly from rest or to negotiate a particularly sharp bend. Sound levels are not directly affected by the speed of taxiing but only by the thrust setting needed to maintain that speed.

4.9 Air traffic data has been provided by Gatwick which separates the predicted aircraft movements into three stand size categories, C, E and F. All category C aircraft movements have been represented by the ‘small’ aircraft type model whilst the remaining larger aircraft movements have all been been represented by the ‘large’ aircraft type model. Based on the measurements, the reference sound power level used for APUs operating on category C stands is 114.3 L_{wA} and 116.7 L_{wA} for category E and F stands. The second figure takes into account the predicted proportion of small stand size category aircraft which would also be likely to use the large size stands in accordance with the predicted aircraft movement data in 2040. The reference sound power level used for taxiing along any route within the airport is 135.1 L_{wA}. This figure also takes into account the predicted proportions of the different stand size category aircraft types predicted to use the airport in 2040.

4.10 Directivity patterns of small and large aircraft were determined by direct measurements at 10 degree increments around each aircraft measured, with constant operating conditions throughout each measurement. For taxiing aircraft it is not practical to carry out radial measurements while the aircraft is actually moving, which is the reason for measuring around a stationary aircraft. Directivity corrections were applied based on the measurements. The directivity pattern for taxiing aircraft is shown at Figure 22. It should be noted that the actual sound power levels and directivity corrections are relatively insensitive to small changes in the relative proportions of small and large aircraft types.

4.11 The acoustic propagation model is as set out in ISO 9613 Part 1 (1993)[2] and Part 2 (1996)[3], with point noise sources for both APU and taxiing noise assumed for a grid of potential source locations around the airport. Unavoidable simplifications adopted for the purposes of the noise model mean that actual sound levels may vary to some extent above and below those calculated in different directions around the airport. For example, and in accordance with the standard, only the attenuation terms in the 500 Hz frequency band are used. Measurements have shown that while the relative frequency content changes in different directions with small changes in engine rotational speed (rpm) at the low power settings used in normal taxiing, the overall effect on average A-weighted sound levels is (usually) quite small. Air turbulence caused by cross winds or upwind obstructions can have a much bigger effect on A-weighted front end fan sound levels than any increases associated with breakaway thrust.

4.12 The aircraft source sound levels used in the calculation take these sources of variability into account by generally representing the maximum sound levels in each direction out of those actually measured. This means that, for some angles around individual aircraft, actual sound levels could be marginally higher or significantly lower than those modelled. For example, for

[2] ISO 9613-1, Acoustics – *Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere*, 1993.

[3] ISO 9613-2, Acoustics – *Attenuation of sound during propagation outdoors – Part 2: General method of calculation*, 1996.

operating conditions in which the engine air intakes are able to ingest undisturbed air flows without significant turbulence, actual sound levels around the front of the aircraft could be considerably lower than those modelled. On the other hand, aircraft operating on a busy airfield or in a pre-departure queue immediately prior to take-off are likely to ingest turbulent air flows from the aircraft in front. The reference sound levels used in the modelling represent the best estimate of long-term average sound levels based on currently available data.

4.13 It should be noted that the aircraft ground noise calculation model is based on a limited number of actual measurements carried out relatively close to each source (150m). The attenuation out to typical receiver distances of several hundred metres and more is then calculated using the ISO standard model. At typical receiver distances, while aircraft ground noise may be audible from time to time, it is not generally possible to be able to isolate by objective measurement the separate contributions made by aircraft ground noise to overall ambient sound levels because of the confounding effect of other noise sources present. This makes it impossible to test the statistical validity of the model. However, previous comparisons between calculated aircraft ground noise sound levels and ambient and background noise sound levels measured in previous background noise surveys have shown that the aircraft ground noise calculation model produces results which are generally consistent with what happens in practice.

Receiver Locations

4.14 Figure 1 shows the 14 representative receiver locations distributed in different directions around the airport referred to in paragraph 4.5 above. Each of these receiver locations was selected to be generally representative of the immediately surrounding residential area to facilitate numeric comparisons between the three cases considered in this report. It should be noted that in the final version of their Appraisal Framework published in April 2014, in paragraph 5.8, the Commission specifies; '*In addition, specific nuances of noise impacts will be assessed at a local level, considering background noise levels*', and in paragraph 5.14, the Commission specifies; '*The local assessment will function in a similar way to the national assessment, but will consider in greater detail the statistics and changes to noise environments in and around short-listed airports, including particular areas of tranquillity, potential future land uses and surface access noise. Therefore, whereas the national assessment only considers statistics and changes to aircraft noise, a local assessment will* *also be made in relation to existing background noise*'. It has not been possible to carry out a comprehensive existing background noise survey within the current timescale for producing this report, but it is intended that an existing background noise survey will be carried out by Gatwick as a part of any future Environmental Impact Assessment of the proposed R2 development, and that any such survey would use these locations. In the absence of any such data there is no indication that any particular residential areas around Gatwick (or any other major airport) likely to be affected by aircraft ground noise are any noisier or quieter (in terms of background noise sound levels) than any otherwise similar areas elsewhere.

Geographical locations of taxiing and APU sources around the airport

4.15 All point sources used within the noise model are highlighted with blue crosses on the noise contour plans included in the Appendix. The taxiing noise source positions for the 2040 Base Case have been modelled as one main route around the runway which runs from one end of the runway to the other and represents all aircraft landing and then making their way around to take off again, ie taking no account of the time spent parked on stand while unloading and then loading passengers and cargo. Somewhere along the main route all aircraft will either park up on a designated stand or join another taxi-route to take it to its designated stand and, after a delay for unloading and loading, will then taxi back to the departure runway and leave the airport. This type of simplifying and in many cases worst case assumption is necessary to permit modelling to take place at all. It is not realistic to be able to predict individual taxiway routes for each and every aircraft operation separately. It should be noted that the model for the R2 2040 and R2 2050 cases uses three main taxi-routes per runway rather than one and this adds more complexity to the model but gives a more realistic operating model based on advice from Gatwick.

4.16 All APUs have been assumed to be at a height of 4m above ground level as a worst case and this is based on the location of the APU towards the tail end of an aircraft. The locations for APU noise have been limited exclusively to fixed points on each stand where aircraft will be parked. The contribution made by APU operation during normal taxiing operation has been ignored because it is negligible compared to main engine noise during normal taxiing. All taxiing noise sources have been assumed to be at a height of 3m above ground level and this is based on the average centreline height of the jet engines on larger aircraft types. The locations of taxiing noise sources for the 2040 Base Case have been limited to the outermost taxi routes (closest to residential receptors) and for the R2 Cases, shorter taxi routes have been agreed with GATWICK.

4.17 The model was set up with each straight length of taxiway divided into a series of short segments of around 100m. All bends in the main taxiways are represented by multiple short straight line segments, which are assumed to be traversed at lower speed than for straight lengths of taxiway to represent typical queuing which occurs at sharp bends and at the pre-departure runway thresholds. The numbers of stands along a given taxiway (taxiing route) as a proportion of the overall number of stands defines the percentage of total aircraft operations travelling along that route. Depending upon the time of day, the forecast numbers of aircraft along a given route can then be calculated and multiplied by the time spent by each separate aircraft operation at each point source. This is in turn dependent on the assumed speed at which each aircraft taxies across each taxiway segment and the assumed length of that segment.

4.18 Each aircraft travelling across each segment of taxiway is assumed to be positioned on the centre of each segment for as long as it would take to traverse that segment at the assumed standard taxiing speeds of 10 m/s for normal taxiing and 3 m/s when negotiating bends. At receiver locations outside the airport boundary this achieves exactly the same results as assuming continuous progression through each segment.

4.19 APU operating times are split up into large and small aircraft in accordance with the classification used for source sound power levels. The operating times (hrs and mins) were assumed to be as follows, based on the most recent operations data provided by Gatwick in the GAN document:

- Large arrivals 00:10
- Small arrivals 00:10
- Large departures 00:50
- Small departures 00:15

For some operations, these times are marginally greater than assumed in previous assessments carried out for Gatwick. However, they are consistent with the most recent information and the assumptions are the same for all options considered in this report. In addition, and as a worst case, no account is taken of fixed electrical ground power (FEGP) on stands which can in practice significantly reduce the need for continuous APU operation when aircraft are parked up on stands.

4.20 Because of differences in acoustical propagation under different wind conditions, on easterly operating days actual sound levels at receiver locations to the west of the Airport could be marginally higher than predicted and actual sound levels at receiver locations to the east of the Airport could be much lower than predicted. On westerly operating days, actual sound levels at receiver locations to the east of the Airport could be marginally higher than predicted and actual sound levels at receiver locations to the west of the Airport could be much lower than predicted. Under downwind conditions, sound levels might be increased by up to around 3 dB compared to under the mildly downwind conditions assumed in ISO 9613, whereas under upwind conditions, sound levels can be decreased by as much as 10 or 20 dB or even more compared to the mildly downwind conditions assumed in ISO 9613.

4.21 The calculated aircraft taxiing and APU sound levels are representative of long-time averages and do not reflect the marginally higher and sometimes considerably lower sound levels which occur at different times in practice. It should be noted that where published in existing standards, guidelines, and regulations, absolute sound level benchmarks are generally determined on the basis that variation above and below the long-term average has already been taken into account, and therefore no additional allowance for variation needs to be made.

Existing and Proposed Physical Screening

4.22 Only those physical structures which make a significant contribution to screening in different directions within and around the Airport are included in the model. These are:

a. the existing noise wall to the north-east of the airport north of North Terminal Pier 4 and South Terminal Pier 3;
b. the existing Terminal buildings and cargo sheds;
c. the existing piers at the North and South Terminals.

The R2 2040 and R2 2050 models also include the two noise bunds around the western ends of the north and south runways and a noise wall around the south-eastern corner of the south runway. These structures are included in the proposals as specific (ie embedded) mitigation against the effects of aircraft ground noise.

4.23 To calculate noise contours, the noise modelling software (CADNA-A) first models all possible receiver locations using a close spaced rectangular grid around the airport, and then interpolates iso-lines of constant sound level to produce the contours. The noise contours can then be overlaid onto any desired base map showing streets and houses around the airport.

4.24 The aircraft ground noise models use the air traffic data as provided by Gatwick for the air noise modelling. In the aircraft ground noise model, individual aircraft operations are then assigned to taxiway routes and parking stands in proportion to the total numbers of parking stands provided in each apron area. This process results in what are notionally fractional allocations of aircraft to particular stands, whereas in practice individual aircraft cannot be divided across more than one stand. This is not a problem in terms of noise modelling because of the averaging process inherent in calculations carried out in terms of the LAeq metric.

Construction Noise

4.25 The information that would be required for a quantitative construction noise assessment based on actual sound level predictions is not available this far in advance of detailed design work, but this is not unusual for a project of this size. Normally, construction noise assessment is an ongoing process. BS 5228:2009 is the relevant standard for assessing construction noise and the standard places a great emphasis on community relations; '*Good relations with people living and working in the vicinity of site operations are of paramount importance. Early establishment and maintenance of these relations throughout the carrying out of site operations will go some way towards allaying people's fears*'

4.26 The standard includes a substantial amount of guidance on noise at work, protecting the hearing of the workers and methods for controlling noise. Gatwick will prepare a Construction Environmental Management Plan which will include a Construction Noise Management Plan as part of the detailed management of the site. All contractors will be obliged to comply with every provision of the plan. The purpose of all such plans is maximise health and safety for all workers and visitors both on and off site and to minimise any residual impact on the local environment. Contractors will prepare construction method statements which will be reviewed for compliance with the Construction Environmental Management Plan and any deficiencies rectified before the contractor is allowed on site.

4.27 Figure A.1 from BS 5228 (part 1) describes the process by which construction noise is controlled under the control of pollution act 1974. The process described in this figure would be taken into account within the construction noise management plan and this gives a broad overview of how construction noise would be monitored and controlled throughout the project.

4.28 Nearer to the time of starting construction, once contractors are commissioned, noise predictions can be carried out to inform a noise assessment. For the noise predictions - and also so that it can be seen where noise could be controlled further - it will be necessary to provide comprehensive lists of all plant and machinery (including numbers of machines where more than one is required eg. tracked excavators) to be used throughout the construction process. It will also be necessary to have layouts of all the haul roads within the site, a breakdown of the construction process into phases (highlighting dependent milestones), the areas which each phase will occupy and the exact locations of the plant that will be used. Also of lesser significance will be road traffic from staff cars or other transport to and from the site.

The key factors in the predicted sound levels are:

1. the proximity to the noise sources,
2. the sound power level of the noise source and
3. the duration and times of exposure.

4.29 Key areas would be hammer driven piling with unavoidably high impact sound levels and earth movement and haul road operations in terms of relative distances to the nearest residential locations. Practical experience shows that any such issues arising can usually be managed satisfactorily by ensuring rigid compliance with agreed construction method statements which will include efficient maintenance of plant and machinery with particular attention paid to silencers where fitted; by careful attention to detailed planning such as, for example, using spoil heaps to act as temporary noise barriers and avoiding noisy operations during sensitive times of the day and night; and by effective community engagement including compensation where excessive construction noise impacts are otherwise unavoidable. Most areas likely to be affected by construction noise would subsequently qualify for noise insulation and other compensation at such time as the new airport facilities are brought into use and, where appropriate, consideration will be given to providing any such compensation early.

5. ASSESSMENT RESULTS

Road Traffic Noise

5.1 Figures 20 and 21 show the differences in $L_{A10,18hr}$ calculated road noise sound levels between the 2040 Base Case and the R2 2040 and R2 2050 development cases respectively. It can be seen that most of the differences are centered around new road developments and most specifically, the A23 diversion. The differences exceed the 3dB threshold for moderate short-term and minor long-term impacts (according to the DMRB) out to around 375m from the line of the road for the R2 2040 comparison and out to around 435m from the line of the road for the R2 2050 comparison. Allowing for the increased landtake of properties from the R2 development, we estimate that less than 50 properties would be included within this boundary. Many, if not all, of these properties will have qualified for the additional noise insulation and financial compensation schemes that form part of Gatwick's proposed mitigation scheme.

5.2 Where differences between the 2040 Base Case and the R2 2040 and R2 2050 road traffic noise sound levels are greater than 3 dB (corresponding to moderate increases in the short-term and minor increases in the long-term as defined in DMRB – see Table 1 in paragraph 4.4 above), at existing residential dwellings located close to the new road developments, consideration will given to providing the residents of these dwellings with higher specification glazing and ventilation in order to reduce internal noise levels as a result of increased traffic volumes. Under standard procedures, the specifics of any such offers are determined on a case-by-case basis, depending on the specific circumstances of the particular dwelling, in discussion with the Local Authority and discussion with the residents of the identified properties. It should be noted that many, if not all, of these properties will already have qualified for additional noise insulation and other forms of compensation for increased air noise under the current proposals put forward by Gatwick.

5.3 It is therefore recommended that this distance of (approximately) 435m out from the line of the road is used as a criterion for the more detailed assessment of entitlement to additional noise insulation or other compensation at such time as it becomes appropriate to consider individual residential properties on a case by case basis, in accordance with the standard procedures.

Aircraft Ground Noise

5.4 Table 2, below, shows the differences in 12 hour daytime, 4 hour evening, and 8 hour night LAeq spot values (interpolated from airport ground noise contours reproduced in Appendix B) for the 2040 Base Case and the R2 2040 and R2 2050 cases. It should be noted that aircraft taxiing and APU noise has been modelled separately for easterly and westerly operations. Minus figures denote reduced aircraft ground noise under the R2 cases and the highlighted figures denote where increases are predicted.

Table 2 Sound Level Differences between R2 (2040 and 2050) Cases and Single Runway Base (2040) for daytime, evening, and night-time LAeq dB

R2 cases minus Base case	Charlwood School	The street	Brook farm	Charlwood Road	Farmfield	Povey Cross Road	Chayne Walk	Horley Gardens	Charlwood Ifield Road	Charlwood south	Charlwood Pine Cafe	Burlands	Cherry Lane	Tinsley green
2040														
Westerly day	-9.1	-9.8	-7.8	-3.2	-1.7	-0.8	-0.9	-1.1	-0.9	-7.1	-8.9	6.4	16	6
Westerly evening	-9.3	-10	-8	-3.5	-1.9	-1.1	-1.1	-1.2	-1	-7.3	-9	6.2	15.7	5.8
Westerly night	-8.8	-9.5	-7.5	-3	-1.4	-0.6	-0.6	-0.7	-0.6	-6.8	-8.5	6.6	16.2	6.3
Easterly day	-7.8	-9.5	-5.9	-1.8	-2.7	-0.9	-1.2	-1.2	1.8	-7.5	-8.6	3.2	7.2	4.3
Easterly evening	-8	-9.7	-6	-1.9	-3	-1	-1.3	-1.3	1.7	-7.6	-8.7	3	7	4.1
Easterly night	-7.5	-9.2	-5.5	-1.5	-2.5	-0.5	-0.8	-0.8	2.2	-7.1	-8.3	3.5	7.5	4.6
2050														
Westerly day	-8.9	-9.5	-7.6	-3	-1.5	-0.6	-0.6	-0.8	-0.7	-6.9	-8.6	6.6	16.2	6.3
Westerly evening	-9	-9.7	-7.7	-3.2	-1.6	-0.8	-0.8	-0.9	-0.8	-7	-8.7	6.4	16	6
Westerly night	-8.5	-9.2	-7.1	-2.7	-1	-0.3	-0.3	-0.4	-0.2	-6.5	-8.2	7	16.6	6.6
Easterly day	-7.6	-9.3	-5.6	-1.6	-2.5	-0.6	-0.9	-0.9	2.1	-7.2	-8.4	3.4	7.4	4.5
Easterly evening	-7.7	-9.4	-5.7	-1.7	-2.7	-0.7	-1	-1	2	-7.3	-8.5	3.3	7.3	4.4
Easterly night	-7.1	-8.8	-5.2	-1.1	-2.2	-0.2	-0.5	-0.5	2.5	-6.8	-7.9	3.9	7.9	4.9

5.5 Table 2 shows that in many areas to the north of the airport, aircraft ground noise is predicted to be significantly less for the R2 cases than for the single runway Base Case. This is because many of the assumed taxiway routings and aircraft operations across the airport are further away from these areas under R2 than if the airport was to remain single runway. For those areas in North Crawley where aircraft ground noise is higher under the R2 cases (positive numbers highlighted within the table), and in other areas relatively close to the airport, the R2 development engineering plans include noise bunds around the western end of the airport and a noise wall around the south eastern corner. These support the objective to minimise and reduce noise impacts. These locations will also benefit from the mitigation and compensation schemes Gatwick has announced that would increase the areas benefiting from noise insulation and provide financial compensation to those most affected by the R2 development.

5.6 Aircraft ground noise is greater, but by no more than 1 dB, in all areas for R2 2050 than R2 2040 because of the small increase in traffic from 2040 to 2050. These differences are too small to be of any practical significance.

Results for Specific Locations

Charlwood (Farmfield, Brook Farm, Charlwood School, The Street, Charlwood Pine Cafe, Charlwood South).

5.7 In these locations to the north and north-west of the airport aircraft ground noise is predicted to be lower with R2 compared to the Base Case. This is because of the overall displacement of aircraft ground operations away from Charlwood village towards the south. Aircraft ground noise under easterly operation only is, however, marginally higher in Charlwood Ifield Road to the south of Charlwood village west of the expanded airport due to the relative proximity to the south runway and associated operating areas.

Povey Cross and Horley (Povey Cross, Cheyne Walk, Horley Gardens).

5.8 In these locations to the north and north east of the airport there are no significant differences in predicted levels of aircraft ground noise.

South of the diverted A23 and east of the railway line (Tinsley Green).

5.9 Aircraft ground noise is predicted to be marginally higher under the R2 2040 and R2 2050 cases compared to the 2040 Base Case in areas to the south of the A23 and east of the railway line under R2 compared to the Base Case, due to the relative proximity to the south runway and associated operating areas.

North Crawley (Burlands, Cherry Lane).

5.10 Aircraft ground noise is significantly higher in parts of North Crawley under the R2 2040 and R2 2050 cases compared to the 2040 Base Case because of the relative proximity to the south runway and associated operating areas.

Construction Noise

5.11 As explained in paragraphs 4.25 to 4.29 above, it is too early in the design process to permit quantitative assessment of construction noise. However, practical experience of many similar large scale infrastructure projects shows that any noise issues arising can usually be managed satisfactorily by following the methods set out in the text and there is no reason why this should not be the case for this development.

6. MITIGATION

6.1 In their paragraph 5.15, fifth bullet point, the Commission specifies 'an estimate of how the spatial and temporal aspects of airport related ground noise will be minimised through reference to change in air traffic movements and runway location'. This chapter sets out the various methods by which Gatwick proposes to meet this requirement.

6.2 Gatwick has a detailed noise strategy and a comprehensive approach to noise management. This is supported by a Section 106 Legal Agreement with West Sussex County Council and Crawley Borough Council which forms the foundation of the airport's Noise Action Plan. Existing mitigation which will continue to be in place with or without a second runway is known as *embedded mitigation* and is fully described in the Air Noise report that forms part of Gatwick's Updated Scheme Design submission to the Commission. *Additional mitigation* is only applied if the new runway development takes place. Specific mitigations which also apply to airport ground noise are as follows:

Construction Noise Management

6.3 A comprehensive set of procedures will be set in place as part of the Construction Environmental Management Plan such that any short-term noise impacts arising will be dealt with satisfactorily. Paragraphs 4.25 to 4.29 above list a range of actions that previous experience of similar large scale infrastructure projects have shown can contribute to effective construction noise management, and there is no reason why these actions should not be similarly effective for this development.

Airport collaborative decision making

6.4 All users of the airport are supported in improving the operating efficiency by reducing delays, increasing the predictability of arrivals and departures times and optimising resources. This all helps to reduce noise and other emissions from all ground operations.

Airspace design

6.5 Actions to improve airspace design to increase operational efficiency also contribute to reducing delays on the ground, thereby reducing noise and other emissions from all ground operations.

Ground noise controls

6.6 A number of specific restrictions are imposed on taxiing and APU operation and on engine ground running for test and maintenance purposes all of which limit the amount of ground noise which might otherwise occur, particularly at night. Wherever possible, Gatwick will concentrate live operations on inner taxiways and aprons at night and other noise sensitive periods. The additional mitigation proposed for R2 includes a commitment that Gatwick will work with the members of GATCOM to explore the possibility of including a ground run pen.

Modernising the aircraft fleet

6.7 Over the last few years, many older noisier types of aircraft have been replaced by newer quieter and more environmentally efficient aircraft types. Aircraft ground noise is not specifically controlled by aircraft noise certification procedures which are mainly addressed to air noise. However, and all other things being equal, aircraft types which are quieter in the air also tend to be quieter on the ground.

Noise barriers, walls and bunds

6.8 There are a number of existing structures around the airport which provide acoustic screening (see paragraph 4.22 above) against ground noise in particular directions and these will continue to provide acoustic screening into the future. Two new noise bunds around the western end of the airport and a new noise wall around the south eastern corner of the airport are included in the R2 development proposals. Subject to more detailed calculations according to the standard procedures set out in DMRB, appropriate noise barriers will also be provided along the south side of the A23 diversion wherever required.

Operating restrictions

6.9 Gatwick is subject to a number of aircraft operating restrictions such as night quota counts which limit the numbers of noisier aircraft types operating at night. All such limits also contribute to reducing airport ground noise, particularly at night.

Noise Insulation Scheme

6.10 From 1st April 2014, Gatwick's noise insulation scheme was updated to extend the areas in which noise insulation can be offered. The new scheme is based on the 60 $L_{Aeq,16hr}$ air noise contour with extensions underneath the approach paths in both runway directions. As such, and although the currently updated scheme applies to the existing single runway airport, it will also include houses subject to increases in ground noise associated with the R2 development. The extent to which the scheme is extended to accommodate increased air noise associated with the R2 development will also increase the number of properties protected against ground noise.

Home Owner Support and Council Tax initiative

6.11 The Home Owner Support Scheme 2005 and the recently announced Council Tax Initiative would provide financial compensation for increased noise and will automatically benefit households subject to increased ground noise simply because of their eligibility on the basis of increased air noise exposure. The Council Tax Initiative, which would provide compensation to those most affected by the R2 development, based on the future $57dBA_{Leq}$ air noise contour, would also cover those adversely affected by ground noise.

7. CONCLUSIONS

7.1 **The road traffic noise assessment** shows differences in $L_{A10,18hr}$ calculated road traffic noise sound levels between the 2040 Base Case and the R2 2040 and R2 2050 development cases which exceed the 3dB threshold for moderate short-term and minor long-term impacts (according to the DMRB) out to around 375m from the line of the road for the R2 2040 comparison and out to around 435m from the line of the road for the R2 2050 comparison associated with the A23 diversion. Allowing for the increased landtake of properties from the R2 development, we estimate that less than 50 properties would be included within this boundary. Many, if not all, of these properties will have qualified for the additional noise insulation and financial compensation schemes that form part of Gatwick's proposed mitigation

7.2 **The aircraft ground noise assessment** shows that in many areas to the northwest of the airport, aircraft ground noise is predicted to be significantly less for the R2 cases than for the 2040 Base Case. This is because many of the assumed taxiway routings and aircraft operations across the airport are further away from these areas under R2 than if the airport was to remain single runway. For those areas in North Crawley where aircraft ground noise is higher under the R2 cases, and in many other areas relatively close to the airport, many of these areas will benefit from the embedded mitigation provided by the proposed noise bunds around the western end of the airport and noise wall around the south eastern corner of the airport as well as the enhanced noise insulation and additional financial compensation schemes that have been proposed by Gatwick.

7.3 **The qualitative construction noise assessment** shows that while it is too early in the design process to permit quantitative assessment of construction noise, there is no reason why any noise issues arising could not be managed satisfactorily by following the methods summarised out in the text.

7.4 Considered overall, while it must be acknowledged that the development and bringing into use of a new second runway at Gatwick will unavoidably increase the numbers of properties to the south of the airport exposed to ground noise as compared to the existing single runway airport, it would also lead to reductions in ground noise impacts on properties to the north of the airport. The number of properties to the south is, however, limited by the surrounding character of built development, with much of the developed land to the south of the airport being industrial development within Manor Royal, with only limited areas of residential properties in close proximity to the expanded airfield.

7.5 A range of mitigation measures are proposed that will minimise and reduce the number of properties and residents likely to be exposed to increases in ground noise. These include engineering features such as noise barriers, walls and bunds; aircraft ground noise controls on aircraft taxiing and APU use; and other operational restrictions that will limit both air and ground noise. In addition Gatwick's recently extended single runway Noise Insulation Scheme, which is based on the $60dBA_{Leq}$ air noise contour, would be extended further with R2 and the area it would encompass would also benefit properties that are subject to increased ground noise. Gatwick has also announced a Council Tax Initiative that will provide compensation to those most affected by the R2 development. The area of the scheme (based on the $57dBA_{Leq}$ air noise contour) would also cover those adversely affected by ground noise. The Noise Insulation Scheme and Council Tax Initiative would be the most generous package currently offered at any other airport in England, and as far as is known, anywhere else in the world.

APPENDIX A - NOTE ON END AROUND TAXIWAYS (EATS)

1. As noted in the recent Runway Options Consultation document published by Gatwick in April 2014 (Appendix 2), Gatwick have been considering the various possibilities for providing End Around Taxiways (EATs) to avoid the requirement for taxiing aircraft to cross the north runway. The quantitative modelling carried out for this report has not taken the possible provision of EATs at each end of the north runway into account. Qualitative assessment suggests that the provision of EATs at each end of the north runway would make little if any difference to ground noise in most of the residential areas around the airport, including Horley, Povey Cross and the northern parts of Crawley. However provision of an EAT around the western end of the north runway could make a material difference to ground noise in Charlwood, as explained in the next paragraph below.

2. Qualitative assessment shows that under operating conditions where taxiing aircraft would use the western EAT rather than crossing in the middle of the north runway from the north apron to the mid-field terminals or to the south runway and vice versa, this would reduce the ground noise benefits in Charlwood that would otherwise ensue from the general displacement of taxiing operations away from that area under the R2 2040 and 2050 cases without EATs. As stated in the consultation document, any such reductions in noise benefit that would otherwise ensue would be offset by the new and larger noise bund which will be provided around the north west corner of the airport (compared to the currently existing noise bund which is of limited height and length). The detailed design of this noise bund would be dependant on quantitative modelling of the ground noise effects of providing EATs around the north runway which would be carried out by Gatwick as a part of any future Environmental Impact Assessment of the proposed R2 development.

Appendix B - Figures

Figure 1: Receiver locations

Figure 2: Ground Noise 2040 Base Case day easterly

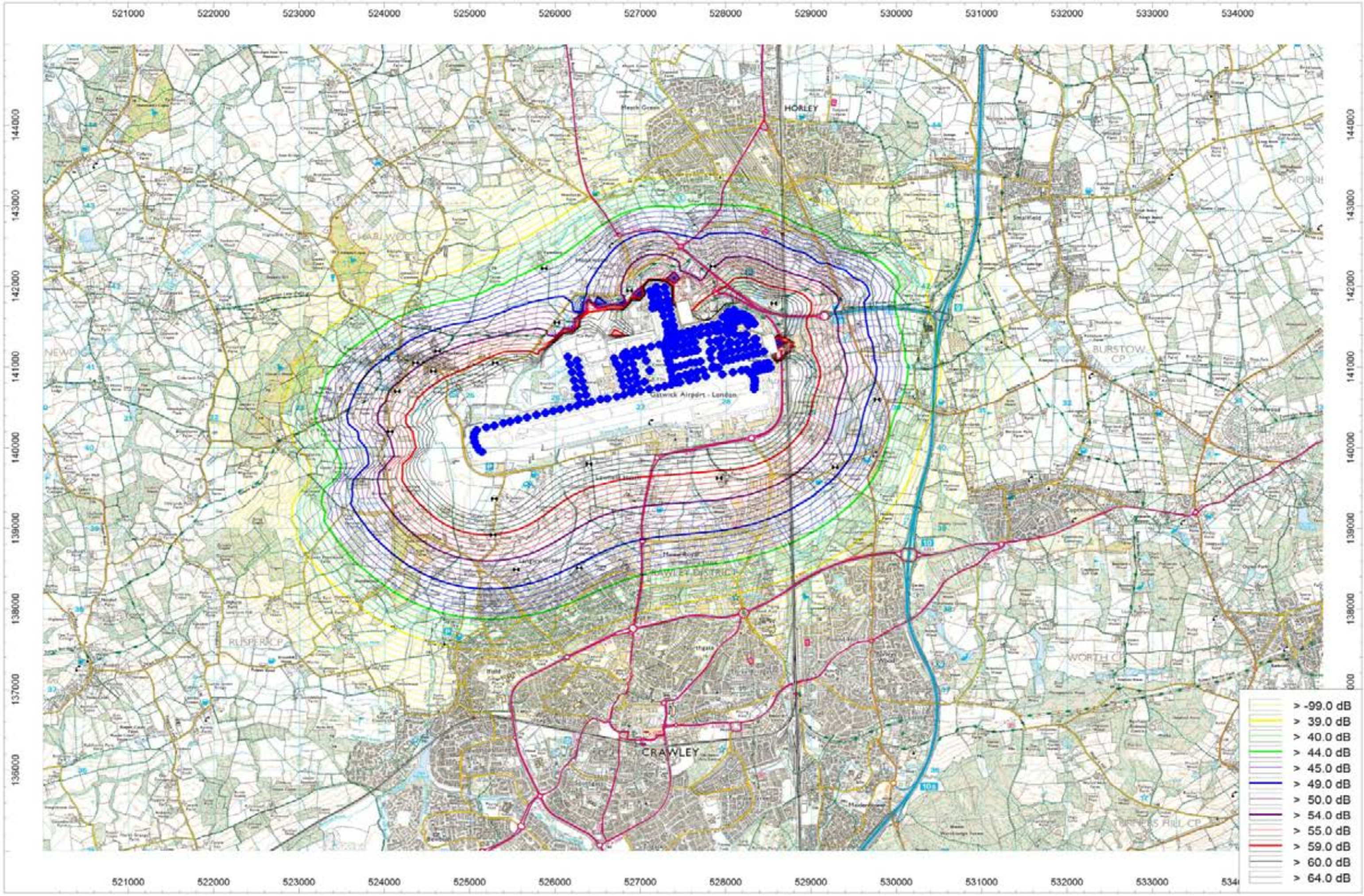

Figure 3: Ground Noise 20140 Base Case day westerly

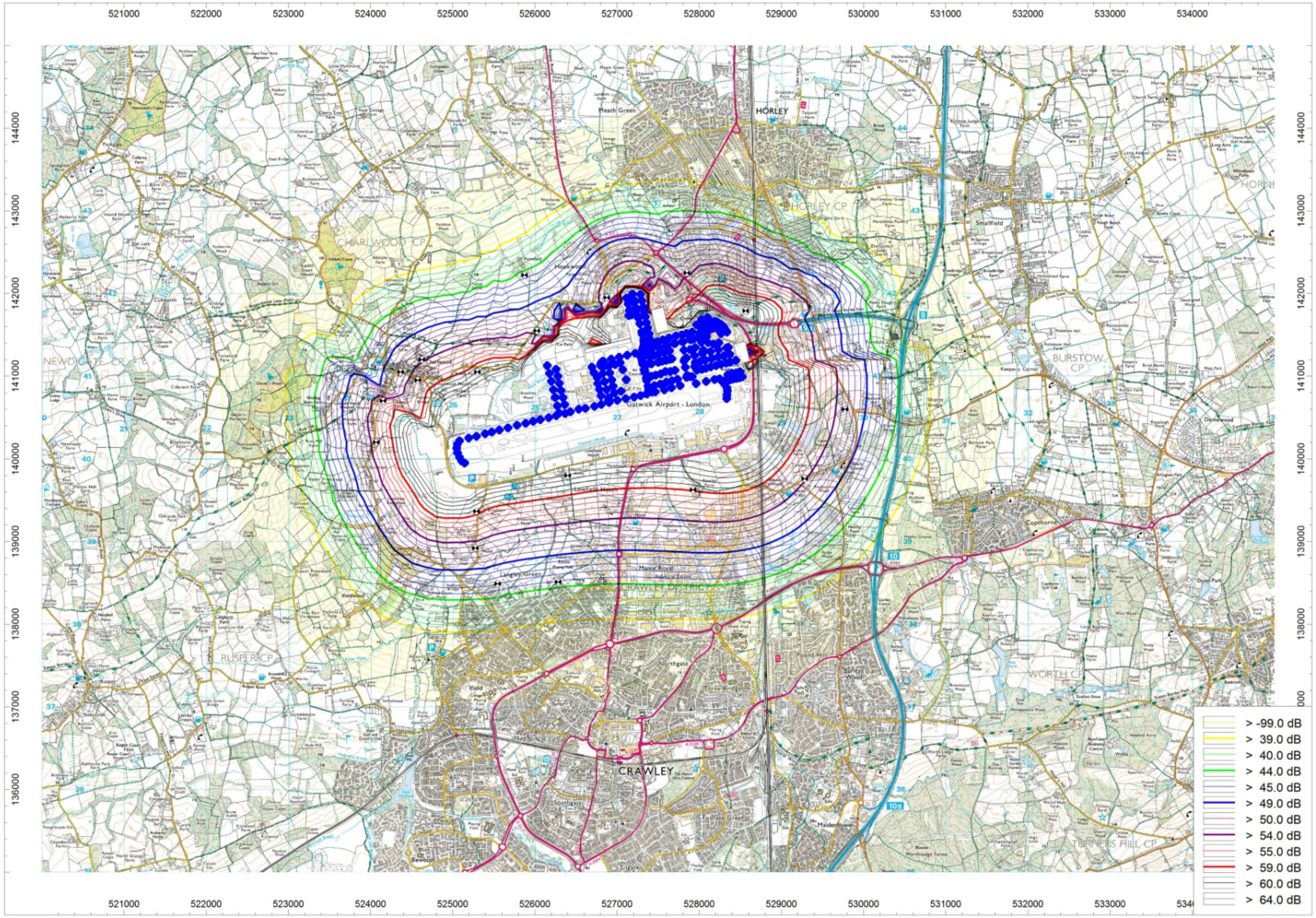

Figure 4: Ground Noise 2040 Base Case evening easterly

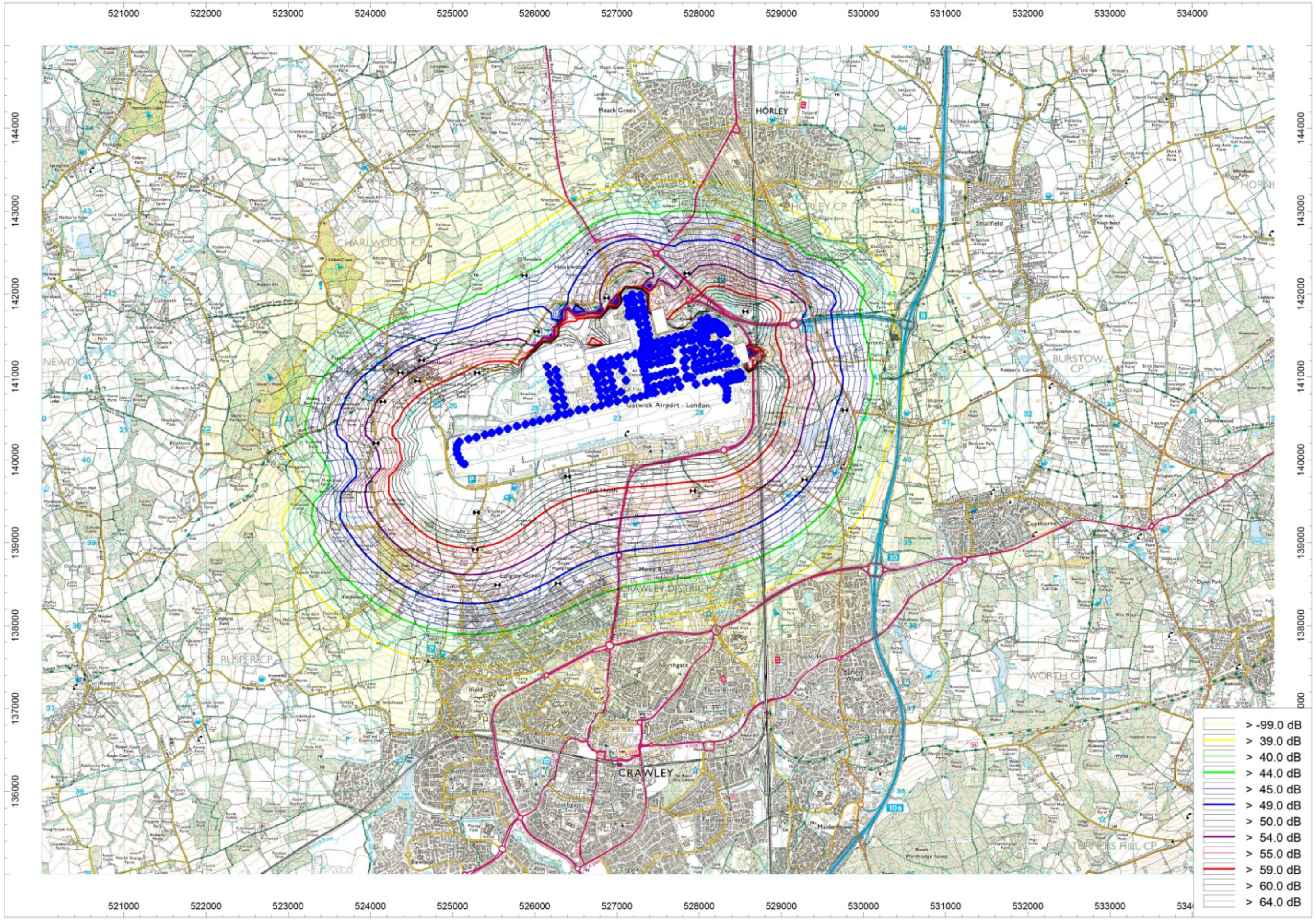

Figure 5: Ground Noise 2040 Base Case evening westerly

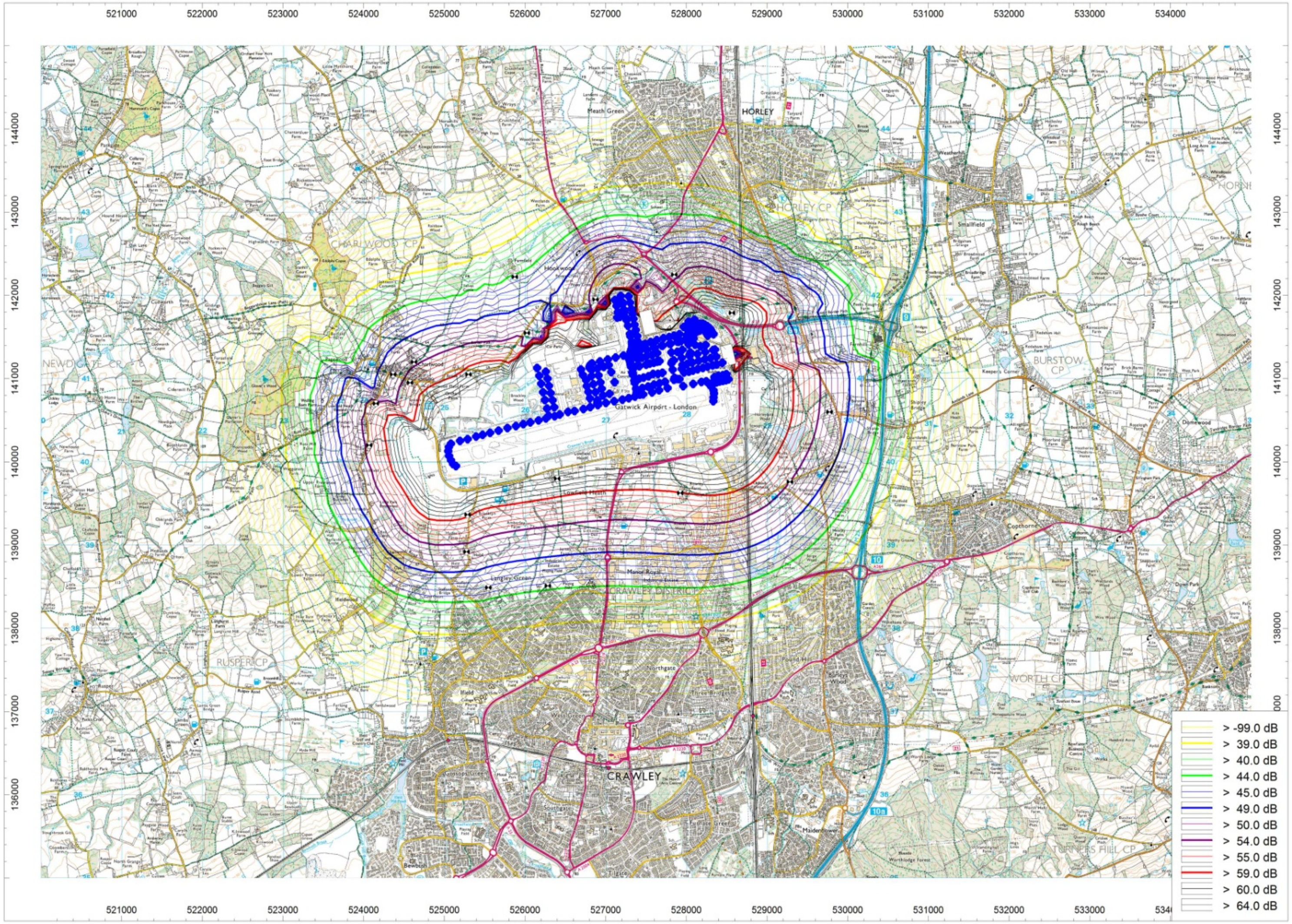

Figure 6: Ground noise 2040 Base Case night easterly

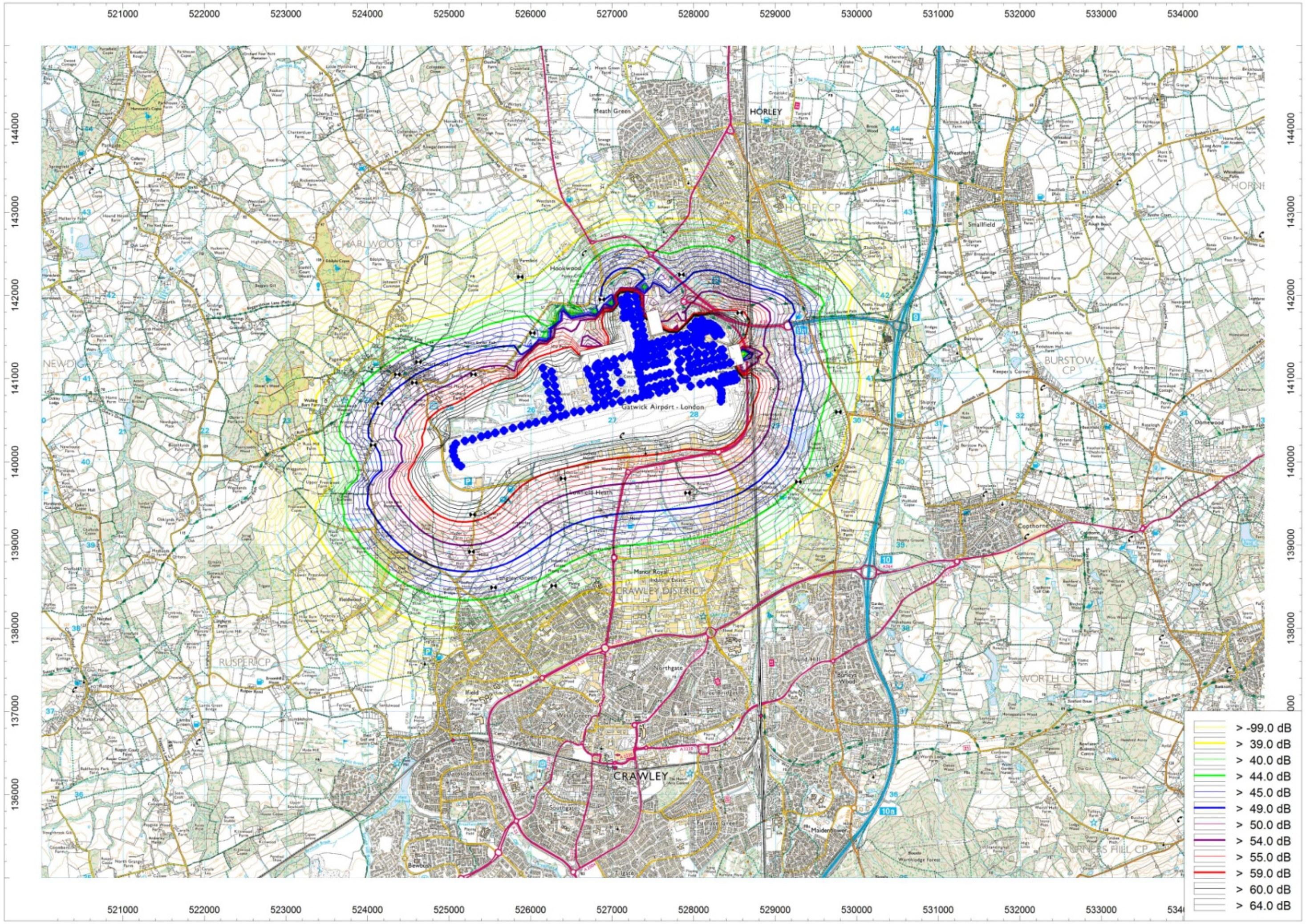

Figure 7: Ground Noise 2040 Base Case night westerly

Figure 8: Ground Noise R2 2040 - day easterly.jpg

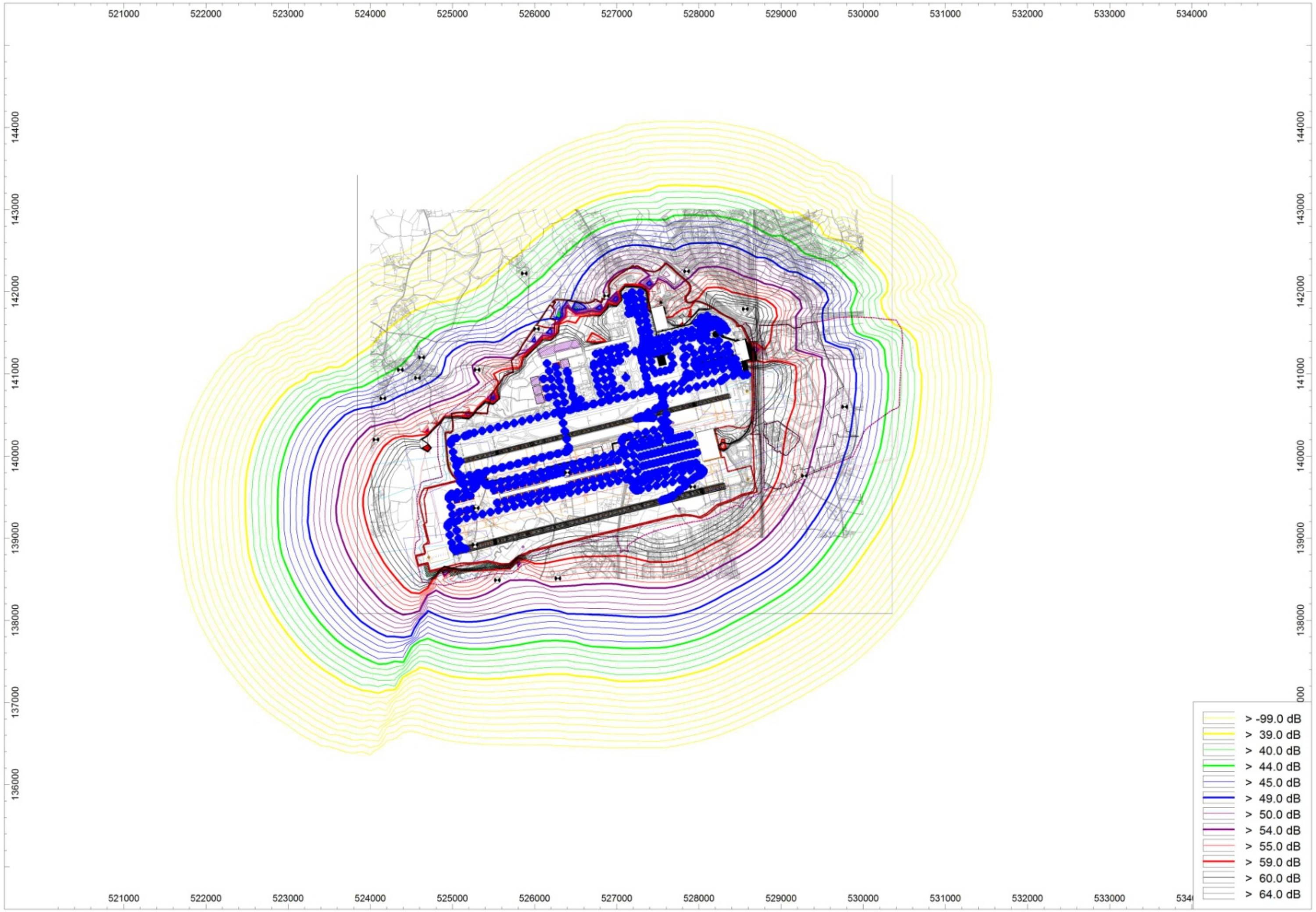

Figure 9: Ground Noise R2 2040 - day westerly.jpg

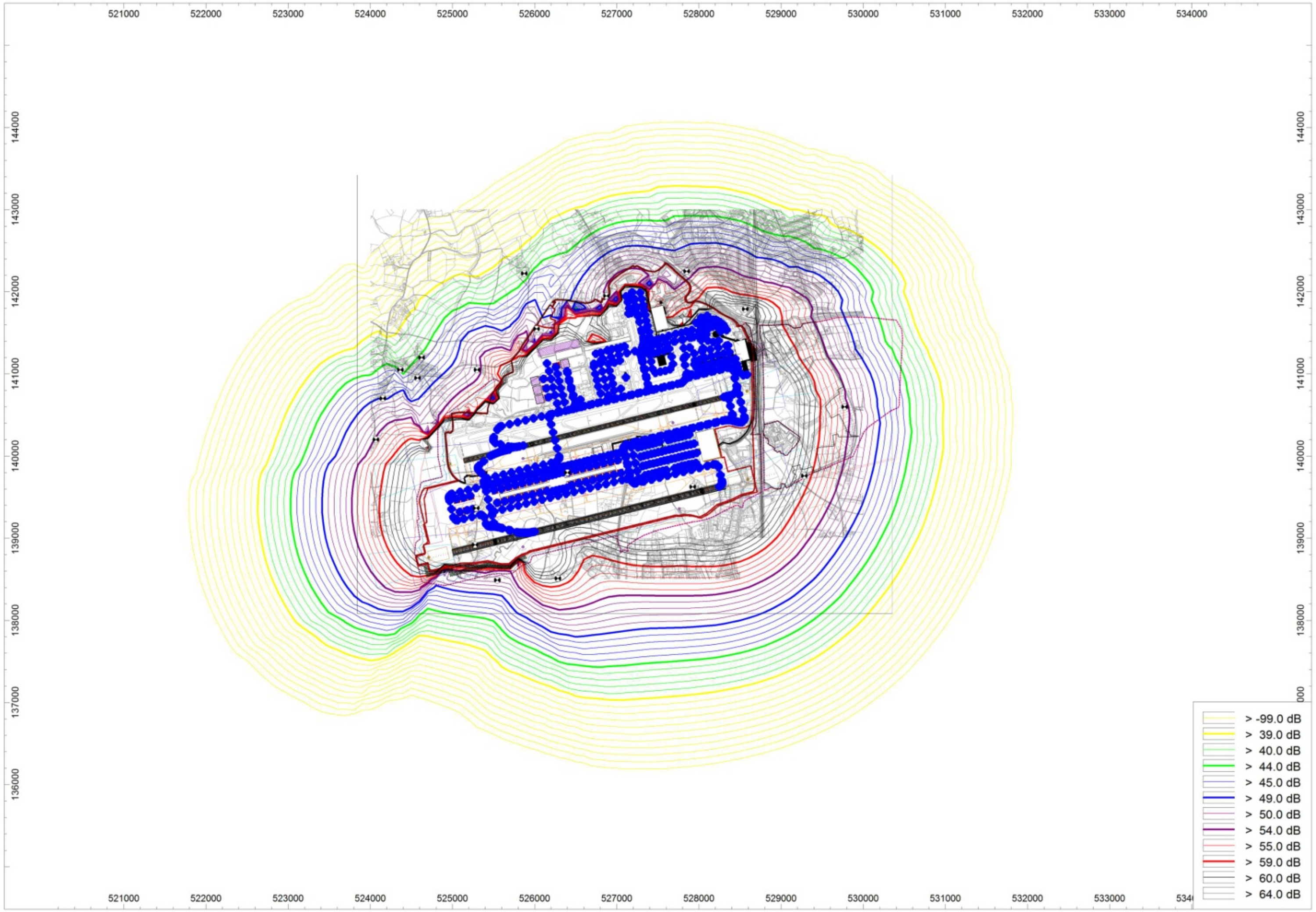

Figure 10: Ground Noise R2 2040 - eve easterly.jpg

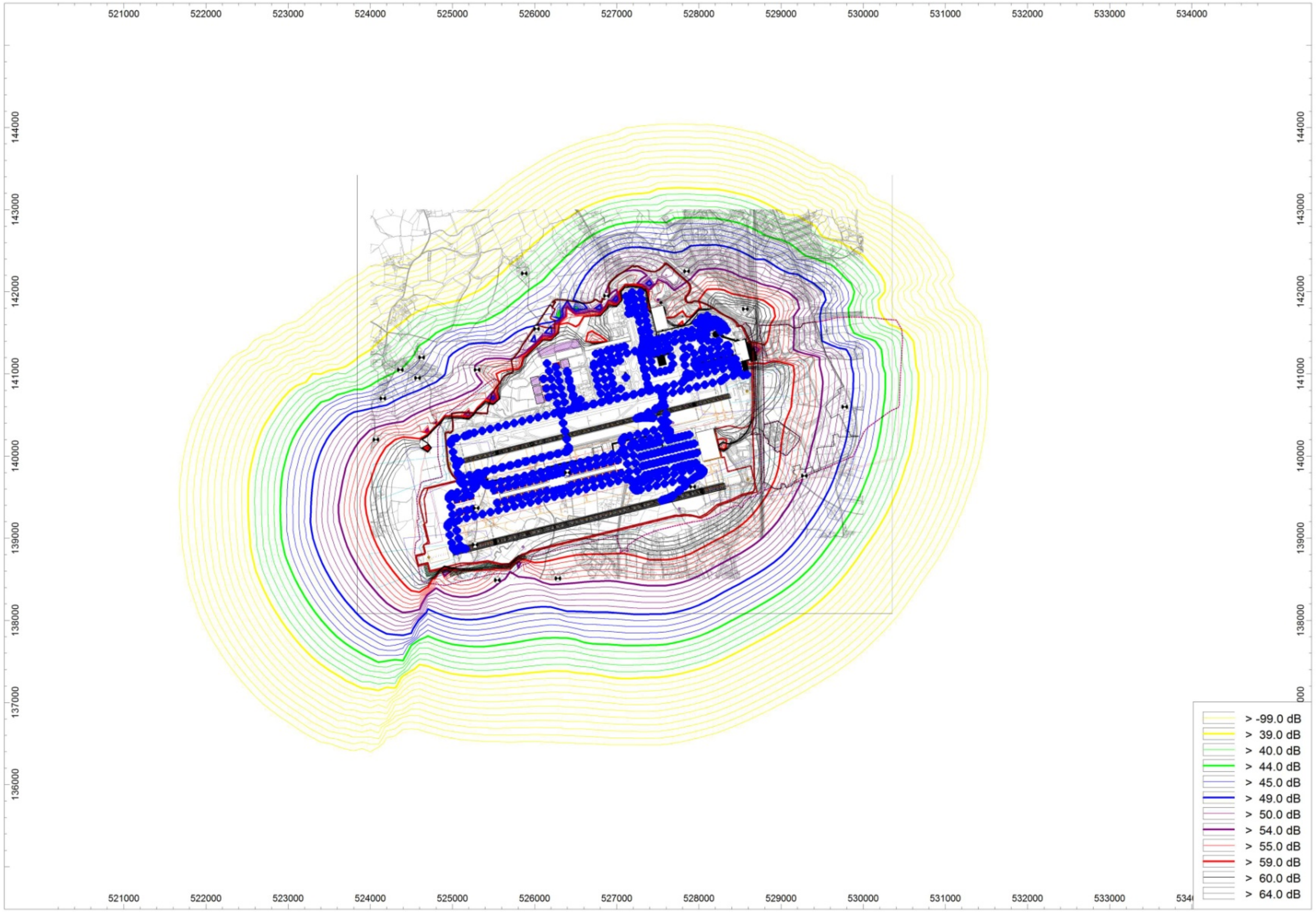

Figure 11: Ground Noise R2 2040 - eve westerly.jpg

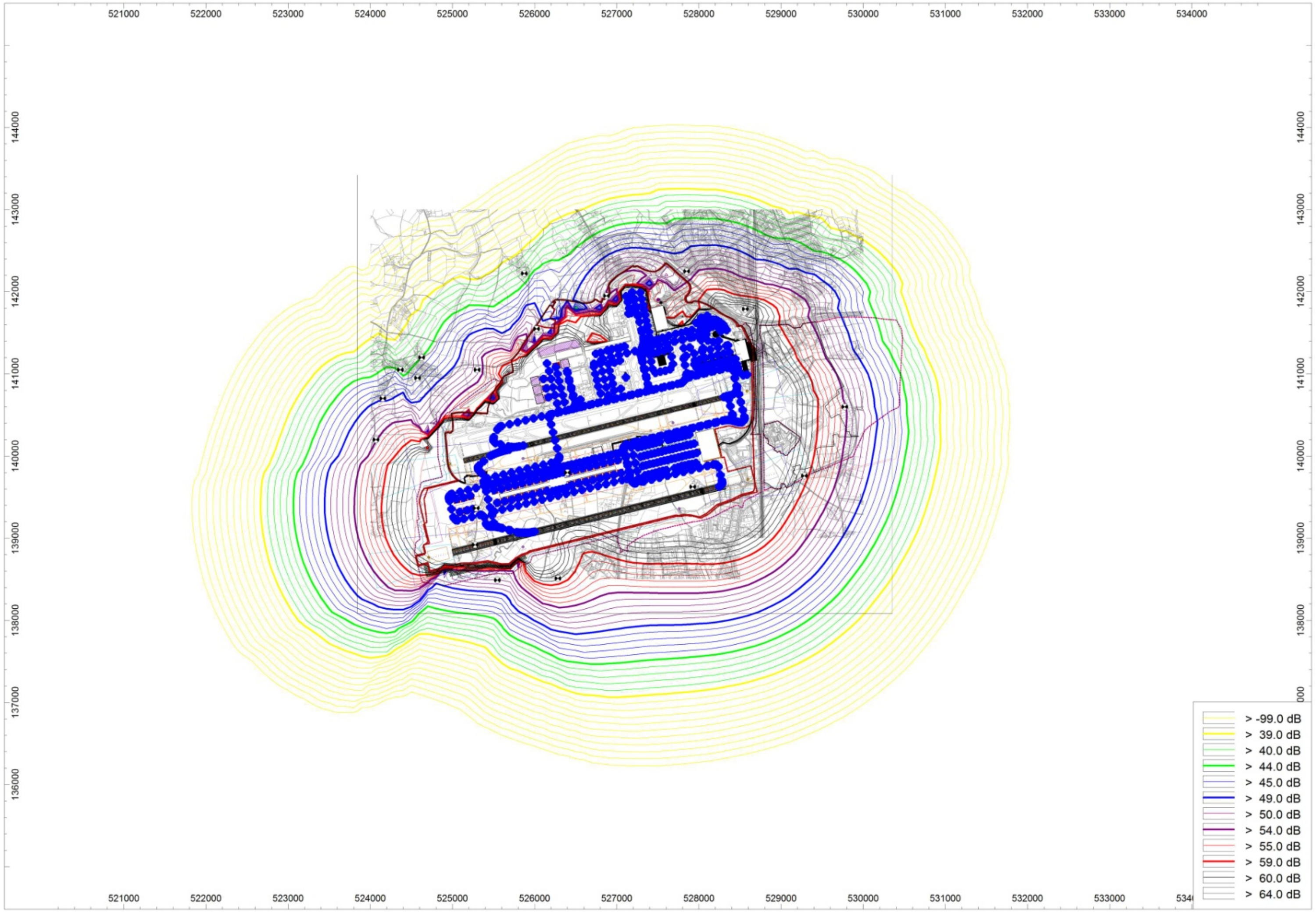

Figure 12: Ground Noise R2 2040 - night westerly.jpg

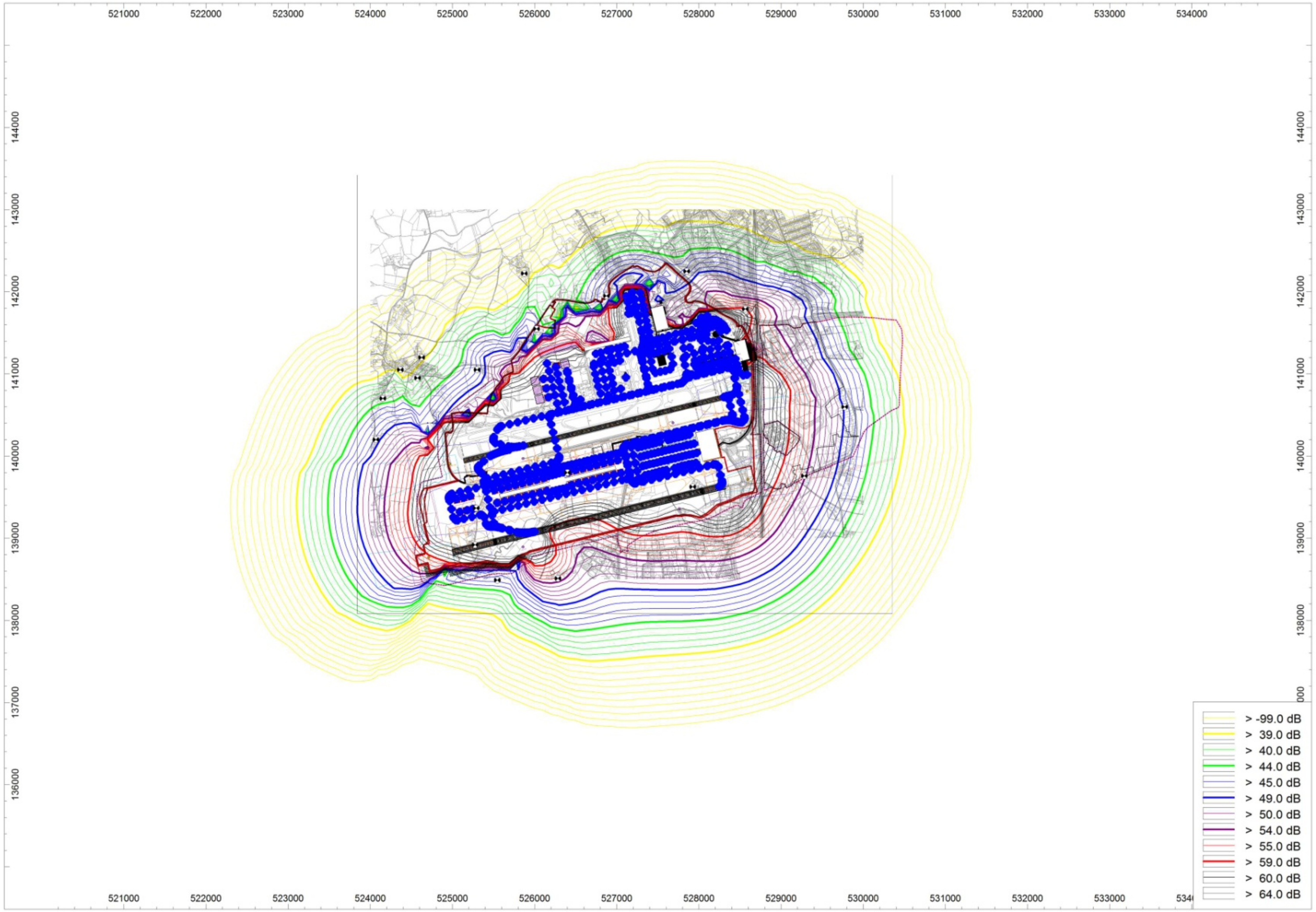

Figure 13: Ground Noise R2 2040- night easterly.jpg

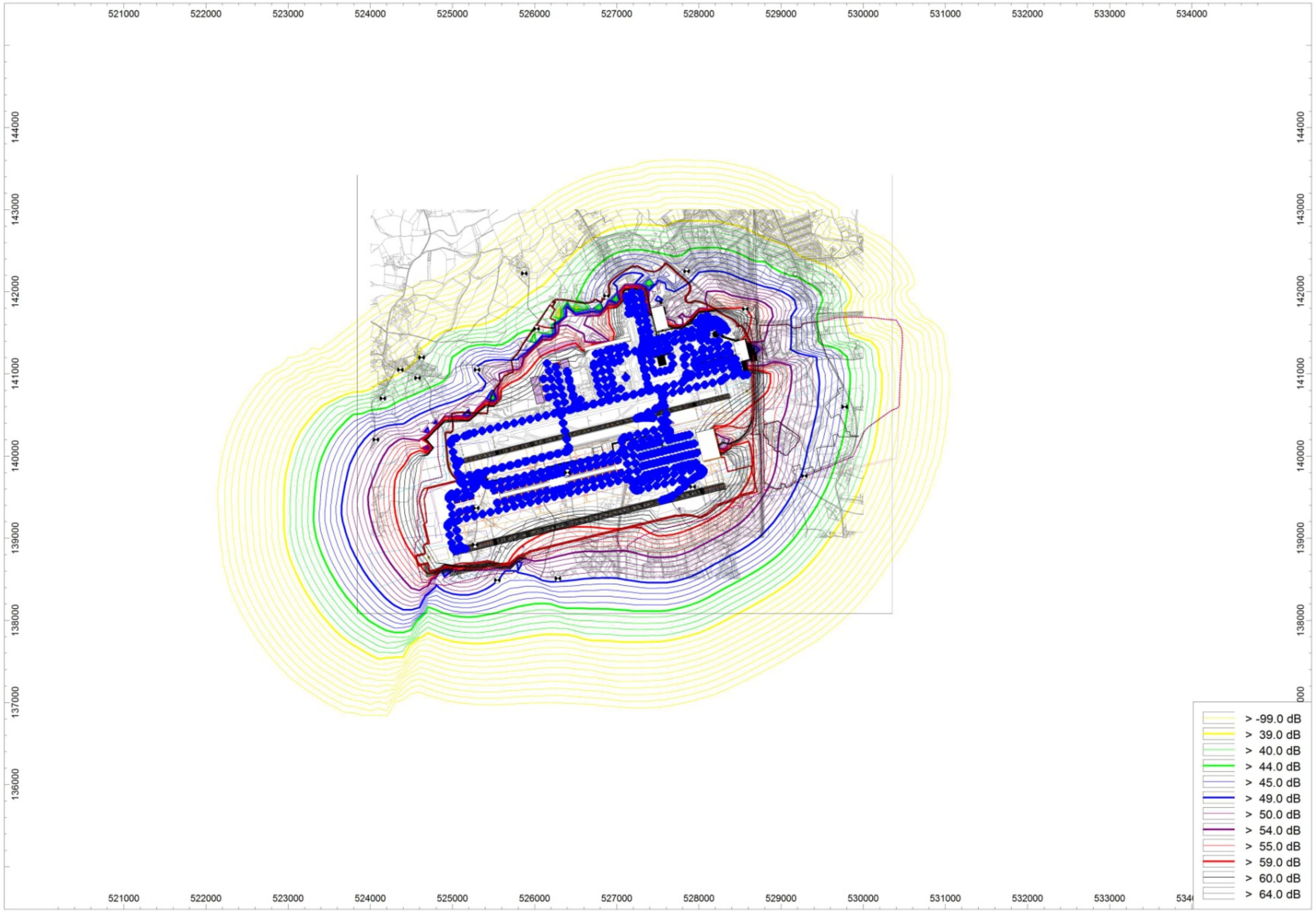

Figure 14: Ground Noise R2 2050 - day easterly.jpg

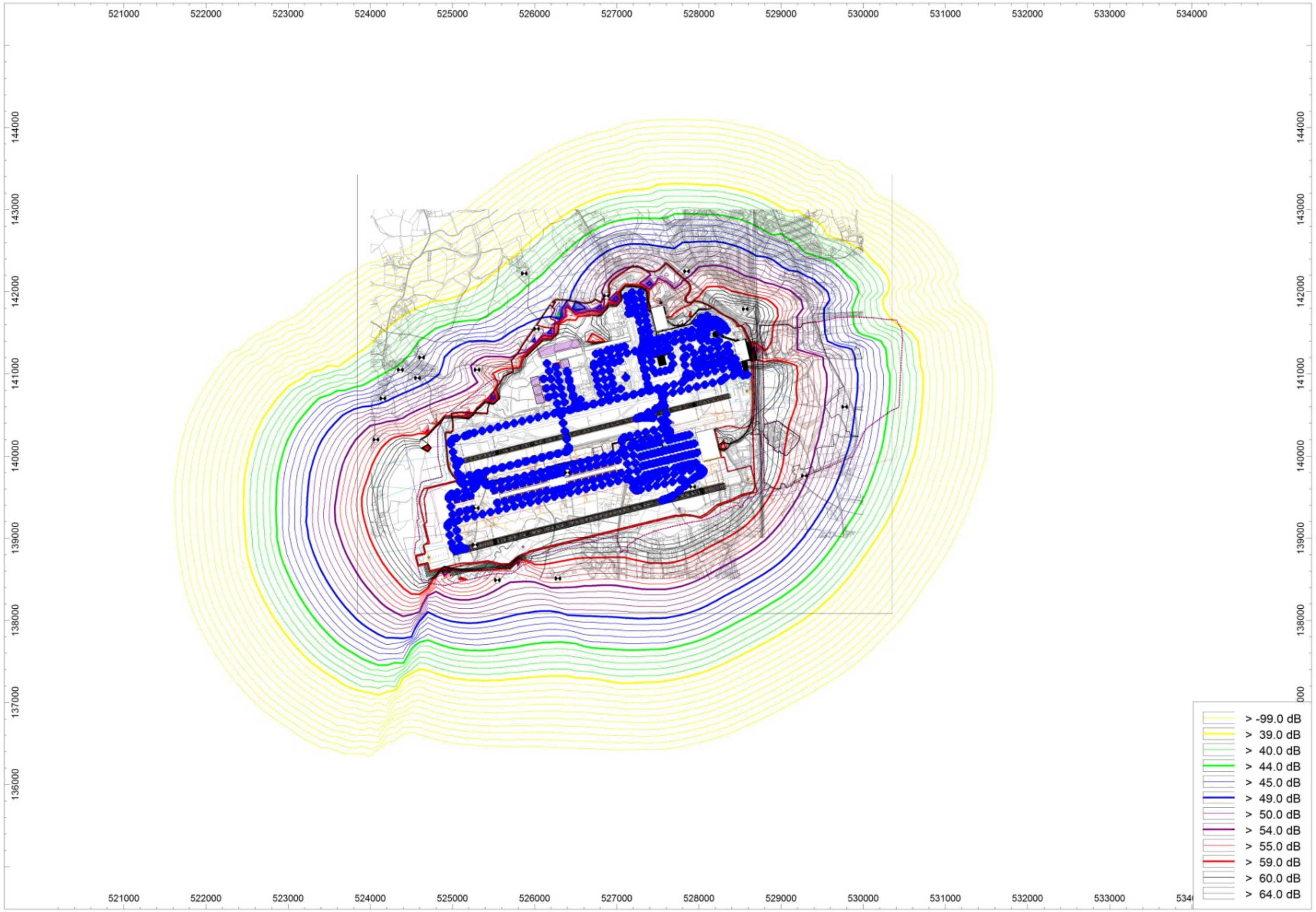

Figure 15: Ground Noise R2 2050 - day westerly.jpg

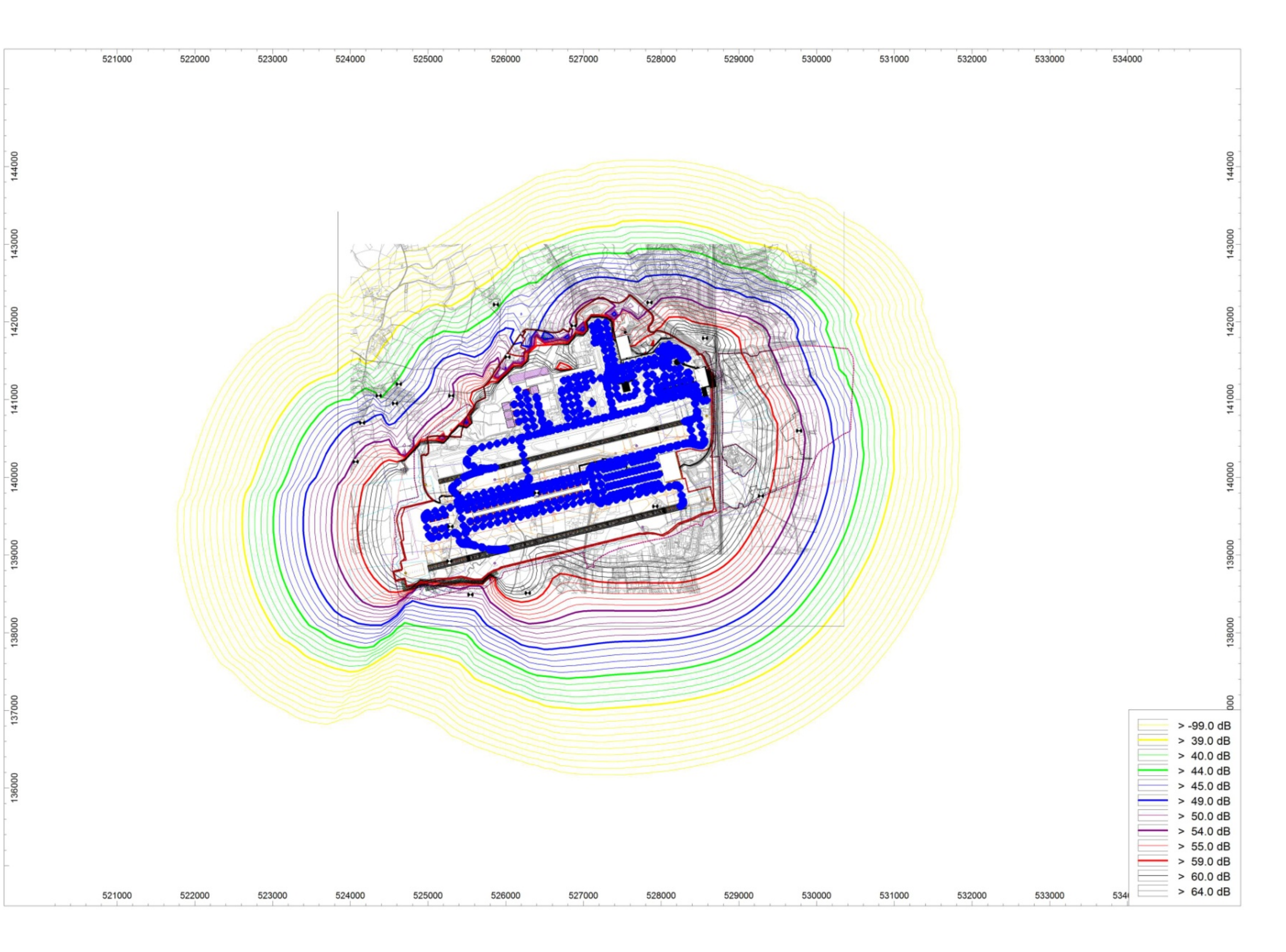

Figure 16: Ground Noise R2 2050 - eve easterly.jpg

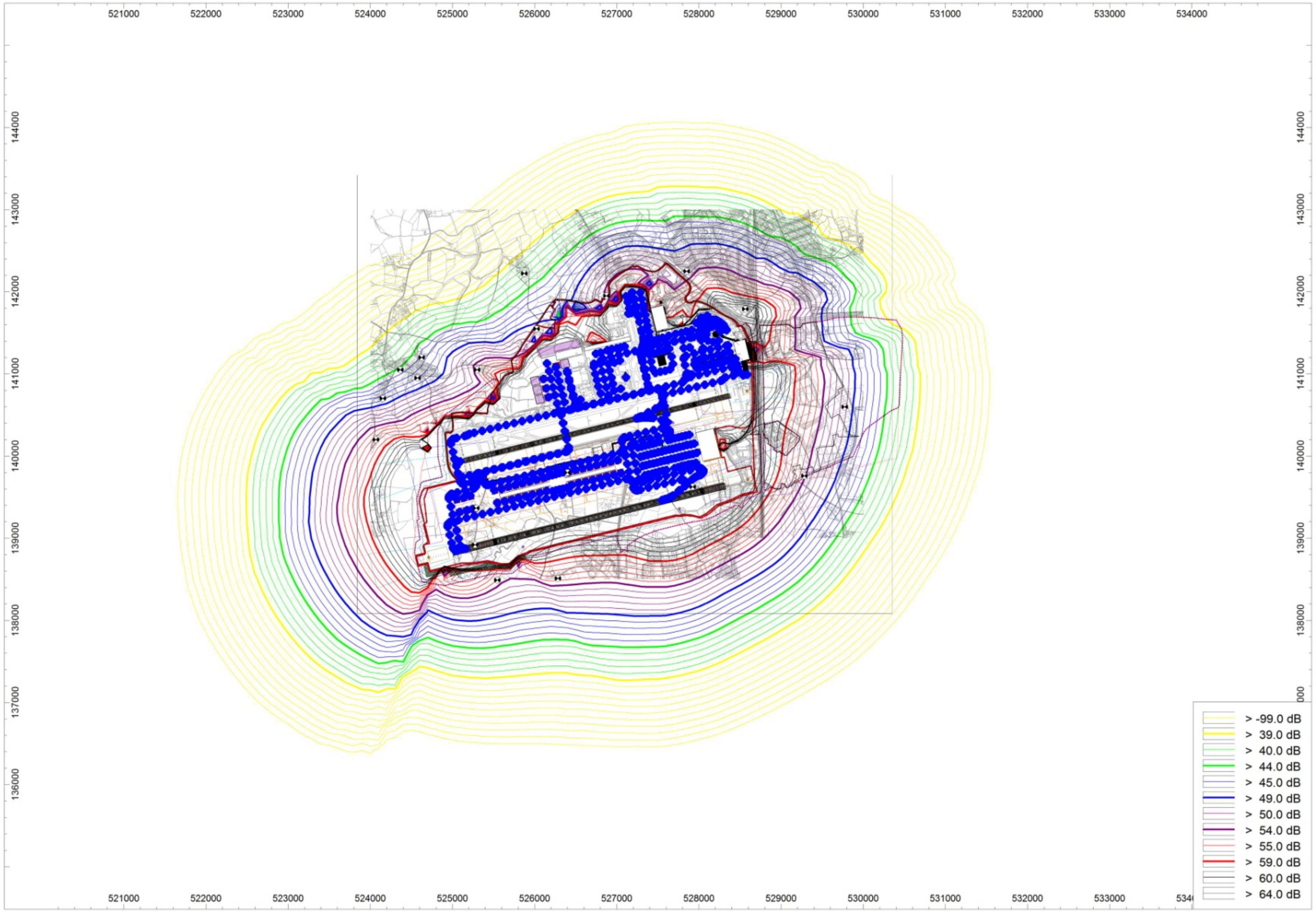

Figure 17: Ground Noise R2 2050 - eve westerly.jpg

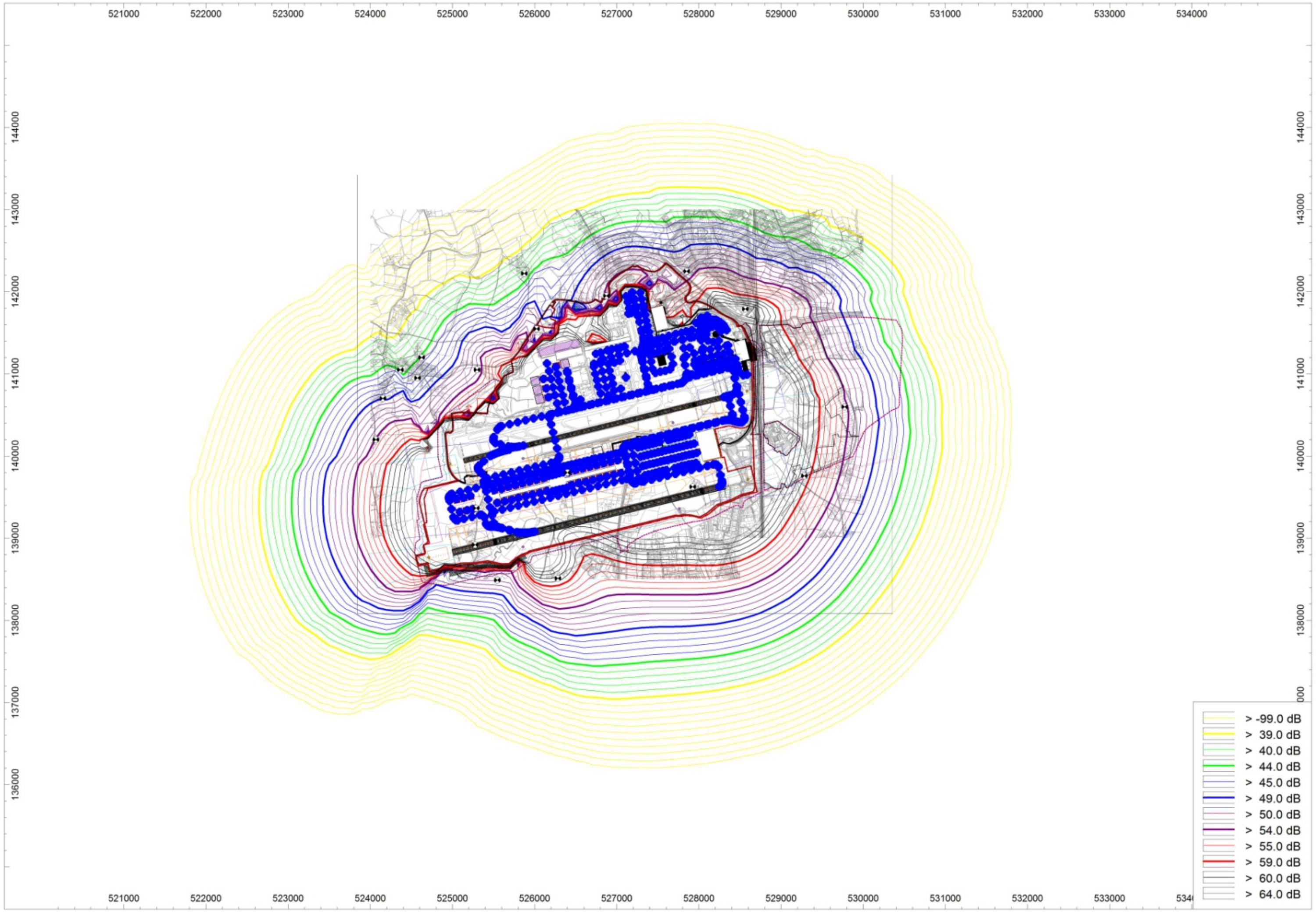

Figure 18: Ground Noise R2 2050 - night easterly.jpg

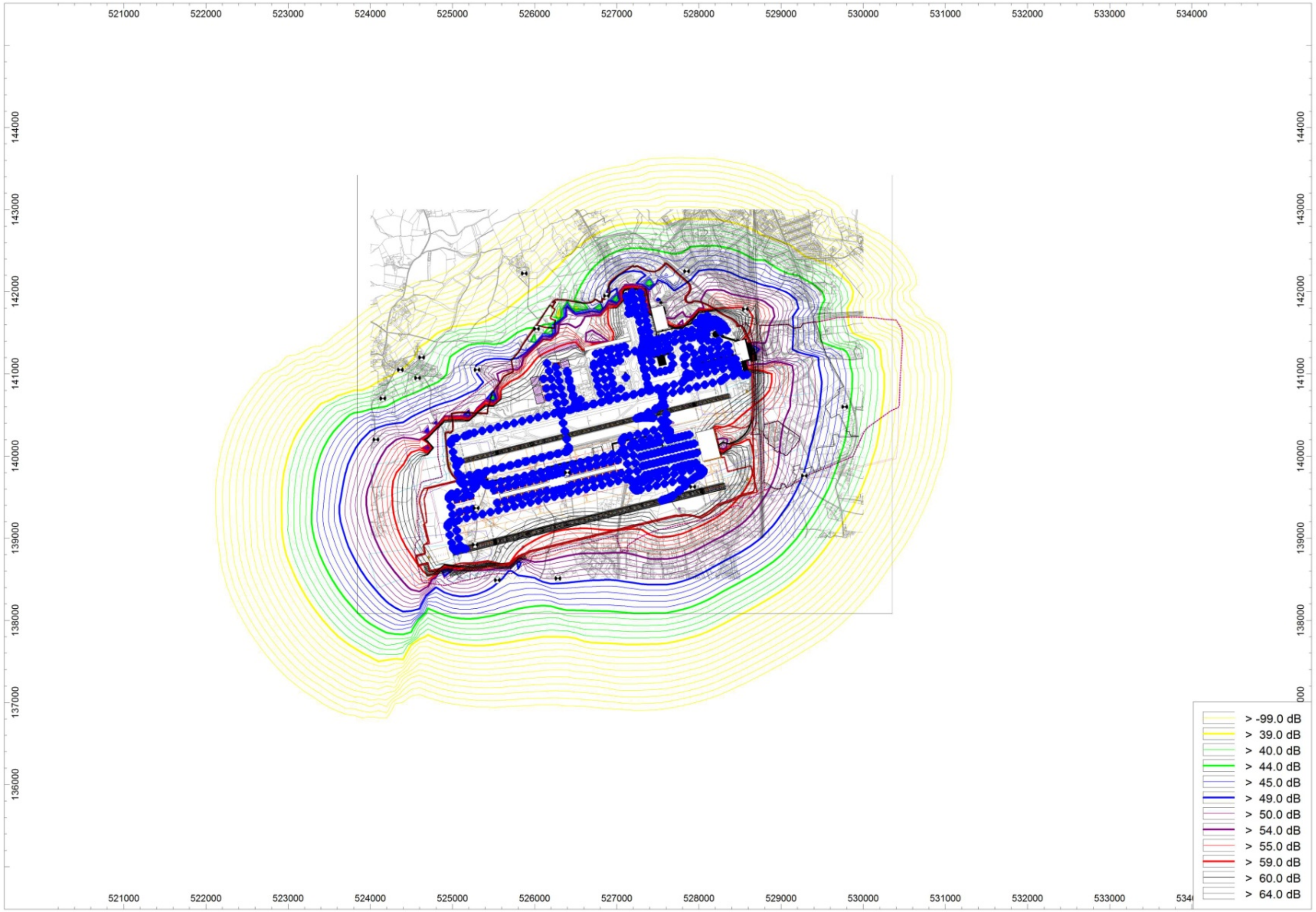

Figure 19: Ground Noise R2 2050 - night westerly.jpg

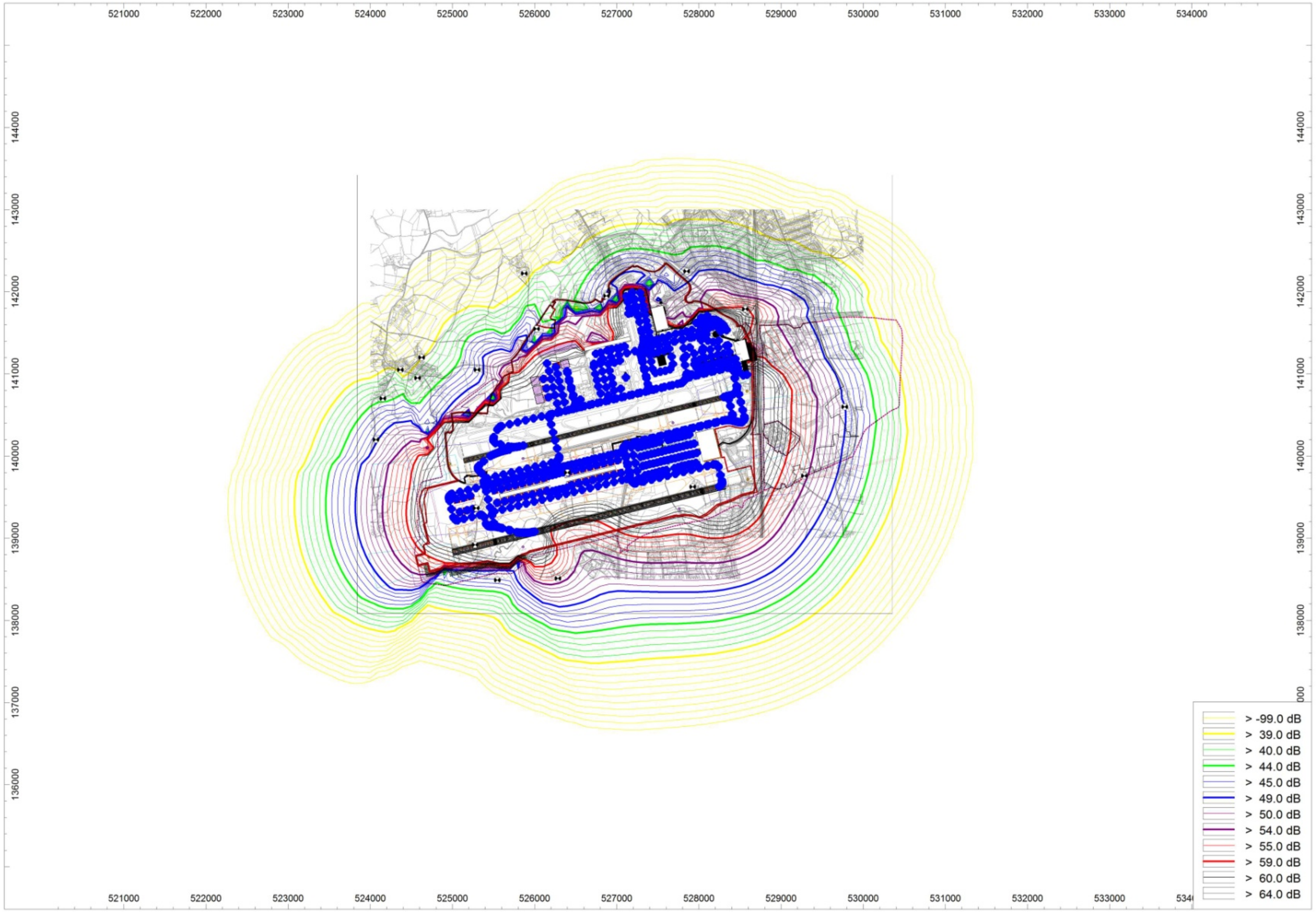

Figure 20: Traffic noise R2 2040 minus Basecase 2040

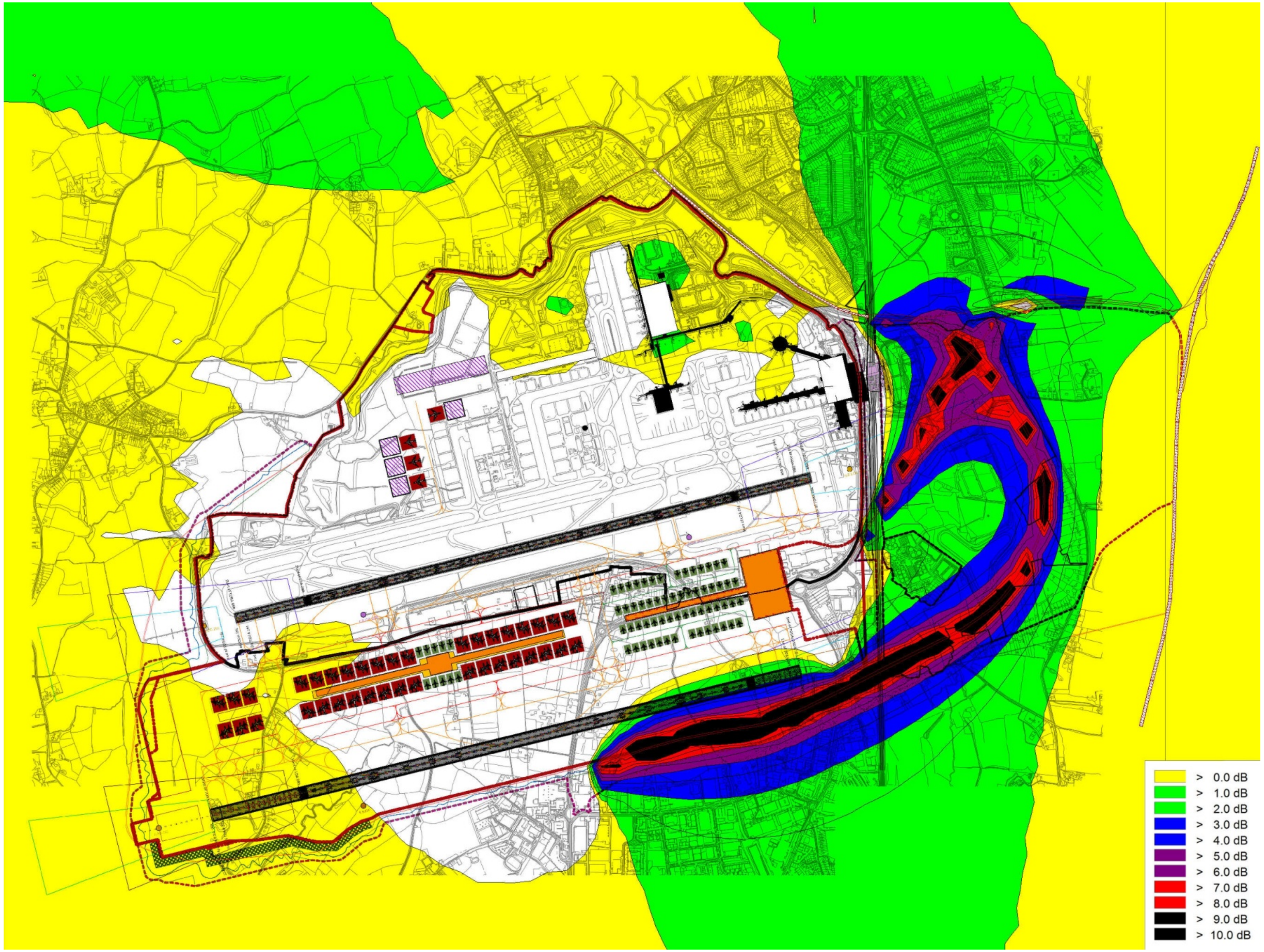

Figure 21: Traffic noise R2 2050 minus Basecase 2040

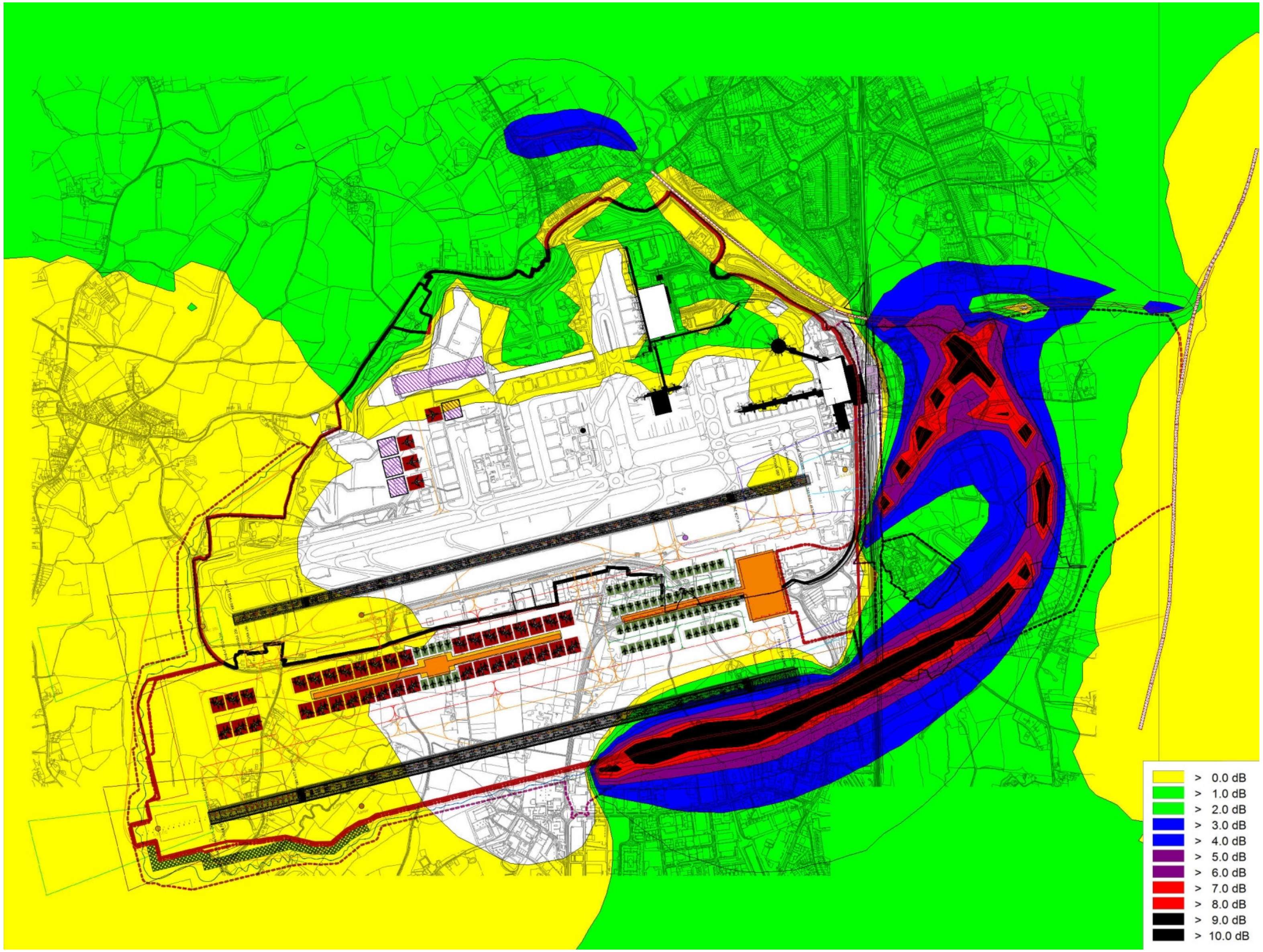

Figure 22– Directivity patterns

Figure 22 shows the assumed directivity pattern of two points (marked with a '+'), the left aircraft pointing to the left and the right aircraft pointing to the right, as based on measurement. The data is normalised for the average proportion of large and small aircraft types included in the ground noise calculation model (20% large and 80% small). The figures show generally higher dBA sound levels around the front of the aircraft which are mainly due to fan noise with twin lobes out to either side at the back which are mainly due to a combination of jet exhaust noise and fan noise. The figures also show the relatively quiet zone directly behind the aircraft, which is normal. Note that directivity patterns at higher engine power settings used in take-off would normally be significantly different.