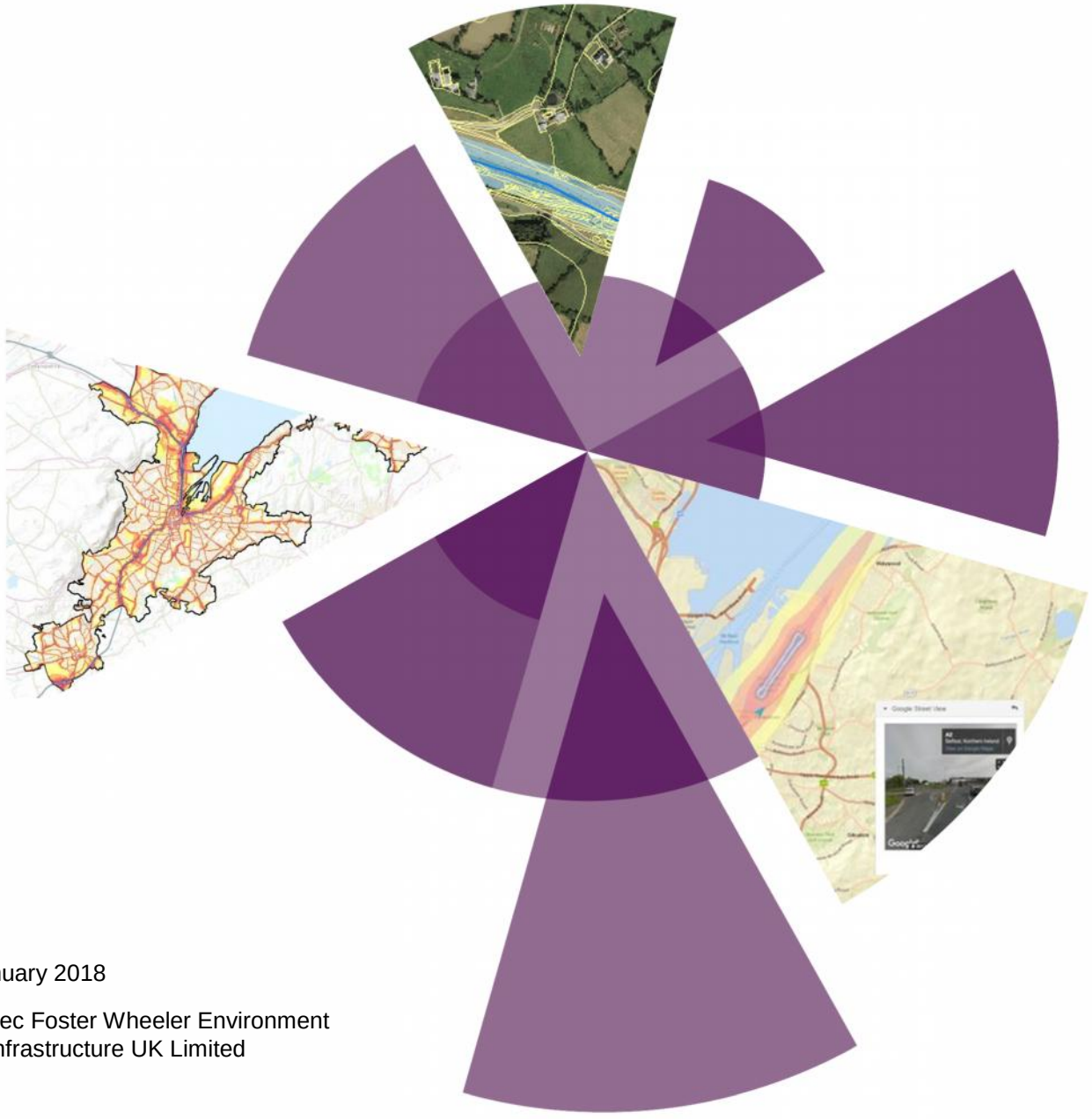
Department of Agriculture, Environment and Rural Affairs – Northern Ireland

Noise Mapping and Action Planning Contract Round 3 - 2016/2017

Industry Modelling Report - Final



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Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

Dan Kennedy and Amy Holmes
Air and Environmental Quality Unit
Environmental Policy Unit
Department for Agriculture, Environment and Rural Affairs
6th Floor, Goodwood House
44-58 May Street
Belfast
BT1 4NN

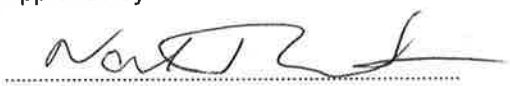
Main contributors

Neil Thurston
Simon Shilton
James Trow

Issued by

Neil Thurston

Approved by



Neil Thurston

Amec Foster Wheeler

Canon Court
Abbey Lawn
Abbey Foregate
Shrewsbury SY2 5DE
United Kingdom
Tel +44 (0) 1743 342 000

Doc Ref.

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Executive summary

Purpose of this report

This report has been produced for the purpose of documenting the processes which have been adopted to develop the industrial noise dataset used within Round Three of noise mapping within Northern Ireland under the Environmental Noise Regulations (Northern Ireland) 2006. The results of the noise mapping process are also presented at the end of the report.

This document aims to give the Northern Ireland Department of Agriculture, Environment and Rural Affairs (DAERA) a full understanding of the model development process including data capturing and processing, development of the industry noise dataset and related QA procedures.

The report begins with providing an introduction to the requirements of the mapping exercise (Section 1) and outlining the extents of the Round Three data capture areas (Section 2). This provides the setting for the specific calculation methods used to develop the Round Three industry maps (Section 3) and the data requirements needed to develop the final noise model maps (Section 4).

The report then outlines the work which has been undertaken to review the datasets used during the Round Two mapping exercise and to identify new data for use within Round Three (Section 5). This includes undertaking a detailed review of each of the IPPC, waste and port/ harbour sites considered in Round Three. Section 5 also provides full details of the new sites considered in Round Three.

The processes used to QA the final industry source and emission datasets produced are discussed in detail in Section 6 of the report. These includes highlighting the automated and manual checks which were completed to ensure that the final datasets are both ‘fit for purpose’ and optimised for the final modelling exercise.

In Section 7 of the report, the discussion covers the final calculation and processing settings which have been used to run the LimA modelling environment. This includes providing further details of the efficiency settings, calculation settings; and computational environment used in the modelling processes. The section concludes by outlining the post-processing steps which have been adopted to produce the final modelling outputs.

The final sections of the report (Sections 8 and 9) detail the preliminary results of the industrial noise exposure analysis. This includes providing area analysis of the different noise levels with the more detailed analysis of population noise exposure. This provides the context for the final Section (Section 10) which provides an assessment of the key differences between the outputs of the Round 2 and Round 3 mapping exercises.

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Glossary

Term	Definition
Agglomeration	Major Continuous Urban Area as set out within the Regulations
AMEC	AMEC Environment and Infrastructure UK Limited
ArcGIS	GIS software package produced by ESRI
ASL	Above Sea Level
Attribute Data	A trait, quality, or property describing a geographical feature, e.g. vehicle flow or building height
Attributing (Data)	The linking of attribute data to spatial geometric data
BCA	Belfast City Airport
BIA	Belfast International Airport
CORINE land cover 2012	Coordination of Information for the Environment (CORINE) land cover dataset last produced the UK in 2012
CRN	The Calculation of Railway Noise 1995. The railway prediction methodology published by the UK Department of Transport.
CRTN	The Calculation of Road Traffic Noise 1988. The road traffic prediction methodology published by the UK Department of Transport.
Data	Data comprises information required to generate the outputs specified, and the results specified
dB	Decibel
DAERA	Department of Agriculture, Environment and Rural Affairs
DEM	Digital Elevation Model
DoE	Department of Environment
DSM	Digital Surface Model
DTM	Digital Terrain Model
DWG/DXF	Autodesk Autocad Drawing (DWG) or Data Exchange File (DXF) format
EC	European Commission
EEA	European Environment Agency
EIONET	EIONET is a partnership network of the European Environment Agency (EEA) and its member and cooperating countries. The network supports the collection and organisation of data and the development and dissemination of information concerning Europe's environment
END	Environmental Noise Directive (2002/49/EC)
ENDRM	Environmental Noise Directive Reporting Mechanism
ENDRM DF8	Environmental Noise Directive Reporting Mechanism Data Flow 8
ESRI	Environmental Systems Research Institute
FDMI	Final Modified Data Inputs
GIS	Geographic Information System
INM	Integrated Noise Model

Term	Definition
Irish National Grid (ING)	The official spatial referencing system of Ireland
ISO	International Standards Organisation
KML/KMZ	Keyhole Markup Language (KML) is used to express geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers. The file format is used within Google Earth and many GIS software packages.
Land Cover Map 2007 / LCM2007	CEH Land Cover Map 2007 depicting 23 individual land use classes across the UK.
LimA	Software product produced by Stapelfeldt for calculating noise levels
Metadata	Descriptive information summarising data
NTF	Ordnance Survey National Transfer Format
NISRA	Northern Ireland Statistics and Research Agency
Noise Bands	Areas lying between contours of the following levels (dB): L_{den} <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >74 L_d <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >74 L_e <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >74 L_n <50, 50 – 54, 55 – 59, 60 – 64, 65 – 69, >69
Noise Levels	Free-field values of L_{den} L_d, L_e, L_n, and $L_{A10,18h}$ at a height of 4m above local ground level
Noise Level - L_d - Daytime	L_d (or L_{day}) = $L_{Aeq,12h}$(07:00 to 19:00)
Noise Level - L_e - Evening	L_e (or $L_{evening}$) = $L_{Aeq,4h}$(19:00 to 23:00)
Noise Level - L_n - Night	L_n (or L_{night}) = $L_{Aeq,8h}$(23:00 to 07:00)
Noise Level - L_{den} – Day/Evening/Night	A noise rating indicator based upon Ld. Le and Ln as follows: L_{den} = 10 * lg 1/24 {12 * 10^((L_{day})/10) + 4 * 10^(($L_{evening}$+5)/10) + 8 * 10^((L_{night}+10)/10)}
Noise Level – $L_{A10,18h}$	$L_{A10,18h}$ = $L_{A10,18h}$ (06:00 to 24:00)
Noise Mapping (Input) Data	Two broad categories: (1) Spatial (e.g. road centre lines, building outlines). (2) Attribute (e.g. vehicle flow, building height – assigned to specific spatial data)
Noise Mapping Software	Computer program that calculates required noise levels based on relevant input data
Noise Model	All the input data collated and held within a computer program to enable noise levels to be calculated.
Noise Model File	The (proprietary software specific) project file(s) comprising the noise model
Output Data	The noise outputs generated by the noise model
OSNI	Ordnance Survey of Northern Ireland
Processing Data	Any form of manipulation, correction, adjustment factoring, correcting, or other adjustment of data to make it fit for purpose. (Includes operations sometimes referred to as ‘cleaning’ of data)
QA	Quality Assurance
Round One	Round One noise modelling for the European Noise Directive (Northern Ireland) - 2007
Round Two	Round Two noise modelling for the European Noise Directive (Northern Ireland) - 2012
Round Three	Round Two noise modelling for the European Noise Directive (Northern Ireland) - 2017
Shapefile	ESRI proprietary GIS dataset format. Contains both geometry to define features, and associated alphanumeric attribute information.

Term	Definition
Spatial (Input) Data	Information about the location, shape, and relationships among geographic features, for example road centre lines and buildings.
Translink	The main public transport service provider for Northern Ireland
WG - AEN	Working Group – Assessment of Exposure to Noise

1. Introduction

1.1 Background

EU Noise Directive

The EU Directive 2002/49/EC on the management and assessment of environmental noise, commonly referred to as the Environmental Noise Directive (END), has provided a driving force behind noise mapping and noise Action Planning within the European Community.

The aim of the END is to provide a common approach across the European Union to avoid, prevent and reduce on a prioritised basis the harmful effects of exposure to environmental noise from transportation and industrial sources. The Directive imposes a requirement on to Member States to:

- inform the public about environmental noise and its effects;
- produce strategic noise maps for the following areas:
  - agglomerations;
  - major roads;
  - major railways; and
  - major airports.
- produce Action Plans (based on the results of the noise mapping exercises) to manage and reduce environmental noise where necessary and to preserve environmental noise quality where it is good.

The qualification of such sources and agglomerations are summarised in Table 1.1 below which highlights the differing requirements of the first and subsequent rounds of mapping and action planning.

Table 1.1 Thresholds stipulated by the END directive

	First Round Threshold	Thresholds for Subsequent Rounds of Mapping
Major Roads	≥ 6 million vehicles / year	≥ 6 million vehicles / year; and ≥ 3 million vehicles / year and < 6 million vehicles / year
Major Railways	≥ 60,000 trains / year	≥ 60,000 trains / year; and ≥ 30,000 trains / year and < 60,000 trains / year
Major Airports	≥ 50,000 movements / year	≥ 50,000 movements / year
Agglomerations[1]	≥ 250,000 inhabitants	≥ 250,000 inhabitants; and ≥ 100,000 and < 250,000 inhabitants

1 For agglomerations all sources of transportation and industry affecting noise levels within agglomerations are to be considered

The END requires Member States (MS) to produce 'strategic noise maps' and complete noise action plans over a 5-year rolling cycle. The first round of noise mapping and action planning required MS to produce noise maps and where relevant have them approved by Competent Authorities by 30 June 2007, with Noise Action Plans required for the same areas by 18 July 2008. For the current third round (R3) the equivalent deadlines are 30 June 2017 for strategic noise maps, and 18 July 2018 for noise action plans.

In preparing the noise maps, the END prescribes clarity on the 'assessment methods' that can be used to produce the noise maps in Annex II. This allows MS to adopt existing 'national methods' or 'recommended interim methods'.

END reporting requirements

Under the END, it is responsibility of MS to report information from the strategic noise maps and summaries of the Action Plans to the European Commission within 6 months of these respective dates. Following submission, the Commission collates all information reported by MS and uses it to support a publication on the implementation of the END for the European Parliament and the Council and to support the publication of information for the public. This process is achieved through the Environmental Noise Directive Report Mechanism (ENDRM) which is managed by the European Environment Agency (EEA).

The END stipulates that the noise mapping and action planning process is taken forward on a five-yearly rolling programme. This led to reporting on the second round of mapping to be completed by 30 December 2012, with updated action plans reported by 18 January 2014.

Due to the change in the thresholds between the first and second rounds as described in Table 2.1 above, the extents of the noise maps were much larger for R2 than for R1. This was highlighted in the technical reports which were delivered at the end of R2.

In keeping with the cycle set by the END, the third round of noise mapping and action planning is now required. The thresholds set by the END will remain unchanged between this coming third round and the previous second round. This means that the majority of the sources and agglomerations considered in R2 will need to be reconsidered for R3. Any new agglomerations or major sources may need to be mapped if these have relocated or have increased to beyond the thresholds since the second round.

The END is very clear in Article 7(5) that as part of the cycle that

> *"The strategic noise maps shall be reviewed, and revised, if necessary, at least every 5 years…"*

As such, the preparation of the third round strategic noise maps can, if necessary, be based upon a review and subsequent revision of the second round mapping. This forms a key component of the approach, processes and methods used to deliver the R3 noise mapping.

Implementation of the regulations in Northern Ireland

The Environmental Noise Regulations (Northern Ireland) 2006 (referred hereon in as the "Regulations") set out the requirements and responsibilities associated with the production of strategic noise maps and action plans as defined by European Directive 2002/49/EC (referred hereon in as the "Directive").

The Regulations also set out the Competent Authorities who have been made responsible for producing noise maps and action plans. These authorities are:

- Road noise – Department of Infrastructure;
- Railway noise – Translink;
- George Best Belfast City Airport noise - George Best Belfast City Airport;
- Belfast International Airport noise - Belfast International Airport; and
- Industrial noise – Northern Ireland Environment Agency.

The regulations also identify the Department of Agriculture, Environment and Rural Affairs (DAERA) (formerly the Department of Environment (DoE)) as the named Authority responsible for overseeing the implementation of the Regulations. This role includes active engagement with the individual competent authorities and the management of the delivery project on behalf of the Competent Authorities.

1.2 Purpose of this report

In September 2016, Amec Foster Wheeler were commissioned to prepare noise maps for the Component Authorities reporting directly to DAERA. As part of the commission, Amec Foster Wheeler have prepared noise maps, all associated population exposure data and supplementary reports as required under the Regulations, the Directive and the EEA ENDRM. The maps and reports will enable Northern Ireland to report the results of the mapping to the European Commission. The following document is one of seven report deliverables produced for DAERA.

The key purpose of this report is to detail the data sources and processes which have been used to develop the industrial source layer used in the development of the END R3 industrial noise models and maps. Full details of the individual data layers developed are detailed later in the remainder of this report.

The Round Three mapping contract was delivered in two stages. Stage 1 was undertaken to the following scope:

- Review of the necessary Competent Authority data to ensure completeness (including data Quality Assurance);
- Appraisal of data provided by DoE (and other stakeholders) with gaps identified with Quality Assuring of the data.
- Identification of gaps in order to define any further information requirements;
- Modifying and/or collecting further information through contractor survey (data cleaning and manipulation);
- Collation of the data into relevant datasets; and
- Preparation of Stage 1 report.

The following tasks were undertaken within Stage 1 of the contract:

- Descriptions of the processes and approaches adopted for the collection, collation, validation, verification, integration and creation of the noise model;
- Description of the datasets to be generated;

- Detailed description of the noise modelling methodology to be applied to each noise source;
- Acceptable approximations and simplifications where appropriate;
- Software to be used (notably noise model and GIS software environments);
- Efficiency settings; and
- Storage and backup of electronic data.

The aim and scope of Stage 2 was:

- the development of digital noise models based upon the FMDIs developed during Stage 1;
- the production of second round noise maps including consolidated noise maps of road, rail, airport and industrial noise within the Belfast Agglomeration;
- generation of datasets identifying the total areas and populations within noise level bands as required by the Regulations and the Directive; and
- provision of suitable Environmental Noise Directive Report Mechanism (ENDRM) Data Flow 4_8 (DF4_8) reporting and associated technical reports for submission to the Commission through the EIONET.

The key stages of the process are summarised below in Plate 1.1.

Plate 1.1 Generalised approach to R3 mapping

2. Data capture extents

Under the Environmental Noise Regulations (Northern Ireland) 2006, Round Three noise maps must encompass the following:

- Major roads with more than 3 million vehicle passages per year;
- Major railways with more than 30,000 passages per year;
- Major airports; and
- Agglomerations (including road, railway, industrial and airport noise sources) with more than 100,000 inhabitants.

The remainder of this section details the extent of the Round Three data capture area for each of the noise sources. Maps showing the geographical extent of the areas are also provided in Plates 2.1 – 2.4.

2.1 Agglomeration modelling extent

The only agglomeration considered in Round Three is the Belfast agglomeration, as defined in the Regulations.

The Belfast agglomeration is presented in Plate 2.1 and has an area of 209.4km^2. This represents an 11km^2 increase on Round Two and reflects both changes in the definition of the Agglomeration following the 2011 census and creation of new housing developments on the edge of Belfast since 2011. The new agglomeration includes all areas modelled at Round 2 plus the new development areas.

It should also be noted that the 2015 population for the Belfast agglomeration is 597,419 and exceeds the required END threshold of 100,000.

A review of potential agglomerations qualifying for Round Three was also been undertaken for completeness. Data obtained from the Northern Ireland Statistics and Research Agency (NISRA) for 2015 shows that the second largest urban area in Northern Ireland is the Derry Urban Area. The Derry Urban Area has a population of 91,602 and therefore falls below the 100,000 threshold. The Derry Urban Area has therefore not been mapped in Round Three.

Using the Belfast agglomeration as a basis, the Round Three data capture extent was created. This was developed by applying a 3km corridor around the boundary of the Belfast agglomeration, and subsequently clipped against the Northern Ireland coastline. The resulting data capture area is shown in Plate 2.1.

2.2 Industry modelling extent

Under the Directive, there is a requirement to assess noise from industrial sources affecting areas within agglomerations.

To meet this requirement, a detailed review of relevant industrial sites in and around the Belfast agglomeration was undertaken. The location and extent of these sites are shown in Plate 2.2. Full details of the sites included in the final modelling are provided in Section 5.

Plate 2.1 Belfast agglomeration including Belfast City and International Airports and major roads

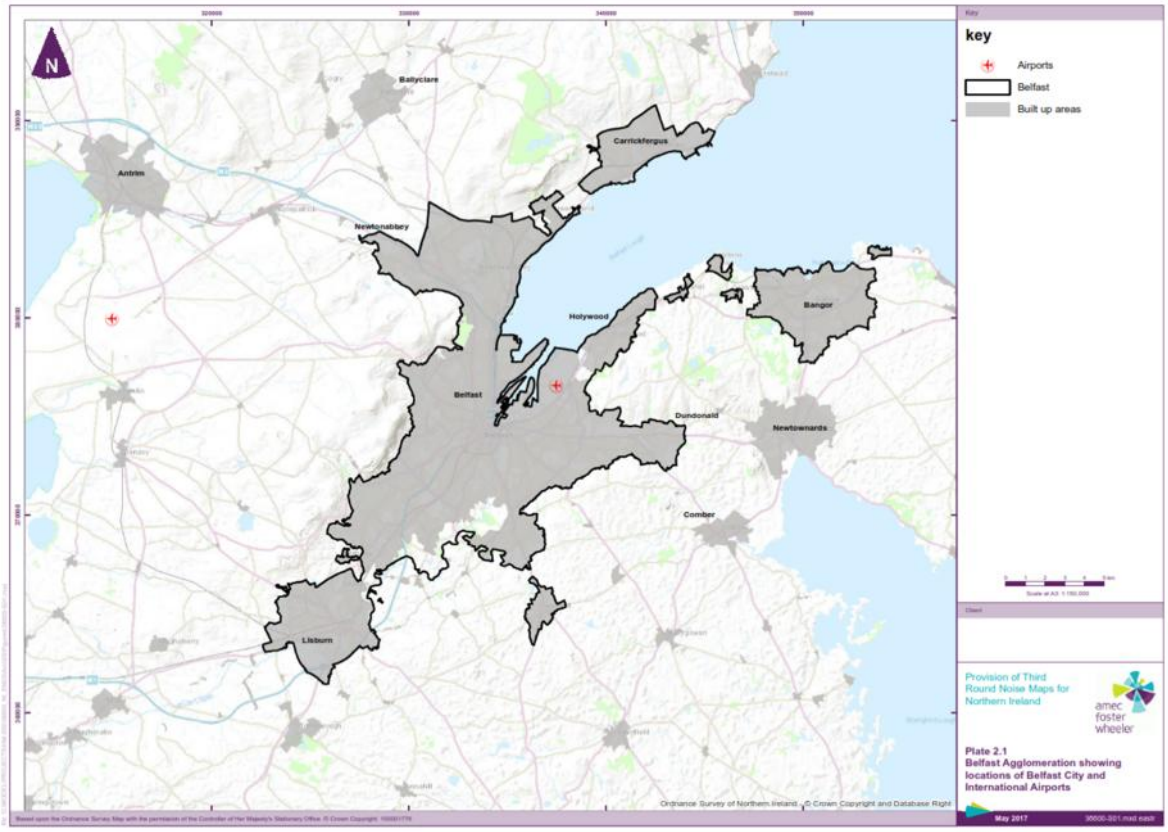
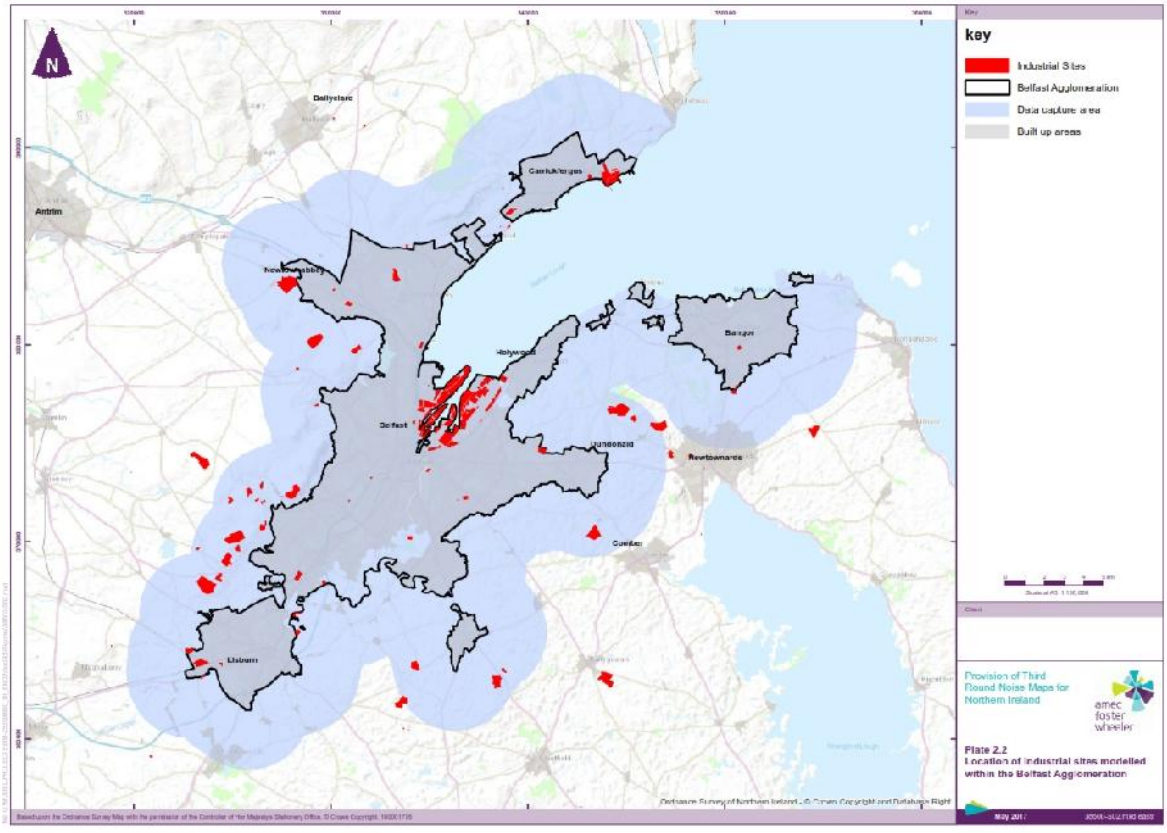


Plate 2.2 Industrial sites modelled within the Belfast agglomeration



3. Calculation methods used for Round Three

Under the Regulations the assessment method prescribed for the mapping of industrial noise sources is set out in Schedule 2, as outlined in Table 3.1. For Round One and Two, the methods outlined in Schedule 2 were adopted and/or supplemented by additional guidance.

Table 3.1 Methods of assessment as outlined in Schedule 2 of the Regulations (Industry)

Assessment methods for industrial noise indicators and port noise indicators

9.—(1) For industrial noise indicators and port noise indicators the propagation assessment method described in "ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of Calculation" (International Standards Organisation, 1996)(a) shall be used in accordance with paragraph 2.5 of the Annex in the Recommendation.

(2) Suitable noise emission data (input data) for "ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation" can be obtained either from measurements carried out in accordance with one of the following methods:

(a) "Acoustics. Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment. Engineering method" (BS ISO 8297:1994, British Standards Institute)(b);

(b) "Acoustics. Determination of sound power levels of noise sources using sound pressure. Engineering method in an essentially free field over a reflecting plane" (BS EN ISO 3744:1995, British Standards Institute)(c);

(c) "Acoustics. Determination of sound power levels of noise sources using sound pressure. Survey method using an enveloping measurement surface over a reflecting plane" (BS EN ISO 3746:1996, British Standards Institute)(d);

or by using Toolkit 10 of the "Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure Version 2, Position Paper Final Draft" (European Commission Working Group Assessment of Exposure to Noise, 13 January 2006)(e).

For industrial noise sources, the assessment for Round One and Round Two was undertaken with reference to the following:

- ISO 9613 Interim as described within the following documents:
  - ISO 9613-2: 'Acoustics — Abatement of sound propagation outdoors, Part 2: General method of calculation';
  - Commission Recommended Adaptations from 2003/613/EC; and
  - The source noise levels used within the calculations should be derived via a methodology in line with the WG-AEN GPGv2 Toolkit 10.

For Round Three, there was no requirement to alter the method adopted for Round One and Two. In addition to the method of assessment, the industry source noise levels were determined in line with WG-AEN GPGv2 Toolkit 2 for consistency with the R1 and R2 approach, as requested by DAERA, .

3.1 Software methods

For Round One and Round Two, noise mapping of industrial noise sources was prepared using the LimA noise modelling package with geo-processing and analysis undertaken with the ESRI ArcGIS software environment.

For Round Three, both software environments have been retained.

The LimA version that has been adopted for Round Three is version 11.2.

Following discussions with Stapelfeldt Ingenieurgesellschaft mbH, developers of the LimA noise mapping software, it is understood that there have been modifications to the implementation of the ISO9613-2 methodology between versions 8.1 and 11.2. However, these modifications pertain to the treatment of side diffractions which were not included within the calculation of R1, R2 or R3 noise levels. On this basis, this modification is unlikely to result in any marked change in calculated noise levels. As a consequence, the results from Round Two and Round Three may be compared directly.

4. Dataset specifications

4.1 Developing the dataset specification

The development of the industrial noise source emission model dataset has been undertaken with the aim of developing and finalising “Final Modified Data Inputs” (FMDIs) in accordance with a data specification satisfying the requirements of the assessment method and software environments.

To calculate noise levels at a specific location or receptor, the following must be established:

- The level of noise being generated at source (i.e. the noise emissions)
- The attenuation of noise levels during propagation from source to receiver (i.e. the propagation)

This report concentrates on the development of the industrial noise emission dataset. Development of the noise propagation dataset is discussed in the accompanying Northern Ireland Round Three Noise Mapping 3D modelling report. It is recommended that this report is read in conjunction with the 3D propagation model report.

For Round One and Two, a dataset specification was developed for the industrial noise emission dataset which was designed to function with the selected software environments. As there has been no change in the calculation methods or software environments employed in Round Three the FMDI dataset specifications have been retained from Round Two. The dataset specification is provided in full in Appendix A.

In order to populate this dataset, a list of data requirements was developed. These data requirements are outlined in Section 4.2.

4.2 Data requirements

In order to develop the industrial noise emission dataset to specification, the following data requirements were formulated. These data requirements are identical to those developed in Round One and used during Round Two. For each industrial the following information was required:

- The geographic extent of the industrial noise sources;
- A description of the industrial process;
- The diurnal characteristics of the industrial noise sources (i.e. hours of operation); and
- A determination of the source noise levels.

5. Round Three industrial source dataset

5.1 Introduction

The first stage of the development of the Round Three industrial source dataset was a review of the Round Two dataset; lists of PPC and waste sites provided by DAERA and updated map information provided by the Port of Belfast. The review was undertaken using an MS Excel spreadsheet linked to a spatial GIS system and set out to identify the following:

- Which of the sites were modelled during Round Two?
- Which of the sites had not been considered or had ceased operating since Round Two?

The review process was undertaken in the form of a spatial cataloguing exercise. The key stages of the processing task were:

- Manual review of updated PPC GIS data provided by DAERA in November 2016. This review was undertaken using a mixture of Google Earth, Google StreetView, and detailed OSNI Aerial imagery;
- Capture of an additional 62 industrial sites within the Port/harbour areas using a hardcopy A1 plan provided by the Ports Authority and additional review of sites using Google Earth, Google StreetView, and detailed OSNI Aerial imagery; and
- Digitisation of the location of three additional waste sites, which were not included in the latest list of PPC sites, but which were identified by DAERA as needing to be modelled in Round Three.

The final outcome of this work was the creation of a dataset of 170 industrial sites within Belfast agglomeration and the surrounding area.

The final GIS processing step applied to this dataset was to identify the industrial sites within the Belfast Agglomeration and within 1km of the agglomeration boundary. The 1km distance was used following analysis of the Round Two maps, and consideration of the possible impact of sites on the periphery of the agglomeration upon the creation of the final strategic noise maps.

This final GIS step resulted in the creation of final dataset of 130 industrial sites (108 within the agglomeration and 22 within the 1km buffer) used in the creation of the Round Three noise maps. Further details of the PPC and waste sites are provided in Tables 5.1 and 5.2.

Table 5.1 Industry – breakdown of sites modelled in Round 3

Site Type	Number of sites	Total area (ha)	Mean site size (ha)
PPC			
Port and Harbour PPC sites	10	34.7	3.5
Waste PPC sites	34	359.5	10.6
Other PPC sites	21	134	6.4
Sub-total	**65**	**528.2**	**8.1**
Non PPC			
Port/Harbour	62	363.7	5.9
Other waste sites	3	10.4	3.5
Sub-total	**65**	**374.1**	**5.8**
Total	**130**	**902.3**	**6.9**

Table 5.2 provides a further licence details of the 65 PPC sites considered in Round Three, while Table 5.3 provides details of the three additional waste sites considered.

A breakdown of the function on the remaining 62 non PPC sites in the Belfast port areas is presented in Table 5.4.

Table 5.2 Industry – PPC sites modelled in Round 3

Location of Site	Site Name	PPC PERMIT	Site Activity	Site Type
Belfast Agglomeration	3M (UK) Ltd	P0118/06A	Coating Activities, Printing and Textile Treatments	PPC
Belfast Agglomeration	ABN Knockmore	P0099/05A	The Treatment of Animal and Vegetable Matter	PPC
Belfast Agglomeration	Biofuels	P0109/06A	Organic Chemicals	PPC
Belfast Agglomeration	Cemex (Sealstown)	PPC0046/08B	Coating road stone with tar or bitumen	PPC
Belfast Agglomeration	Coca Cola Bottlers (Ulster) Limited Knockmore	P0287/08A	The Treatment of Animal and Vegetable Matter	PPC
Belfast Agglomeration	Coca Cola Bottlers (Ulster) Ltd Lambeg	P0105/05A	The Treatment of Animal and Vegetable Matter	PPC
Belfast Agglomeration	Coca Cola HBC Northern Ireland	P0287/08A	THE TREATMENT OF ANIMAL AND VEGETABLE MATTER AND FO	PPC
Belfast Agglomeration	ContourGlobal Solutions (Northern Ireland) Ltd	P0303/09A	Combustion Process	PPC
Belfast Agglomeration	Derek Hall	P0234/07A	Intensive Farming	PPC
Belfast Agglomeration	Diageo	P0098/05A	The Treatment of Animal and Vegetable Matter	PPC
Belfast Agglomeration	Diageo Baileys Global Supply Mallusk	P0063/04A	The Treatment of Animal and Vegetable Matter	PPC
Belfast Agglomeration	HMG Powder Coatings	PPC0183/08B	Dyestuffs, printing ink and coating materials	PPC
Belfast Agglomeration	Kiel Pharma	P0062/04A	Pharmaceutical Production	PPC
Belfast Agglomeration	Montupet (UK) Ltd	P0056/04A	Non-Ferrous Metals	PPC

Location of Site	Site Name	PPC PERMIT	Site Activity	Site Type
Belfast Agglomeration	NK Coatings	P0046/04A	Ferrous Metals	PPC
Belfast Agglomeration	Royal Group of Hospitals	P0084/05A	Combustion Activities	PPC
Belfast Agglomeration	Ryobi aluminium Casting (UK) Ltd	P0058/04A	Non-Ferrous Metals	PPC
Belfast Agglomeration	Source Oil Limited	P0450/14A	Organic Chemicals	PPC
Belfast Agglomeration	Tennants textile Colours Ltd	P0124/06A	Organic Chemicals	PPC
Within 1km of the Belfast Agglomeration	Lisburn Proteins	P0065/05A	The Treatment of Animal and Vegetable Matter	PPC
Within 1km of the Belfast Agglomeration	Whitemountain Quarry	PPC0110/08B	Other mineral activities	PPC
Belfast Agglomeration	Belfast sewage Sludge Incinerator	P0081/05A	Waste Disposal - Incineration	PPC/Harbour
Belfast Agglomeration	Belfast terminal	PPC0002/08B	Gasfication, Liquefaction and Refining Activities	PPC/Harbour
Belfast Agglomeration	Charles Tennant & Co (NI) Ltd	PPC0019/08B	Coating road stone with tar or bitumen	PPC/Harbour
Belfast Agglomeration	Duncrue Street	P0161/07A	DISPOSAL OR RECOVERY OF HAZARDOUS WASTE OTHER THAN	PPC/Harbour
Belfast Agglomeration	Full Circle Generation Limited	P0446/13A	The incineration of non-hazardous waste	PPC/Harbour
Belfast Agglomeration	J Thompson	P0100/05A		PPC/Harbour
Belfast Agglomeration	Larsson - Processing fine aggregates	P0405/12B	PRODUCTION OF CEMENT AND LIME	PPC/Harbour
Belfast Agglomeration	NuStar terminals Limited	PPC0006/08B		PPC/Harbour

Location of Site	Site Name	PPC PERMIT	Site Activity	Site Type
Belfast Agglomeration	SITA	P0186/07A	TEMPORARY AND UNDERGROUND STORAGE OF WASTE	PPC/Harbour
Belfast Agglomeration	United feeds	P0102/05A	The Treatment of Animal and Vegetable Matter	PPC/Harbour
Belfast Agglomeration	AFBI VSD	PPC0168/08B	Waste Disposal - Incineration	PPC/Waste
Belfast Agglomeration	Ballyduff Landfill Site	P0156/06A	Disposal of waste by Landfill	PPC/Waste
Belfast Agglomeration	Boyds Quarry	PPC0060/08B	Other mineral activities	PPC/Waste
Belfast Agglomeration	Browns Landfill Site (William Brown)	P0294/08A	DISPOSAL OF WASTE BY LANDFILL	PPC/Waste
Belfast Agglomeration	Carrickfergus WWTW Sludge Thickening Plant	P0316/09A	DISPOSAL OR RECOVERY OF NON-HAZARDOUS WASTE	PPC/Waste
Belfast Agglomeration	Cottonmount Landfill	P0090/05A	Disposal of waste by Landfill	PPC/Waste
Belfast Agglomeration	Drumhirk Way Landfill	P0304/09A	DISPOSAL OF WASTE BY LANDFILL	PPC/Waste
Belfast Agglomeration	Dunmurry WWTW	P0238/07A	Disposal of waste other than by incineration or landfill	PPC/Waste
Belfast Agglomeration	ENVA (NI) Ltd	P0108/05A	Recovery of Waste	PPC/Waste
Belfast Agglomeration	Kilroot Landfill Site	P0155/06A	Disposal of waste by Landfill	PPC/Waste
Belfast Agglomeration	Kilroot Power Ltd	P0120/06A	Combustion Activities	PPC/Waste
Belfast Agglomeration	Kinnegar Sludge Treatment Centre /Kinnegar WWTW, Holywood, Co Down BT18 9TW	P0434/13A	DISPOSAL OR RECOVERY OF NON-HAZARDOUS WASTE	PPC/Waste
Belfast Agglomeration	New Holland WWTW	P0242/07A	Disposal of waste other than by incineration or landfill	PPC/Waste

Location of Site	Site Name	PPC PERMIT	Site Activity	Site Type
Belfast Agglomeration	Newtownbreda WWTW	P0239/07A	Disposal of waste other than by incineration or landfill	PPC/Waste
Belfast Agglomeration	Northstone	PPC0047/08B	Production of Cement and Lime	PPC/Waste
Belfast Agglomeration	Renewable Power Systems, Dargan Rd Gas Engines	P0307/09A	INCINERATION AND CO-INCINERATION OF WASTE	PPC/Waste
Belfast Agglomeration	Wastebeater Recycling	P0468/14A		PPC/Waste
Belfast Agglomeration	Whitehouse WWTW Sludge Thickening Plant	P0310/09A	DISPOSAL OR RECOVERY OF NON-HAZARDOUS WASTE	PPC/Waste
Within 1km of the Belfast Agglomeration	Aughrim Quarry	PPC0043/08B	Other Mineral Activities	PPC/Waste
Within 1km of the Belfast Agglomeration	Blackmountain	PPC0109/08B	Other mineral activities	PPC/Waste
Within 1km of the Belfast Agglomeration	Blackmountain Phase i ii iii landfill	P0259/07A	Disposal of waste by Landfill	PPC/Waste
Within 1km of the Belfast Agglomeration	Colin Glen Road Landfill (Aughrim Quarry 0192/01B Closed)	P0162/07A	Disposal of waste by landfill	PPC/Waste
Within 1km of the Belfast Agglomeration	Colinglen Road Landfill	P0246/07A	Disposal of waste by landfill	PPC/Waste
Within 1km of the Belfast Agglomeration	Dorisland WTW	P0371/11A	DISPOSAL OR RECOVERY OF NON-HAZARDOUS WASTE	PPC/Waste
Within 1km of the Belfast Agglomeration	F P McCann Ltd	PPC0135/08B	Coating road stone with tar or bitumen	PPC/Waste
Within 1km of the Belfast Agglomeration	Greenisland WWTW Sludge Thickening Plant	P0315/09A	DISPOSAL OR RECOVERY OF NON-HAZARDOUS WASTE	PPC/Waste

Location of Site	Site Name	PPC PERMIT	Site Activity	Site Type
Within 1km of the Belfast Agglomeration	Hightown Landfill	P0324/09A	DISPOSAL OF WASTE BY LANDFILL	PPC/Waste
Within 1km of the Belfast Agglomeration	Mullaghglass Landfill Site	P0107/05A	Disposal of waste by Landfill	PPC/Waste
Within 1km of the Belfast Agglomeration	NWP Ltd	P0341/10A	DISPOSAL OR RECOVERY OF NON-HAZARDOUS WASTE	PPC/Waste
Within 1km of the Belfast Agglomeration	PSNI Seapark	P0064/05A	Waste Disposal - Incineration	PPC/Waste
Within 1km of the Belfast Agglomeration	Renewable Power Systems (NI) Limited	P0457/14A	Incineration and co-incineration of waste	PPC/Waste
Within 1km of the Belfast Agglomeration	Roadmix	PPC0169/08B	Other Mineral Activities	PPC/Waste
Within 1km of the Belfast Agglomeration	Rumbling Hole	P0247/07A	Disposal of waste by landfill	PPC/Waste
Within 1km of the Belfast Agglomeration	Wolfhill Landfill Site - Belfast	P0345/10A	DISPOSAL OF WASTE BY LANDFILL	PPC/Waste

Table 5.3 Industry – Additional waste sites modelled in Round 3

Site name
Clearway Disposals Ltd, East Twin Rd, Belfast Harbour Estate, Belfast, BT3 9EN
Natural World Products Ltd, Glenside Rd, Dunmurry, Co Antirm BT17 0LH
Whitehill Quarry landfill, Glenside Rd, Dunmurry, Co Antrim BT17 0LH

Table 5.4 Industry – Function of non PPC industrial sites in the Belfast port area

Function	No of sites
Area with light industry	20
Asphaltic concrete	2
Bulk Terminal	2
Chemical Storage	1
Coal Storage	1
Construction	1
Ferry Terminal	1
Liquid and Gas Storage	13
Shipyard	4
Trans-shipment	5
Warehouse/Storage	11
Wind Turbine	1
Total	**62**

5.2 Assigning emission levels

The final stage of the developing the industry source layer was the structured assignment of emission levels to each of the 133 sites.

The process used in Round 3 repeated the steps undertaken during R1 and R2, and involved the assignment of emission levels based upon the hours of operation of the sites in terms of the day, evening and night-time periods prescribed by the Regulations. This was given consideration through the information provided by DAERA and Port of Belfast.

All emission levels were defined in terms of a sound power level per m^2 with emission levels developed in line with the options set out in GPG-WG-AEN Toolkit 10 Tool 10.5, as outlined in Plate 5.2 below.

Plate 5.2 WG-AEN Toolkit 10 Tool 10.5

Tool 10.5: Sound power levels unknown						
Method				complexity	accuracy	cost
Obtain sound power levels from **source operator**						
Determine sound power levels using ISO 8297						
Use input data contained in an **EIA** (Environmental Impact Assessment)						
Use nationally defined **default source sound power levels**						
Use nationally defined **maximum permissible sound power levels per unit of surface area**						
If Directive 2000/14/EC provides limiting values for source under consideration, use these values						
Use **public databases** (examples see Table 1 and Table 2). Also see IMAGINE Project (Ref.19) which is developing a database						
Use the following **default values**:						
Type of industry	**Default value for L_w" ($/m^2$)**					
	day	evening	night			
Area with heavy industries	65 dB(A)	65 dB(A)	65 dB(A)			
Area with light industries	60 dB(A)	60 dB(A)	60 dB(A)			
Area with commercial uses	60 dB(A)	60 dB(A)	45 dB(A)			
Ports	65 dB(A)	65 dB(A)	65 dB(A)			

This work undertaken in Round Three also involved reviewing and reassignment of noise emission values based on the IPPC process category and type of production process identified. This worked included reference to conference papers, the Dutch 2004 database of typical noise emissions from industry and a web search for noise impact assessment reports for WWTW.

This source material led to re-evaluation of noise emissions for a number of sites. These were:

- Hospital incinerator - reduced from 60 to 50 d/e
- 2 x quarries - reduces from 60, 60, 60 to 55, 55, 45
- 5 x landfill sites - reduced from 60, 60, 60 or 45, to 50, 50, 45
- 6 x WWTW - reduced from 60, 60, 60 to 50, 50, 50
- 6 x drinks bottling plants - reduced from 60, 60, 45 to 55, 55, 45
- Intensive farm - reduced from 60, 60, 45 to 50, 50, 45

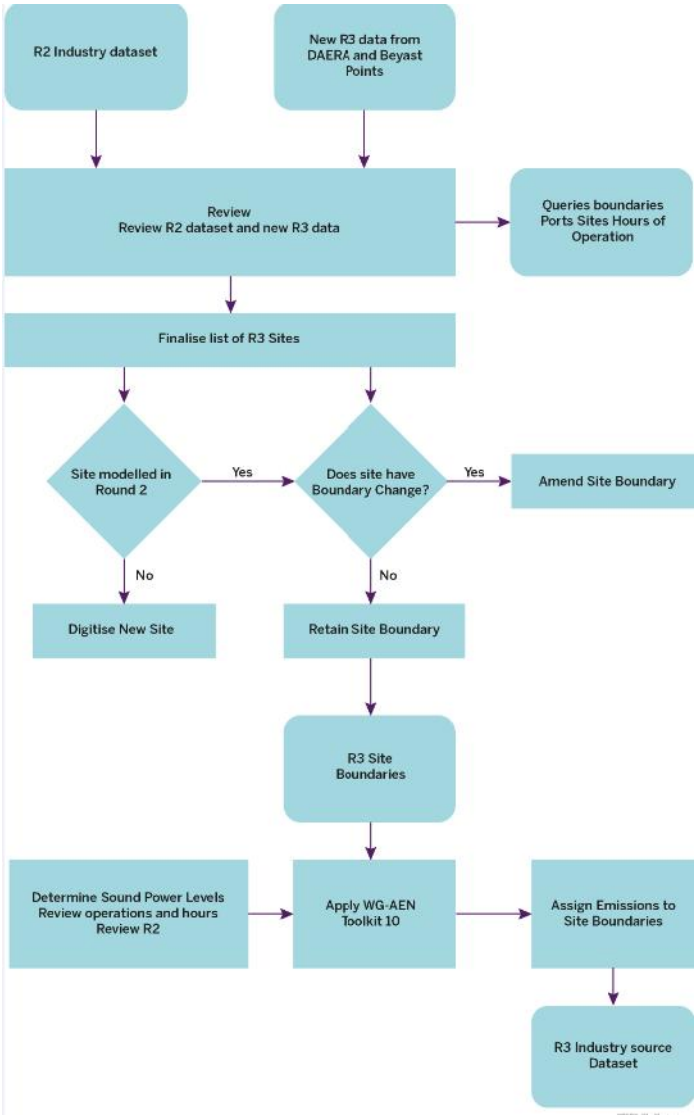
It should be noted that where a new site was understood not to operate during night-time periods, the default values were adjusted for the night-time period to 45 dB per m^2 to reflect permitting. Appendix B provides a complete list of all modelled Round Two industrial sites and their noise emission level assignment.

5.3 GIS dataset development

The Round Two industrial noise emission dataset was developed within a GIS environment. The dataset development broadly follows the approach outlined in Section 5.1 and 5.2 and is summarised in Plate 5.3 below.

The plate shows the receipt of Round Three PPC sites, along with the R1 and R2 datasets. This is followed by the review process and the issuing and receipt of subsequent queries. Following the review process, the plate shows the finalisation of Round Three industrial sites, at which point the dataset development split into two work streams: the finalisation of Round Three industrial site boundaries; and the determination of sound power levels. The dataset was finalised following the conclusion of these processes.

Plate 5.3 Development of Round Three industrial noise dataset



6. Quality assurance

6.1 Introduction

This section details the Quality Assurance procedures applied to the development of industrial source and related 3D propagation dataset. Full details of the QA processes applied to the 3D modelling layers are outlined in the accompanying Northern Ireland Round 2 Noise Mapping 3D modelling report.

As discussed in the earlier section of this report, the industrial source dataset was developed in the GIS environment in accordance with the established LimA object dataset schemas. This approach was taken to reduce the processing required within the LimA software environment, and seeks to ensure that datasets are in compliance with the LimA software.

The Quality Assurance of the Round Three datasets marked the transition from the GIS environment to the LimA software environment, and also marked the beginning of Stage 2 of the project. The QA procedures aimed to identify whether the industrial GIS dataset had been developed to specification. It also aimed to ensure that calculations would run without error and that any issues encountered with the source datasets were identified before calculation and corrected as required.

The QA procedures adopted by the project team broadly reflect those implemented for Round Two with all QA procedures undertaken with the assistance of electronic proformas. These proformas ensure that all steps within each stage of the QA procedures are adhered to in sequence and are correctly implemented. The proformas also allow version control, file paths and corrective actions to be formally issued between the noise calculation and GIS teams. Plate 6.1 presents an example proforma.

Plate 6.1 Example QA proforma

Stage 3A QA - Integrity Checks in LimA Modelling Env.

Project Title	Northern Ireland Third Round Noise Mapping
Project Number	38600
Project Sub-Area	_AreaA
LimA Server Project Path	\\emanlima1\LimAjobs\38600\DATA

Note: Scroll over the QA Check to review checking requirements. Perform Checks from Left to Right

Shapefile Data Inputs								
Data Layer	File	CHECK 1 OK?	CHECK 2 OK?	CHECK 4 OK?	CHECK 7 OK?	Renumber ELEs	SAVE	Pass / Fail?
HIN_HA1	No Data Layer for Project Sub-Area		n/a		n/a			
HIN_HA2	\\emanlima1\LimAjobs\38600\DATA_AreaA\MODEL\HIN_HA2_AreaA_HIN_HA2	Yes	Yes	Yes	n/a	Yes	Yes	Pass
HIN_HA4	\\emanlima1\LimAjobs\38600\DATA_AreaA\MODEL\HIN_HA4_AreaA_HIN_HA4	Yes	n/a	Yes	n/a	Yes	Yes	Pass
HIN_HA7	\\emanlima1\LimAjobs\38600\DATA_AreaA\MODEL\HIN_HA7_AreaA_HIN_HA7	Yes	Yes	Yes	Yes	Yes	Yes	Pass
GEL	\\emanlima1\LimAjobs\38600\DATA_AreaA\MODEL\GEL_AreaA_GEL_02.BNA	Yes	n/a	Yes	n/a	Yes	Yes	Pass
BRL	No Data Layer for Project Sub-Area		n/a		n/a			
RDL	No Data Layer for Project Sub-Area		n/a		n/a			
RD	No Data Layer for Project Sub-Area				n/a			

Corrective Actions		
Data Layer	File Path	Description
HIN_HA1	No Data Layer for Project Sub-Area	
HIN_HA2	\\emanlima1\LimAjobs\38600\DATA_AreaA\SOURCE\HIN_HA2_AreaA_HIN_HA	No edits required - saved as rev2
HIN_HA4	\\emanlima1\LimAjobs\38600\DATA_AreaA\SOURCE\HIN_HA4_AreaA_HIN_HA	No edits required - saved as rev2
HIN_HA7	\\emanlima1\LimAjobs\38600\DATA_AreaA\SOURCE\HIN_HA7_AreaA_HIN_HA	Incorrect bridge geometry on ID 32, 37 - corrected in rev2
GEL	\\emanlima1\LimAjobs\38600\DATA_AreaA\SOURCE\GEL_AreaA_GEL_02.SHP	No errors - all checks completed

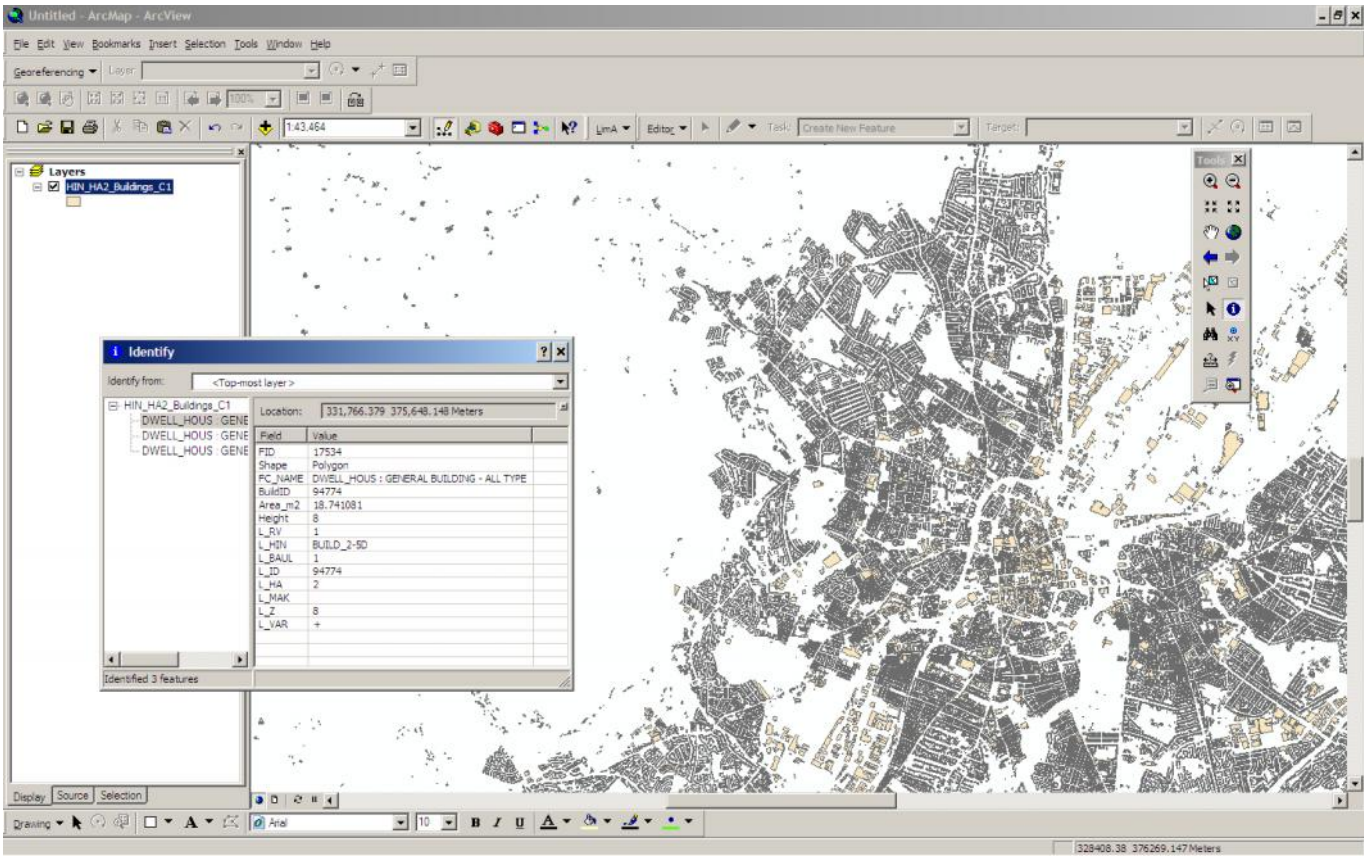
The QA procedure comprised a four stage process. The first three stages of the QA procedure were implemented on a layer by layer basis. The final stage of the QA procedure required the interaction of all 3D modelling layers ensuring that the noise model was correctly compiled.

6.2 Stage 1 of the QA process

Stage 1 of the QA procedure was a check of the datasets in the GIS environment by a member of the noise calculation team prior to import into the LimA environment, see Plate 6.2. The purpose of this stage was to ensure that the data had been correctly prepared in terms of spatial extent, object type and attribution and was generally suitable to be imported into the LimA environment.

These checks were applied to both the updated R3 industry source layer (133 sites) and the revised Round Three ground model data layers.

Plate 6.2 GIS dataset checking in ArcGIS prior to import into LimA



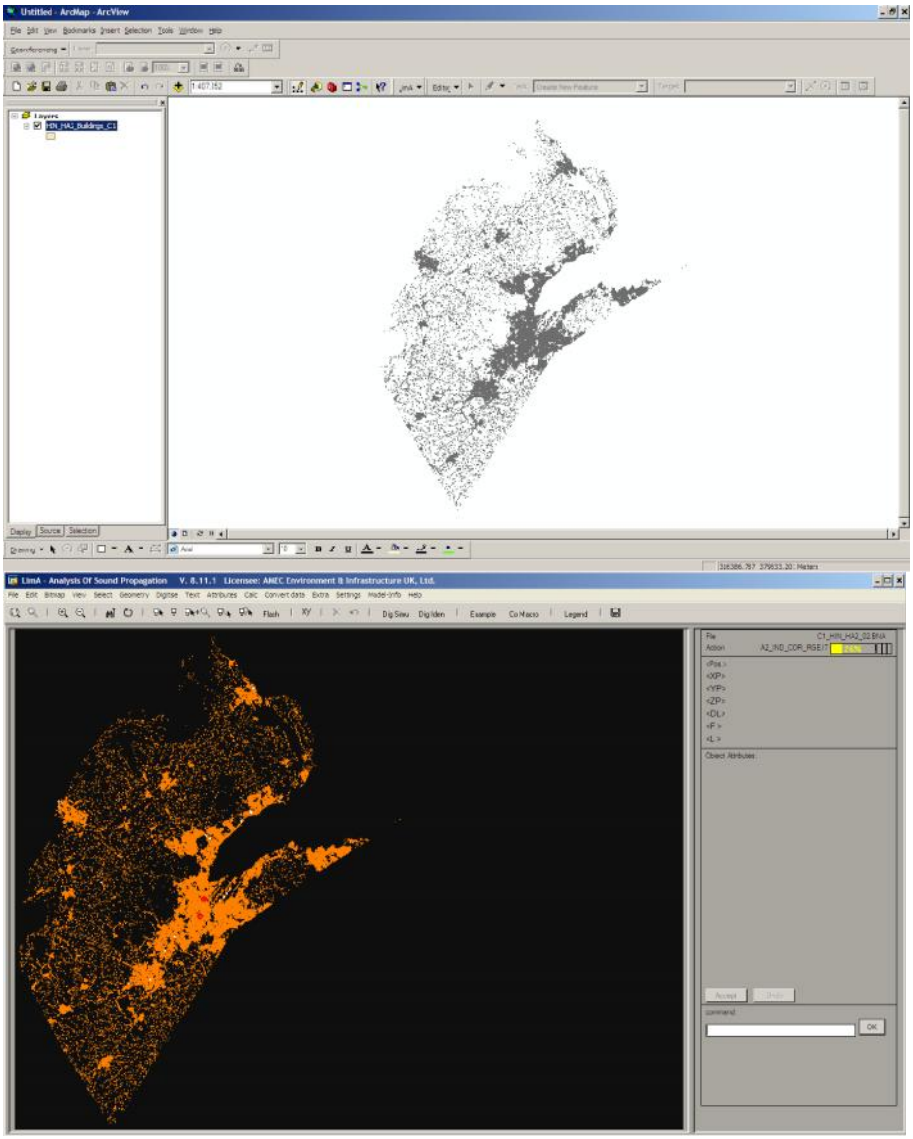
6.3 Stage 2 of the QA process

Stage 2 of the QA procedure imported the industrial source and 3D model layers into the LimA environment. All data was exported from the GIS environment in Shapefile format and imported into the LimA environment to the software's proprietary BNA file format. The import process was a one-to-one conversion and is illustrated in Plate 6.3. This means that all objects in GIS must be stored as single features and should have unique identification

numbers. As part of the importation, LimA warned of any objects which did not meet this requirement or had significant non-compliant topographies.

The QA process in Stage 2 required the documentation of any errors during importation and feedback to the GIS project team when any errors were encountered, along with corrective actions.

Plate 6.3 Data in ArcGIS and LimA environments



6.4 Stage 3A of the QA process

Stage 3A incorporated the testing of the imported datasets within the LimA modeling environment. The LimA modeling environment has several built-in check procedures which look for topographic and attribution issues and/or errors. Each type of 3D modeling layer underwent a different series of checks. For example, bridge objects had a check designed specifically for their object type.

Once imported the QA procedure required each LimA modeling object (e.g. bridge, building etc.) to undergo a series of checks. These checks included:

- Object integrity checks (i.e. does the object meet its topographic definitions);
- Attribution checks (i.e. are the attributes populated appropriately);
- Object definitions checks; and
- Duplicable object checks.

Where errors were identified by the check procedures, LimA marked the objects for correction. Depending upon the number of corrections required, the QA procedures allowed these to be undertaken within LimA or alternatively passed back to the GIS team for corrective action. Any amendments were documented within the proformas.

6.5 Stage 3B of the QA process

Stage 3B of the QA procedure reflected those undertaken in Stage 3A except these checks were undertaken within the LimA calculation environment. Each layer was subjected to LimA's 'Model Check' procedure. When performed on a layer-by-layer basis, this check highlighted any object attribution or topographic errors that were not highlighted within the LimA modelling environment. These included:

- Incorrect object attribution (i.e. are the attributes populated appropriately);
- Duplicable object checks; and
- Incorrect or incompatible topographies (e.g. polylines with incomparable vertex spacing).

The checks undertaken as part of LimA's 'Model Check' function were more rigorous that than those undertaken in Stage 3A within the LimA modeling environment. These checks ensured that each model layer was error free prior to Stage 4.

6.6 Stage 4 of the QA process

Stage 4 was the most involved stage of the QA process. Stage 4 was a QA of the interaction of all the various datasets comprising the noise model. The Stage 4 QA process was broken into several small stages as outlined in Table 6.1.

Table 6.1 Tests undertaken in Stage 4 of the QA process

Test	Model Layers	Description
T1	HIN HA 4, GEL, HIN HA 7	Bridges interact correctly with the DTM
T2	HIN HA 4, GEL, HIN HA 2	Buildings interact correctly with the DTM
T3	HIN HA 4, GEL, HIN HA 1	Barriers interact correctly with the DTM
T4	HIN HA 4, GEL, HIN HA 2, HIN HA 7, HIN HA 1, TOP	Bridge, Barrier and Building interact correctly with the DTM and Ground Cover
T5	As T4 and Noise Source Dataset	Check Complete Ground Model interaction with Noise Sources

Each test culminated in a complete QA of the ground model within the LimA calculation environment using the 'Model Check' feature.

In Test T1, the noise calculation team reviewed the digitisation of each bridge and their 3D positioning. Each bridge was reviewed in 3D and corrected if necessary. Bridges which were incorrectly digitised were automatically flagged by the LimA calculation core, however incorrect position was not. A manual check was therefore the only means of ensuring that bridges were correctly modelled.

In Test T2, the 'Model Check' functions evaluated the height of flat topped buildings, based on the relative height of the building and the height of the terrain at the start point of the building object. The key output of the check was the identification of buildings which had relative heights which fell below the surrounding terrain. This was possible in locations where buildings were located on sloping terrain.

Where this occurred, it was necessary to reposition the start point of the building object to another location which ensured that the top of the building object was above the terrain at all locations. For Round One, these errors had to be correctly manually. For Round Two and Three, an automated solution was used to correct the start position of the building objects where the building falls below the terrain.

For Test T3, each barrier was reviewed in 3D to ensure that it is correctly aligned with respect to the DTM. Where alignment appeared incorrect, these were corrected within the software. Where barriers were positioned on bridges, these were also reviewed to ensure that they sat correctly on the bridge structure and the adjoining terrain. Each barrier was reviewed in 3D and corrected as appropriate.

For Test T4, all ground model layers were interacted together. The output from the LimA 'Model Check' function was reviewed to ensure that the interaction of objects did not result in any additional errors. Areas were selected from the model and 3D views generated which were reviewed manually. These areas were selected in the location of bridges and barriers.

6.7 LimA version QA

The round Two strategic noise mapping of industry was undertaken using LimA version 8.11. In preparation for the Round Three strategic noise mapping test calculations were run using a part of the Round Two model in Belfast with v8.11 and the current LimA v11.2.

The test model held a 7 x 7 km section of Belfast, near to the port and BCA, as shown in Plate 6.4. The calculation area was the central 3 x 3 km area shown. The same R2 model data was loaded and run in LimA v8.11 and LimA v11.2, using the same calculation settings, on the same computer hardware.

Following the completion of the calculations, the v8.11 grid results were subtracted from the v11.2 results and the difference results analysed.

For the industry calculation according to ISO 9613-2, across the 75,021 grid points considered, the mean level difference was 0.02 dB, and range calculated in accordance with ISO 17534 & DIN 45687 had a 0.1 quantile of -0.08 dB and 0.9 Quantile of 0.06 dB. The distribution of level difference is shown in Plate 6.5.

The results of this testing indicate that the use of the current version of LimA v11.2 for the Round Three strategic noise mapping will not introduce any significant variance into the R3 results compared to the R2 results.

Plate 6.4 7 x 7 km area used for LimA testing

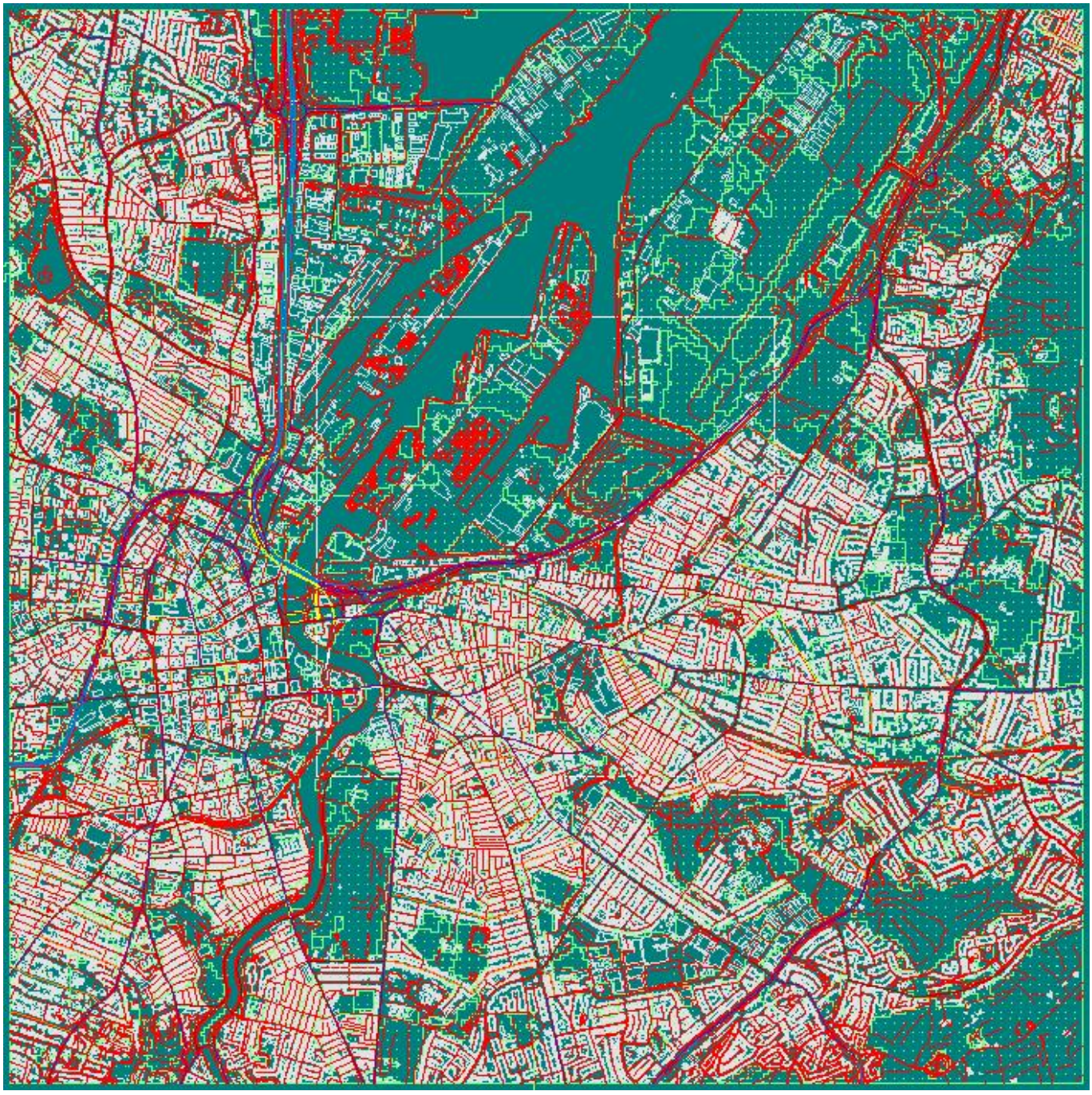
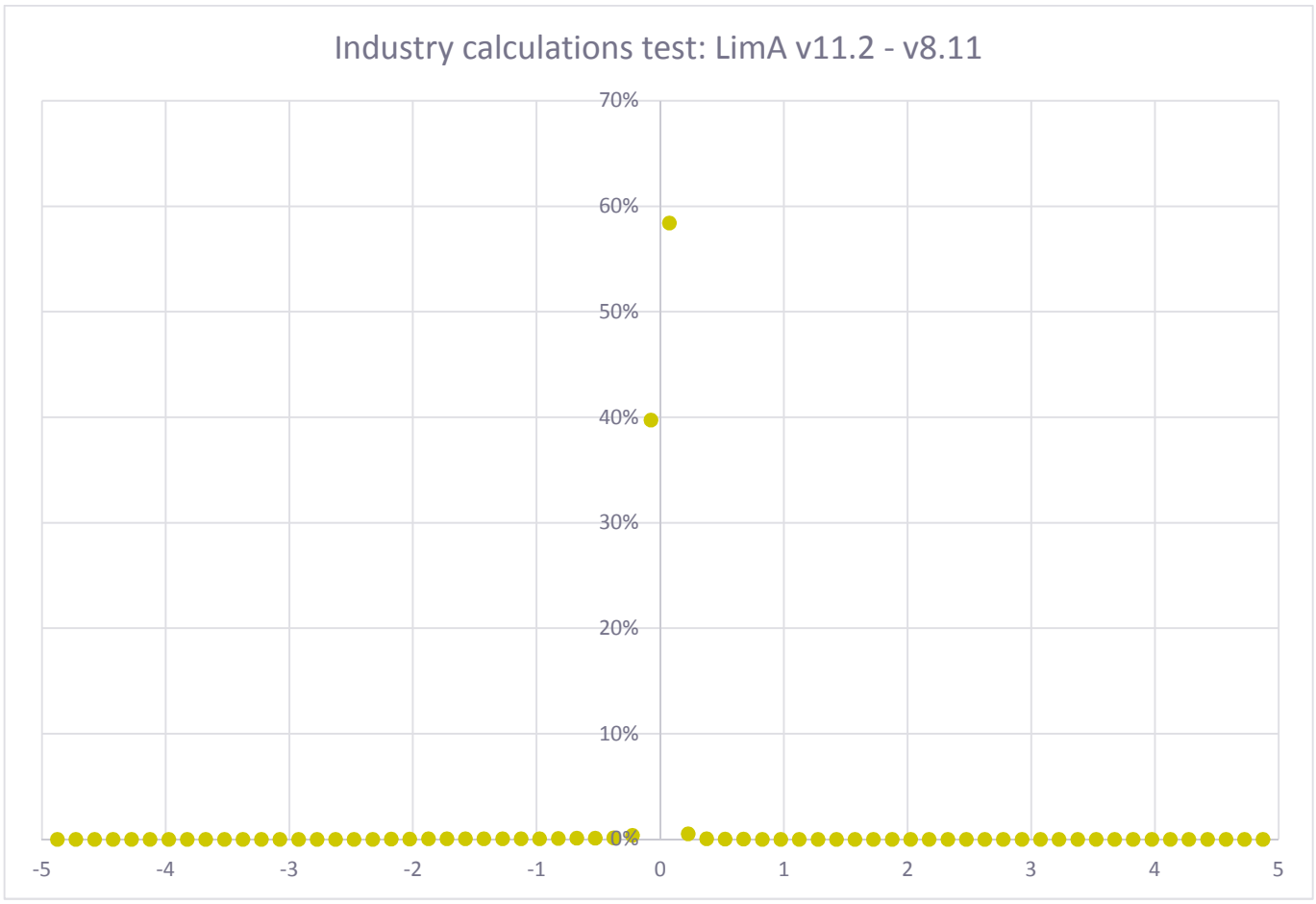


Plate 6.5 Distribution of level difference



7. Noise level calculations

Section 7 details the approach to the noise level calculations for the assessment of industrial noise in Northern Ireland. The noise calculations are a culmination of the source emission datasets and the 3D modelling datasets which facilitate the propagation of noise from the point of emission into the environment and to the receptors.

The means by which these calculations are undertaken, and indeed the accuracy of these calculations, can vary significantly depending upon choices made in the settings for the calculations. Some calculation settings simply determine how many calculations should be undertaken and to what resolution these should occur. Other calculation settings require the user to determine how certain elements of a calculation method are handled whilst other calculation settings are used to derive efficiencies in the overall calculation process. All these settings combine to determine the computational load of the calculations and the compliance of the calculations with the various assessment methodologies.

Strategic noise mapping under the Directive and the Regulations is clear in terms of the area and resolution of the calculations. Therefore, in order to ensure that calculations are undertaken in a compliant but efficient manner, consideration must be given to settings and calculation technique which allow calculations to be efficient, yet allow the calculated noise levels to remain compliant with the assessment method without introducing excessive uncertainties.

7.1 Efficiency settings

Efficiency settings are designed to reduce the computational load of a noise calculation by either reducing the number of calculations required or by reducing the complexity of each calculation. This is achieved by settings which instruct the calculation core to ignore or discount certain noise sources or aspects of the calculation. As outlined above, although efficiency settings have advantages in reducing the computation load and time of the calculations, they can introduce uncertainties into the calculated noise levels. As a rule of thumb, a slower calculation is likely to introduce less uncertainty than a faster one.

Efficiency settings can be applied separately or in combination with each other. A series of efficiency settings were tested for the calculation of industrial noise during Round One and Round Two. This testing studied the effect of the settings upon noise levels above 55 dB L_{den} and 45 dB L_{night} thresholds i.e. those requiring reporting of population exposure under the Directive. The testing was comprehensive and demonstrated that a combination of settings could result in significant benefits in calculation times whilst introducing low levels of uncertainty into the final noise level results.

The project team have reviewed these settings against the settings currently available within the LimA calculation environment. This review has confirmed that there are new and modified settings in relation to the treatment of side diffractions however all other settings remain the same as those used in Round One and Round Two. It is noted that side diffraction was not considered in Round One or Round Two and therefore these new settings are not required for mapping Round Three. Project policy has therefore been to retain the efficiency settings adopted in Round One and Round Two for Round Three.

There are several advantages to retaining the same efficiency settings for Round Three, namely consistency within the calculations. Efficiency settings can introduce uncertainties therefore changes in these settings between Round Two and Round Three may mask any actual changes in noise levels between Round Two and Round Three. As such, in order to identify any real change in noise levels between Round Two and Round Three, two sets of calculations would be required using Round Two efficiency settings and any new settings adopted for Round Three. It is the view of the project team that the settings adopted for Round Two should be retained until the introduction of the new Common Method set out in EU Directive 996/2015 during Round Four in 2022. The new common assessment method is likely to require a review of all calculation efficiency and compliance settings.

7.2 Calculation settings

Table 7.1 presents an overview of the calculation settings adopted for the calculation of industrial noise in Northern Ireland. These settings were retained from the Round One and Round Two modelling exercises.

Table 7.1 Industrial calculation settings

Setting	Type	Description	Setting in Round Three
Grid Resolution	Calculation Grid Definition	Defined by the Regulations and Directive as 10m. This setting defined the distance between grid points in the calculation grid.	10m
Calculation Height	Calculation Grid Definition	This setting defines the calculation height of each point within the calculation grid. The Regulations and Directive define calculation height at 4m relative to the ground.	4m
Reflection Order	Compliance	Reflection order is the number of reflections considered in any given source to receiver propagation.	1
Reflection Distance	Compliance	Reflection distance is the distance at which reflections from reflective objects are considered to effect noise levels at receivers. There is no guidance in CRN as to what distances reflections should be considered. For Round One, a value of 50m was adopted as this is the upper rounded value of reflections considered in the example calculations within the appendices of CRN.	50m
Dynamic Error Margin	Efficiency	Dynamic error margin is the maximum uncertainty allowed within any calculation. The setting functions by estimating the influence of a noise source at a receiver through performing a simple noise distance attenuation. Where the influence is considered not to materially affect noise levels at the receiver, the source is discounted. Where the source is considered to affect noise levels, a full propagation calculation is undertaken for the source.	On – 0.5 dB
Simplify Propagation Analysis	Efficiency	When turned off, each propagation path assessed by LimA is considered in full with all obstacles (i.e. buildings and barriers) assessed in terms of their screening potential. When turned on, obstacles that are located a reasonable distance from the source and receiver are discounted as these are least likely to have any screening potential.	On

Setting	Type	Description	Setting in Round Three
Eliminate Inner Walls	Efficiency	When activated, this setting instructs the LimA calculation core to ignore the effect of any walls of buildings that are identical i.e. the walls between buildings in a terrace.	Off
Source Search Radius	Efficiency & Compliance	This setting limits the distance from a receiver point at which noise sources are considered for calculation.	1500m
Distance Area Search	Efficiency & Accuracy	This setting governs rules of segmentation for area noise sources. The setting determines how area sources are to be represented by lines and then converted into points. The setting specifies the maximum distance between lines. A large distance will result in a lower number of points representing the area and a lower calculation time however this may affect accuracy.	200m

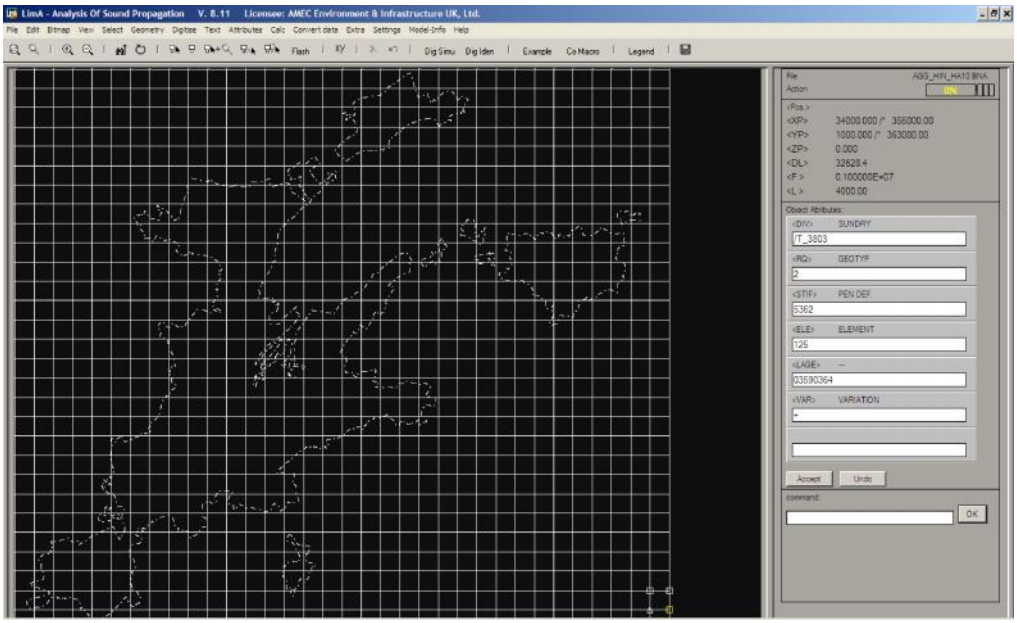
7.3 Distributed calculation

In addition to efficiency settings, calculations can be made quicker through distributing calculations across hardware and computer processors. Additional savings in calculation time can also be found through the optimisation of the hardware environment.

Calculation tiling

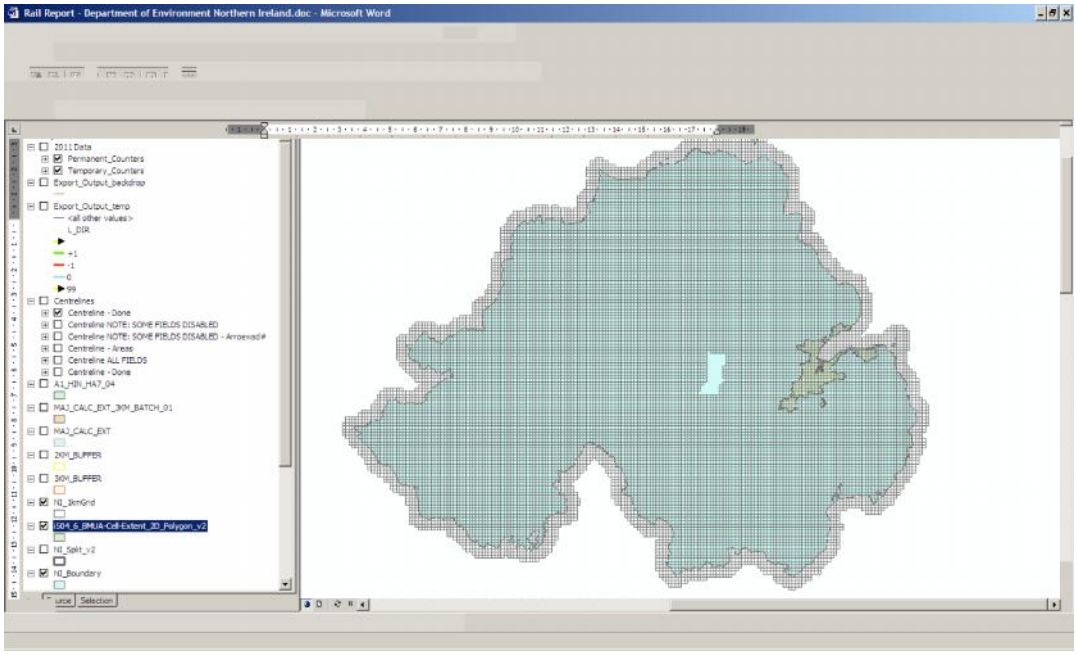
The primary method of distributing calculations within the LimA software environment is through the use of its 'Tiling' functionality. This is illustrated in Plate 7.1. The tiling function allows a large model and calculation area to be segmented into a series of smaller areas which can be calculated on a number of processors and across several computers at once. Plate 7.1 shows an example of calculation tiling for calculation within Belfast agglomeration. The plate shows that calculation area is broken up into a grid of calculation tiles which can be distributed for calculation. The size of these tiles can be specified within the tiling function however it has been previously demonstrated that 1km by 1km calculation tiles result in quicker calculation times than larger tiles due to the amount of modelling information read and processed by the calculation core.

Plate 7.1 Example of tiling function within the Belfast agglomeration



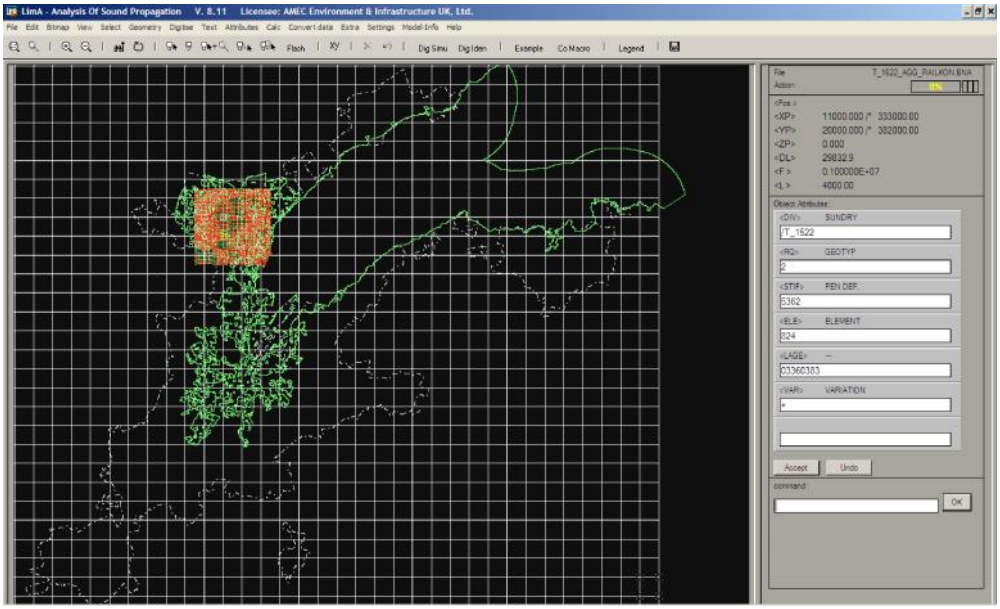
The use of tiling has not been limited to the calculations. Many aspects of the project have been undertaken with respect to the grid lines that are formed through the tiling function. For example, queries raised during the modelling of the major road network have been flagged by calculation tile to allow calculations in other locations to be undertaken away from areas which are still waiting to be resolved. To this extent, the project team have developed a tiling grid which covers Northern Ireland to facilitate the management of the modelling and calculations. This grid is shown below in Plate 7.2.

Plate 7.2 National tiling grid



Prior to calculation, LimA creates a series of calculation instruction files and results folders for each calculation tile. The instruction files tell the LimA calculation core to read in only the model data that is relevant to calculations within the tile. This is defined at the calculation extents plus the distance defined by the source search distance calculation setting. This approach ensures that only the modelling data required to calculate noise levels within the calculation tile is read into the LimA calculation core. An example of this is presented in Plate 7.3. The instruction files also instruct the calculation core to only calculate noise levels within the tile.

Plate 7.3 LimA tiling example



The key advantage of the LimA tiling function is:

- **Reduced calculation times** through the distribution of calculations and through efficient use of model data during calculations; and
- **Redundancy** – tiling calculations can be restarted and models revised on a tile by tile basis allowing calculations to revised or started in the event of model errors or hardware failure.

Calculation servers

LimA manages calculations using its LimAserver management software. The management software allows the automation of calculations. Hardware is allocated a LimA calculation core per processor. When a tiling calculation is started, calculation run files are copied to a 'Global Spool' folder. The LimAserver management software reads the Global Spool folder for run files and then reviews whether any LimA calculation cores are available. When a calculation core is available, the LimAserver software copies the run file to the available core and starts the calculation accordingly. The LimAserver software can manage processors on a single hardware device or on many devices that are distributed across a network.

The LimA server management software ensures that calculations are continuous. The server system is also designed to identify and report if any calculation tiles have fatal errors.

Hardware

AMEC has two dedicated noise calculation servers comprising a total of 44 available calculation cores. These machines are optimised for calculations using the LimA calculation core and were acquired with processors with high floating point performances. Optimisations of these servers have been undertaken in terms of physical memory allocation to ensure that calculations can occur almost entirely within the Random Access Memory (RAM).

7.4 Post processing and output grids

The LimA tiling function and calculation cores produce results grids for each calculation tile as well as the indicators defined during calculation, namely the day, evening and night time periods. In order to simplify the assessment of population exposure, it is necessary to join together each of the tiled results grids into a single grid representative of the area under assessment. In addition, the calculation core is currently restricted to the computation of certain noise indicators. As such, the process of post processing the output grids must also be configured to enable the calculation of additional noise indicators, namely the $L_{Aeq,\ 16hr}$ and the L_{den}. In order to produce the final grid results for all the required noise indicators, a two stage process was undertaken, the first in LimA and the second in GIS.

Calculation output files

The first stage of the post processing is to check the output files produced by each calculation tile. The purpose of this stage is to ensure that each tile within the calculation area has been calculated and that there are no error messages, failed calculations or warnings. Although errors and warnings are covered by the QA process described in Section 7, errors and warnings can result from the clipping process which is undertaken by the LimA calculation core during tiling.

Checks are undertaken to ensure that results files of the expected size have been created for each of the tiles, that error files have not been generated and that the output message files form the tile calculations do not contain error or warning messages. In the event of any errors, warnings or incomplete calculations, the issues are investigated and resolved, and the specific tile(s) are recalculated.

Combining the tile results, interpolating within buildings and export to GIS

The next stage of the post processing routine is undertaken using LimA_9.exe which enables a single step procedure to achieve three parts of the process, namely:

- Combining the 1,118 tile results files into a single results dataset;
- Interpolating results within buildings; and
- Exporting the grid results to GIS files.

In order to combine the tile results a list of the tile results files is generated and read by LimA_9.exe, which then load all the files into memory as one large results dataset.

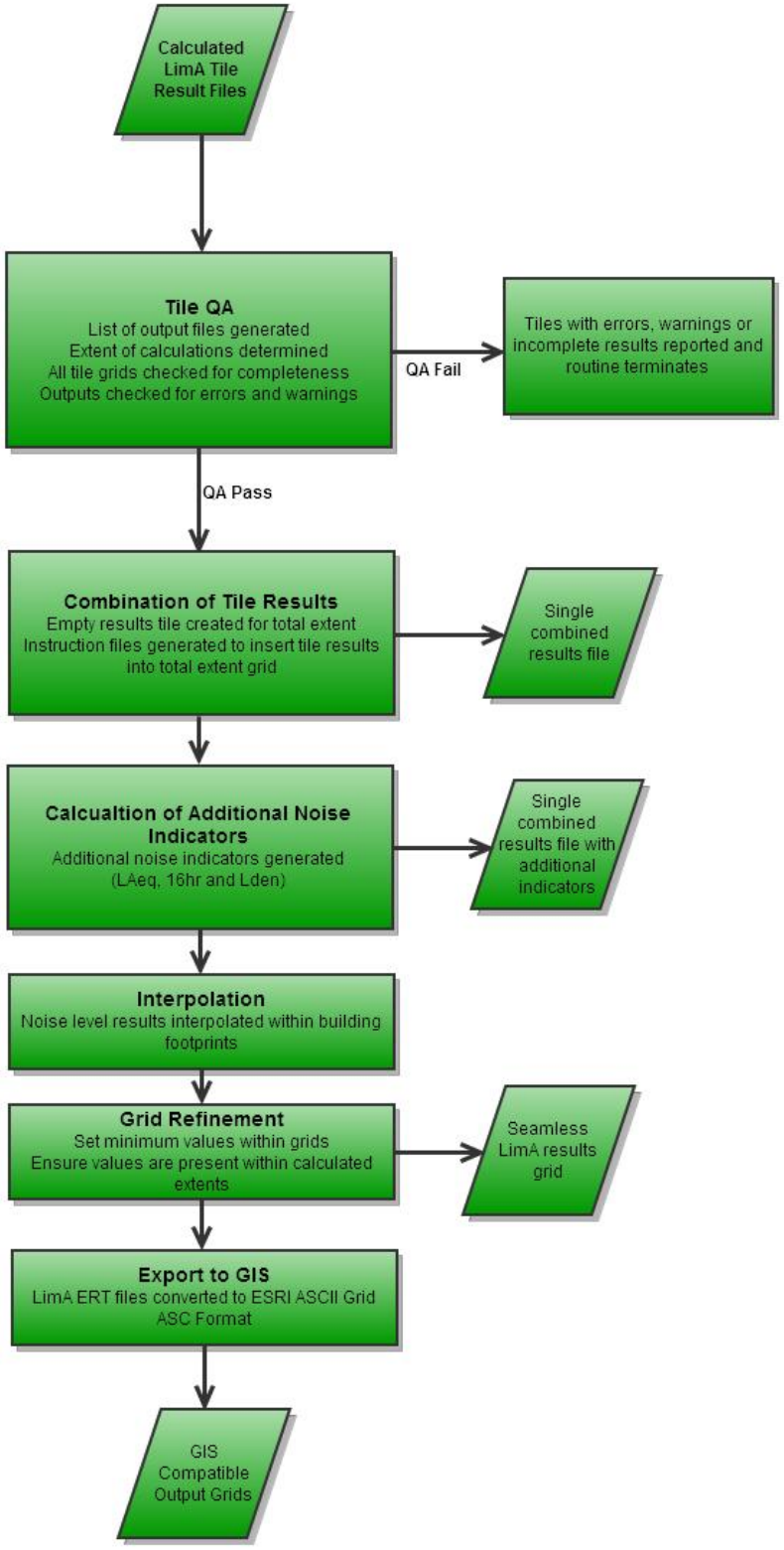
To enable population exposure, a seamless results grid is required. During calculation, LimA reports default values where noise level grid points are located within buildings. The LimA_9 module has a function to interpolate noise levels within buildings using noise levels immediate to their extents. This process through the results data held in memory.

The interpolated noise level results grids are then exported as ESRI ASCII Grid (ASC) format files as listed in Table 7.2.

Table 7.2 GIS ASC results files for industry noise mapping

File	Major Rail/ Agglomeration Rail	Noise Indicator	Description
LDAY	Agglomeration	L_{day}	Annual Average 12-hour daytime noise level (0700-1900hrs)
LEVE	Agglomeration	L_{eve}	Annual Average 4-hour evening noise level (1900-2300hrs)
LNGT	Agglomeration	L_{night}	Annual Average 8-hour night-time noise level (2300-0700hrs)

Plate 7.4 Process flow of the post processing routine



Calculation of additional noise indicators

As discussed, the LimA calculation does not currently calculate all of the noise indicators required under this contract during the primary calculation run. Following the export of the Lday, Levening and Lnight results to GIS files, the additional noise indicators have been calculated in GIS under the second stage of post processing as detailed in Table 7.3.

Table 7.3 Noise indicators required under the END contract

Indicator	Description	Incumbent Within	Produced During
L_{den}	Annual Average Day-Evening-Night Noise Rating Level (24-hour)	Regulations and END	Post-processing in GIS
L_{day}	Annual Average 12-hour daytime noise level (0700-1900hrs)	Regulations and END	Calculation
L_{eve}	Annual Average 4-hour evening noise level (1900-2300hrs)	Regulations and END	Calculation
L_{night}	Annual Average 8-hour night-time noise level (2300-0700hrs)	Regulations, END and NI Planning Policy Guidance	Calculation
$L_{Aeq,\ 16hr}$	Annual Average 16-hour daytime noise level (0700-2300hrs)	NI Planning Policy Guidance	Post-processing in GIS

As outlined in Table 7.3, the L_{den} and $L_{Aeq,\ 16hr}$ indicators were generated as part of the GIS post-processing routine. The formula used for L_{den} was:

$$L_{den} = 10\log\left[\left(\frac{1}{24}\right)\times\left(12\times10^{\frac{L_{day}}{10}} + 4\times10^{\frac{L_{eve}+5}{10}} + 8\times10^{\frac{L_{night}+10}{10}}\right)\right]$$

The formula used for $L_{Aeq,\ 16hr}$ was:

$$L_{Aeq,16hr} = 10\log\left[\left(\frac{12}{16}\times10^{\frac{L_{day}}{10}}\right) + \left(\frac{4}{16}\times10^{\frac{L_{eve}}{10}}\right)\right]$$

Following completion of the post processing, the final results datasets for R3 strategic noise mapping of industry were prepared for delivery to DAERA as an ESRI Geodatabase.

8. Area calculations

The first post processing step that was undertaken on the raw continuous output noise grids was a reclassification of the grids into bands. The reclassification bands used are outlined in Table 8.1.

Table 8.1 Noise bands used to reclassify output grids

Noise Level Result	Noise Bands						
L_{den}	< 50	50-54	55-59	60-64	65-69	70-74	>=75
L_{day}	< 50	50-54	55-59	60-64	65-69	70-74	>=75
$L_{evening}$	< 50	50-54	55-59	60-64	65-69	70-74	>=75
$L_{Aeq, 16\ hour}$	< 50	50-54	55-59	60-64	65-69	70-74	>=75
L_{night}	< 45	45-49	50-54	55-59	60-64	65-69	>=70

The geometric area of the noise bands for each of the bands was calculated based on the outputs. The area results for industrial noise sources within the agglomeration are shown in Table 8.2, with full maps presented in Appendix C.

Table 8.2 Industry - area of noise bands in km²

Noise Level	$L_{Aeq, 16\ hour}$	L_{den}	L_{day}	L_{eve}	Noise Level	L_{night}
50-54	2.8	4.1	2.9	2.6	**45-49**	3.6
55-59	1.9	2.9	1.9	1.4	**50-54**	2.8
60-64	3.9	2.2	4.0	3.2	**55-59**	1.9
65-69	1.1	3.2	1.2	1.1	**60-65**	4.0
70-74	0.0	2.2	0.0	0.0	**65-69**	1.2
>=75		0.2			**>=70**	-
Total	**9.8**	**14.8**	**10.0**	**8.2**	**Total**	**13.5**

9. Population exposure analysis

9.1 Population exposure methodology

Annex VI of the END states that a population exposure assessment is required as an output of the END noise mapping process and that the results of this assessment need to be reported to the European Commission (EC). Annex VI also states that the estimated number of people (in hundreds) living in dwellings that are exposed to noise are to be calculated for the various scenarios mapped. There is no definition of a 'dwelling' in the END although the term is used within Article 3 (q), Annex I (1), Annex III, Annex IV (1) and Annex VI (1.5, 1.6) and (2.5, 2.6).

Four primary datasets were used within the population exposure assessment developed in the Round Three study. The datasets used were:

- Detailed individual building polygons recorded in the 2016 version of the OSNI large scale mapping[1]. However, it is important to note that the date of the imagery used to update the detailed OSNI mapping varies from 2013-2015. Further information is provided in the accompanying Round Three Ground model report.
- The OSNI Pointer dataset which provides details of the residential, public-use and commercial classifications of individual buildings across Northern Ireland[2]. The Pointer data set is described by OSNI as the primary address database for Northern Ireland and is maintained by Land & Property Services (LPS), with input from Local Councils and Royal Mail. This dataset was supplied to Amec Foster Wheeler in September 2016 and contains records until this date.
- Geographical boundary file for the 4537 Small Areas (SAs) which were introduced in Northern Ireland after the 2011 Census[3]. Small Areas are generally created by amalgamating 2011 Census Output Areas which were built from clusters of adjacent postcodes. This is the smallest spatial unit for which annual population estimates are produced for Northern Ireland – see below, and
- Northern Ireland Statistics and Research Agency 2015 population estimates for the 4,537 census small areas (SAs) across Northern Ireland[4]. The total estimated usual resident population across these areas was 1,828,971. This represents a 3% increase in population from Round 2.

The key steps used to create the final population dataset used in the population exposure assessment are summarised below. This builds upon the methodology adopted for Round Two but introduces a more robust approach to the assessment of the number of residential addresses within individual buildings and ultimately the distribution of population across residential buildings in Northern Ireland.

Step A - Assessment of the number of addresses in each residential building object

- A1 - Identification of all individual buildings within the OSNI large scale dataset which were either defined by OSNI as being residential and/or a mixed function building containing at least one residential address as defined in the OSNI Pointer dataset. The total number of residential building objects was 774,424.
- A2 – GIS query run to identify all built residential property addresses within the LPS Pointer dataset. The criteria used for selection is shown in Table 9.1. Please note that the number of records for A2

[1] https://www.nidirect.gov.uk/articles/large-scale-vector
[2] https://www.nidirect.gov.uk/publications/pointer-technical-specification
[3] https://www.nisra.gov.uk/support/geography/northern-ireland-small-areas
[4] https://www.nisra.gov.uk/publications/2015-mid-year-population-estimates-small-areas

was larger than A1 due to the presence of buildings with multiple addresses (e.g. apartments and flats).

Table 9.1 Criteria for selection of LPS Pointer data

Classification	Address Status	Used in development of the population dataset	No of LSP Pointer records
Domestic (DO_)	Approved	Yes	757,064
Domestic (DO_)	Provisional, Candidate, Historical or Rejected	No	112,361
Non_Domestic (ND_) or Null	All values	No	87,075
Total			956,500

- A3 - GIS tool used to count the number of completed domestic residential "built" LPS Pointer address within each OSNI building object identified in Step A1. This number ranged from 1 (majority of buildings) to 282 (large apartment type buildings). It should also be noted that the analysis only considered LPS Pointer records which had a confirmed Address Status of "Approved", which effectively means a completed building rather than a building under construction.

Step B – Assessment of population per address for each Small Area in Northern Ireland

- B1 – GIS tool used to spatial join the 2015 population estimates to each of the 4,537 census small areas (SAs);
- B2 - GIS spatial join tool used to assign the Small Area (SA) reference code to each of the buildings identified in Step A1. This was achieved using the centroid of the building object.
- B3 – GIS aggregation tool used to count the total number of residential address in each of the 4,537 Small Areas across Northern Ireland; and
- B4 – Final estimate of a population per address calculated by dividing the 2015 population estimate by the total number of address in each of the 4257 Small Areas across Northern Ireland.

Step C – Estimating a total population for each residential building in Northern Ireland

- A final estimate of population in each residential building was calculated by multiply the number of individual residential addresses in the building (Step A3) by the estimate of population per address (Step B4).

These final estimates were subject to a final set of QA checks to ensure a representative distribution of the 1,828,971 population recorded by the NISRA in the 2015 population estimate dataset. The mean value per residential building is 2.36.

As per the assumptions used in the Round One and Round Two studies, Annex I (1) of the END indicates that noise exposure assessments should be at the most exposed façade. The most exposed façade is defined as the external wall facing onto and nearest to the specific noise source. For the purposes of this assessment the highest overall value assigned to a dwelling is to be considered the most exposed façade as per recommendations set out within the WG-AEN Good Practice Guide v2.

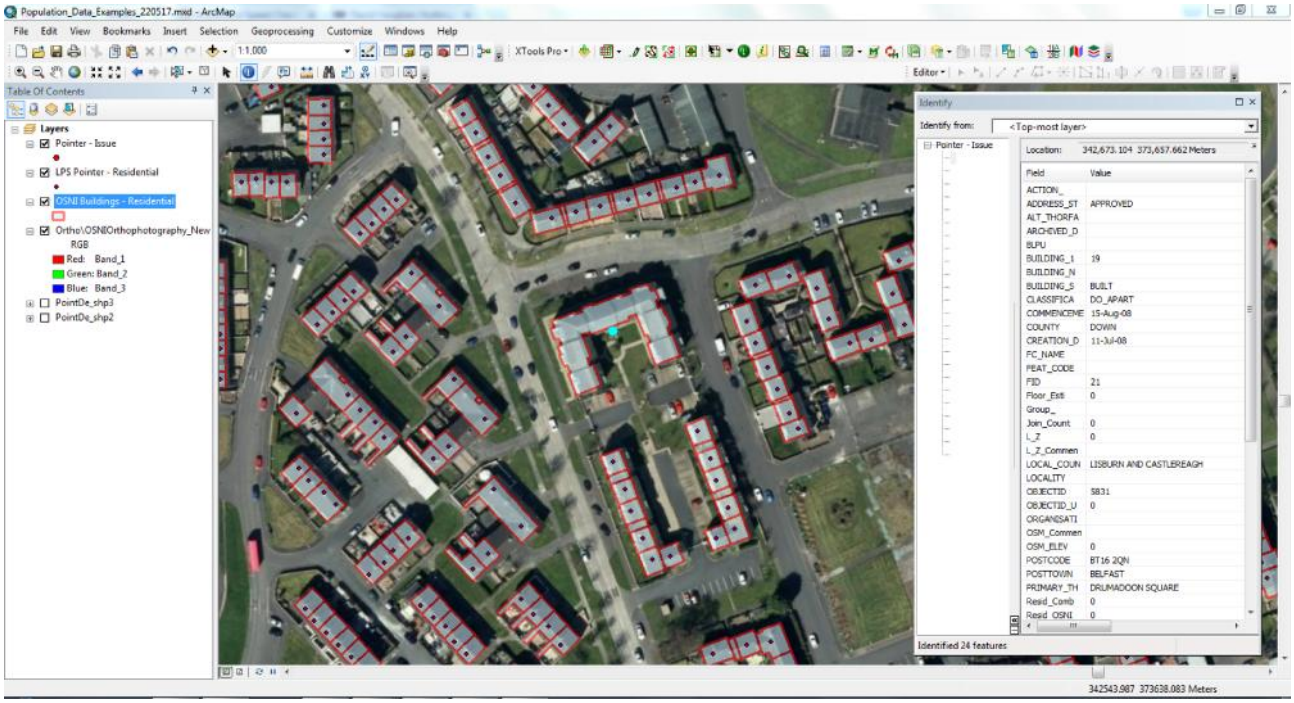
To calculate the level of exposure the residential building extents were intersected with the reclassified noise grids using an automated GIS processing script. From this process, the number of residential buildings and the number of people exposed in the required 5dB END noise intervals were calculated. The results of this analysis are presented in Section 9.2.

In reviewing the final exposure results, it is important to consider the various factors which influence the final exposure analysis. These factors include: improvements in the calculation of populations for buildings with multiple dwellings; differences in the age of the OSNI building, LPS Pointer and NIRAS population datasets used in the

analysis; changes and improvements in the OS Pointer address dataset since Round Two; and the remaining limitations of the OSNI Pointer address dataset. These limitations include the absence of an attribute code to distinguish communal residences (i.e. student residence, army living accommodation) from standard residential accommodation, and potential mis-alignment of Pointer records in relation to the OSNI detailed large scale mapping.

This last issue is illustrated below in Plate 9.1, where the Pointer centroid is located just outside the OSNI building object rather than located within the boundary of the building object. This means that the 24 addresses located at the point location have not been automatically assigned to the adjacent building. Further manual edits where applied to the population database to address this issue in key locations.

Plate 9.1 Spatial mismatch between the LSP Pointer and OSNI building data



9.2 END population exposure results

An estimate of the number of residential buildings and population exposed to industrial noise sources is provided below in Tables 9.1 and Table 9.2. These results have been produced using the methodology described in Section 9.1 above.

Table 9.1 Agglomeration - Industry – Residential Buildings

Noise Level (dB)	$L_{Aeq, 16\ hour}$	L_{den}	L_{day}	L_{eve}	Noise Level (dB)	L_{night}
50-54	72	1,389	97	48	**45-49**	746
55-59	21	160	23	13	**50-54**	97
60-64	7	36	7	1	**55-59**	23
65-69	-	4	-	-	**60-65**	7
70-74	-	3	-	-	**65-69**	
>=75	-	-	-	-	**>=70**	
Total	100	1,592	127	62	**Total**	873

Table 9.2 Agglomeration - Industry - Population

Noise Level (dB)	$L_{Aeq, 16\ hour}$	L_{den}	L_{day}	L_{eve}	Noise Level (dB)	L_{night}
50-54	197	3,953	253	131	**45-49**	2,423
55-59	36	392	39	24	**50-54**	253
60-64	13	68	13	1	**55-59**	39
65-69	-	8	-	-	**60-65**	13
70-74	-	5	-	-	**65-69**	
>=75	-	-	-	-	**>=70**	
Total	246	4,426	305	156	**Total**	2,728

9.3 Industry - ENDRM reporting

There is a requirement to report exposure assessments to the EC in order to comply with END. The EEA ENDRM consists of 6 core Data Flows which cover the reporting requirements under the END. The results of the strategic noise mapping, including the population exposure statistics are reported via Data Flow 4_8.

The results set out in Tables 9.1 and 9.2 above were rounded to the nearest hundred and entered into the relevant Data Flow 4_8 data tables that are available from the EEA (http://dd.eionet.europa.eu/datasets/2906). For the Industry report, the relevant table reference is DF4_8_Agg_Ind (Agglomeration - Industry). Additional spatial datasets have been projected into ETRS89 Lambert Azimuthal Equal Area 52N 10E grid in line with EEA guidance (www.eionet.europa.eu/gis/).

It is important to note that only certain elements (mandatory fields) in Data Flow 4_8 are required to be reported and these fields are detailed below in Table 9.3.

Table 9.3 ENDRM mandatory fields for Table DF4_8_Agg_Ind

Required Reporting Element	Description
UniqueAgglomerationId	Unique Agglomeration ID assigned by the reporting entity to each agglomeration.
* Lden5559	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lden between 55-59 dB(A), 4 m above the ground and on the most exposed façade.
* Lden6064	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lden between 60-64 dB(A), 4 m above the ground and on the most exposed façade.
* Lden6569	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lden between 65-69 dB(A), 4 m above the ground and on the most exposed façade.
* Lden7074	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lden between 70-74 dB(A), 4 m above the ground and on the most exposed façade.
* Lden75	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lden from a Major Source >75 dB(A), 4 m above the ground and on the most exposed façade.
* Lnight5054	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lnight between 50-54 dB(A), 4 m above the ground and on the most exposed façade.
* Lnight5559	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lnight between 55-59 dB(A), 4 m above the ground and on the most exposed façade.
* Lnight6064	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lnight between 60-64 dB(A), 4 m above the ground and on the most exposed façade.
* Lnight6569	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lnight between 65-69 dB(A), 4 m above the ground and on the most exposed façade.
* Lnight70	The estimated total number of people (rounded to the nearest hundred) living inside agglomerations in dwellings that are exposed to values of Lnight from a Major Source >70 dB(A), 4 m above the ground and on the most exposed façade.
* ComputationAndMeasurementMethods ReportDetails	Computation and measurement methods report details

10. Discussion and Conclusions

10.1 Changes in noise exposure between Round Two and Round Three

In total, 130 industrial sites were modelled in Round Three compared to the 111 industrial sites modelled in Round Two. Many of the new sites added in Round Three were located in/around the Belfast harbour, but also included a small number of new sites across the wider agglomeration.

Although the number of sites has increased, the spatial pattern of industrial noise exposure is broadly similar between Round Two and Round Three. This includes higher industrial noise levels around Belfast and Carrickfergus Harbours (see Plate 8.1) and reflects the concentration of industrial (industry, ports and waste) sites in these areas.

In overall terms, there was a small reduction in the geometric extent of the industrial noise bands when compared to Round Two. However the overall geographical extent remains relatively small.

These characteristics are reflected in the relatively small number of residential buildings and population located in areas with noise exposure levels above 55dB. The numbers are also lower than those recorded for Round Two.

The overall numbers are actually higher for the lowest (50-55dB) category for the Lnight and Lden indicators. The reason for this change is sensitivity of the Lnight and Lden maps to increases (45-60dB) in the night time emission levels for a small number of individual sites in the harbour area.

However it is important to note that a large proportion of the residential buildings and population identified in the industry population analysis are located in areas with a relatively low exposure level (50-52dB). This includes a number of new large multi-floor residential developments located in the harbour area which have been built during the last five years.

10.2 Factors influencing the Round Three results

There have been a number of changes in the datasets (including buildings, breaklines, ground cover and population datasets) used in the development of the Round Three industrial noise maps. These changes, in combination with differences in the location of emission sources (as described above) contribute to the differences in the Round Three industry maps when compared to Round Two. The key changes in the datasets used are summarised in the remainder of this section.

Source emission changes

The emission value for all sites was reviewed during the development of the Round Three maps and led to the reassignment of emission values for 21 sites. These changes were listed earlier in Section 5.

3D Model

Changes in the topography and terrain model within the 3D model will have resulted in localised changes in noise exposure. For example, the demolition and construction of buildings between Round Two and Round Three will affect noise propagation and population exposure. In addition, any fundamental changes or recapturing of terrain by OSNI can also result in change in propagation and resultant noise levels and population exposure.

Population and Building Data

As outlined in Section 10, there are a number of additional factors which influence the direct comparison of the outcomes of the population exposure analysis between Round Two and Round Three. These factors include: differences in the age (2010 vs 2015) of the population datasets used; changes and improvements in the OS Pointer address dataset since Round Two; and improvements in the methodology used to assess the number of residential addresses within individual buildings and ultimately the distribution of population across residential buildings in Northern Ireland. It is also important to recognise the continued limitations of the OSNI Pointer address dataset for detailed population analysis. These limitations include the absence of an attribute code to distinguish communal residences (i.e. student residence, army living accommodation) from standard residential accommodation.

Appendix A
Industry dataset specifications

Table A.1 IND Object Overview

Layer Overview	Spatial Reference	Object Dimensions	Elevation Reference	Elevation Reference Position	Elevation Definition	Unit	LimA Object Type
IND ISO9613-2 Industrial Noise Emission Object	Polygon	2.5D Polygon	Relative	Relative	Constant per object	Metre (m)	**IND**

Note: IND polygon objects should not have vertices with a separation distances less than 0.05m.

Table A.2 IND Object Specification

Field/ Attribute Name	Full Description	Data Type	Status	Properties		Special Values
L_IND	Industry Name	String	Data Input	Default Value	IND_2-5D	None
				Max. Length	20	
L_ID	Unique ID Number	String	Data Input	Unique ID		None
				Max. Length	20	
L_RQ	Geometry Type	Integer	Data Input	Default Value	2	None
				Max. Length	4	
L_PED	12-hour Daytime Noise Emission Level (CRN $L_{Aeq, 0700\text{-}1900hrs}$)	String	Data Input	Default Value	0 V	None
				Precision	1 d.p.	
				Max. Length	6	
L_PEE	4-hour Evening Noise Emission Level (CRN $L_{Aeq, 1900\text{-}2300hrs}$)	String	Data Input	Default Value	0 V	None
				Precision	1 d.p.	
				Max. Length	6	
L_PEN	8-hourNight Noise Emission Level (CRN $L_{Aeq, 2300\text{-}0700hrs}$)	String	Data Input	Default Value	0 V	None
				Precision	1 d.p.	
				Max. Length	6	

Table A.2 (continued) IND Object Specification

Field/ Attribute Name	Full Description	Data Type	Status	Properties		Special Values
L_FRQ	Main Frequency of Propagation	Floating Point	Data Input	Default Value	500.0	None
				Precision	1 d.p.	
				Max. Length	6	
				Precision	1 d.p.	
				Max. Length	6	
L_Z	Height of Object in AMSL	String	Calculated	Default Value	8.00	None
				Min Value.	0.00	
				Max Value	9999.99	
				Precision	2 dp	
				Max. Length	10	
L_VAR	Calculation variant	String	Data Input	Default Value	+	-
				Max. Length	20	
				Max. Length	1	

Appendix B
Round Three sites and emission levels

L_IND	L_ID	L_PD	L_PE	L_PN	Site Name	PPC_PERMIT
IND SOURCE	1	60	60	60	NK Coatings	P0046/04A
IND SOURCE	2	60	60	60	Montupet (UK) Ltd	P0056/04A
IND SOURCE	3	60	60	60	Ryobi aluminium Casting (UK) Ltd	P0058/04A
IND SOURCE	4	55	55	45	Diageo Baileys Global Supply Mallusk	P0063/04A
IND SOURCE	5	60	60	60	Belfast sewage Sludge Incinerator	P0081/05A
IND SOURCE	6	55	55	45	Diageo	P0098/05A
IND SOURCE	7	60	60	60	J Thompson	P0100/05A
IND SOURCE	8	60	60	60	3M (UK) Ltd	P0118/06A
IND SOURCE	9	60	60	60	Kilroot Power Ltd	P0120/06A
IND SOURCE	10	60	60	45	Tennants textile Colours Ltd	P0124/06A
IND SOURCE	11	60	60	60	PSNI Seapark	P0064/05A
IND SOURCE	12	60	60	60	NuStar terminals Limited	PPC0006/08B
IND SOURCE	13	60	60	45	Harbour - Asphaltic concrete	
IND SOURCE	24	50	50	45	Royal Group of Hospitals	P0084/05A
IND SOURCE	28	60	60	60	Harbour - Liquid and Gas Storage	
IND SOURCE	29	60	60	60	Harbour - Liquid and Gas Storage	
IND SOURCE	29	60	60	45	Full Circle Generation Limited	P0446/13A
IND SOURCE	30	60	60	60	Harbour - Warehousing	
IND SOURCE	31	60	60	60	Harbour - Warehousing	
IND SOURCE	32	60	60	60	Harbour - Area with light industry	
IND SOURCE	33	65	65	65	Harbour - Bulk Terminal	
IND SOURCE	34	65	65	65	Clearway Disposals Ltd, East Twin Rd, Belfast Harbour Estate, Belfast, BT3 9EN	
IND SOURCE	35	65	65	65	Harland & Wolf	P0001/03A
IND SOURCE	36	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	37	60	60	60	Harbour - Liquid and Gas Storage	
IND SOURCE	38	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	39	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	40	65	65	65	Harbour - Construction	
IND SOURCE	41	60	60	60	Harbour - Effluent treatment	
IND SOURCE	42	60	60	60	Harbour - Area with light industry	
IND SOURCE	44	60	60	60	Harbour - Area with light industry	
IND SOURCE	45	65	65	65	Belfast terminal	PPC0002/08B
IND SOURCE	46	60	60	45	Harbour - Area with commercial	
IND SOURCE	50	60	60	60	Harbour - Liquid and Gas Storage	
IND SOURCE	51	60	60	60	Harbour - Area with light industry	
IND SOURCE	52	60	60	60	Harbour - Transshipment	
IND SOURCE	53	60	60	60	Harbour - Warehousing	
IND SOURCE	54	60	60	45	Harbour - Warehousing	
IND SOURCE	55	65	65	65	Harland and Woolfe	

L_IND	L_ID	L_PD	L_PE	L_PN	Site Name	PPC_PERMIT
IND SOURCE	56	60	60	60	Harbour - Light Engineer	
IND SOURCE	57	60	60	60	Harbour - Area with light industry	
IND SOURCE	58	60	60	60	Harbour - Area with light industry	
IND SOURCE	59	60	60	60	Harbour - Area with light industry	
IND SOURCE	60	60	60	60	Harbour - Area with light industry	
IND SOURCE	61	65	65	65	Harbour - Shipyard	
IND SOURCE	62	65	65	65	Harbour - Shipyard	
IND SOURCE	63	65	65	65	Harbour - Asphaltic concrete	
IND SOURCE	64	65	65	65	Harbour - Liquid and Gas Storage	
IND SOURCE	65	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	66	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	67	60	60	60	Harbour - Area with light industry	
IND SOURCE	68	60	60	60	Harbour - Warehousing	
IND SOURCE	69	65	65	65	Harbour - Transshipment	
IND SOURCE	70	60	60	60	Harbour - Warehousing	
IND SOURCE	71	60	60	60	Harbour - Warehousing	
IND SOURCE	72	60	60	60	Harbour - Transshipment	
IND SOURCE	73	65	65	65	Harbour - Bulk Terminal	
IND SOURCE	74	65	65	45	Harbour - Transshipment	
IND SOURCE	75	60	60	45	Harbour - Area with commercial	
IND SOURCE	76	60	60	60	Harbour - Warehousing	
IND SOURCE	77	60	60	60	Harbour - Area with light industry	
IND SOURCE	78	60	60	60	Harbour - Warehousing	
IND SOURCE	79	60	60	60	Harbour - Liquid and Gas Storage	
IND SOURCE	80	60	60	45	Harbour - Area with commercial	
IND SOURCE	81	60	60	60	Harbour - Area with light industry	
IND SOURCE	82	60	60	60	Shorts	
IND SOURCE	83	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	84	60	60	45	Harbour - Liquid and Gas Storage	
IND SOURCE	85	60	60	45	Duncrue Street	P0161/07A
IND SOURCE	86	50	50	45	Ballyduff Landfill Site	P0156/06A
IND SOURCE	87	55	55	45	Boyds Quarry	PPC0060/08B
IND SOURCE	87	60	60	45	F P McCann Ltd	PPC0135/08B
IND SOURCE	87	50	50	45	Cottonmount Landfill	P0090/05A
IND SOURCE	88	50	50	45	Kilroot Landfill Site	P0155/06A
IND SOURCE	89	60	60	45	HMG Powder Coatings	PPC0183/08B
IND SOURCE	90	55	55	45	Coca Cola HBC Northern Ireland	P0287/08A
IND SOURCE	90	60	60	45	ContourGlobal Solutions (Northern Ireland) Ltd	P0303/09A
IND SOURCE	91	50	50	45	Derek Hall	P0234/07A

L_IND	L_ID	L_PD	L_PE	L_PN	Site Name	PPC_PERMIT
IND SOURCE	92	50	50	50	Whitehouse WWTW Sludge Thickening Plant	P0310/09A
IND SOURCE	94	60	60	60	Greenisland WWTW Sludge Thickening Plant	P0315/09A
IND SOURCE	95	50	50	50	Dunmurry WWTW	P0238/07A
IND SOURCE	96	60	60	60	Renewable Power Systems, Dargan Rd Gas Engines	P0307/09A
IND SOURCE	97	50	50	50	Carrickfergus WWTW Sludge Thickening Plant	P0316/09A
IND SOURCE	98	60	60	45	SITA	P0186/07A
IND SOURCE	99	50	50	50	Newtownbreda WWTW	P0239/07A
IND SOURCE	100	50	50	50	New Holland WWTW	P0242/07A
IND SOURCE	101	50	50	45	Browns Landfill Site (William Brown)	P0294/08A
IND SOURCE	102	50	50	45	Drumhirk Way Landfill	P0304/09A
IND SOURCE	103	60	60	60	United feeds	P0102/05A
IND SOURCE	104	60	60	60	Harbour - Wind Turbine	
IND SOURCE	105	60	60	60	Harbour - Ferry Terminal	
IND SOURCE	106	60	60	45	Harbour -	
IND SOURCE	107	60	60	45	Harbour - Coal Storage	
IND SOURCE	108	65	65	45	Larsson - Processing fine aggregates	P0405/12B
IND SOURCE	109	60	60	60	Harbour - Transshipment	
IND SOURCE	110	60	60	45	Harbour - Chemical Storage	
IND SOURCE	111	60	60	45	Unknown	
IND_SOURCE	112	60	60	45	Mullaghglass Landfill Site	P0107/05A
IND_SOURCE	113	60	60	60	Aughrim Quarry	PPC0043/08B
IND_SOURCE	113	60	60	45	Renewable Power Systems (NI) Limited	P0457/14A
IND_SOURCE	114	50	50	50	Kinnegar Sludge Treatment Centre /Kinnegar WWTW, Holywood, Co Down BT18 9TW	P0434/13A
IND_SOURCE	115	60	60	45	Wastebeater Recycling	P0468/14A
IND_SOURCE	116	60	60	45	Blackmountain	PPC0109/08B
IND_SOURCE	116	60	60	45	Roadmix	PPC0169/08B
IND_SOURCE	116	60	60	45	Blackmountain Phase i ii iii landfill	P0259/07A
IND_SOURCE	117	60	60	45	Colin Glen Road Landfill (Aughrim Quarry 0192/01B Closed)	P0162/07A
IND_SOURCE	118	60	60	45	Natural World Products Ltd, Glenside Rd, Dunmurry, Co Antirm BT17 0LH	
IND_SOURCE	120	60	60	45	Whitehill Quarry landfill, Glenside Rd, Dunmurry, Co Antrim BT17 0LH	
IND SOURCE	122	60	60	45	Cemex (Sealstown)	PPC0046/08B

L_IND	L_ID	L_PD	L_PE	L_PN	Site Name	PPC_PERMIT
IND SOURCE	122	55	55	45	Northstone	PPC0047/08B
IND SOURCE	126	60	60	45	Kiel Pharma	P0062/04A
IND SOURCE	127	60	60	45	Lisburn Proteins	P0065/05A
IND SOURCE	128	60	60	45	Biofuels	P0109/06A
IND SOURCE	134	55	55	45	ABN Knockmore	P0099/05A
IND SOURCE	135	55	55	45	Coca Cola Bottlers (Ulster) Ltd Lambeg	P0105/05A
IND SOURCE	136	60	60	45	ENVA (NI) Ltd	P0108/05A
IND SOURCE	137	60	60	45	Whitemountain Quarry	PPC0110/08B
IND SOURCE	139	55	55	45	Coca Cola Bottlers (Ulster) Limited Knockmore	P0287/08A
IND SOURCE	140	60	60	45	Charles Tennant & Co (NI) Ltd	PPC0019/08B
IND SOURCE	144	60	60	45	Rumbling Hole	P0247/07A
IND SOURCE	146	60	60	45	AFBI VSD	PPC0168/08B
IND SOURCE	147	60	60	45	Colinglen Road Landfill	P0246/07A
IND SOURCE	150	60	60	45	Dorisland WTW	P0371/11A
IND SOURCE	153	60	60	45	NWP Ltd	P0341/10A
IND SOURCE	154	60	60	45	Wolfhill Landfill Site - Belfast	P0345/10A
IND SOURCE	155	60	60	45	Hightown Landfill	P0324/09A
IND SOURCE	157	60	60	45	Source Oil Limited	P0450/14A
IND SOURCE	158	60	60	60	Harbour - Warehousing	
IND SOURCE	159	60	60	45	Harbour - Light Industry	
IMD SOURCE	160	60	60	45	Harbour - Light Industry	

Appendix C
Round Three Industry Maps

Key

Belfast Agglomeration

Industry Noise Map

L_{day}

END Round Three - 2017

The Environmental Noise Regulations (Northern Ireland) 2006

Key

Noise Level (dB)

- 50 - 54
- 55 - 59
- 60 - 64
- 65 - 69
- 70 - 74
- > = 75
- Belfast Agglomeration

0 1 2 3 4 5 km

Scale at A3: 1:140,000

N

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Signature

Director

The L_{day} is the equivalent continuous sound level in dB(A) that, over the period 07:00 – 19:00 hours, contains the same sound energy as the actual fluctuating sound that occurred in that period.

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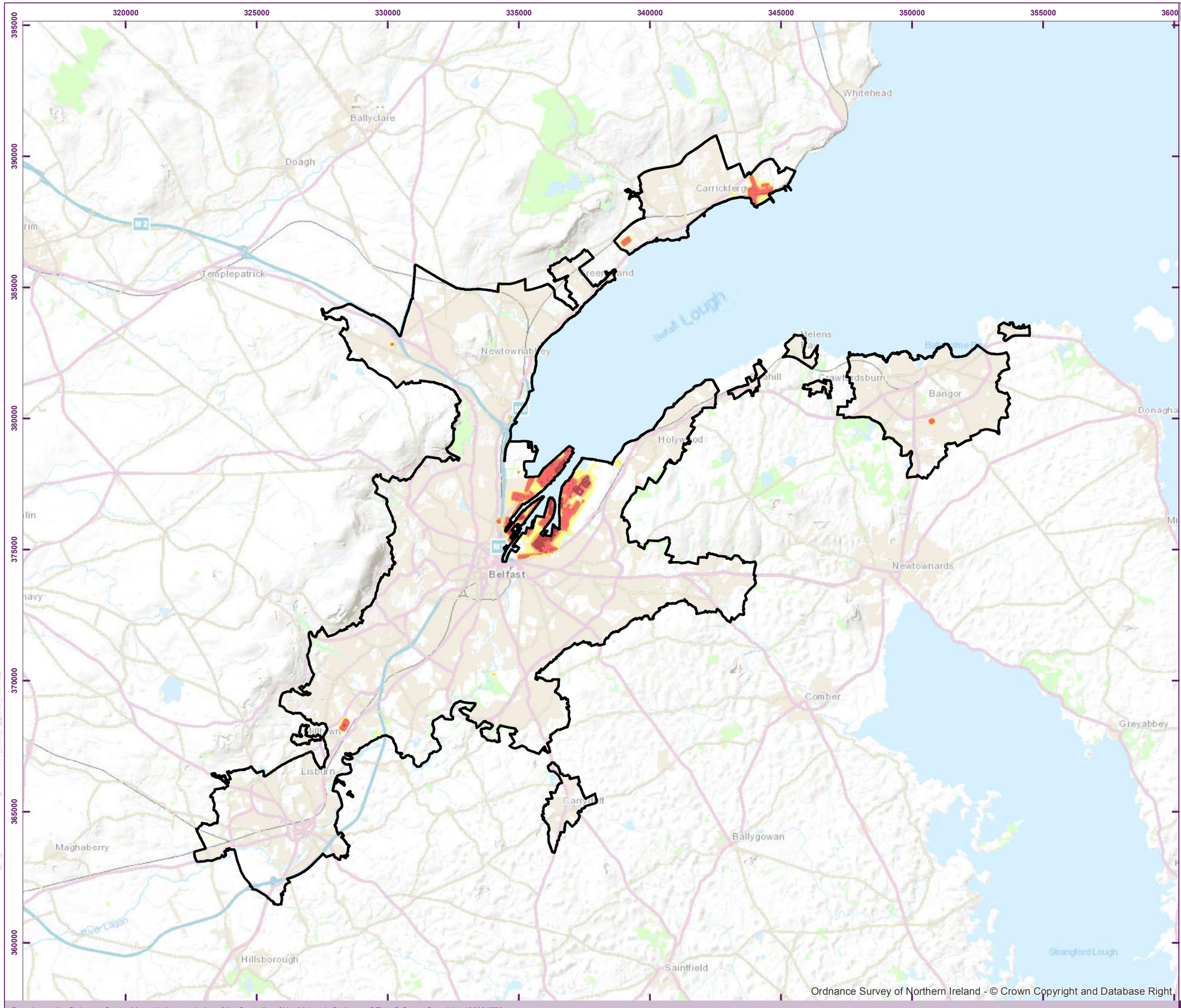

Key

Belfast Agglomeration

Industry Noise Map

L_{eve}

END Round Three - 2017

The Environmental Noise Regulations (Northern Ireland) 2006

Key

Noise Level (dB)

- 50 - 54
- 55 - 59
- 60 - 64
- 65 - 69
- 70 - 74
- > = 75
- Belfast Agglomeration

0 1 2 3 4 5 km

Scale at A3: 1:140,000

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The L_{eve} is the equivalent continuous sound level in dB(A) that, over the period 19:00 – 23:00 hours, contains the same sound energy as the actual fluctuating sound that occurred in that period.

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Key

Belfast Agglomeration

Industry Noise Map

L_{night}

END Round Three - 2017

The Environmental Noise Regulations (Northern Ireland) 2006

Key

Noise Level (dB)

- 45 - 49
- 50 - 54
- 55 - 59
- 60 - 64
- 65 - 69
- > = 70
- Belfast Agglomeration

0 1 2 3 4 5 km

Scale at A3: 1:140,000

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The L_{night} is the equivalent continuous sound level in dB(A) that, over the period 23:00 – 07:00 hours, contains the same sound energy as the actual fluctuating sound that occurred in that period.

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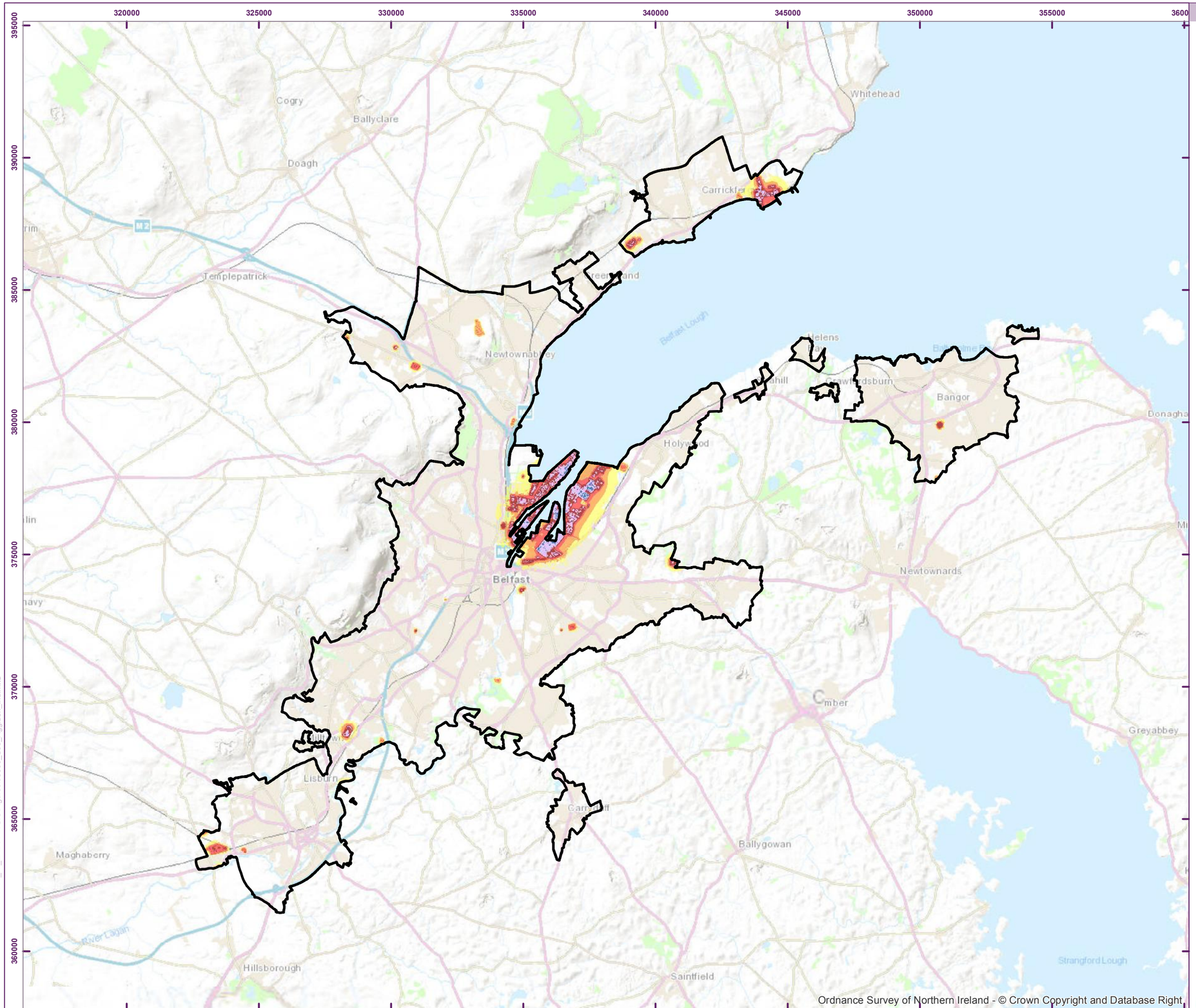

Key

Belfast Agglomeration

Industry Noise Map

L_{den}

END Round Three - 2017

The Environmental Noise Regulations (Northern Ireland) 2006

Key

Noise Level (dB)

- 50 - 54
- 55 - 59
- 60 - 64
- 65 - 69
- 70 - 74
- > = 75
- Belfast Agglomeration

0 1 2 3 4 5 km

Scale at A3: 1:140,000

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The day-evening-night (L_{den}) is a noise rating indicator based upon an annual average 24 hour noise level (L_{Aeq}) with a 5 dB(A) penalty for evening noise (i.e. 19.00 - 23.00) and a 10 dB(A) penalty for night-time noise (23.00 - 07.00).

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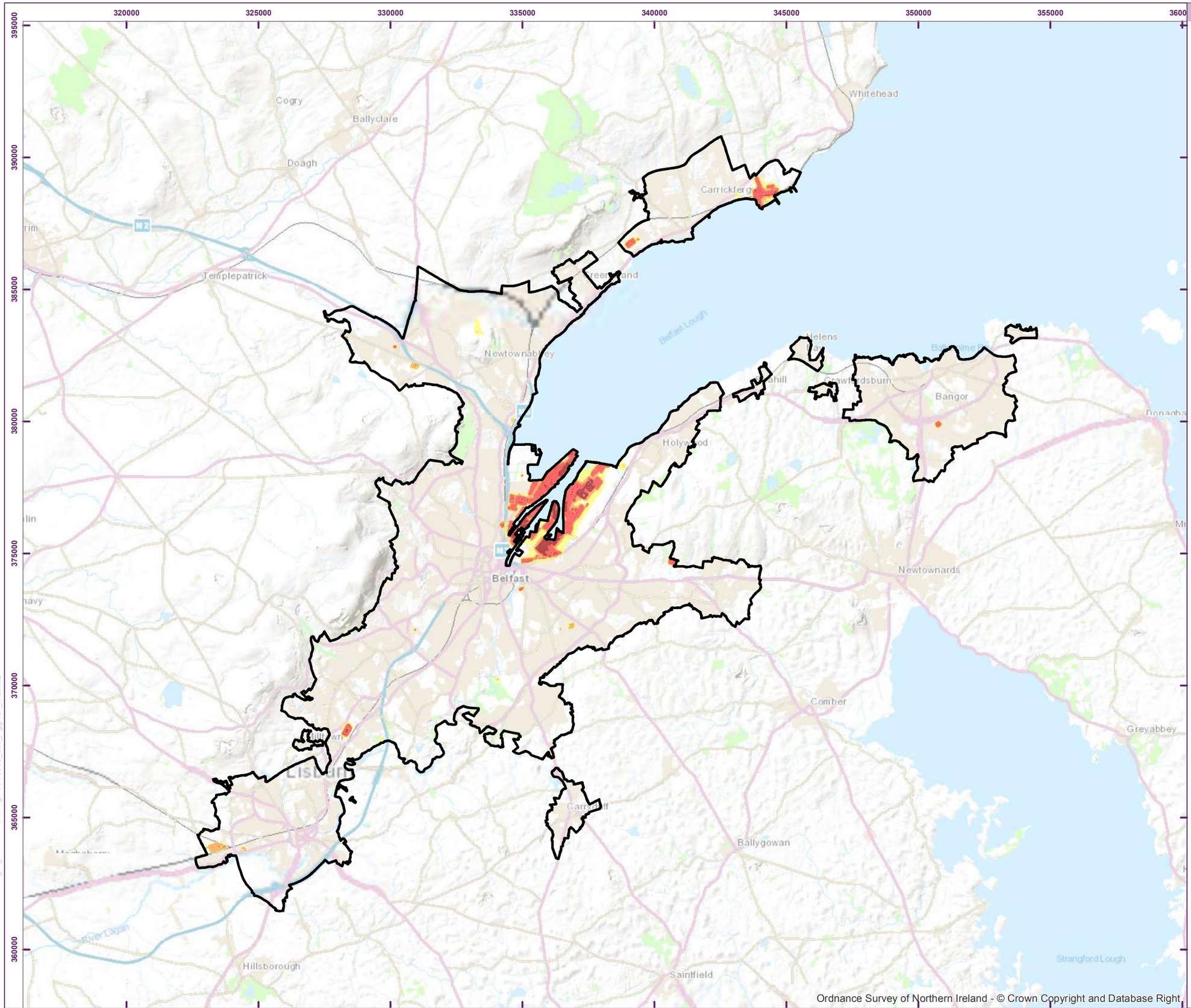

Key

Belfast Agglomeration

Industry Noise Map

$L_{aeq,16h}$

END Round Three - 2017

The Environmental Noise Regulations (Northern Ireland) 2006

Key

Noise Level (dB)

- 50 - 54
- 55 - 59
- 60 - 64
- 65 - 69
- 70 - 74
- > = 75
- Belfast Agglomeration

0 1 2 3 4 5 km

Scale at A3: 1:140,000

N

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The $L_{aeq,16hr}$ is the equivalent continuous sound level in dB(A) that, over the period 07:00 – 23:00 hours, contains the same sound energy as the actual fluctuating sound that occurred in that period.

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