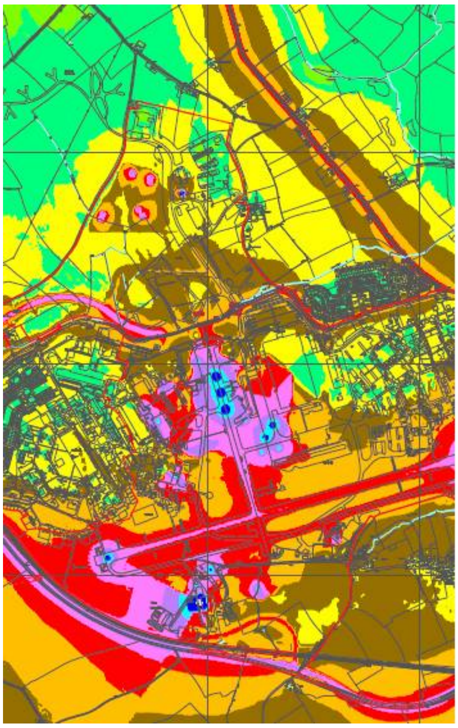
# Department of Environment Northern Ireland

# Provision of Second Round Noise Maps for Northern Ireland

Road Noise Mapping – Final Report



27 July 2012

AMEC Environment & Infrastructure UK Limited

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## Document Revisions

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| 1 | Draft Report | 28 June 2012 |
| 2 | Final Report | 27 July 2012 |

# Department of Environment Northern Ireland

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Road Noise Mapping – Final Report

27 July 2012

AMEC Environment & Infrastructure UK Limited

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# Executive Summary

This document outlines the processes which have been adopted to develop the roads dataset used within Round Two of noise mapping within Northern Ireland under the Environmental Noise Regulations (Northern Ireland) 2006. The results of the noise mapping process are also presented.

This document aims to give the Northern Ireland Department of the Environment (DoE) and Department for Regional Development - Roads Service (hereby known as 'Roads Service') an understanding of the model development process including data capturing and processing, development of the road 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 Two data capture areas (Section 2). This provides the setting for the specific calculation methods used in Round Two (Section 3) and the data requirements needed to develop the final major roads and agglomeration roads noise maps (Section 4).

The report then outlines the work which has been undertaken to review the datasets used during the Round One mapping exercise and to identify new data for use within Round Two (Sections 5 and 6). This includes the preparation of input data covering Roads Centrelines; Road Traffic Statistics; Road Direction; Road Gradient; Road Surface Type; Road Surface Texture Depth and Carriageway Width.

The processes used to QA the final road source and emission datasets produced are discussed in detail in Section 7 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 8 of the report, the discussion covers the final calculation and processing settings which have been used to undertake the calculations for road noise. 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 (Section 9 -11) detail the results of the agglomeration and major roads noise exposure analysis. This includes providing area analysis of the different noise levels with the more detailed analysis of population and dwelling noise exposure (Sections 9 and 10). This provides the context for the final Section (Section 11) which provides an assessment of the key differences between the outputs of Round One and Round Two mapping exercises.

# Contents

# 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 2000 | Coordination of Information for the Environment (CORINE) land cover dataset last produced the UK in 2000 |
| CRN | The Calculation of Railway Noise 1995.<br>The railway prediction methodology published by the UK Department of Transport. |
| CRTN | The Calculation of Road Traffic Noise 1988.<br>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 |
| 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):<br>$L_{den}$ <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >74<br>$L_d$ <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >74<br>$L_e$ <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >74<br>$L_n$ <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:<br>$L_{den}$ = 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:<br>(1) Spatial (e.g. road centre lines, building outlines).<br>(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 |

| Term | Definition |
|---|---|
| Shapefile | ESRI proprietary GIS dataset format.  Contains both geometry to define features, and associated alphanumeric attribute information. |
| 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 |

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# 1. Introduction

## 1.1 Background

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 set out the Competent Authorities who have been made responsible for producing noise maps and action plans. Under the Regulations, the Department of Environment (DoE) is named as the Authority responsible for overseeing the implementation of the Regulations. As the overseeing Authority, DoE decided that the noise mapping should be undertaken in a consistent manner and therefore let a single contract for the preparation of noise maps on behalf of the Competent Authorities.

AMEC Environment and Infrastructure UK Limited (AMEC) were commissioned to prepare noise maps for the Competent Authorities reporting directly to DoE. As part of the commission, AMEC have prepared noise maps, all associated population exposure data and supplementary reports as required under the Regulations and the Directive. The maps and reports will enable Northern Ireland to report the results of the mapping to the European Commission.

This project relates to the second round of noise mapping. Under the Regulations, noise maps and noise action plans must be prepared over a 5-year rolling cycle. The first round of noise mapping in Northern Ireland was undertaken and completed in 2007 using data representative of 2006. For reporting in 2012, the second round of mapping is being undertaken using data representative of 2011.

For the first round of mapping in 2007, the Regulations required the preparation of noise maps for the following:

- All major roads with more than 6 million vehicle passages per year;
- Major railways with more than 60,000 passages per year;
- Major airports with more than 50,000 movements per year; and
- All agglomerations with more than 250,000 inhabitants.

Within agglomerations, the Regulations require the mapping of all road, railway, industry and airport noise sources regardless of the thresholds outlined above. For the second and subsequent rounds of mapping, the Regulations reduce the thresholds for which noise mapping and action planning should be prepared and reported to the following:

- All major roads with more than 3 million vehicle passages per year;
- Major railways with more than 30,000 passages per year;
- Major airports with more than 50,000 movements per year; and

- All agglomerations with more than 100,000 inhabitants.

Under the Regulations, this project aims to establish estimates of the total number of people (in hundreds) living in dwellings that are exposed to major transportation noise sources and all transportation and industrial noise sources within agglomerations. The exposure estimates are for the $L_{den}$ noise indicator calculated 4 metres above the ground and on the most exposed façade of a residential dwelling.

The $L_{den}$ noise exposure statistics are required in the following bands: 55-59, 60-64, 65-69, 70-74 and >= 75. The total area (in $km^2$) exposed to values of $L_{den}$ higher than 55, 65 and 75 dB respectively, along with the estimated total number of dwellings (in hundreds) and the estimated total number of people (in hundreds) living in each of these areas must also be given and reported to the European Commission.

The same information is also required for the $L_{night}$ indicator except reporting is necessary for noise level bands 5 dB lower than for $L_{den}$. Under this contract, noise level exposure statistics are also required for other supplementary noise indicators which are incumbent within national noise policy guidance.

The contract was delivered in two stages which are described below. This report documents work undertaken by AMEC for both stages of the contract.

Stage 1 of the contract was undertaken to the following scope:

- Appraisal and quality assurance of the data provided by DoE and the Competent Authorities;
- Identification of gaps in order to define any further information requirements;
- Modifying and/or collecting further information through contractor survey. This includes any data cleaning and manipulation required to prepare the dataset for Stage 2;
- Collation of the data into relevant datasets; and
- Preparation of Stage 1 report.

Stage 1 of the contract also included delivery of the following specific elements of work:

- 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.

Stage 2 of the contract was undertaken to the following scope:

- Interrogation of the final datasets produced in Stage 1;
- Creating the digital model in an appropriate format;
- Calculating the defined noise data level outputs;
- Completing modelling, generating maps and reports;
- Presenting the final modified data, metadata and a technical manual for the modelling of road noise sources; and
- Provision of a report in a suitable format specified by the Electronic Noise Data Reporting Mechanism as preferred by the Commission and suitable for uploading to EIONET.

## 1.2 Purpose of this Report

This report details the processes used to develop the Round Two road traffic noise modelling datasets for the mapping of noise levels for roads across Northern Ireland. The aim of this report is to provide DoE and Roads Service with an understanding of the processes involved in the development of these datasets which have been used to support the assessment of noise for the second round of mapping.

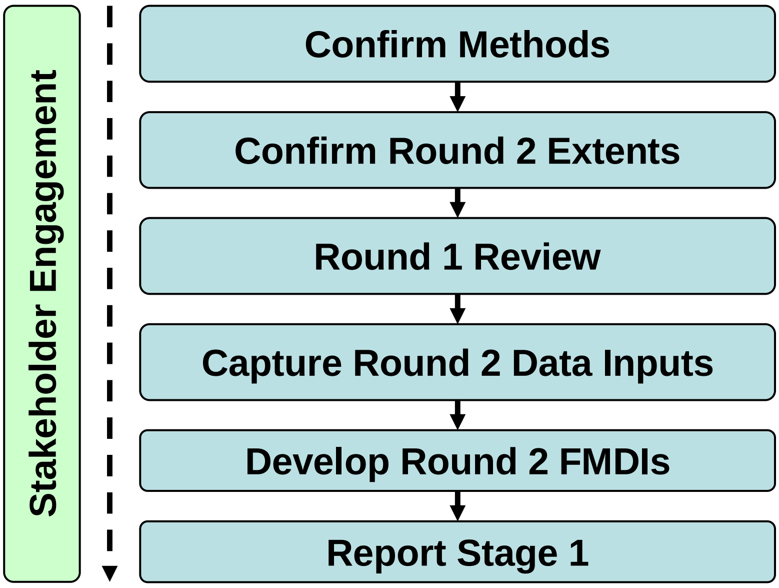
## 1.3 Overview of the Second Round Approach

Under the contract let by DoE, the second round of mapping was split into two stages as outlined below.

### 1.3.1 Stage 1

The primary aim of Stage 1 was to develop the Final Modified Data Inputs (FMDIs) needed to facilitate the noise mapping and reporting of noise exposure under the Regulations. Plate 1.1 presents an overview of Stage 1.

**Plate 1.1 Overview of Stage 1**




Stage 1 was structured to identify and ensure that data inputs and information gathered and processed during the first round of mapping were where possible retained and utilised in the production of noise maps for the second round.

The process was initiated through confirming the methods to be used for the mapping and confirmation of the second round extents. This was followed by a review of the first round datasets and the information used in their development with respect to the project extents and methods. Following this review, and where necessary, additional data capture exercises were undertaken.

This report does not explicitly report the findings of the Round One review. Instead the report outlines the results of the Round One review alongside all other relevant sections. For example, noise calculation environments and the preparation of various elements of the road traffic noise datasets are discussed in this report in relation to both the approach undertaken in Round One and the methodology adopted for Round Two.

### 1.3.2 Stage 2

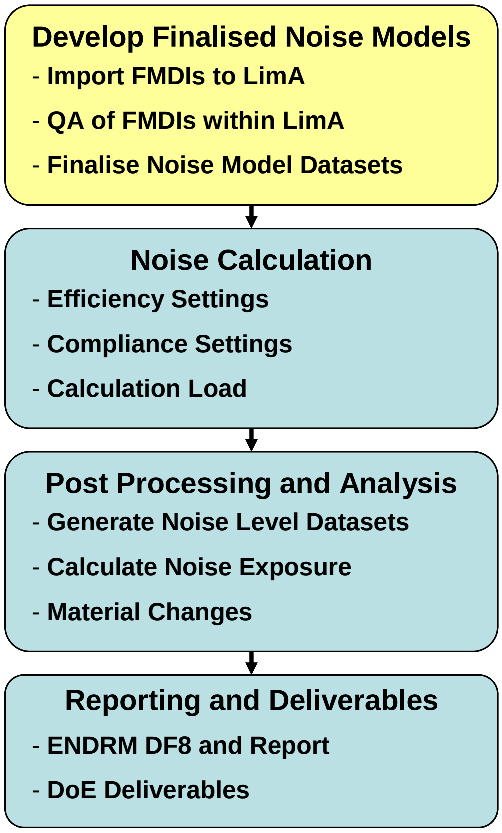
The key aims of Stage 2 of the contract were:

- 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;

- provision of suitable Environmental Noise Directive Report Mechanism (ENDRM) Data Flow 8 (DF8) reporting and associated technical reports for submission to the Commission through the EIONET.

Plate 1.2 presents an overview of the Stage 2 process.

**Plate 1.2 Overview of Stage 2**



# 2. Data Capture Extents

Under the Environmental Noise Regulations (Northern Ireland) 2006, Round Two noise maps in relation to road traffic noise must encompass:

- Major roads with more than 3 millions movements per year;
- All 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 Two data capture area under the Regulations for road traffic noise sources in Northern Ireland. Maps showing the geographical extent of the areas are also provided in Plates 2.1 – 2.2.

## 2.1 Agglomeration Modelling Extent

The only agglomeration in Northern Ireland considered in Round Two is the Belfast agglomeration, as defined in the Regulations. The Belfast agglomeration is presented in Plate 2.1 and has an approximate area of 198km$^2$. Data currently available for 2008 shows the Belfast Urban Metropolitan Areas has a total population of 267,742. The Agglomeration was considered in Round One due its population exceeding the Round One threshold of 250,000. The extents of the Agglomeration for Round Two are the same as for Round One.

A review of potential agglomerations qualifying for Round Two has also been undertaken for completeness. Data obtained from the Northern Ireland Statistics and Research Agency (NISRA) for 2008 shows that the second largest urban area in Northern Ireland is the Derry Urban Area. The Derry Urban Area has a population of 85,016 and therefore falls below the 100,000 threshold.

Using the Belfast agglomeration as a basis, a Round Two data capture extent was created. This was developed by applying a 3km corridor to the boundary of the Belfast agglomeration and subsequently clipped against the Northern Ireland coastline. The resulting data capture area of 596km$^2$ is shown in Plate 2.1.

## 2.2 Major Roads Extents

At the beginning of Stage 1 of the contract, AMEC reviewed the major road extents from Round One and the DoE's Data Flow 5 (DF5) submission to the European Commission. The DF5 is issued to the Commission to provide an indication of the extents of strategic noise mapping which is required in subsequent rounds. The latest DF5 submission for Northern Ireland was made along with of other UK Devolved Administrations (DAs) in late 2008. This presented a set of extents for major roads within and outside of the Belfast agglomeration. This was used as the basis of defining the major road extents for Round Two.

Following a review of the DF5 datase, several deficiencies were identified in the quality and consistency of the data presented. This led to the decision that the major road extents for Round Two should be reassessed in their entirety without any assistance from DF5. This position was taken to ensure that subsequent DF5 submissions to the Commission would be more accurate and more informative.

The extents of major roads within Northern Ireland have been based on an assessment of roads which are likely to exceed the 3 million vehicle movement threshold as set out in the Regulations. This assessment has been undertaken using a number of core data sources, along with several derivation techniques. The following information was employed in the identification of major roads.

- Automatic Traffic Counters (ATC) – ATCs available within Road Service's C2 database were used to identify roads which exceed the 3 million vehicle movement threshold in terms of Annual Average Daily Traffic (AADT);

- Temporary Counters (TC) – temporary counter information was processed to establish AADT traffic volumes;

- Belfast Traffic Model (BTM) – Information obtained from Round One datasets and identified as originating from the 2001 Belfast Traffic Model (BTM) were used within the Belfast Agglomeration to assign roads and major roads where information from the BTM dataset joins adjacent sections of major road as identified from ATC and TC;

- Rapid Transit – Localised updates to the BTM as part of the Roads Service Rapid Transit scheme was used to assist the identification of major roads, as described for the BTM data;

- Derived Information – where major road extents disperse and are likely to be above the 3 million vehicle movement threshold, and no information is available from ATCs or TCs to inform of extents, Road Service used local knowledge to derive flows and extents of the major roads.

The extents to which the above data sources apply to sections of roads was based on the location of counters, road configurations, local knowledge and derivation techniques which are described within Section 5 and 6 of this report. Within the Belfast agglomeration, it was also been necessary, in places, to derive default traffic flows. However these were not used as the basis of designating major roads within the agglomerations.

## 2.3 Round One and Round Two Data Capture Extents

Table 2.1 provides a summary of the extent of the data capture areas used for the Round One and Round Two road mapping exercises. Table 2.2 also provides a summary of the length of roads mapped in the two modeling exercises. The geographical extent of the major roads and roads within the Belfast Agglomeration modelled in Round Two are shown in Plates 2.1 and 2.2 respectively.

**Table 2.1 Agglomeration and Major Roads - Extent of the Data Capture Area**

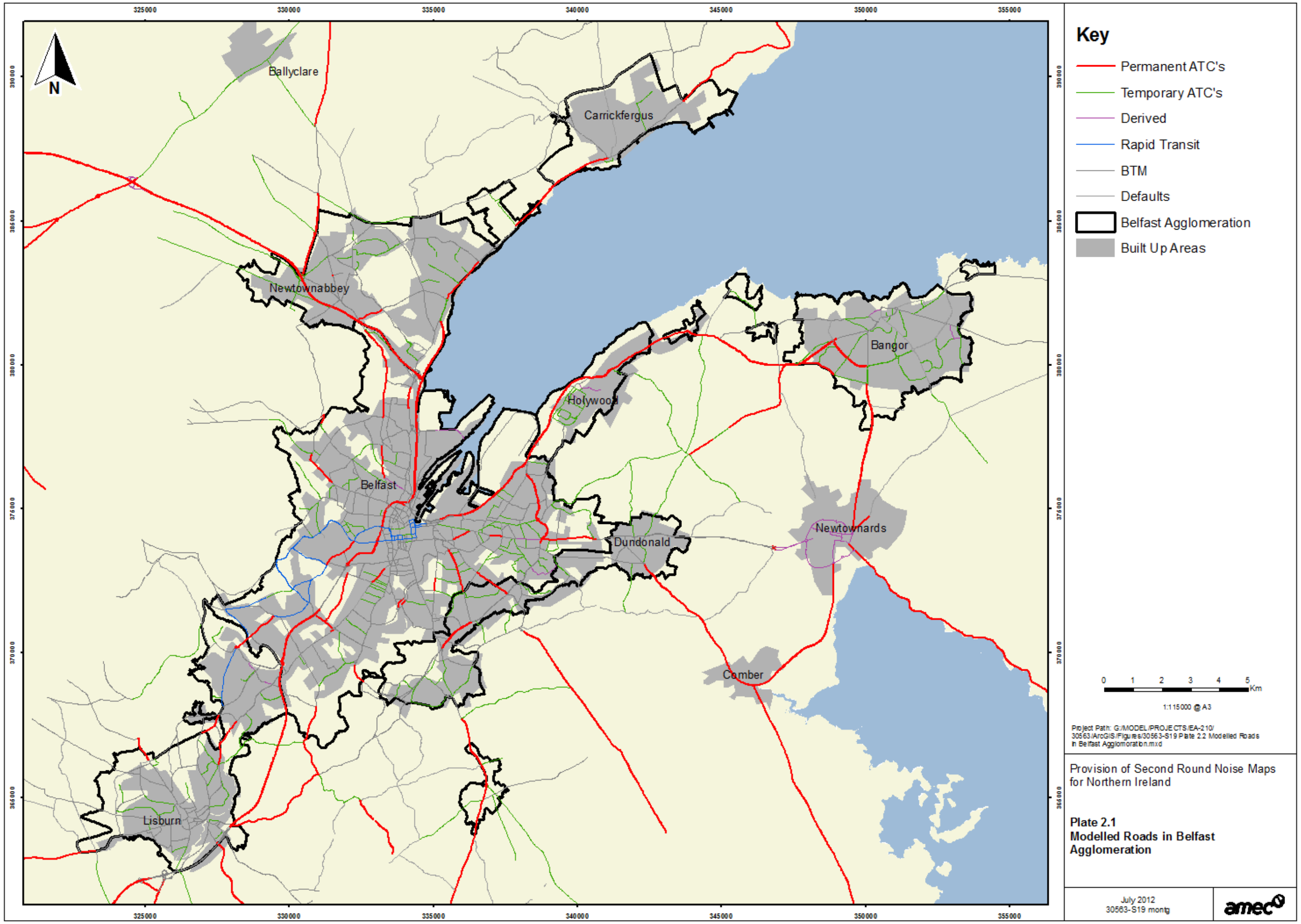
| Noise Source | Round One ($km^2$) | Round Two ($km^2$) | Increase in Area ($km^2$) | Percentage Increase |
|---|---|---|---|---|
| Agglomeration | 596 | 596 | 0 | 0% |
| Major roads (outside the Belfast agglomeration | 1,582 | 4,460 | 2,878 | 182% |
| Total area | 2,178 | 5,056 | 2,878 | 132% |

**Table 2.2 Agglomeration and Major Roads - Length of Roads Mapped**

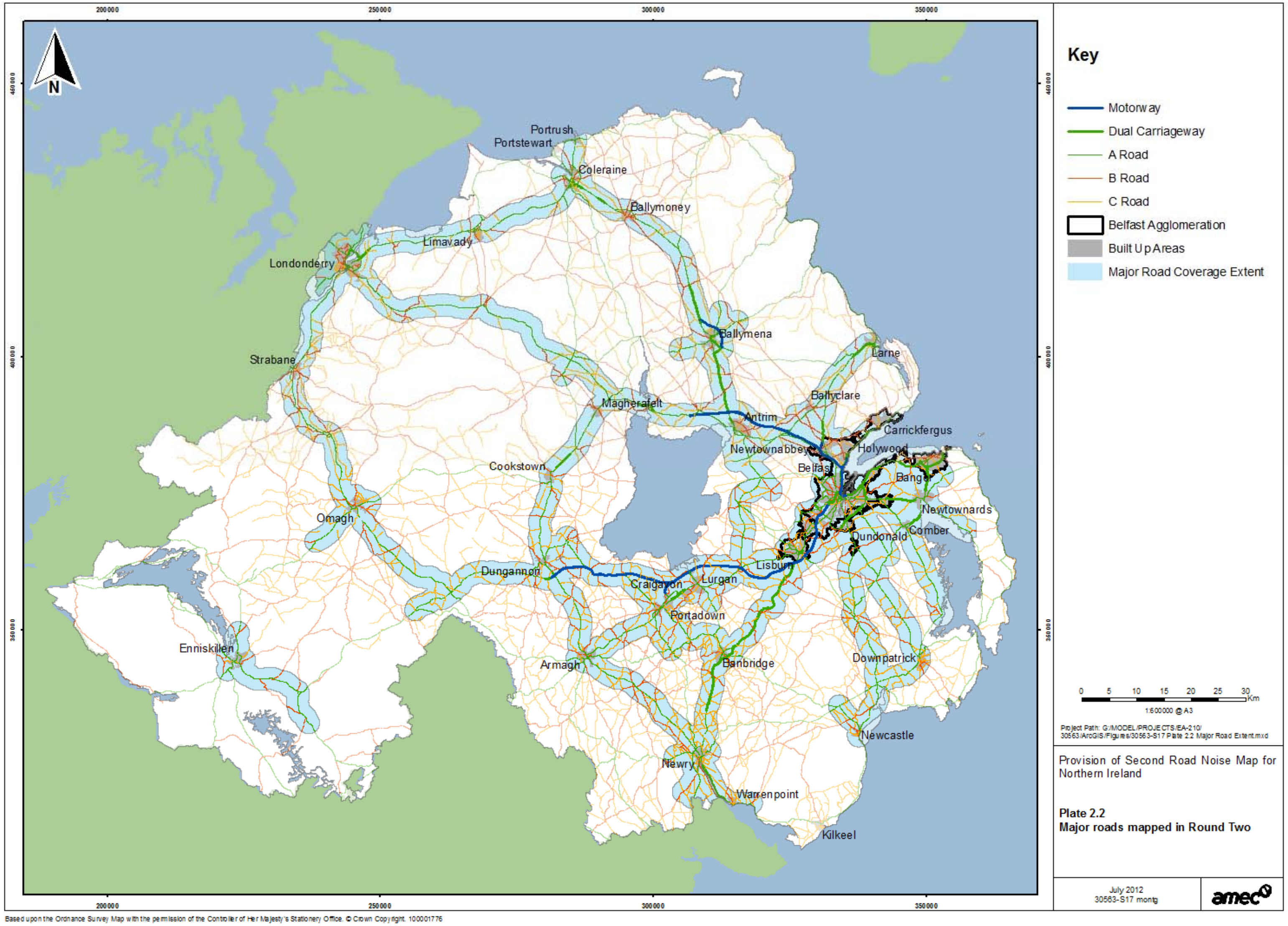
| Noise Source | Round One (km) | Round Two (km) | Increase in Length (km) | Percentage Increase |
|---|---|---|---|---|
| Agglomeration | 937 | 1,020 | 83 | 9% |
| Major roads (outside the Belfast agglomeration | 442 | 1,291 | 849 | 192% |
| Total area | 1,379 | 2,311 | 932 | 68% |

As highlighted in Tables 2.1 and 2.2, the lowering of the major road movement threshold from 6 million to 3 million vehicle passages from Round One to Round Two has resulted in a significant increase in the number of roads (i.e. increase of 182%) and data capture area (i.e. increase of 192%) which have needed to be modelled in Round Two. The remainder of this report considers the development of the expanded Round Two models and the END population exposure analysis undertaken in these areas.

## Plate 2.1 Round Two - Extent of the Roads Modelled for the Belfast Agglomeration



### Plate 2.2 Round Two - Extent off the Major Roads Modelled



# 3. Confirmation of Calculation Methods

## 3.1 Noise Calculation Method

Under the Regulations the assessment method prescribed for the mapping of road traffic noise sources is outlined in Table 3.1. It is confirmed from a review of Round One that the same methods were adopted and applied during Round One. For Round One, 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 (Roads)**

| ***Assessment method for road traffic noise indicators*** |
|---|
| *6. For road traffic noise indicators the assessment method "Calculation of road traffic noise" (Department of Transport, 7 June 1988, HMSO)(b) shall be used, adapted using the report "Method for converting the UK traffic noise index LA10,18h to EU noise indices for road noise mapping" (DEFRA, 24 January 2006)(c).* |

For road noise, the assessment for Round One was undertaken with reference to the following:

- Roads: Calculation of Road Traffic Noise (CRTN) (UK) – adapted version comprising:
  - Department of Transport publication, *'Calculation of Road Traffic Noise'*, HMSO, 1988 ISBN 0115508473; and
  - Defra, Method for Converting the UK Road Traffic Noise Index $L_{A10,18h}$ to the EU Noise Indices for Road Noise Mapping, st/05/91/AGG04442, 24th January 2006.

For Round One, the method adopted for the conversion of $L_{A10, 18h}$ noise levels from CRTN to the EU Noise Indices was Method 2. This method has been retained for Round Two and as such there has been no requirement to alter the method adopted for Round One. It was also concluded that the adopted method outlined above remains relevant to the delivery of the strategic noise maps under the Regulations.

For Round Two, the noise calculation assessment method described in this section has been used to inform data requirements and identify any additional data capture requirements.

## 3.2 Software Methods

For Round One, noise mapping of road traffic noise sources were prepared using the LimA version 5.2 noise modelling package with geo-processing and analysis undertaken with the ESRI ArcGIS software environment.

For Round Two both software environments have been retained. The LimA version that has been adopted for Round Two is version 8.1. Following discussions with Stapelfeldt Ingenieurgesellschaft mbH, developers of the LimA noise mapping software, it is understood that there have been no modifications to the implementation of the core CRTN methodologies between versions 5.2 and 8.1. Modifications have been implemented to incorporate additional guidance on the calculation of road traffic noise for use with the guidance outlined in Annex 4 of Volume 11 Section 3 Part 7 of the *'Design Manual for Roads and Bridges'*. This guidance is supplementary to the requirements of the Regulations and requires additional data capture which falls beyond the scope of strategic noise mapping. These amendments have not been included within Round Two mapping in Northern Ireland.

# 4. Dataset Specifications

The development of the road traffic 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:

i. The level of noise being generated at source (i.e. the noise emissions)

ii. The attenuation of noise levels during propagation from source to receiver (i.e. the propagation)

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

For Round One, a dataset specification was developed for the roads 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 Two, the FMDI dataset specifications have been retained from Round One. 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 4.1.

## 4.1 Data Requirements

A number of specific data requirements were required to develop a 'fit for purpose' road noise emission dataset which could be used as an input for the Round Two mapping exercise. These data requirements are identical to those developed in Round One and include:

- Road Centreline Geometry
  - Total traffic flow to be presented in terms of annual average day, evening, night and 18-hour traffic;
  - Percentage of total flow which comprises of Heavy Goods Vehicles (HGV) which are defined as having unladen weight of < 1525kg in terms of an annual average for day, evening, night and 18-hour periods;
  - Average traffic speeds expressed as an annual average for day, evening, night and 18-hour periods;
  - Road Surface type and texture depth;
  - Gradient of road centreline;

- Road Classification (if required);
- Direction of Traffic;

- Road Designation
  - Major or Non-Major Road designation based on annual AADT traffic and 3 million vehicle movement threshold;
- Carriageway width
  - expressed in metres between carriageway edges;
- Carriage separation
  - expressed in metres (if greater than 5m and not accounted for by road centreline geometry).

At project inception, Roads Service confirmed that road traffic statistics (i.e. flows, composition and speeds) were available or derivable from ATCs and TCs for the four time periods defined within the Regulations and as outlined below.

- Annual Average Daily Traffic (AADT) Daytime – 0700-1900hrs
- Annual Average Daily Traffic (AADT) Evening – 1900-2300hrs
- Annual Average Daily Traffic (AADT) Night – 2300-0700hrs
- Annual Average Weekday Traffic (AAWT) 18-hour – 0600-0000hrs

The availability of road traffic data for the four periods outlined above, and the use of TRL Method 2 for the conversion of $L_{A10}$ noise levels to $L_{Aeq}$ based noise levels for CRTN meets the specification of the RDP road emission source line object within LimA. A high level overview of the data requirements for the LimA RDP object is presented in Table 4.1 below with a full GIS based data specification for the object presented in Appendix A.

**Table 4.1 Road Noise Emission Dataset Requirements**

| Input | Spatial Reference | Object Type | Unit | Validated Range |
|---|---|---|---|---|
| Road Centreline Geometry | Vector | Polylines | Metre (m) | n/a |
| Average Traffic Speed | n/a | n/a | $kmh^{-1}$ / $mph^{-1}$ | 20 – 130kmh |
| Road Traffic Flow | n/a | n/a | Vehicles per period | n/a |
| %HGV (>1525kg unladen weight) | n/a | n/a | Percentage (%) | 0 – 80% |
| Road Gradient | n/a | n/a | Percentage (%) | n/a |

**Table 4.1 (continued) Road Noise Emission Dataset Requirements**

| Input | Spatial Reference | Object Type | Unit | Validated Range |
|---|---|---|---|---|
| Traffic Direction | Vector | n/a | n/a | +1 (direction of digitisation), 0 (both directions), -1 (counter to digitisation direction) |
| Surface Type | n/a | n/a | n/a | Impervious, Pervious or Concrete |
| Texture Depth | n/a | n/a | Millimetres (mm) | n/a |
| Carriageway Width | n/a | n/a | Metres (m) | n/a |
| Carriageway Separation (if required based on road centreline geometry) | n/a | n/a | Metres (m) | >5m |
| Road Classification | n/a | n/a | n/a | Special Road, Single Carriageway, Dual Carriageway, Motorway |

Note: Validated range based on values displays within the charts and tables of Calculation of road traffic noise" (Department of Transport, 7 June 1988, HMSO)

# 5. Round Two Data Capture

## 5.1 Reviewing the Round One Data Sources

Prior to the development of the Round Two road traffic noise emission datasets, the project team undertook a review of the Round One datasets. The review was undertaken through a study of the GIS FMDIs and the final Round One road noise mapping report produced by the previous contractor and the proposed Round Two mapping extents as submitted to the Commission through DF5. The review process set out to identify the following:

- The data sources used to create the Round One datasets;
- Availability of the Round One data sources for the Round Two modelling exercise;
- The applicability of any extents and any work undertaken as part of DoE's DF5 submission;
- Where any added value or editing was present within the Round One dataset; and
- Whether or not data sources could be improved upon or further refined for Round Two.

This first deliverable of this review was the preparation of a data review questionnaire which was submitted to the Department for Regional Development - Roads Service. The purpose of this questionnaire was to understand whether there had been any changes in the agglomeration and major road networks in Northern Ireland that may influence the Round Two data capture and results; and also to assist with the review process. Table 5.1 presents a summary of the key outcomes of this data review.

**Table 5.1 Reviewing the Round One Datasets**

| Data Input | Round One Data Source | Round One Coverage relevant for Round Two Mapping | Value Adding/ Editing | Potential Improvement? |
|---|---|---|---|---|
| Road Centrelines | OSNI LargeScale | Yes | Yes | Yes |
| Road Traffic Flows | ATCs, BTM, Defaults | Yes but limited | No | Yes |
| Road Direction | Derived | n/a | Yes | No |
| Road Gradient | Derived from 3D Ground Model | n/a | No | No |
| Surface Type | Assumed | n/a | No | Yes |
| Texture Depth | Assumed | n/a | No | No |
| Carriageway Width | Assumed | n/a | No | No |
| Carriageway Separation (if required based on road centreline geometry) | Not Required | n/a | No | No |

The review also highlighted that the Round One datasets were only available for around 35% of the major roads data capture area needing to be assessed in Round Two. It was therefore concluded that the noise mapping of roads for Round Two would need to be treated as a completely new data capture exercise rather than a ‘review and replace’ approach as taken for other noise sources. This has been reflected in the significant data capture tasks and consultation with Roads Service which is described in the remainder of Sections 5 and 6.

The following sections outline the capture of data relevant to the Round Two road source emission dataset. Where relevant, the use of Round One data has been presented. The use of the data for the development of the Round Two dataset is presented in Section 6.

## 5.2 Road Centrelines

Road centrelines are required to present the spatial location of road emission sources. Within a GIS environment, road centrelines can be used to store data relevant to the road itself. In the context of road traffic noise modelling, this data can include details of road traffic flows and vehicle compositions etc.

Road centrelines have been taken from OSNI’s Road Centreline dataset as available within the OSNI Largescale digital mapping dataset. This dataset was provided to AMEC under a project licence agreement. The data presents the spatial location of roads within Northern Ireland in terms of their centreline alongside information, such as road name, road number an indicative traffic speed/ speed limit. This dataset is the latest version and revision of OSNI’s Road Centreline dataset version 1.3, as used in Round One.

The centrelines have been used as the base spatial dataset for the road traffic noise emission dataset. As part of AMEC’s review and through queries with Road Service during the production of the road traffic noise dataset, amendments to the OSNI centrelines were identified where the currency of the data was not relevant to 2011. This mainly concerned new road schemes (i.e. bypasses) which were operational in 2011 but not captured by the OSNI dataset. In these situations, the OSNI centrelines were amended to reflect the spatial location of the new road schemes.

## 5.3 Road Traffic Statistics

Road traffic statistics containing total traffic volumes, vehicle compositions and average traffic speeds have been obtained from a number of different sources. The following sections presents various different data sources used for the development of the Round Two road traffic noise data set.

For Round Two, the Roads Service has reviewed the various definitions of traffic composition used for the derivation of %HGV during Round One. Based on the definition of HGVs as defined within CRTN, the Roads Service has decided to change the definition so that C2 vehicle classes are considered as HGVs. This differs from Round One where C3 vehicle classes were treated as HGVs. Table 5.2 presents an outline of the vehicle classifications as taken from the Roads Service’s Automatic Traffic Counters (ATCs).

**Table 5.2 Vehicle Classifications and Revised Classification of HGVs**

| Vehicle Classification | Description of Classification |
|---|---|
| C1 | Car, Car & Trailer and Light Van |
| C2 | Medium Goods Van and Minibus (<8.7m) |
| C3 | Rigid Heavy Goods Vehicle (>8.7m) |
| C4 | Articulated Vehicle and Rigid Heavy Goods Vehicle & Trailer |
| C5 | Bus and Coach |
| C_TOTAL | C1 + C2 + C3 + C4 + C5 |
| C_HGV | C2 + C3 + C4 + C5 |

For Round Two, data is to be representative of the relevant year of 2011. It should be noted that due to project timescale, it was not possible for Roads Service to provide ATC data representative of 2011 from their database. This was due to the processing of this data coincided with the project timeframes. For ATC sites, the project has used fully formatted and reviewed ATC data for 2010. The Roads Service has reviewed the changes in traffic statistics for selected number of counter sites between 2010 and 2011 and have confirmed that that 2010 statistics are representative of 2011 as there are marginal differences between these years.

### 5.3.1 Automatic and Temporary Traffic Counters (ATC)

For Round One, traffic data was provided for 266 sites in Northern Ireland with 122 relevant to the mapping by qualifying either as major roads (>6 million movements) or falling within extents relevant to the mapping of road traffic noise within the Belfast agglomeration.

At the start of Round Two, AMEC attempted to assess and review the traffic data used in Round One. However the available information was rather limited, with no detailed attributes distinguishing how many of these counters were permanent or temporary ATCs.

The level of information available for each site also varied considerably. For all ATCs, traffic volumes were provided for the four time periods and for %HGV. However, not all counters could provide speed information and as such default traffic speeds were adopted for these counters based on location, road classification and road configuration.

For Round Two, Roads Service has made available traffic statistics from 222 permanent ATC sites and 406 temporary ATC sites. For permanent ATC sites, total traffic volumes, average traffic speeds and % HGVs have been obtained from the Roads Service C2 database for all four time periods. For the temporary ATC sites, total traffic volumes and % HGVs have been provided for all four time periods; together with a single average traffic speed for each site. To allow a diurnal distribution of traffic speed, the Roads Service also provided a series of conversion factors which presented in Appendix B. The factors included in these tables are based upon typical distributions of traffic flow, %HGV and traffic speed.

It should be noted that Road Service has adopted a different definition of HGVs based on the vehicle classifications captured by its ATCs. For Round Two, an additional vehicle classification has been captured as HGVs and as such, the derived HGVs for Round Two are generally higher than those for Round One.

### 5.3.2 Belfast Traffic Model (BTM)

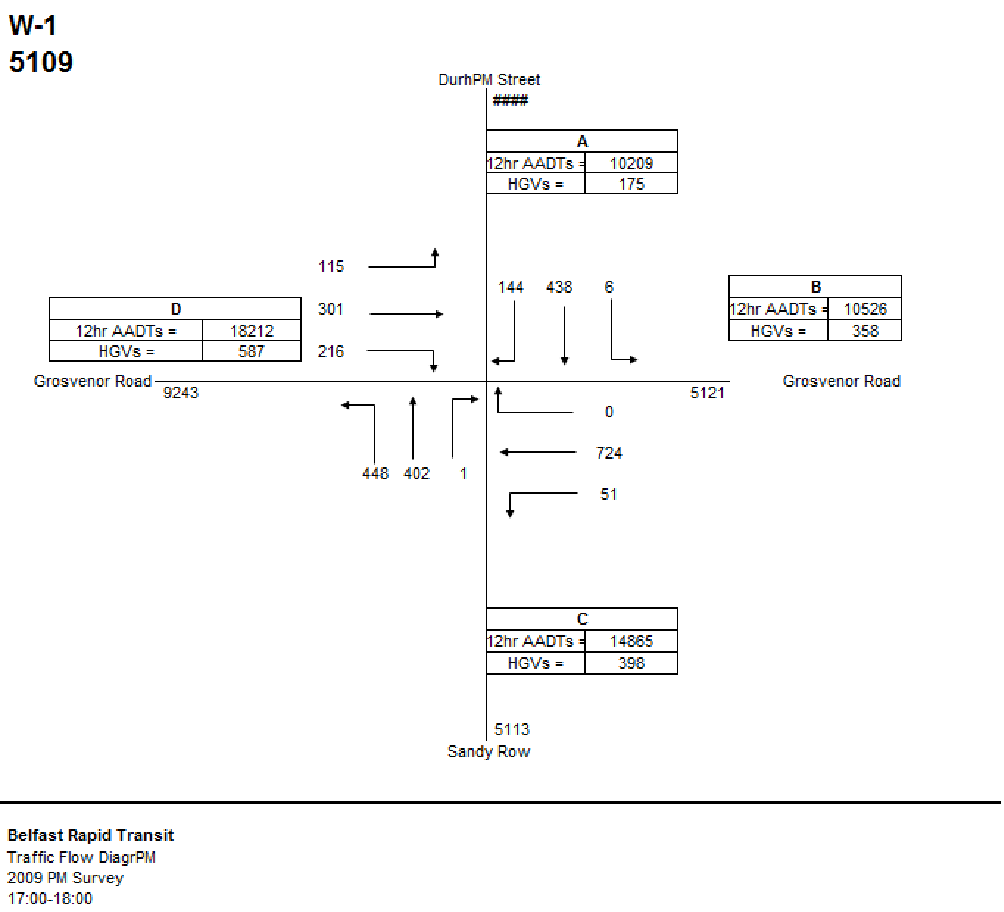
For Round One, the Belfast Traffic Model (BTM) was used to model roads within the Belfast agglomeration and to inform the extent of major roads within the agglomeration with relation to ATCs. In its original format, the BTM is representative of 2001 AM peak traffic statistics within Belfast. For Round One, the peak traffic statistics were converted using a series of factors to the four time periods and subject a growth factor in order to be representative of 2006. The extent to which the BTM was used within Round One was identified from reverse engineering the Round One road emission FMDI for the Belfast agglomeration.

Following discussions with Roads Service, it was established that the 2001 BTM had not been updated or revised to any latter date apart from some localised revisions made as part of the Rapid Transit scheme. On this basis, where BTM data was used in Round One and was not updated as part of Rapid Transit, information held within the Round One road emission FMDIs was the most relevant data available to Round Two.

Discussions with the Roads Service and analysis of the permanent and temporary ATC sites within Belfast also highlighted that there is insufficient change in road traffic flows to justify factoring up the derived 2006 BTM data to reflect 2011 traffic volumes. Road Service did however advise that %HGV presented within the Round One BTM data should be adjusted to reflect the change in the definition of HGVs.

Discussions with Roads Service also highlighted that the localised updates to the BTM as part of the Rapid Transit scheme were available. Roads Service provided a series of network diagrams presenting a 12-hour AADT and %HGV for the roads encompassed by Rapid Transit. An example of a network diagram is presented in Plate 5.1.

**Plate 5.1 Example RTS Network Diagram**




Roads Service also provided a series of factors to help derive traffic flows for each of the four time periods. These factors are presented in Appendix B.

### 5.3.3 Derived Traffic

Derived traffic has been required in situations where ATC information has suggested the continuation of a major road beyond a point representative of an ATC. Derived traffic has been required for major roads outside of the Belfast agglomeration where there is no other information available to establish traffic flows. Derived traffic locations have been identified through the assignment of ATC sites to sections of roads, as is described in Section 6. Plate 5.2 presents an example of derived traffic query provided by Roads Service where roads are believed to be above the major road movement threshold but not subject to counts.

**Plate 5.2 Example RTS Network Diagram**

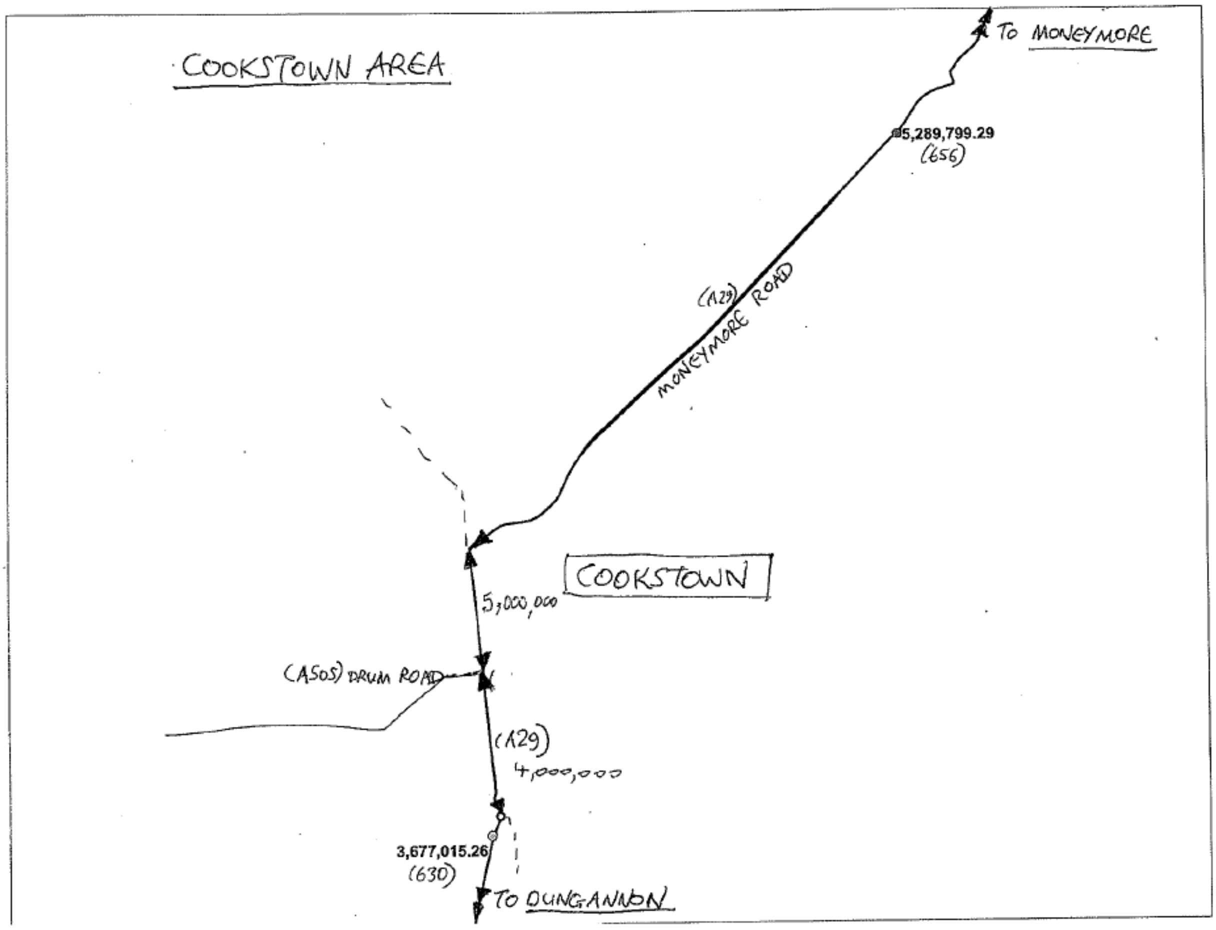



Plate 5.2 shows that the derived traffic has been presented in terms of annual traffic volumes. Roads Service advised that diurnal traffic volumes for these roads should be derived using factors as presented in Appendix B. Road traffic speeds for these roads have been set to default values based on indicative road traffic speeds held within the "SPEED" attribute of the OSNI Road Centreline dataset, road classification and guidance on the modelling of road traffic speeds as presented in CRTN. This approach reflects that adopted during Round One for where speed information was unavailable.

Roads Service also provided a 'Motorway Junctions Calculation' spreadsheet which was used to derive traffic flows at junctions between major roads.

Traffic has also derived from temporary ATCs where counters are directional and an overall traffic flow is required. This has simply required the summation of flows from each counter and the derivation of %HGV and speeds.

### 5.3.4 Default Traffic

For Round One, traffic data was not available for all roads considered by the mapping. This resulted in the requirement to develop default traffic flows that would complete the coverage. Road traffic flows were derived from flows obtained from ATCs and from the BTM. Default flows were developed for "urban" roads i.e. those within the agglomeration boundary; and for "rural" roads i.e. those that were outside of the agglomeration boundary but within the 3km model buffer area.

Default flows have also been required for Round Two. These have been derived from permanent and temporary ATC data for the same 'rural' and 'urban' designations described above. Appendix B-8 presents the defaults developed for Round Two.

Default flows have not been used as a basis of designating major roads.

## 5.4 Road Direction

Road direction is required to correctly implement gradient corrections within CRTN. Road direction must be known so that the noise model can apply gradient corrections to all traffic, half of the traffic or no traffic depending upon the direction of traffic with respect to the incline of a road.

For Round One, it was identified that road centrelines were not modelled with respect to direction of traffic. As a consequence, road directions were manually added to the OSNI Road Centreline dataset

For Round Two, it was anticipated that the direction information collected for the Round One FMDIs Road dataset could be used directly. However a manual review of the Round One dataset highlighted that digitisation directions were somewhat different from the information contained in the latest OSNI dataset. Due to this problem, it was concluded that road direction information collected in Round One could not be used and that direction should captured and coded again for the Round Two exercise.

This task was a time consuming but was assisted by the use online mapping and One-Way orders as provided by Roads Service to identify one-way streets. For road configurations such as roundabouts, dual carriageways, and slip roads, these have been identified through via a walkthrough of the OSNI road centreline dataset.

## 5.5 Road Gradient

Road gradients are required for roads which run up-hill in a single direction. CRTN requires road gradient to be defined a percentage slope and is used to adjust emission levels to reflect the additional traction of a vehicles engine during the climb.

During Round One, it was identified that Roads Service did not hold data relating specifically to road gradients. As such, for Round One, road gradients were derived from the OSNI Enhanced DTM and 3D noise model. This approach has been adopted for Round Two and is discussed further in Section 6.5.

## 5.6 Road Surface Type

Road surface type along with road texture depth is used by CRTN to model any noise emission enhancements generated by the interaction of a vehicles tyres with certain road surfaces. For Round One, it was revealed that Roads Service store surfacing information within their Highways Inventory but unfortunately this was in a format which could not be related to the OSNI road centreline dataset. AMEC discussed the possibility of using the Highways Inventory for this purpose as part of Round Two. However Roads Service believed that this would be a significant undertaking within the scope and timeframes of the project.

For Round One, road surfaces were modelled entirely as bituminous surfaces. For Round Two, this assumption has also been adopted.

## 5.7 Road Surface Texture Depth

Road surface texture depth is required by CRTN and influences the various emission enhancements incumbent within the various modelled road surfaces. Texture depth only influences these enhancements where traffic speeds are modelled as greater or equal than 75 $kmh^{-1}$.

For Round One, Roads Service was unable to provide data in relation to texture depths and as such a default value of 2mm was adopted based on guidance outlined in Toolkit 17b.1 outlined in Defra research project NANR93 '*WG-AEN's Good Practice Guide And The Implications For Acoustic Accuracy*'. For Round Two, texture depth was discussed with Roads Service. This led to the understanding that some information on texture depth may be available however it is not stored centrally or in an accessible form. To obtain this information would be a significant undertaking and may not provide sufficient coverage. On this basis, Roads Service confirmed that the assumption of 2mm should also apply for Round Two.

## 5.8 Carriageway Width

Carriageway widths are required by CRTN to locate the position of the effective source emission line, which is positioned 3.5m from the carriageway edge. As the base geometry of the road noise emission dataset is based on the OSNI road centreline dataset, it is necessary to define carriage widths through attribution.

During Round One, Roads Service confirmed that they do not hold any data relating to carriageway widths although the Highways Inventory contains scope to do so. During Round One, investigations were made to investigate the potential derive carriageway widths from the OSNI Largescale mapping project. However these investigations highlighted that the use of the OSNI Largescale mapping could result in some misleading results.

As a consequence, carriageway widths in Round One were assigned a default value of 7.5m which reflects a standard width of a single two lane carriageway. This assumed default has also been adopted for Round Two.

Information regarding carriageway separation has not been required as the OSNI road centrelines model roads as separate carriageway where lanes are separated by a central reservation. This means that carriageway separation is managed within the geometry of the road noise emission dataset and therefore requires no further consideration.

## 5.9 Cross Border Roads

In order ensure consistency in noise levels at locations where roads cross into the Republic of Ireland (RoI), it is necessary to model roads running across the border. If roads are not modelled across the border this will result in a “tailing off” in noise levels which can result in misleading exposure statistics.

Data regarding cross border major roads was gathered with the assistance of the National Roads Authority (NRA) of Ireland. Data was exchanged between the project team and the NRA allowing the modelling of road emissions and development of the 3D modelling environment at key cross border locations. This was supplemented in some locations by additional data capture by the project team.

# 6. Development of Round Two Road Emission Dataset

This section of the report presents the development of the Round Two road noise emission dataset using the information captured and adopted as outlined in Section 5. The Section describes the processes undertaken by the project team and the consultation and responses supplied by Roads Service in the development of the dataset. The section also discusses and describes additional guidance offered in recognised publications and the relevance to the development of the dataset.

## 6.1 Determining Relevance

During Round One, a decision was made to only model C class roads or higher. This decision had particular relevance to road traffic noise modelling within the Belfast agglomeration as this rules out the modelling of residential streets.

This decision was made during Round One due to the fact that little information was available to determine traffic flows on unclassified roads and the potentially significant consequences on noise exposure statistics given the close proximity of these roads to residential populations.

This decision has been carried through into Round Two and as such only Motorway, A, B and C class roads have been considered relevant to the mapping exercise. In some instances, and where data is available, U class roads have been modelled. This has mainly occurred where temporary counter information has been available within residential areas which has mainly encompassed large residential areas with unclassified through roads. Likewise, where derived flows obtained from Roads Service inform of traffic flows on unclassified roads, these have also been modelled. However, the default position has been to ignore U (unclassed) class roads unless information is available which has been beneficial to the modelling process.

## 6.2 Assigning Road Traffic Statistics to Road Centrelines

The main task in the development of the road noise emission dataset has been the assignment of road traffic statistics to road centrelines. Determining the extents and order of priority to which road traffic statistics relate to a road centreline has required on-going consultation with Roads Service and various techniques and assumptions made using other available data sources. Invariably this has led to different approaches being adopted for the various road traffic statistic data sources presented in Section 5.3.

For the modelling of road traffic noise within the Belfast agglomeration, the following hierarchy as outlined in Table 6.1 has been applied the assignment of traffic statistics to road centrelines. For major roads outside of the Belfast agglomeration, Priority 1-3 data sources have been used to assign road traffic statistics to road centrelines.

The priority presented in Table 6.1 represents the quality and currency of the road traffic statistics provided by Roads Service. This hierarchy was agreed with Roads Service and has been used to make decisions on the use selection of data. For example, where a section of road has been determined as being representative of a permanent ATC site, no other data sources will be used to model road traffic on this particular road as no better information exists. In the event, a road has a selection of road traffic data sources the data source with the highest priority is assigned. For example, where a road has data from both Rapid Transit and a temporary ATC, the data from the temporary ATC is assigned.

Table 6.1 also presents the level of consultation required with Roads Service in determining the spatial extents of the road traffic statistics. The table also shows that generally, data sources that are more current and of better quality require more consultation in the determination of spatial extents. Based on the experience of the project team, it is considered that derived data sources require the most consultation. This is due to the requirement for Roads Service to derive the information and for it to be presented back to the project team in a format which can be readily used. This has required the exchange of hand drawn maps and for internal consultation with Roads Service.

The following sub sections describe the processing in assigning road traffic statistics to the road centrelines in terms of both spatial extent and data processing.

**Table 6.1 Hierarchy of Adopted Road Traffic Statistic Data Sources for Modelling within Belfast Agglomeration**

| Priority | Data Source | Currency | Data Processing Requirements | RS Consultation in Determining Spatial Extents |
|---|---|---|---|---|
| 1 | Permanent ATCs | Constant measured traffic data representative of 2011 | Low: No processing requirements, data fit for purpose | Low-Medium: Consultation required in confirming the spatial extent of road to which counter site represents traffic. |
| 2 | Temporary ATCs | Measured traffic data for discrete periods factored to represent 2011 | Low: Factored to 2011, speeds also require factoring to time periods | Low-Medium: Consultation required in confirming the spatial extent of road to which counter site represents traffic. |
| 3 | Derived | Based on Permanent ATC and Temporary ATC data, derived from local and expert knowledge. | High: Derivation of diurnal flows, speeds and HGV required using factors | Medium-High: RS required to derive traffic flows and present information back in various formats for incorporation within the noise model. |
| 4 | Rapid Transit | Modelled traffic based on updates to BTM in 2009 factored to represent | Medium-High: Factoring required to facilitate diurnal traffic statistics | Low: Spatial extents defined by network diagrams. |
| 5 | BTM | Modelled traffic and presented in Round One road noise emission dataset FMDIs representative of 2006 | Low-Medium: No factoring to 2011, however HGVs require factoring to reflect change in definition | Low: Spatial extents already defined by Round One road noise dataset FMDI |
| 6 | Defaults | Default traffic flows derived from 2011 representative permanent and temporary ATC data. | Low: Flows assigned by entry rather through derivation. | Low: Spatial extents determined by requirement. |

The assignment of road traffic data to road centrelines is a significant undertaking and is critical to the development of the noise emission dataset. It is important as part of noise action planning purposes that Roads Service and DoE are clear as to how road traffic has been modelled and how traffic has been allocated.

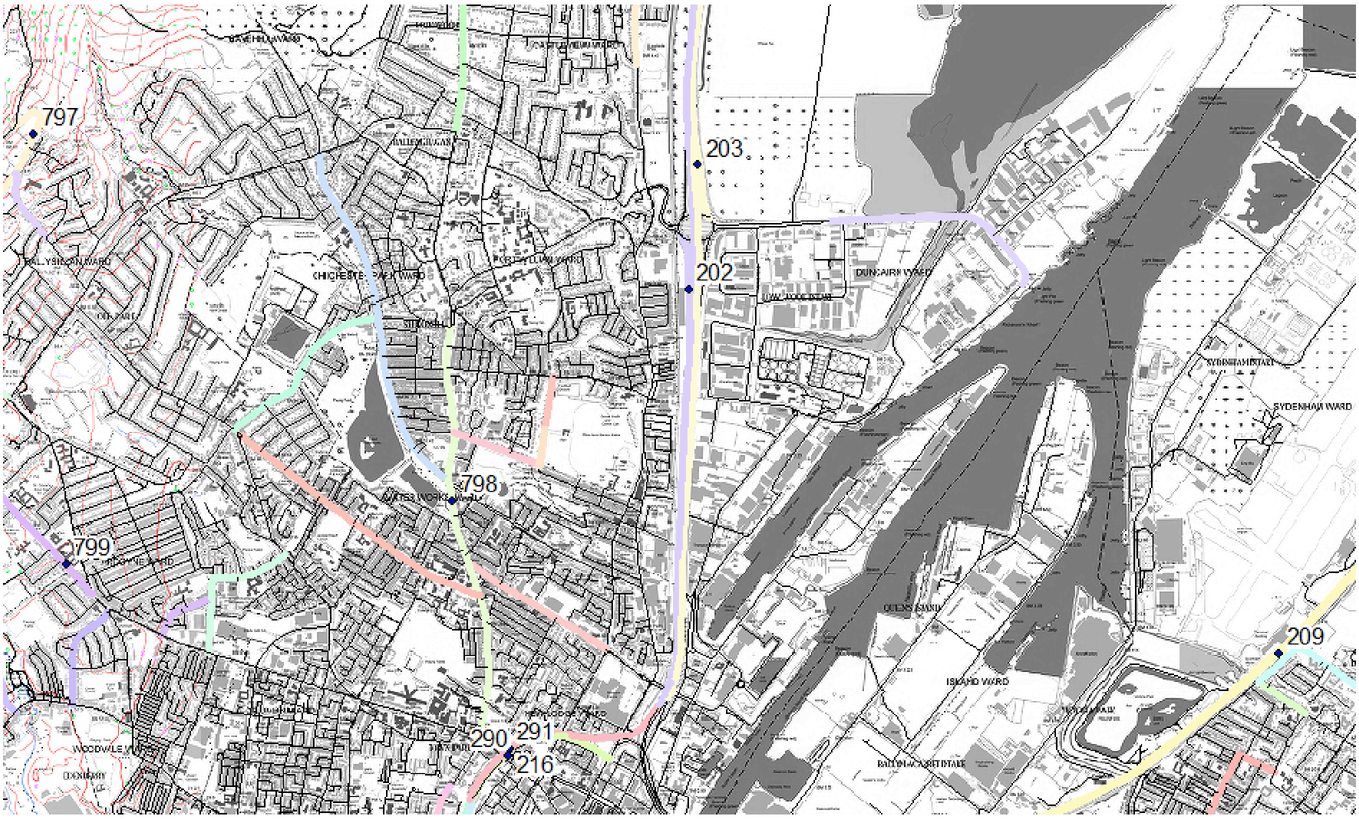
For Round One, the allocation and attribution of road traffic was described within a technical report.  Due to the increased extents for Round Two and the increased number of data sources available to the project team, the process is described in the remainder of this section and an accompanying electronic appendix.

The final electronic appendix presents a complete Round Two traffic allocation model for Northern Ireland.  This has been produced as a GIS dataset and presents the spatial location, the road traffic data source used within noise emission dataset and the final traffic figures.  This dataset does not present noise emission or other assumptions but simply outline what traffic data has been used where.  This would remove the requirement for documented paper maps and could be used by Roads Service and DoE as the basis for future DF5 submissions.  This will also help reduce demands on Roads Service during future rounds of mapping, reduce uncertainty and ultimately help improve the overall quality of future noise maps.

### 6.2.1 Permanent ATCs

During project initiation, Roads Service provided a GIS dataset presenting the location of their Permanent and Temporary counter sites inside and outside of Belfast.  These counter sites were overlaid onto the OSNI road centreline dataset and OSNI raster mapping, as shown Plate 6.1, thus presenting the general position of the counter site with the road.

**Plate 6.1 Example of Permanent Counter Site in Relation to Road Centreline**

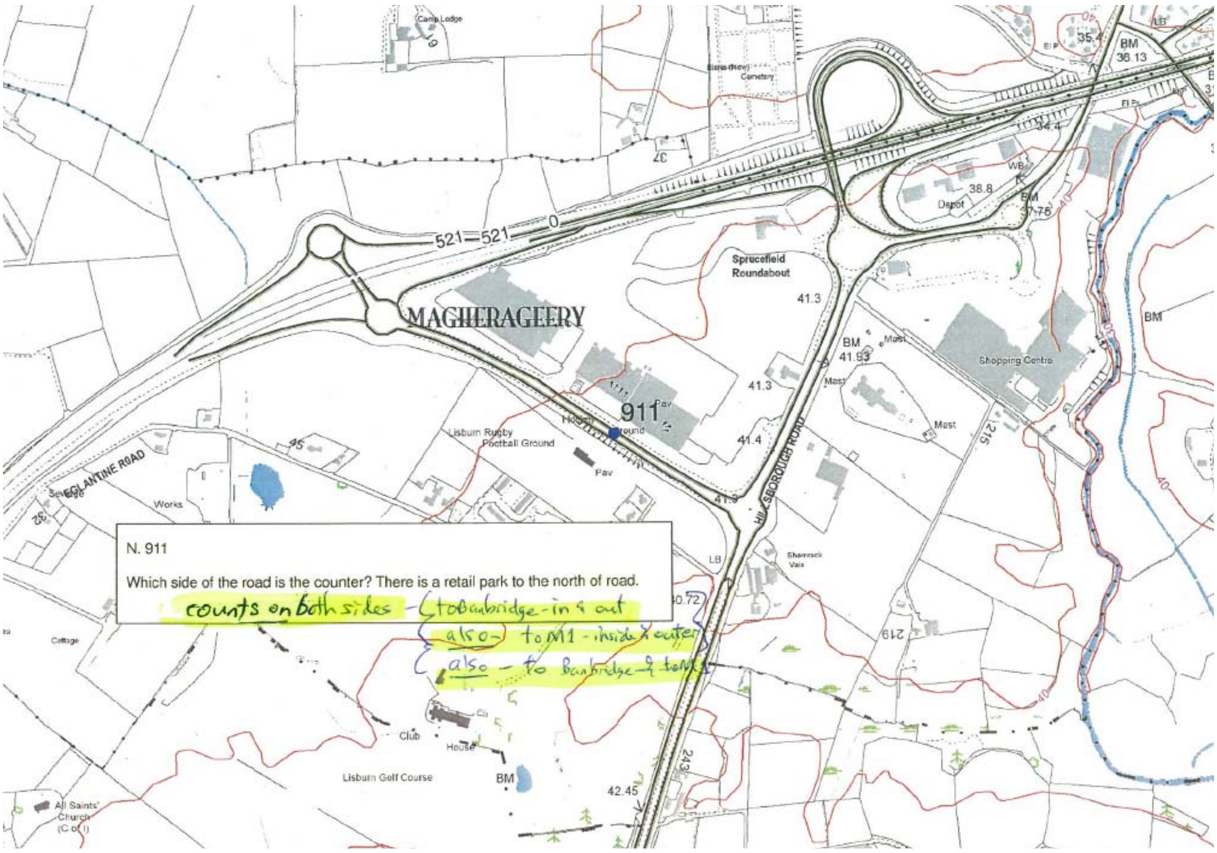


The assignment of the ATCs to spatial road extents has been based on the following:

- Existing informed extents based on those presented within Round One reports and FMDIs;
- Spatial extent of road section (e.g. junction to junction);
- Extent of existing traffic flows as presented in other existing data sources i.e. Round One BTM flows within the Belfast Agglomeration; and
- Consultation with Roads Service.

The assignment of ATCs to the spatial road extents required consultation with Roads Service where the project team could not confidently determine spatial extents. Plate 6.2 presents an example of clarification obtained from Roads Service.

**Plate 6.2 Example Clarification for a Permanent ATC**




Once the spatial extent of a temporary ATC was determined, an "aCNT" field within the road centreline data was attributed against the traffic counter and the "FLOW_TYPE" field assigned to 'PERM' facilitating the ability to join the traffic statistics to the dataset.

It should be noted that the assignment of permanent ATCs has considered directional and bi-directional counters. Where a directional counter has been identified, this has been assigned to the road centreline reflecting the direction of flow. For bidirectional ATCs, traffic statistics have been assigned in full where the road is represented by a single centreline. Where the road is represented by two centrelines (i.e. one for each carriageway), road traffic flows have been split equality between each carriageway. This approach was also adopted during Round One.

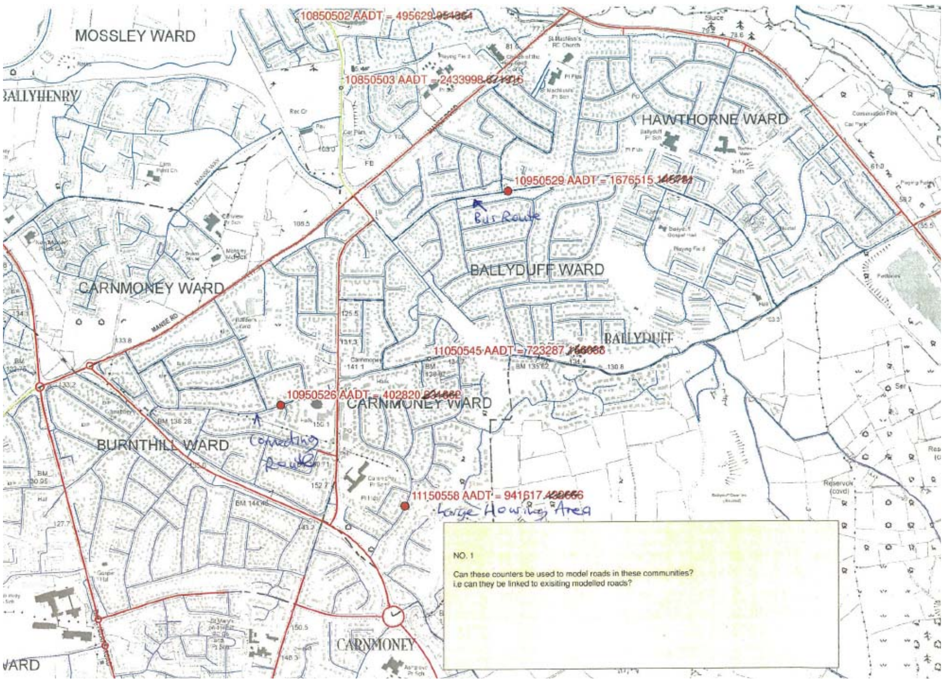
### 6.2.2 Temporary ATCs

The incorporation of Temporary ATC data, in terms of spatial extents and road traffic information has been undertaken in a similar manner to that of the Permanent ATCs. Where temporary ATC data has been adopted the “FLOW_TYPE” field been set to ‘TEMP’. As a single value of speed information has been provided for the temporary ATCs, it has been necessary to factor speed data across the time periods using the factors presented in Appendix B.

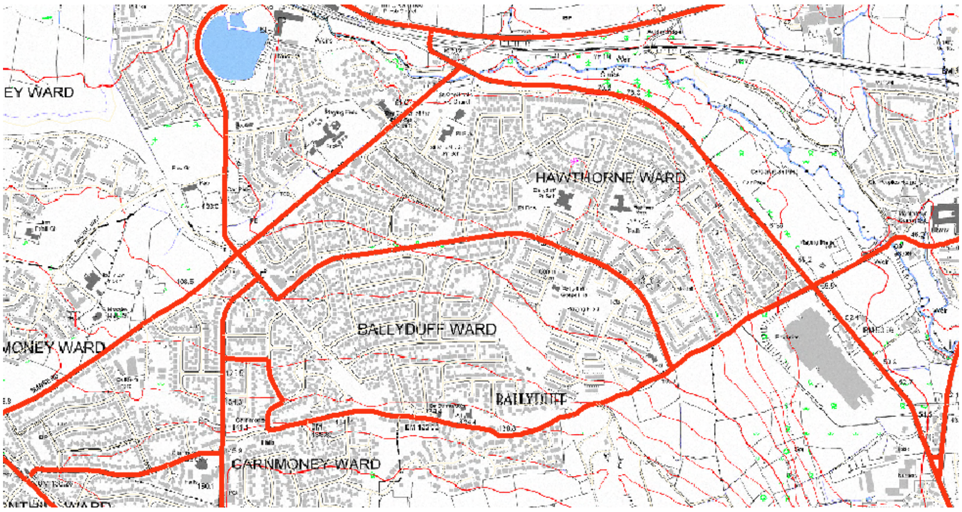
Not all temporary ATCs have been used in modelling road traffic. ATCs have been used to model C class roads and above where they share an extent. Where temporary ATCs are located on unclassified roads, these have been used where possible. For example, where temporary ATC can be used to model routes through residential houses estates, from for example, bus routes, Roads Service have provided information to facilitate this. Likewise, where a temporary ATC joins one modelled road to another, they have also been included. Where flows from temporary ATCs have been used to derive traffic patterns in residential areas, the “FLOW_TYPE” attribute has been set to “TEMP_DER” in the traffic allocation model. Plate 6.3 presents examples of the derived use of temporary ATCs.

Temporary ATC data has not been used where it has not been possible to link other modelled roads, or it has not been possible to derive traffic routes or traffic volumes as the temporary ATCs do not give sufficient coverage.

**Plate 6.3 Example of Temporary ATCs used to Model Routes within Residential Areas**




Query Received back from Roads Service



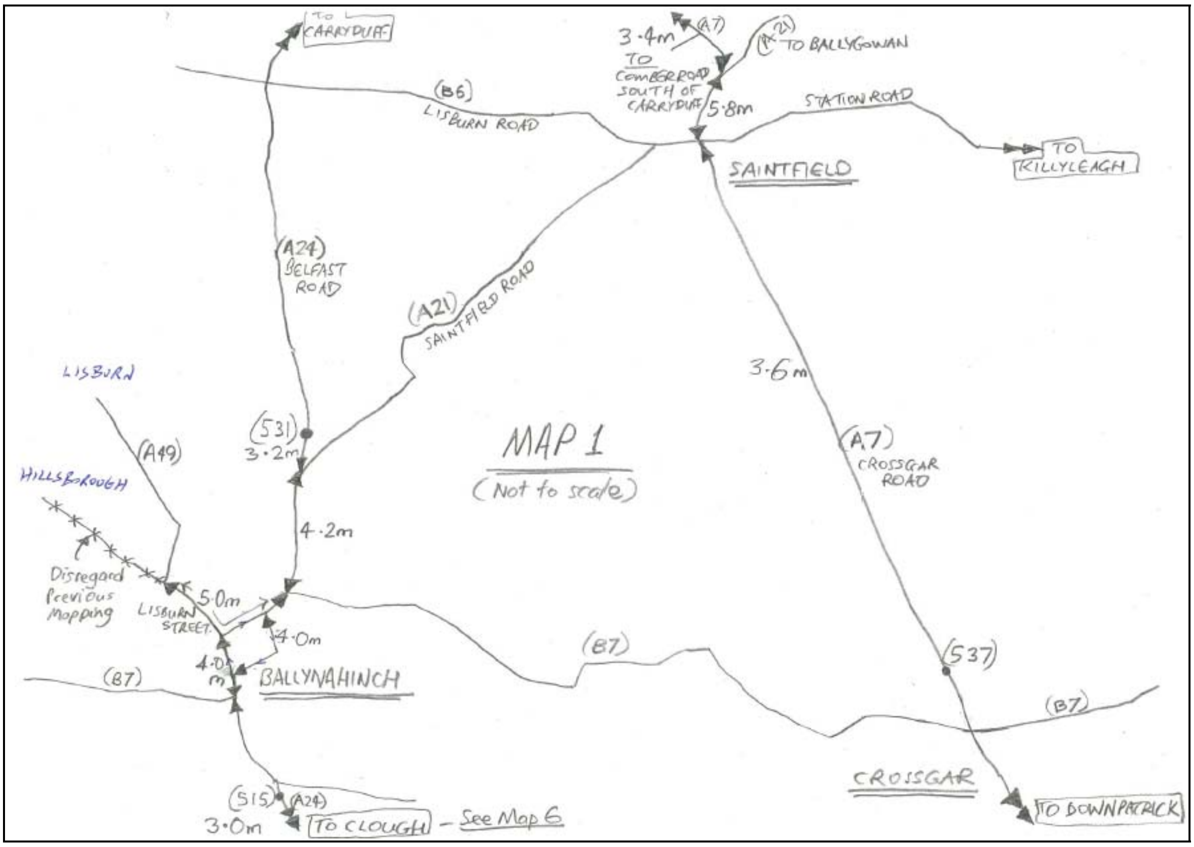

Route incorporated into modelled roads

## 6.2.3 Derived Traffic

Derived traffic has mainly been used outside of the Belfast agglomeration for the modelling of major roads. Derived traffic has been required where ATC data suggests roads beyond the extents covered by the ATC are above the major threshold of 3 million movements and no other readily available data can be used to confirm extents or flows. For example, where an ATC indicates a traffic volume significantly above the 3 million threshold at a point before a road forks, and there are no ATCs on the roads after the fork, flows must be derived.

The derivation of traffic flows has been undertaken by Roads Service. The derivation of these flows has been based on local knowledge and professional judgement. The derived flows have been supplied to the project team in the form of hand drawn maps, as illustrated in Plate 6.4.

**Plate 6.4 Derived Traffic as received from Roads Service**




As shown in Plate 6.4, derived traffic flows have been provided in terms of annual traffic volumes. In order to yield diurnal traffic statistics, the annual traffic volumes have been converted to 24-hour flows and the factored according to road classification using the factors presented in Appendix B.

Using the factors presented in Appendix B, a similar process has been undertaken to yield diurnal %HGVs against road classification. The identification of road classifications has been undertaken using the "CLASS" attribute held in the OSNI road centrelines.

Average road traffic speeds have been derived using the following:

- Understanding of road configuration i.e. single carriageway, dual carriageway etc;
- Road classification i.e. A,B or C class;

- Indicative traffic speeds/ limits as held within the OSNI road centrelines within the “SPEED” attribute and other available information such as online virtual mapping/ walkthroughs; and
- Guidance on the modelling of average road traffic speeds within CRTN.

The process for the assignment of average traffic speeds is as follows:

- Determine road configuration and classification using the OSNI road centrelines and road classification from “CLASS” attribute;
- Determine indicative traffic speed/ limit;
- Identify appropriate modelling speeds based on CRTN guidance;
- Assign modelling speed to all four time periods.

This approach broadly reflects the use of the CRTN guidance during Round One except additional information on indicative speed limits has been used rather than just road classification and configuration.

Derived traffic flows have required significant consultation and data exchange between the project team and Roads Service. In addition, the project team was able to derive traffic flows for junctions using the “Motorway Junctions Calculation” spreadsheet provided by Roads Service. The spreadsheet was used to model junctions connecting one major road to another. This approach ensures continuity in the resulting noise maps.

Where derived flows have been used in the traffic allocation model the “FLOW_TYPE” attribute has been set to “DERIVED”.

### 6.2.4 Rapid Transit

As part of discussions surrounding the use of the BTM data for Round Two, it was revealed that localised updates to the BTM had been made as part of the Rapid Transit scheme. Although this data does not provide the same level of coverage as the BTM, it provides a more current understanding of traffic volumes and composition on several main routes into the Belfast agglomeration.

The Rapid Transit traffic statistics were provided in the form of spreadsheets presenting a nodal traffic model at several junctions and points along the road network in Belfast. The spreadsheets also provided a 12-hour traffic flow and %HGV for each road. The first task in converting this data to a workable form was to ‘geo-code’ the nodal traffic network presented in the spreadsheets onto the OSNI road centrelines. This involved a manual exercise of:

- Selecting the roads in GIS represented within the spreadsheet; and
- Attributing the roads accordingly with the 12-hour flow and %HGV, splitting the flows across two centrelines if presenting a dual carriageway.

As part of the supply of the road network spreadsheets for the Rapid Transit data, Roads Service also provided a series of factors to allow the derivation of diurnal flows and %HGV for each of the four time periods as presented in Appendix B. These factors were applied accordingly.

The Rapid Transit data did not contain any traffic speed information. Based on the hierarchy presented in Table 6.1, Rapid Transit may be used to replace either default flows or traffic flows derived from the BTM. In practice, only roads previously modelled using BTM data have been replaced by flows using Rapid Transit data. For the purposes of consistency, speeds held within the BTM data for these roads have been carried forward for use in the Round Two.

Where Rapid Transit data has been used in the traffic allocation model the “FLOW_TYPE” attribute has been set to “RTS”.

### 6.2.5 Belfast Traffic Model

During the study, Roads Service confirmed that apart from the Rapid Transit dataset, there had been no major update to the original 2001 Belfast Traffic Model used to derive 2006 diurnal flows and speeds for used in Round One. During Round One, the BTM was geo-coded from its native nodal format onto OSNI road centrelines for use in the modelling of road traffic noise in the Belfast agglomeration. Using a series of global and localised factors, the AM and PM peak data held within the BTM was converted to diurnal 2006 traffic flows.

Through an analysis of road traffic volumes and compositions based on 2006 and 2011 ATC data, the project team identified that, on the whole, there had been minimum change in road traffic within the Belfast agglomeration. This analysis was reviewed by Roads Service who confirmed that the derived 2006 BTM flows could be reused for Round Two modelling in the Belfast agglomeration however uplift factors would need to be applied in order to correct the %HGV values to reflect the revised definition of %HGV as employed for other data sources.

In order to use BTM for the purposes of Round Two, the project team has undertaken the following tasks:

- Reverse engineer the Round One road emission FMDIs using the technical reports prepared for Round One to identify road centrelines populated with information derived from the BTM;
- Undertake a spatial join of the Round One modelled BTM links on to the Round Two OSNI road centrelines in order to transfer the information from one dataset to another;
- Undertake a manual review of the spatial join to ensure that the correct BTM traffic data values have been mapped across where road geometries are different or have been subject to simplification techniques as part of Round One processing; and
- Apply the factors presented in Appendix B to increase %HGV in accordance with the revised definition.

This process has been time consuming and has required significant manual processing in GIS.

It should also be noted that within the Belfast agglomeration  junctions have already been modelled using the BTM data (where it exists) in preference to the junction calculator.

### 6.2.6 Default Flows

During Round One, default traffic flows were used where no other information was available.  For Round One, default traffic flows were used only for the purposes of modelling road traffic noise within the Belfast agglomerations and were applied to C class roads or above.

The derivation of default flows during Round One was based on ATC data and in some instances, data obtained from the derived BTM flows.  Default flows were derived for M, A, B and C class roads using data obtained from data representative of these classifications.  In order to consider the potential differences between urban and rural roads in Belfast, defaults were developed for “urban” roads, i.e. those located within the Belfast agglomeration and “rural” roads i.e. those located outside of the Belfast agglomeration.

For Round Two, the project team has derived default flows for the same road classifications and urban and rural definitions.  For Round Two, there has been a significant increase in the number of ATC sites available for the derivation of default flows and as such defaults flows have been based upon measured data only.

In order to assign default flows, the following process has been undertaken by the project team;

- Identify roads which are C class and above that do not have any attributed “FLOW_TYPE” from ATCs, derived, rapid transit or BTM data;
- Identify whether the roads falls within the Belfast agglomeration and if so attribute the “FLOW_TYPE” as “DEFAULT_U” for urban default;
- Identify whether the roads falls outside the Belfast agglomeration and if so attribute the “FLOW_TYPE” as “DEFAULT_R” for rural default; and
- Use the “DEFAULT_R” and “DEFAULT_U” designation along with the road classifications stored within the OSNI road centreline “CLASS” attribute to assign the default flows as presented in Appendix B.

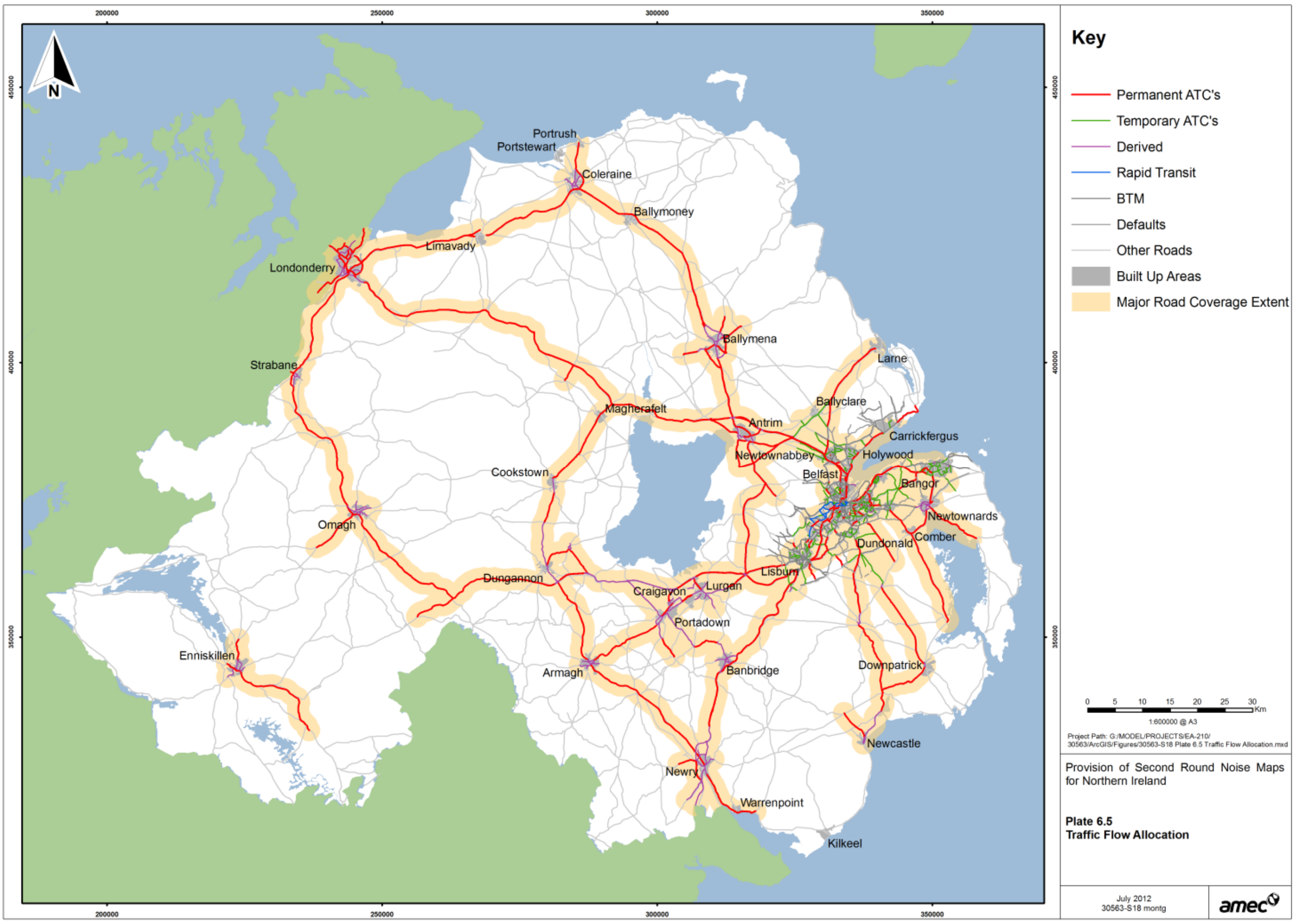
### 6.2.7 Overview of Traffic Allocation

The preceding sections set out the processes in using the various traffic data sources available to the project. Table 6.2 presents a summary of the extent which each data source has been used for the modelling of road traffic noise in Round Two.  The extent is based on length of modelled road.  Plate 6.5 presents an illustration of the allocation of road traffic data across the major roads and within the Belfast agglomeration.

### Table 6.2 Summary of Road Traffic Source Data used in Round Two

| Data Source | Length (km) | % of Total |
|---|---|---|
| Permanent ATCs | 1,152 | 50% |
| Temporary ATCs | 231 | 10% |
| Derived | 344 | 15% |
| Rapid Transit | 24 | 1% |
| BTM | 442 | 19% |
| Defaults | 118 | 5% |
| **Total** | **2,311** | 100% |

### Plate 6.5 Allocation of Road Traffic Data - Major Roads and the Belfast Agglomeration



## 6.3 Road Designation

The designation of roads as either major or non-major sources has been undertaken in accordance with the approach outlined in CRTN. Where roads have been designated as major roads, the L_MAJ attribute has been set to 1. Where roads are modelled as non-major roads, the L_MAJ attribute has been set to 0.

## 6.4 Road Direction

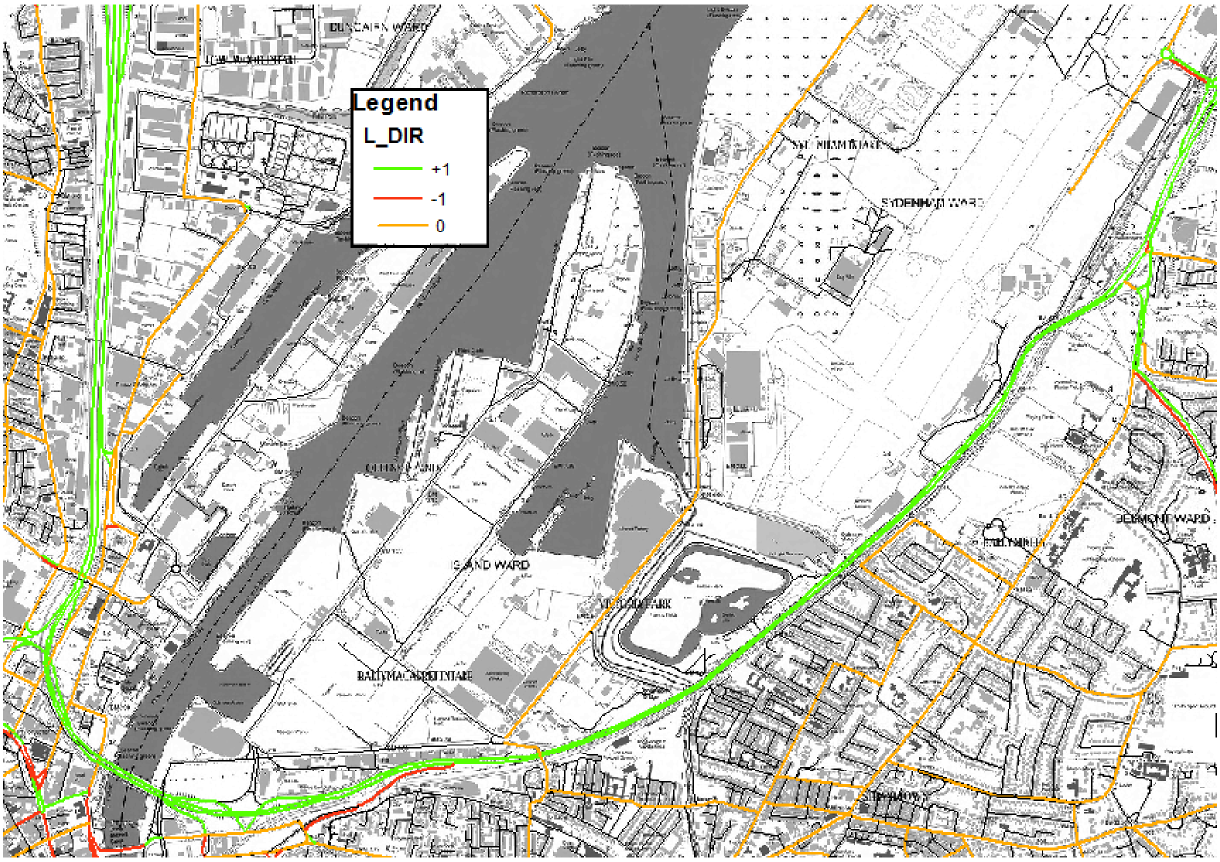
Road direction is required in order to correctly implement gradient corrections within CRTN. Direction must be known so that the noise model can apply gradient correction to all traffic, half of the traffic or no traffic depending upon the direction of traffic with respect to the incline of a road. The road types for which this must be understood include: dual carriageways, slip roads, one-way streets and one-way junctions and roundabouts.

The data specification for the LimA RDP object allows consideration of road direction through the L_DIR attribute as follows:

- L_DIR = 0 – road centreline models a carriageway where traffic runs in both directions;
- L_DIR = +1- road centreline models a carriageway where traffic runs in the direction of digitisation; and
- L_DIR = -1 – road centreline models a carriageway where traffic runs counter to the direction of digitisation.

To model road direction correctly, the project team has reviewed each modelled road centreline in terms of road configuration and digitisation direction. Through using symbology within GIS, digitisation directions have been established and the L_DIR attribute amended accordingly. Plate 6.6 presents an example of this process.

**Plate 6.6 Example of L_DIR Attribution**




The project team also used recent one-way orders (as provided by Roads Service) and online mapping to identify the location of one-way streets. This information was integrated into the final Round Two road centreline dataset.

## 6.5 Road Gradient

For Round One, road gradient was calculated using the LimA calculation core as part of the QA process. This approach has been retained for Round Two.

During the QA process, the project team draped the RDP objects over the 3D model within the LimA calculation core. As part of this process, the LimA software calculates average road gradients (in percentage) for sections of road using the underlying 3D model and deposits the gradient back onto the RDP object within the L_GRD attribute. As part of the process, the LimA software warns of any excessive gradients. Excessive gradient can often be a result of missing bridge objects or errors in terrain. Any excess gradients which were identified were subsequently reviewed by project team, with any final changes incorporated into the final noise model.

## 6.6 Road Surface Type

As discussed in Section 5.6, it was not possible to obtain readily available information on road surface types in Northern Ireland. This was also the case during Round One however Roads Service did confirm that most of the roads in Northern Ireland were bituminous surfaces. Based on this information, for Round One all roads in Northern Ireland were modelled as an "impervious bituminous" surface type in CRTN.

For Round Two, this assumption has been carried forward and applied. This has resulted in the RDP objects being configured with the L_SRF attribute set to I.

## 6.7 Road Surface Texture Depth

In CRTN, road surface texture depth is used in combination with road surface type to model the various noise enhancements as a result of the type/ road interface. For the assumed "impervious bituminous" surface type described in Section 6 above, texture depth has no effect on noise emissions unless mean traffic speeds are above 75 $kmh^{-1}$. This means that texture depths only effect the noise emissions from roads with relatively free flowing traffic with speed limits above 40 mph.

For Round One, the selection of an assumed texture depth was informed from Report 7 of Defra's NANR93 project. This report presents various toolkits for the modelling of road traffic noise using CRTN. Tool 17b.3 of the report shows that where texture depth cannot be measured or where the data is not available, an assumption of 2.0mm for "impervious macadam" surfaces will result in an accuracy of around 1 dB. This is presented below in Plate 6.7 below.

This assumption was applied during Round One and has been subsequently adopted for all modelled roads in Round Two. This has been implemented by populating the "L_TD" attribute for all RDP objects with the value of 2.

**Plate 6.7 NANR93 Tool 17b.3 – Road Surface Texture Depth**

<table>
<tr><th colspan="4">Tool 17b.3: Texture depth not known, road surface type known</th></tr>
<tr><td>Method</td><td>complexity</td><td>accuracy</td><td>cost</td></tr>
<tr><td>Measure texture depth on unknown sections using "sand patch" test</td><td></td><td>< 0.5 dB</td><td></td></tr>
<tr><td>Use default values of texture depth for each surface type from the following table:<br><table><tr><th>Surface Type</th><th>Texture depth</th></tr><tr><td>Pervious macadam</td><td>1.5 mm</td></tr><tr><td>Impervious macadam</td><td>2.0 mm</td></tr><tr><td>Concrete</td><td>2.0 mm</td></tr></table></td><td></td><td>1 dB</td><td></td></tr>
</table>

## 6.8 Carriageway Width

As discussed in Section 5.8, no data was readily available for explicit modelling of carriageway widths. Investigations into the automated derivation of carriageway widths using the OSNI Largescale mapping product have been investigated and were found to result in errors and the requirement for significant manual review. Similar issues were identified during Round One which led to the adoption of an assumed carriageway width.

For Round One, the assumed carriageway width was set at 7.5m as this represents the majority of two lane carriageways. Within the OSNI Centreline dataset, dual carriageways are represented by two centrelines thus an assumed carriageway width of 7.5m aligns well for most conventional two lane, bi-directional roads and carriageways.

The assumption of a default carriageway width of 7.5m has been applied to all roads in Northern Ireland for Round Two. This assumption may not reflect accurately situations such as 3-line motorways, where carriageway widths may be wider, or small residential streets, where carriageway widths may be smaller. However these are likely to reflect a minority of the overall modelled road network. This assumption has been applied by setting the L_LNW attribute of all RDP objects to 7.5.

## 6.9 Cross Border Roads

Cross border major roads were modelled in four locations. These were:

- Muff - Londonderry/ Derry
- Bridge End - Londonderry/ Derry
- Strabane
- Newry

Road emission data provided by the NRA comprised of total vehicle flow, %HGV and traffic speeds for a 24-hour period. To enable modelling in the four time periods to be considered by the RDP object, the project team apportioned this data in accordance with the traffic statistics on the NI side of the border. In the case of Muff, the emission source from NI was extended into the Republic of Ireland.

The 3D modelling data for these locations was principally provided by the NRA and incorporated into the 3D model. This was supplemented (were necessary) by additional data capture by the project team.

# 7. Round Two Road Traffic Noise Model Development with the LimA Environment

## 7.1 Introduction

This section details the Quality Assurance procedures implemented upon the Round Two road traffic noise model dataset. All road traffic noise emission datasets and 3D modelling datasets were developed in the GIS environment in accordance with the various LimA object dataset schemas associated with each model layer. This approach aims to reduce the processing required within the LimA software environment and seeks to ensure that datasets are compliant with the LimA software.

The Quality Assurance of the Round Two datasets marks the transition from the GIS environment to the LimA software environment and marks the beginning of Stage 2 of the project. The QA procedures aim to identify whether the various GIS datasets comprising the roads noise model have been developed to specification. It also aims to ensure that calculations will run without error and that any issues encountered with any of the noise model layers are identified before calculation and corrected as required.

The QA procedures adopted by the project team broadly reflect those implemented for Round One. However developments within the LimA software have allowed many of these procedures to become automated and further refined. Like the approach adopted in Round One, all QA procedures have been 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 7.1 presents an example proforma.

**Plate 7.1 Example QA Proforma**

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

| | |
|---|---|
| Project Title | **Northern Ireland Second Round Noise Mapping** |
| Project Number | **30563** |
| Project Sub-Area | **A2** |
| LimA Server Project Path | \\emanlima1\LimAjobs\30563\DATA_TESTING |

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\30563\DATA_TESTINGA2\MODEL\HIN_HA2\A2_HIN_HA2_03.BN | Yes | Yes | Yes | n/a | Yes | Yes | Pass |
| HIN_HA4 | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\MODEL\HIN_HA4\A2_HIN_HA4_02.BN | Yes | n/a | Yes | n/a | Yes | Yes | Pass |
| HIN_HA7 | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\MODEL\HIN_HA7\A2_HIN_HA7_02.BN | Yes | Yes | Yes | Yes | Yes | Yes | Pass |
| GEL | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\MODEL\GEL\A2_GEL_01.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 | | | |
| ~~IND~~ | ~~No Data Layer for Project Sub-Area~~ | | | | n/a | | | |

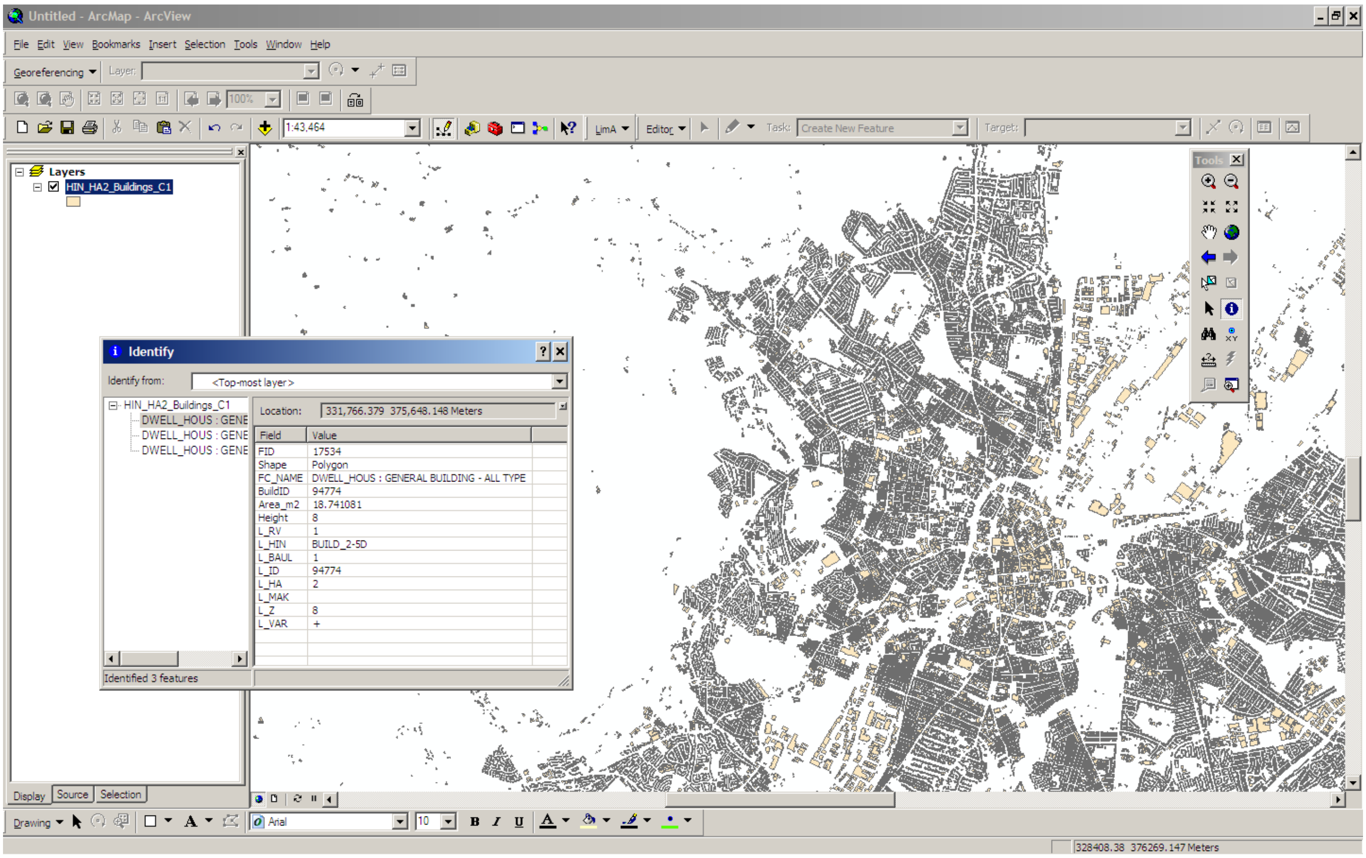
| Corrective Actions | | Description |
|---|---|---|
| Data Layer | File Path | |
| ~~HIN_HA1~~ | ~~No Data Layer for Project Sub-Area~~ | |
| HIN_HA2 | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\SOURCE\HIN_HA2\A2_HIN_HA2_03.S | Doubles identified and elements renumbered, saved as rev03 |
| HIN_HA4 | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\SOURCE\HIN_HA4\A2_HIN_HA4_02.S | All clean - saved rev02 |
| HIN_HA7 | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\SOURCE\HIN_HA7\A2_HIN_HA7_02.S | All clean - saved rev02 |
| GEL | \\emanlima1\LimAjobs\30563\DATA_TESTINGA2\SOURCE\GEL\A2_GEL_01.SHP | All clean - saved rev02 |

The QA procedure comprises of a five stage process.  The first three stages of the QA procedure are implemented on a layer by layer basis.  The fourth stage of the QA procedure requires the interaction of all 3D modelling layers to ensure that the noise model is correctly compiled.  The fifth and final stage of the QA process involves undertaking test calculations.

## 7.2 Stage 1 of the QA Process

Stage 1 of the QA procedure is a check of the datasets in the GIS environment by a member of the noise calculation team prior to import into the LimA environment.  The purpose of this stage is to ensure that the data has been correctly prepared in terms of spatial extent, object type and attribution and is generally suitable for importation into the LimA environment.  This process is outlined in Plate 7.2.

**Plate 7.2 GIS Dataset Checking in ArcGIS Prior to Import into LimA**

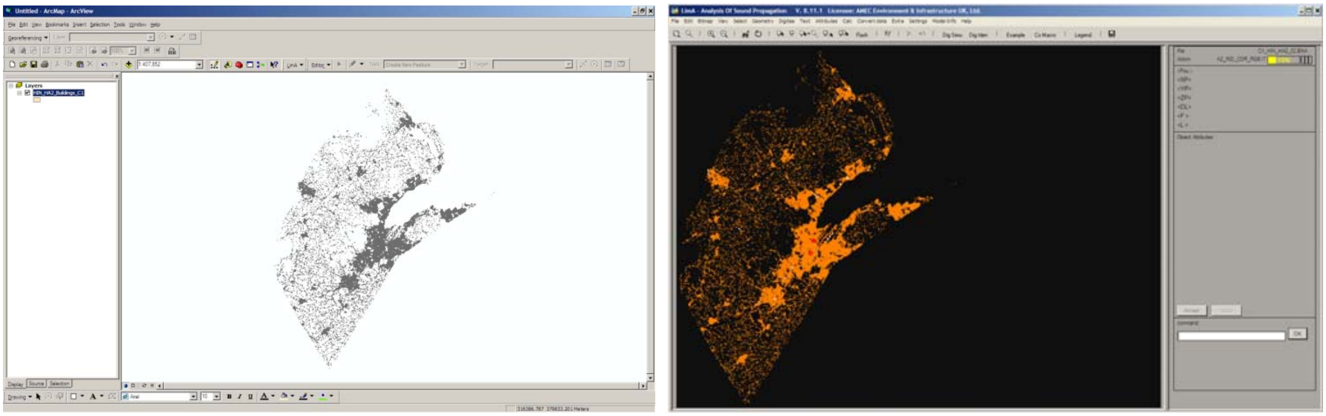



## 7.3 Stage 2 of the QA Process

Stage 2 of the QA procedure is the importation of the GIS model layers into the LimA environment.  All data is exported from the GIS environment in Shapefile format and imported into the LimA environment in the software's proprietary BNA file format. The importation process is a one-to-one conversion as is illustrated in Plate 7.3. This means that all objects in GIS must be stored as single feature and should have unique identification numbers. As part of the importation, LimA warns of any objects which do not meet this requirement or have significant non-compliant topographies.

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

**Plate 7.3 Data in ArcGIS and LimA Environments**



## 7.4 Stage 3A of the QA Process

Stage 3A incorporates 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 model layer has a different series of checks that it must undergo. For example, bridge objects have a check designed specifically for their object type.

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

- 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 are identified by the check procedures, LimA marks the objects for correction. Depending upon the number of corrections required the QA procedures allows these to be undertaken within LimA or alternatively passed back to the GIS team with a set of corrective actions. All amendments are documented within the proformas.

## 7.5 Stage 3B of the QA Process

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

- 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 are more rigorous that than those undertaken in Stage 3A within the LimA modeling environment. These checks ensure that each model layer is error free prior to Stage 4.

## 7.6 Stage 4 of the QA Process

Stage 4 is the most involved stage of the QA process. Stage 4 is a QA of the interaction of the various model datasets comprising the noise model. The Stage 4 QA process is broken into several small stages as outlined in Table 7.1. An example of the interface used for this review process is provided in Plate 7.4.

**Table 7.1 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 BRT Objects | Check Complete Ground Model interaction with BRT Road Noise Emission Objects |

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

In Test T1, the noise calculation team review the digitisation of each bridge and their 3D positioning as outlined in Section 8. Each bridge is reviewed in 3D and corrected if necessary. Bridges which are incorrectly digitised are automatically flagged by the LimA calculation core however incorrect position is not. A manual check is therefore the only means of ensuring that bridges have been correctly digitised.

In Test T2, the ‘Model Check’ functions evaluates 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 is the identification of buildings which have relative heights which fall below the surrounding terrain. This is possible in locations where buildings are located on sloping terrain.

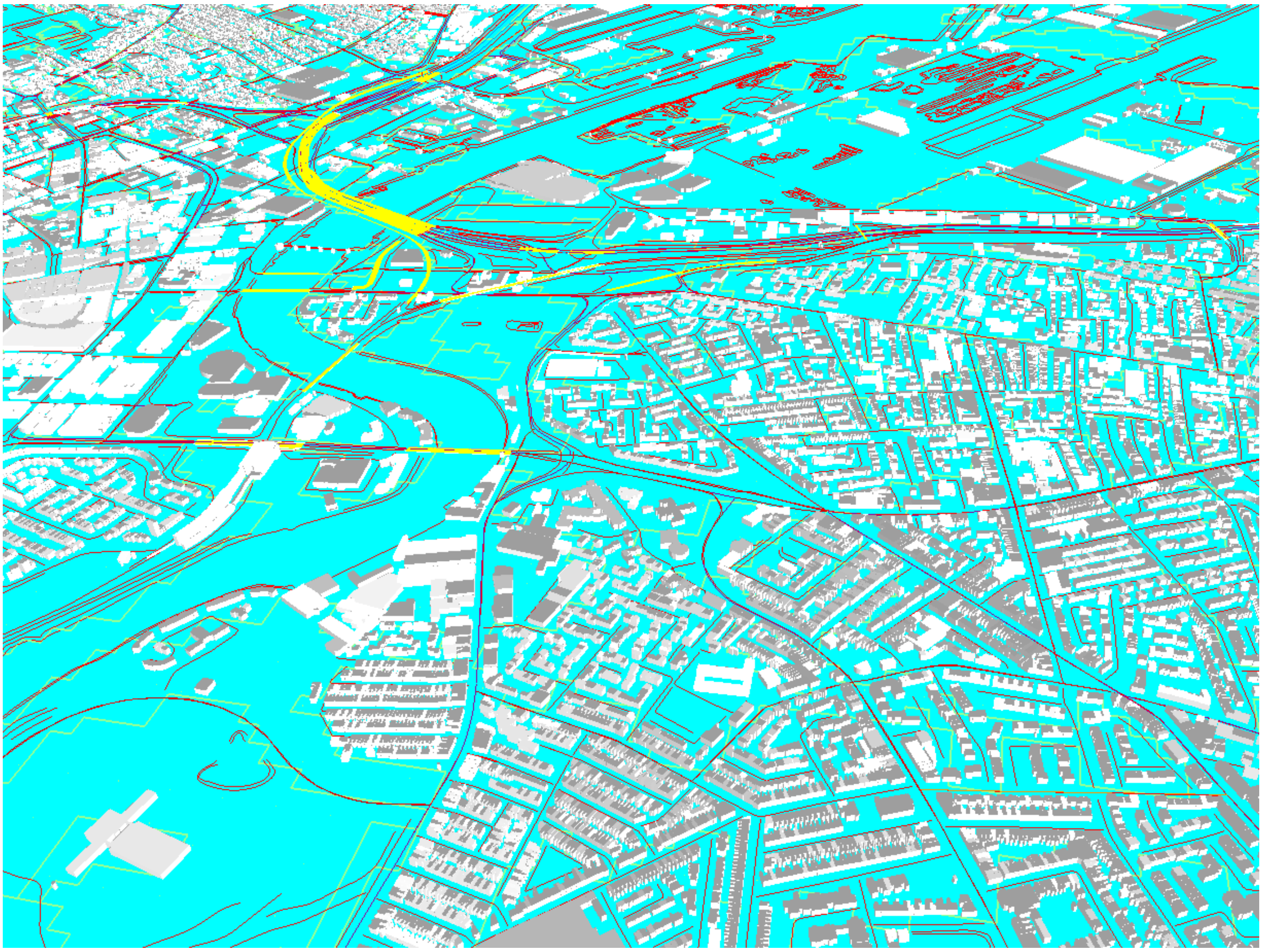
Where this occurs, it is necessary to reposition the start point of the building object to another location which ensures that the top of the building object is above the terrain at all locations. For Round One, these errors had to be correctly manually. Due to the increased extents in Round Two, the project team worked with Stapelfeldt to develop an automated solution which corrects 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 alignments appear incorrect, these are corrected within the software. Where barriers are positioned on bridges, these must also be reviewed to ensure that they sit correctly on the bridge structure and the adjoining terrain. Each barrier is reviewed in 3D and corrected appropriately.

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

For Test T5, all ground model layers are interacted with the source datasets. For the road datasets, the model is reviewed in 3D in areas where roads sources interact with bridges to ensure that the sources are correctly positioned above or below the bridge objects. If corrections are required, these are made within the LimA modelling environment.

**Plate 7.4 Example of Stage 4 - 3D Model Review**



3D from the Westlink from above Belfast City Centre

## 7.7 Stage 5 of the QA Process

Stage 5 of the QA process involved undertaking a series of test calculations to ensure that the noise model and calculations would not fail and that no errors identified during the development of the modelling layers has been missed or has not been corrected. The test calculations also ensure that any errors that cannot be identified through the QA process that may lead to fatal errors in the calculation core are identified prior to the actual calculation of the model. To ensure that all models were subject to a full QA, a separate member of the project team was tasked to undertake Stage 5.

Test calculations were undertaken using low resolution grid settings with LimA's tiling function activated to replicate the actual final calculation configuration. This process also ensured that settings pertaining to the extent of calculation and the associated tiles required within the calculation were correct.

Calculation logs produced by LimA for each tile were reviewed for any error messages or warning to ensure that the tiling of the calculation did not result in any additional errors. Following successful completion of the test calculations, the project undertook the following task in preparation for the calculations.

- All model layers are copied into a final calculation folder and renamed as final;
- All calculation environment settings files were copied to the final calculation folder;
- The calculation of the model was scheduled against a resource planner.

# 8. Noise Level Calculations

This section details the approach to the noise level calculations for the assessment of road traffic 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 receptor.

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 of the calculations. Some calculation settings simply determine how many calculations should be undertaken and to what resolution these should occur to. Other calculation settings require the user to determine how certain elements of a calculation method are handled whilst other calculations settings are used to derive efficiencies in the calculation process. All these settings combine to determine the computational load of the calculations and the compliance of the calculations with the various assessment methods.

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 calculated noise levels to retain compliance with the assessment method without introducing excessive uncertainties.

## 8.1 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 road traffic noise during Round One. The testing studied the effect of the setting upon noise levels above 55 dB $L_{den}$ and 50 dB $L_{night}$ thresholds 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 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 no new settings or modifications to the settings testing during Round One. Project policy has therefore been to retain the efficiency settings adopted for Round One for Round Two.

There are several advantages to retaining the efficiency settings from Round One to Round Two, namely consistency within the calculations. Efficiency settings can introduce uncertainties; therefore changes in these settings from Round One to Round Two may mask any actual changes in noise levels between Round One and Round Two. As such, and in order to identify any real changes in noise levels between Round One and Round Two, two sets of calculations would be required using Round One efficiency settings and any new settings adopted for Round Two. It is the view of the project team that the settings adopted for Round One should be retained in perpetuity until the introduction of any new assessment method. Any new assessment method is likely to require a review of all calculation efficiency and compliance settings.

## 8.2 Calculation Settings

Table 8.1 presents an overview of the calculation settings adopted for the calculation of road traffic noise in Northern Ireland. These settings were retained from Round One.

**Table 8.1 Road Traffic Noise Calculation Settings**

| Setting | Setting Type | Description | Setting in Round Two |
|---|---|---|---|
| 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. CRTN gives consideration to 1 reflection with the exception of those produce when a road is within a retained cutting. | 1 |
| Reflection Distance | Compliance | Reflection distance is the distance at which reflections from reflective objects are considered to effect noise levels at receivers.<br>There is no guidance in CRTN 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 CRTN. | 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. | Off – 0 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 |

**Table 8.1 (continued) Road Traffic Noise Calculation Settings**

| Setting | Setting Type | Description | Setting in Round Two |
|---|---|---|---|
| Eliminate Inner Walls | Efficiency | When activated, this setting instructions 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. | 2000m |

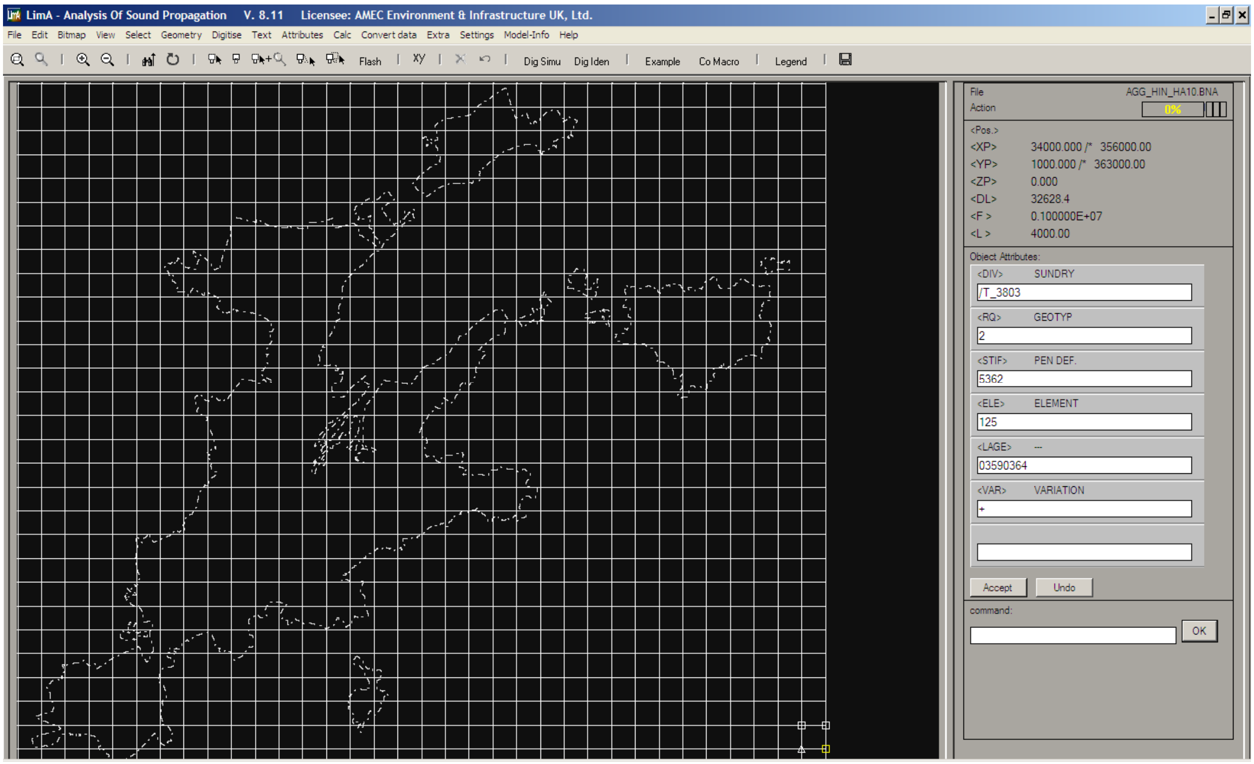
## 8.3 Distributed Calculation

In addition to efficiency settings, calculations can also 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.

### 8.3.1 Calculation Tiling

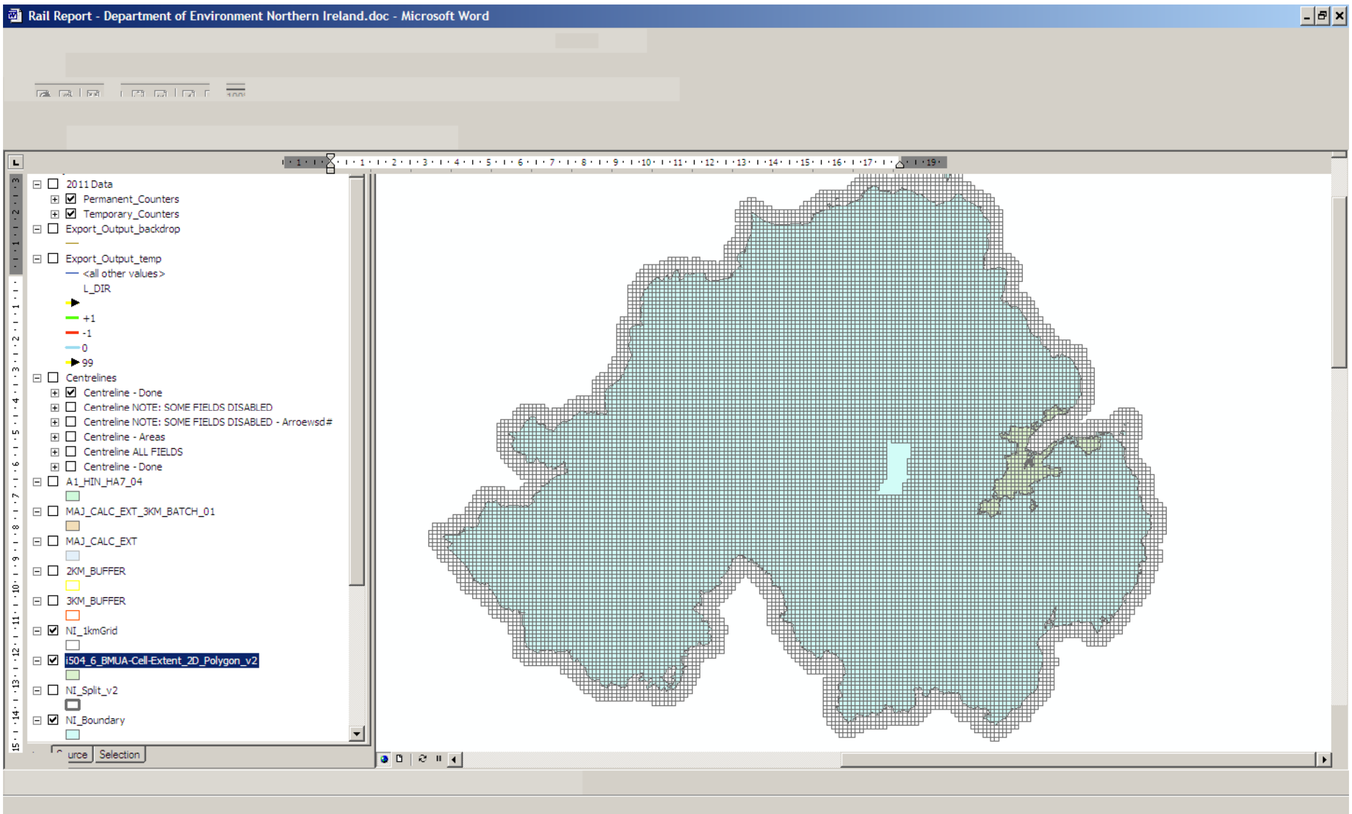
The primary method of distributing calculations within the LimA software environment is through the use of its ‘Tiling’ functionality. The tiling function allows a large model and calculation area to be segmented into a series of smaller areas which can be calculated on a number of processors and across several computers at once. Plate 8.1 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 demonstrated that 1km by 1km calculation tiles result in quicker calculations than larger tiles due to amount of modelling information read and processed by the calculation core.

**Plate 8.1 Example of Tiling Function within the Belfast Agglomeration**



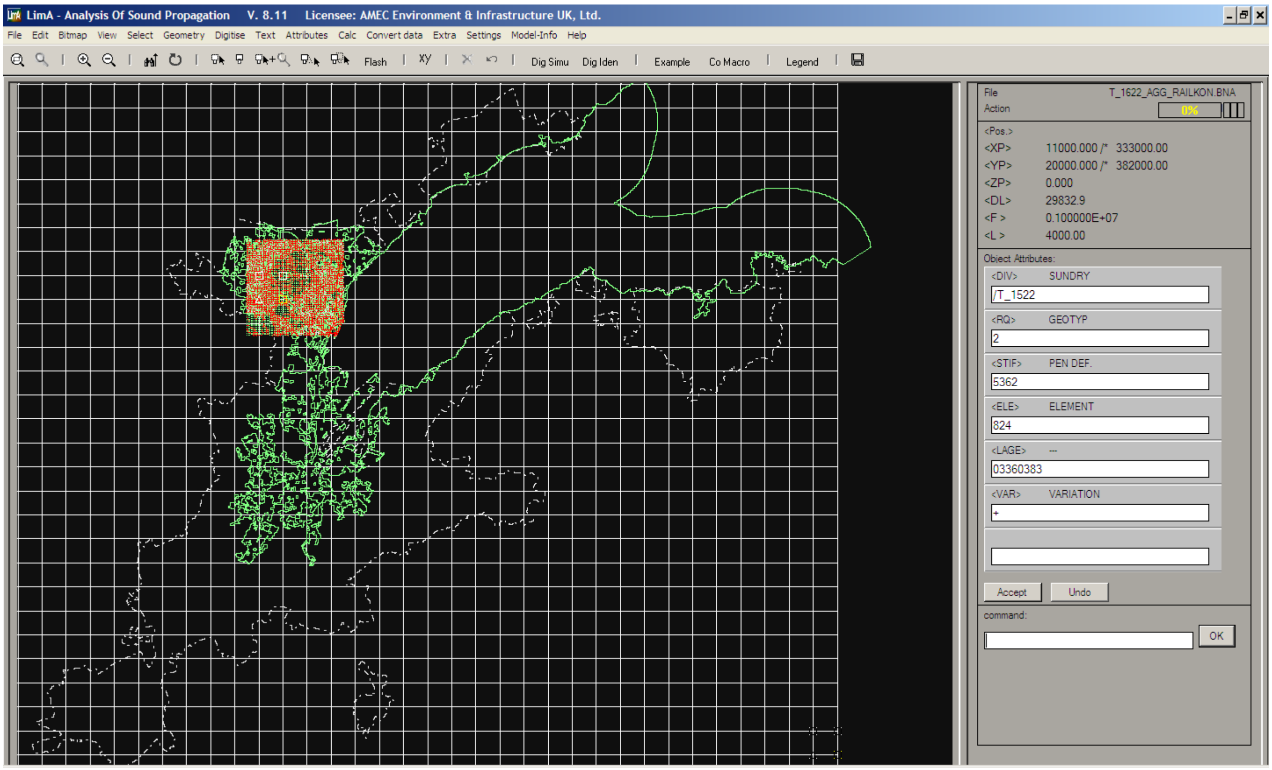

The use of tiling has not been limited to calculation. Many aspects of the project have been undertaken with respect to the grid lines that are formed through the tiling function. For example, queries raised during the modelling of the major road network have been flagged by calculation tile to allow 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 as illustrated in Plate 8.2.

**Plate 8.2 National Tiling Grid**




Prior to calculation, LimA creates a series of calculation instruction files and results folders for each calculation tile. The instruction files instruct 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 process is presented in Plate 8.3. The instruction files also instruct the calculation core to only calculate noise levels within the tile.

**Plate 8.3 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 be revised or started in the event of model errors or hardware failure.

### 8.3.2 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 calculations core 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 LimAserver management software ensures that calculations are continuous. The server system is also designed to identify and report any calculation tiles that exhibit fatal errors.

### 8.3.3 Hardware

AMEC have two dedicated noise calculation servers comprising a total of 22 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).

## 8.4 Post Processing and Output Grids

The LimA tiling function and calculation core produce results grids for each calculation tile and the indicators defined during calculation. In order to simplify the assessment of population exposure, it is necessary to join each tiled results grid together into a single grid representative of the area under assessment. In addition, the calculation core is currently restricted to the computation of a certain number of noise indicators. As such, the process of producing output grids must also be configured to enable the calculation of additional noise indicators. Whilst there are tools within the LimA software package that allow this to occur, the specific requirements of this contract have required the development of a post processing routine.

This post processing routine has been automated through the development of a Python script. Each stage of the post processing script is outlined in the following sections and summarised in Plate 8.4.

### 8.4.1 Calculation Output Files

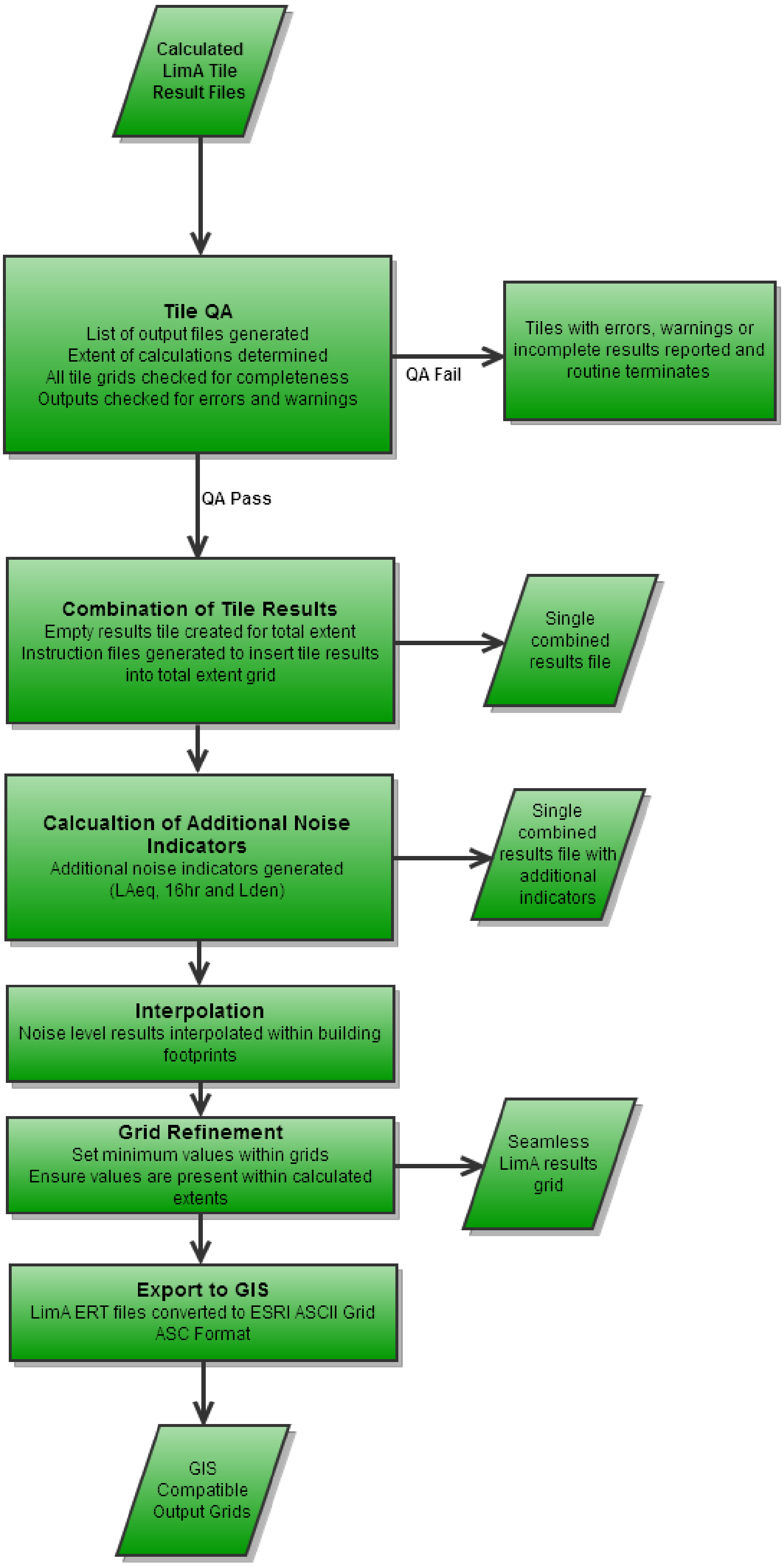
The first stage of the post processing script is to check each of the output files produced by each calculation tile. The purpose of this stage is to ensure that each tile within the calculation area has been calculated and that there are no error messages, failed calculations or warnings. Although errors 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.

In the event of any errors, warnings or incomplete calculations, the post processing script halts and produces a message to enable further investigation.

### 8.4.2 Combining the Tile Results

The next stage of the post processing routine is the combination of the tiles into a single results grid. The first step of this process is the identification of the total calculation extents. This is achieved by reading the calculated extents of each tile and identifying the maximum and minimum grid positions. Once identified, the processing routine sends an instruction to the LimA_9 module to generate blank results grids for these extents. Once produced, a series of additional instruction files are produced for the LimA_9 module for the insertion of each calculated result file into the single result grid. The processing routine monitors the progress of the LimA_9 module through this step ensuring that instruction files are sent once a tile has been added.

**Plate 8.4 Process Flow of the Post Processing Routine**



### 8.4.3 Calculation of Additional Noise Indicators

As discussed, the LimA calculation does not calculate all of the noise indicators required under this contract. These additional indicators have therefore been calculated as part of the post processing routine and are detailed in Table 8.2.

**Table 8.2 Noise Indicators required under the Round Two Contract**

| Indicator | Description | Incumbent Within | Produced During |
|---|---|---|---|
| $L_{den}$ | Annual Average Day-Evening-Night Noise Rating Level (24-hour) | Regulations and END | Post-processing |
| $L_{day}$ | 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 |
| $L_{A10, 18hr}$ | Annual Average 18-hour daytime noise level (0600-0000hrs) | CRTN, Noise Insulation Regulations 1975, WebTAG, Design Manual for Roads and Bridges | Calculation |

As outlined in Table 8.2, the $L_{den}$ and $L_{Aeq, 16hr}$ indicators were generated as part of the post-processing routine. This was undertaken within the post processing routine through reading line by line through the single complete grids and calculating the values based on indicators output as part of the calculation.

For $L_{den}$ the post processing routine calculated this indicator as follows:

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

For $L_{Aeq, 16hr}$ the post processing routine calculated the indicator as below:

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

Once calculated, the $L_{den}$ and $L_{Aeq, 16hr}$ results are appended to the result file.

### 8.4.4 Interpolation within Buildings

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.

Following the calculation of the supplementary indicators, the processing script creates instruction files for the LimA_9 module to interpolate within building footprints. As part of the interpolation process, an additional column "INT" is appended to the results file to identify results which are produced as part of calculation and those which are the result of interpolation.

### 8.4.5 Grid Refinement

Calculations are undertaken within defined calculation areas. In the case of road traffic noise, noise levels are calculated 2000m from major road sources. For agglomeration roads, road traffic noise levels are calculated within the agglomeration boundary. Over large distances, attenuations during propagation can be higher than noise levels at source. This results in calculated noise levels that are below a measurable threshold within the environment. Although these levels are not required in terms of reporting population exposure to the commission, it is necessary that areas where these levels are identified have a notational value for the purposes of identifying quiet areas.

The next stage of the processing script is to refine the calculated results grids. This requires two actions:

- Setting all calculated noise levels so that no calculated noise level falls below a minimum value of 15 dB(A); and
- Ensuring that all noise levels within the calculations areas have values.

This is achieved using functions held within the LimA_9 module. Following interpolation, the processing script sends instruction to LimA_9 to undertake the actions outlined above.

### 8.4.6 Export to GIS

Following grid refinement, the noise level results grids are export to the ESRI ASCII Grid (ASC) format. This was achieved through the processing routine sending instructions to the LimA_39 module which manages translations from LimA to a variety of GIS formats. As part of the exportation process, the files outlined in Table 8.3 were generated.

**Table 8.3 GIS ASC Results Files for Road Noise Mapping**

| File | Type | Noise Indicator | Description |
|---|---|---|---|
| LPED | Agglomeration | $L_{day}$ | Annual Average 12-hour daytime noise level (0700-1900hrs) |
| LPEE | Agglomeration | $L_{eve}$ | Annual Average 4-hour evening noise level (1900-2300hrs) |
| LPEN | Agglomeration | $L_{night}$ | Annual Average 8-hour night-time noise level (2300-0700hrs) |
| LDAY | Agglomeration | $L_{A10, 18hr}$ | Annual Average 18-hour daytime noise level (0600-0000hrs) |
| L16H | Agglomeration | $L_{Aeq, 16hr}$ | Annual Average 16-hour daytime noise level (0700-2300hrs) |
| LDEN | Agglomeration | $L_{den}$ | Annual Average Day-Evening-Night Noise Rating Level (24-hour) |
| M_LPED | Major Road | $L_{day}$ | Annual Average 12-hour daytime noise level (0700-1900hrs) |
| M_LPEE | Major Road | $L_{eve}$ | Annual Average 4-hour evening noise level (1900-2300hrs) |
| M_LPEN | Major Road | $L_{night}$ | Annual Average 8-hour night-time noise level (2300-0700hrs) |
| M_LDAY | Major Road | $L_{A10, 18hr}$ | Annual Average 18-hour daytime noise level (0600-0000hrs) |
| M_L16H | Major Road | $L_{Aeq, 16hr}$ | Annual Average 16-hour daytime noise level (0700-2300hrs) |
| M_LDEN | Major Road | $L_{den}$ | Annual Average Day-Evening-Night Noise Rating Level (24-hour) |

# 9. 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 9.1.

**Table 9.1 Noise Bands used to Reclassify Output Grids**

| Noise Level Result | Noise Bands | | | | | | |
|---|---|---|---|---|---|---|---|
| $L_{Aeq, 16 hour}$ | < 50 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | >=75 |
| $L_{A10, 18 hour}$ | < 50 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | >=75 |
| $L_{den}$ | < 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 |
| $L_{eve}$ | < 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 results are shown in Table 9.2 for the Major Roads and Table 9.3 for the Agglomeration Roads, with examples of $L_{den}$ map outputs provided in Plate 9.1 and 9.2.

**Table 9.2 Major Roads - Area of Noise Bands (dB) in km²**

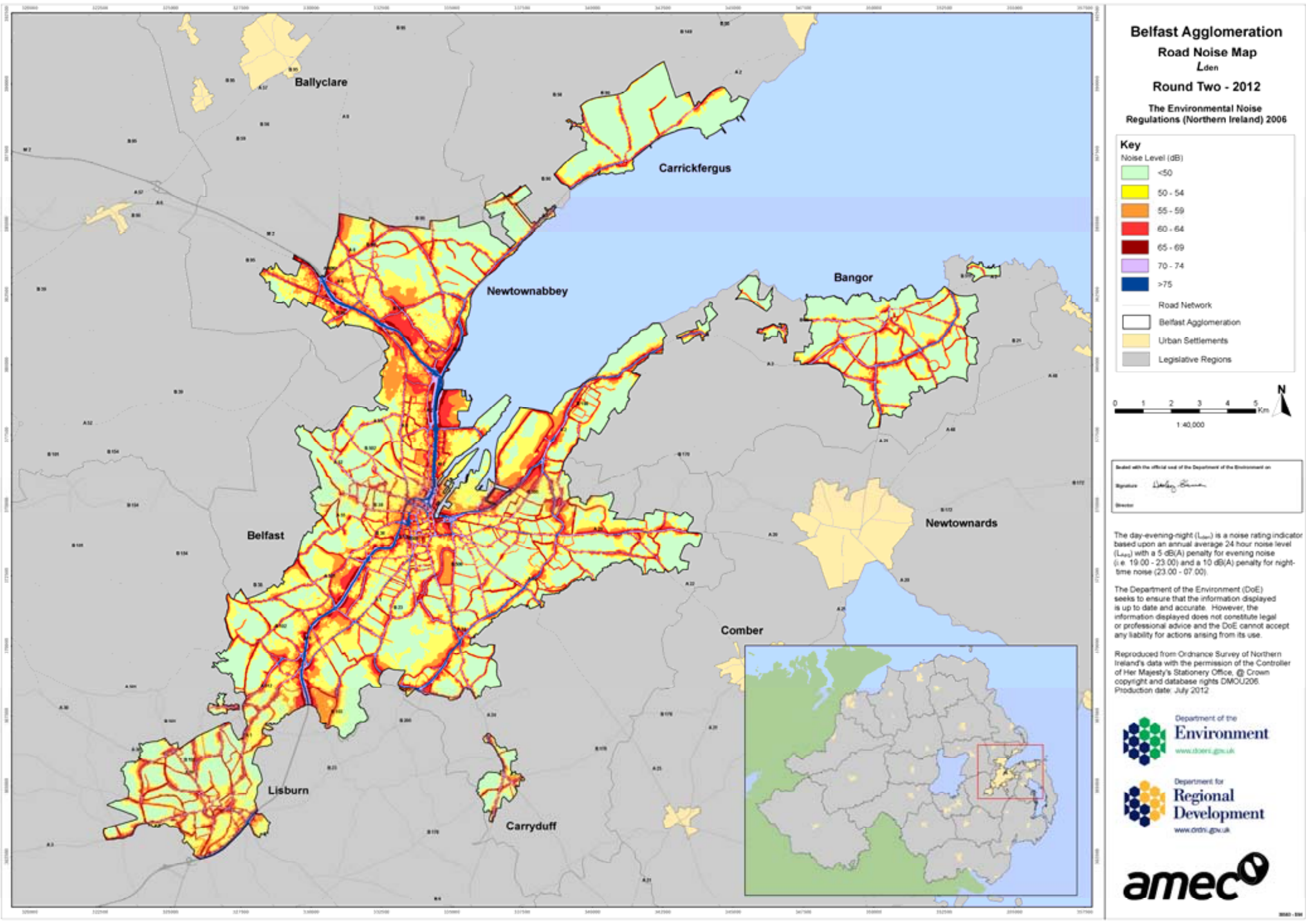
| Noise Level | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| 50-54 | 351.1 | 452.0 | 434.6 | 387.1 | 217.1 | 45-49 | 282.2 |
| 55-59 | 176.0 | 239.3 | 231.1 | 196.8 | 106.5 | 50-54 | 144.1 |
| 60-64 | 88.1 | 120.0 | 116.1 | 98.3 | 58.9 | 55-59 | 73.3 |
| 65-69 | 52.5 | 61.9 | 61.4 | 55.0 | 37.2 | 60-64 | 46.2 |
| 70-74 | 31.1 | 41.8 | 40.0 | 35.8 | 13.2 | 65-69 | 20.2 |
| >=75 | 8.8 | 19.4 | 17.8 | 12.0 | 1.7 | >=70 | 6.2 |
| Total | 707.6 | 934.3 | 901.0 | 785.0 | 434.6 | Total | 572.2 |

**Table 9.3 Agglomeration Roads - Area of Noise Bands in km²**

| Noise Level | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **< 50** | 95.5 | 72.8 | 79.2 | 85.5 | 135.3 | **< 45** | 117.1 |
| **50-54** | 41.4 | 50.7 | 47.6 | 45.7 | 24.4 | **45-49** | 30.7 |
| **55-59** | 23.0 | 27.7 | 26.7 | 25.0 | 15.8 | **50-54** | 20.6 |
| **60-64** | 15.9 | 18.9 | 18.3 | 17.1 | 13.0 | **55-59** | 13.9 |
| **65-69** | 12.4 | 13.2 | 13.1 | 12.6 | 7.0 | **60-64** | 10.6 |
| **70-74** | 7.8 | 10.1 | 9.6 | 9.2 | 1.9 | **65-69** | 3.7 |
| **>=75** | 2.2 | 4.6 | 3.7 | 3.0 | 0.6 | **>=70** | 1.5 |
| **< 50** | 95.5 | 72.8 | 79.2 | 85.5 | 135.3 | **< 45** | 117.1 |
| **>= 50** | 102.6 | 125.3 | 118.8 | 112.6 | 62.8 | **<=45** | 81.0 |
| **Total** | 198.1 | 198.1 | 198.1 | 198.1 | 198.1 | **Total** | 198.1 |

**Plate 9.1 Round Two - Major Roads $L_{den}$ Noise Map**

**Plate 9.2 Round Two – Agglomeration Roads $L_{den}$ Noise Map**



# 10. Population Exposure and Analysis

## 10.1 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).

A number of key dataset have been used within the population exposure assessment developed in the second round study. These datasets used were:

(a) Detailed building polygons recorded in the OSNI large scale mapping. This data was also used as a key input into the development of the noise maps.

(b) OSNI Pointer dataset which provide details of the function of individual buildings across Northern Ireland. 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.

(c) 2008 and 2010 estimates of population are provided by the Northern Ireland Statistics and Research Agency. The 2008 dataset is the latest population estimates available for the 5022 detailed census output areas, while the 2010 population estimates provides information for the coarser 890 super output areas covering Northern Ireland.

The first step in the population exposure assessment involved the development of an effective estimate of the 2010 population in each of the 5022 detailed census output areas. This was achieved by analysing the changes in population between 2008 and 2010 using the coarser datasets to derive an increase factor which could be applied to the detailed 2008 population data. This results in the production of the final dataset used in the remainder of the Round Two population analysis.

The second stage of the process was focused on developing an estimate of the number of people per house needed to undertake the population exposure assessment. This was generated by calculating the number of residential properties in each census area and dividing this value by the estimates of 2010 population in the census area. One limitation of this method is that the pointer data might not identify all of the residential properties, for instance if a residential property is located above commercial premises. As a consequence, the methodology is reliant on the accuracy and currency of the Pointer dataset and the classification of the class of building.

As per the assumptions used in the Round One study, 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 dwelling building extents were intersected with the reclassified noise grids. From this process, the number of dwellings and the number of people exposed was calculated. The results of this analysis are presented in Section 10.2.

In reviewing the final exposure results, it is important to consider the various factors which influence the final exposure analysis. These factors include: differences in the age of the population datasets used in the analysis; changes and improvements in the OS Pointer address dataset since Round One; 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.

An additional example of data currency issues and an explanation of why some areas of the agglomeration have lower than expected exposure values is demonstrated on the Queens road area of the docks development. The top left plate shows the buildings from the OSNI Largescale data, the dwellings are identified in colour and other buildings are shown in grey. The top right and bottom left plate show images from Google maps that show the development, in construction and more recently constructed. As the date of the census data is 2008, it is possible that the census data doesn’t include these apartment complexes and/or that the building data does not reflect the correct building classification.

**Plate 10.1 Example of Data Currency in the Population Exposure Analysis**

## 10.2 Roads - Population Exposure Analysis

Tables 10.1– 10.6 detail the results of the Round Two END dwelling and population analysis for major roads, within the Belfast Agglomeration, outside the Belfast Agglomeration and across the whole of Northern Ireland.

**Table 10.1 Major Roads - Number of Dwellings (Belfast Agglomeration)**

| Noise Level (dB) | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **<50** | 186,480 | 160,589 | 166,409 | 175,180 | 224,058 | **<45** | 207,255 |
| **50-54** | 39,329 | 54,596 | 51,014 | 46,354 | 16,086 | **45-49** | 25,419 |
| **55-59** | 13,837 | 19,720 | 18,838 | 16,104 | 7,881 | **50-54** | 11,786 |
| **60-64** | 8,852 | 10,383 | 9,940 | 9,412 | 9,797 | **55-59** | 7,952 |
| **65-69** | 8,588 | 8,036 | 8,495 | 8,358 | 3,834 | **60-64** | 7,890 |
| **70-74** | 4,550 | 7,242 | 6,401 | 5,894 | 314 | **65-69** | 1,547 |
| **>=75** | 339 | 1,409 | 878 | 673 | 5 | **>=70** | 126 |
| | | | | | | | |
| **< 50** | 186,480 | 160,589 | 166,409 | 175,180 | 224,058 | **< 45** | 207,255 |
| **>= 50** | 75,495 | 101,386 | 95,566 | 86,795 | 37,917 | **<=45** | 54,720 |
| **Total** | 261,975 | 261,975 | 261,975 | 261,975 | 261,975 | **Total** | 261,975 |

**Table 10.2 Major Roads - Population Exposure (Belfast Agglomeration)**

| Noise Level (dB) | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **<50** | 408,803 | 352,459 | 365,266 | 384,570 | 491,385 | **<45** | 454,518 |
| 50-54 | 86,119 | 119,500 | 111,582 | 101,131 | 34,482 | 45-49 | 55,415 |
| 55-59 | 29,959 | 42,739 | 40,792 | 34,827 | 17,253 | 50-54 | 25,427 |
| 60-64 | 19,316 | 22,424 | 21,507 | 20,478 | 21,357 | 55-59 | 17,405 |
| 65-69 | 18,718 | 17,598 | 18,621 | 18,292 | 7,965 | 60-64 | 16,989 |
| 70-74 | 9,519 | 15,493 | 13,568 | 12,442 | 613 | 65-69 | 3,071 |
| >=75 | 630 | 2,851 | 1,729 | 1,325 | 9 | >=70 | 240 |
| | | | | | | | |
| **< 50** | 408,803 | 352,459 | 365,266 | 384,570 | 491,385 | **< 45** | 454,518 |
| **>= 50** | 164,262 | 220,606 | 207,799 | 188,495 | 81,680 | **<=45** | 118,547 |
| Total | 573,065 | 573,065 | 573,065 | 573,065 | 573,065 | **Total** | 573,065 |

**Table 10.3 Major Roads - Number of Dwellings (Outside Agglomeration)**

| Noise Level (dB) | $L_{Aeq, 16\ hour}$ | $L_{A10,18\ hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **<50** | 427,866 | 407,789 | 412,944 | 421,422 | 449,016 | **<45** | 442,114 |
| **50-54** | 28,131 | 38,844 | 35,977 | 31,480 | 17,443 | **45-49** | 20,058 |
| **55-59** | 13,098 | 17,349 | 16,365 | 14,417 | 9,995 | **50-54** | 12,271 |
| **60-64** | 10,409 | 11,287 | 11,156 | 10,635 | 10,199 | **55-59** | 9,916 |
| **65-69** | 9,501 | 9,960 | 9,979 | 9,801 | 4,840 | **60-64** | 6,598 |
| **70-74** | 2,809 | 6,096 | 5,036 | 3,918 | 414 | **65-69** | 931 |
| **>=75** | 94 | 583 | 451 | 235 | 1 | **>=70** | 20 |
| | | | | | | | |
| **< 50** | 427,866 | 407,789 | 412,944 | 421,422 | 449,016 | **< 45** | 442,114 |
| **>= 50** | 64,042 | 84,119 | 78,964 | 70,486 | 42,892 | **<=45** | 49,794 |
| **Total** | 491,908 | 491,908 | 491,908 | 491,908 | 491,908 | **Total** | 491,908 |

**Table 10.4 Major Roads - Population Exposure (Outside Agglomeration)**

| Noise Level (dB) | $L_{Aeq, 16\ hour}$ | $L_{A10,18\ hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **<50** | 1,047,659 | 999,144 | 1,011,836 | 1,032,184 | 1,098,413 | **<45** | 1,081,874 |
| **50-54** | 67,579 | 93,368 | 86,268 | 75,586 | 41,934 | **45-49** | 48,166 |
| **55-59** | 31,482 | 41,980 | 39,472 | 34,697 | 23,980 | **50-54** | 29,437 |
| **60-64** | 24,829 | 26,991 | 26,713 | 25,418 | 24,037 | **55-59** | 23,485 |
| **65-69** | 22,245 | 23,625 | 23,530 | 23,059 | 11,182 | **60-64** | 15,361 |
| **70-74** | 6,496 | 14,077 | 11,655 | 9,035 | 957 | **65-69** | 2,133 |
| **>=75** | 214 | 1,321 | 1,031 | 527 | 3 | **>=70** | 49 |
| | | | | | | | |
| **< 50** | 1,047,659 | 999,144 | 1,011,836 | 1,032,184 | 1,098,413 | **< 45** | 1,081,874 |
| **>= 50** | 152,847 | 201,362 | 188,670 | 168,322 | 102,093 | **<=45** | 118,632 |
| **Total** | 1,200,506 | 1,200,506 | 1,200,506 | 1,200,506 | 1,200,506 | **Total** | 1,200,506 |

**Table 10.5 Major Roads - Number of Dwellings (Northern Ireland)**

| Noise Level (dB) | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **<50** | 614,346 | 568,378 | 579,353 | 596,602 | 673,074 | **<45** | 649,369 |
| **50-54** | 67,460 | 93,440 | 86,991 | 77,834 | 33,529 | **45-49** | 45,477 |
| **55-59** | 26,935 | 37,069 | 35,203 | 30,521 | 17,876 | **50-54** | 24,057 |
| **60-64** | 19,261 | 21,670 | 21,096 | 20,047 | 19,996 | **55-59** | 17,868 |
| **65-69** | 18,089 | 17,996 | 18,474 | 18,159 | 8,674 | **60-64** | 14,488 |
| **70-74** | 7,359 | 13,338 | 11,437 | 9,812 | 728 | **65-69** | 2,478 |
| **>=75** | 433 | 1,992 | 1,329 | 908 | 6 | **>=70** | 146 |
| | | | | | | | |
| **< 50** | 614,346 | 568,378 | 579,353 | 596,602 | 673,074 | **< 45** | 649,369 |
| **>= 50** | 139,537 | 185,505 | 174,530 | 157,281 | 80,809 | **<=45** | 104,514 |
| **Total** | 753,883 | 753,883 | 753,883 | 753,883 | 753,883 | **Total** | 753,883 |

**Table 10.6 Major Roads - Population Exposure (Northern Ireland))**

| Noise Level (dB) | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **<50** | 1,456,463 | 1,351,603 | 1,377,102 | 1,416,753 | 1,589,798 | **<45** | 1,536,392 |
| **50-54** | 153,699 | 212,868 | 197,850 | 176,717 | 76,416 | **45-49** | 103,581 |
| **55-59** | 61,441 | 84,719 | 80,264 | 69,524 | 41,233 | **50-54** | 54,865 |
| **60-64** | 44,146 | 49,415 | 48,220 | 45,896 | 45,394 | **55-59** | 40,891 |
| **65-69** | 40,963 | 41,224 | 42,151 | 41,351 | 19,147 | **60-64** | 32,349 |
| **70-74** | 16,016 | 29,570 | 25,224 | 21,476 | 1,571 | **65-69** | 5,204 |
| **>=75** | 844 | 4,172 | 2,760 | 1,852 | 12 | **>=70** | 289 |
| | | | | | | | |
| **< 50** | 1,456,463 | 1,351,603 | 1,377,102 | 1,416,753 | 1,589,798 | **< 45** | 1,536,392 |
| **>= 50** | 317,108 | 421,968 | 396,469 | 356,818 | 183,773 | **<=45** | 237,179 |
| **Total** | 1,773,571 | 1,773,571 | 1,773,571 | 1,773,571 | 1,773,571 | **Total** | 1,773,571 |

### 10.2.1 Agglomeration - Roads

Tables 10.7 and 10.8 detail the results of the Round Two END dwelling and population analysis for all roads within the Belfast Agglomeration.

**Table 10.7 Agglomeration Roads - Dwellings**

| Noise Level (dB) | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **< 50** | 142,140 | 109,654 | 118,931 | 127,441 | 194,698 | **< 45** | 173,875 |
| **50-54** | 54,543 | 72,214 | 67,022 | 62,833 | 26,292 | **45-49** | 34,761 |
| **55-59** | 23,372 | 29,922 | 28,050 | 25,794 | 18,439 | **50-54** | 22,799 |
| **60-64** | 19,336 | 21,096 | 20,889 | 20,021 | 17,400 | **55-59** | 16,970 |
| **65-69** | 15,916 | 16,226 | 17,004 | 16,404 | 4,820 | **60-64** | 11,772 |
| **70-74** | 6,301 | 11,262 | 9,128 | 8,748 | 321 | **65-69** | 1,668 |
| **>=75** | 367 | 1,601 | 951 | 734 | 5 | **>=70** | 130 |
| | | | | | | | |
| **< 50** | 142,140 | 109,654 | 118,931 | 127,441 | 194,698 | **< 45** | 173,875 |
| **> 50** | 119,835 | 152,321 | 143,044 | 134,534 | 67,277 | **> 45** | 88,100 |
| **Total** | 261,975 | 261,975 | 261,975 | 261,975 | 261,975 | **Total** | 261,975 |

**Table 10.8 Agglomeration Roads - Population**

| Noise Level (dB) | $L_{Aeq, 16 hour}$ | $L_{A10,18 hour}$ | $L_{den}$ | $L_{day}$ | $L_{eve}$ | Noise Level (dB) | $L_{night}$ |
|---|---|---|---|---|---|---|---|
| **< 50** | 314,004 | 243,471 | 263,912 | 282,798 | 428,100 | **< 45** | 382,747 |
| **50-54** | 118,289 | 156,835 | 145,293 | 135,679 | 56,762 | **45-49** | 75,643 |
| **55-59** | 50,971 | 64,894 | 60,806 | 56,092 | 40,262 | **50-54** | 49,336 |
| **60-64** | 41,716 | 45,592 | 45,231 | 43,317 | 37,342 | **55-59** | 36,702 |
| **65-69** | 34,396 | 35,035 | 36,790 | 35,494 | 9,962 | **60-64** | 25,061 |
| **70-74** | 13,007 | 24,004 | 19,159 | 18,237 | 627 | **65-69** | 3,328 |
| **>=75** | 682 | 3,235 | 1,873 | 1,447 | 9 | **>=70** | 248 |
| | | | | | | | |
| **< 50** | 314,004 | 243,471 | 263,912 | 282,798 | 428,100 | **< 45** | 382,747 |
| **>=50** | 259,060 | 329,594 | 309,152 | 290,267 | 144,964 | **>= 45** | 190,318 |
| **Total** | 573,065 | 573,065 | 573,065 | 573,065 | 573,065 | **Total** | 573,065 |

## 10.3 Roads - ENDRM Reporting

There is a requirement to report exposure assessments to the EC in order to comply with END. The ENDRM consists of 10 core Data Flows which cover the first two implementation rounds of the END. The results of the noise mapping including the population and the dwelling are reported via Data Flow 4 and 8

The results from this round were entered into the relevant Data Flow 4 and 8 data tables that are available from the EC (http://dd.eionet.europa.eu/datasets/2906). For the Roads report, the relevant table reference is DF4_8_MRoad (Major roads) and DF4_8_Agg_Road (Agglomeration roads). Additional spatial datasets will be 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 and 8 are required to be reported and these fields are detailed below in Table 10.9 and 10.10.

**Table 10.9 ENDRM Mandatory Fields for Tables DF4_8_Agg_Road**

| Required Reporting Element | Description |
|---|---|
| *ReportingEntityUniqueCode | |
| * 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. |
| * Lden5559FromMajorSource | 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 between 55-59 dB(A), 4 m above the ground and on the most exposed façade |
| * Lden6064FromMajorSource | 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 between 60-64 dB(A), 4 m above the ground and on the most exposed façade |

**Table 10.9 (continued) ENDRM Mandatory Fields for Table DF4_8_Agg_Road**

| Required Reporting Element | Description |
|---|---|
| * Lden6569FromMajorSource | 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 between 65-59 dB(A), 4 m above the ground and on the most exposed façade |
| * Lden7074FromMajorSource | 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 between 70-74 dB(A), 4 m above the ground and on the most exposed façade |
| * Lden75FromMajorSource | 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 >70 dB(A), 4 m above the ground and on the most exposed façade |
| * Lnight5054FromMajorSource | 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 between 50-54 dB(A), 4 m above the ground and on the most exposed façade. |
| * Lnight5559FromMajorSource | 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 between 55-59 dB(A), 4 m above the ground and on the most exposed façade |
| * Lnight6064FromMajorSource | 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 between 60-64 dB(A), 4 m above the ground and on the most exposed façade |
| * Lnight6569FromMajorSource | 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 between 65-69 dB(A), 4 m above the ground and on the most exposed façade |
| * Lnight70FromMajorSource | 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. |
| * ComputationAndMeasurementMethodsReportDetails | The full name of the report, the author/publisher and date of production. |

**Table 10.10 ENDRM Mandatory Fields for Tables DF4_8_MRoad**

| Required Reporting Element | Description |
|---|---|
| *ReportingEntityUniqueCode | A single character Unique code assigned by the Member State to each Reporting Entity. |
| * Lden5559 | The estimated total number of people (rounded to the nearest hundred) living outside 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 outside 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 outside 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 outside 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 outside 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 outside agglomerations in dwellings that are exposed to values of Lnight from a Major Source 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 outside agglomerations in dwellings that are exposed to values of Lnight from a Major Source 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 outside agglomerations in dwellings that are exposed to values of Lnight from a Major Source 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 outside agglomerations in dwellings that are exposed to values of Lnight from a Major Source 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 outside agglomerations in dwellings that are exposed to values of Lnight from a Major Source >75 dB(A), 4 m above the ground and on the most exposed façade. |
| * AreaExposedToLden55IncludingAgglomerations | The estimated total area (in km2) exposed to values of Lden higher than 55 dB. The area must include agglomerations. |
| * AreaExposedToLden65IncludingAgglomerations | The estimated total area (in km2) exposed to values of Lden higher than 65 dB. The area must include agglomerations. |
| * AreaExposedToLden75IncludingAgglomerations | The estimated total area (in km2) exposed to values of Lden higher than 75 dB. The area must include agglomerations. |
| * Lden55IncludingAgglomerations | The estimated total number of people (rounded to the nearest hundred) exposed to values of Lden higher than 55 dB. The number of people must include agglomerations. |

**Table 10.10 (continued) ENDRM Mandatory Fields for Tables DF4_8_MRoad**

| Required Reporting Element | Description |
|---|---|
| * Lden65IncludingAgglomerations | The estimated total number of people (rounded to the nearest hundred) exposed to values of Lden higher than 65 dB. The number of people must include agglomerations. |
| * Lden75IncludingAgglomerations | The estimated total number of people (rounded to the nearest hundred) exposed to values of Lden higher than 75 dB. The number of people must include agglomerations. |
| * DwellingsExposedToLden55IncludingAgglomerations | The estimated total number of dwellings (rounded to the nearest hundred) exposed to values of Lden higher than 55 dB. The number of dwellings must include agglomerations. |
| * DwellingsExposedToLden65IncludingAgglomerations | The estimated total number of dwellings (rounded to the nearest hundred) exposed to values of Lden higher than 65 dB. The number of dwellings must include agglomerations. |
| * DwellingsExposedToLden75IncludingAgglomerations | The estimated total number of dwellings (rounded to the nearest hundred) exposed to values of Lden higher than 75 dB. The number of dwellings must include agglomerations. |
| * ComputationAndMeasurementMethodsReportDetails | Computation and measurement methods report details |

The final Data Flow 4 and 8 tables have been provided as a separate deliverable under this contract and will enable DoE to fulfil Northern Ireland’s requirements for the END.

# 11. Comparison between Round One and Round Two

The following sections present a qualitative, and where worthwhile, a quantitative comparison of road traffic noise exposure between Round One and Round Two for major roads and roads within the Belfast Agglomeration. However it is important to note that making direct comparisons between the results of the mapping from Round One and Round Two is difficult due to the differences in model areas considered and the range of datasets used in the modelling process.

## 11.1 Major Roads

The lowering of the major road movement threshold from 6 million to 3 million vehicle passages from Round One to Round Two has resulted in a significant increase in the number of roads encompassed by the Regulations. This means that where a major road has been modelled in Round One, the modelled and mapped extents of this road are likely to be larger for Round Two. Likewise, the decrease in the movement threshold has introduced new roads for consideration under the Regulations. These changes have resulted in a dramatic increase (around 200%) in the area which has needed to be modelled in Round Two (see Tables 2.1 and 2.2) and ultimately increases in population exposure to major road noise sources.

It should also be noted that in Round Two there was a change of %HGV definition. This was described in detail in Section 5.3. The effect of this change will be site specific but will ultimately result in increased noise emissions due to increased %HGV value. This increase could be in the order of 1-2 dB (A) depending upon the site.

Although it is possible to compare changes in noise emissions for major roads modelled in Round One and Round Two, this requires detailed investigations to be made on a site by site, or counter by counter basis. This type of analysis is best undertaken as part of the action planning process, and particularly for any roads which have resulted in the allocation of candidate Noise Management Areas (NMAs).

## 11.2 Belfast Agglomeration

For roads within the Belfast Agglomeration, it is possible to make comparisons of noise exposure between Round One and Round Two. This is principally due to the agglomeration extents being the same between the two rounds. However, it is important to highlight that different approaches have been taken to the modelling of roads within the Belfast agglomeration and as such the results are not directly comparable. Likewise, changes in 3D modelling have affected noise exposure. These factors are discussed in the following sections.

### 11.2.1 Road Traffic Noise Emissions Data

The modelling of road traffic noise within the Belfast agglomeration has incorporated a greater number of data sources that during Round One. The differences in these data sources and the application of them for mapping in

Round Two has resulted in changes in road traffic noise emissions between Round One and Round Two datasets. These differences include:

- All Permanent ATC data for Round Two use measured speeds rather than defaults;
- For Round Two, Temporary ATC data has replaced some of the BTM and default traffic data;
- For Round Two, Temporary ATC data has resulted in residential routes being modelled which were previously ignored in Round One;
- The definition of %HGV has changed between rounds resulting in an increase in %HGV on all roads modelled in Round One;
- Default traffic flows were revised and derived from more ATC data than available during Round One;
- For certain routes, Turning Movement Count traffic data (as derived from the Belfast Rapid Transit study) was used to replace BTM and default flows data used in Round One.

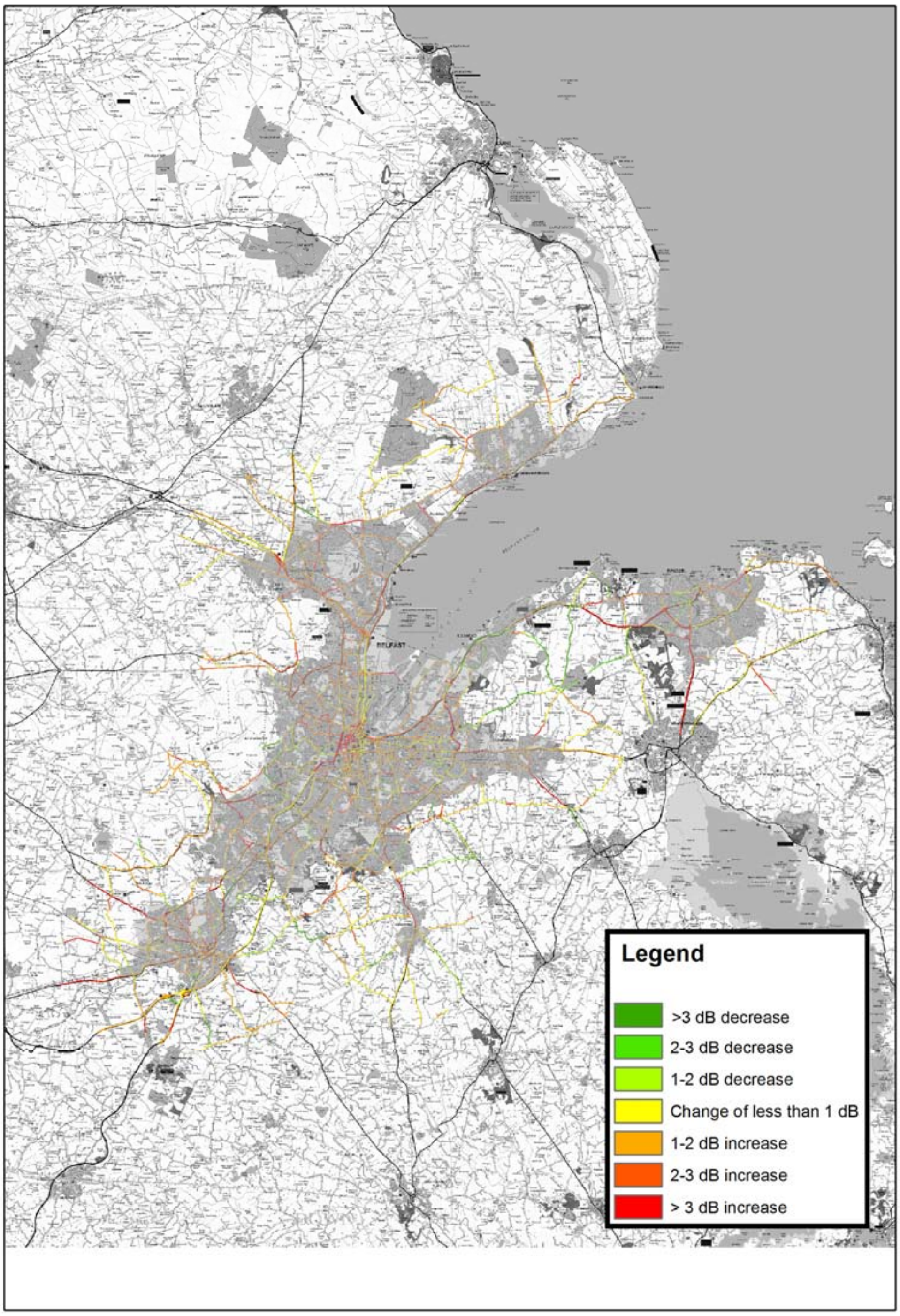
The effect of the above upon noise emissions and resultant population noise exposure depends upon the spatial location and extents of any road concerned. To provide an understanding of changes in noise emissions within the Belfast agglomeration, Plate 11.1 presents an example of changes in $L_{den}$ emission levels between Round One and Round Two.

The plate shows that in general, most modelled roads are restricted to changes of less than 2 dB (A) in $L_{den}$. Further analysis shows that where the BTM links have been remodelled with a change in HGV definition, this mainly results in a 1-2 dB (A) increase in emissions. It should be noted that the change in HGV definition has affected noise emissions on previously modelled Permanent ATC roads where, in general, noise emissions have increased by less than 2 dB $L_{den}$.

In some instances, there are changes in excess of 3 dB $L_{den}$. Many of these are roads which were not previously modelled. In other instances, these are due to changes in data sources, notably where BTM links have been replaced with data of a higher priority.

Analysis of the roads results indicates that there is, on average, an increase of around 1.2 dB $L_{den}$ for the roads considered in the modelling of road traffic noise within the Belfast agglomeration.

**Plate 11.1 Change in $L_{den}$ Emission between Round One and Round Two in Belfast Agglomeration**



### 11.2.2 Number of Modelled Roads

The number of roads which have been modelled has increased for Round Two. In the Belfast agglomeration, this has resulted from information provided by Roads Service and the availability of data sources which were not available during Round One. Table 11.1 presents a summary of the length of road modelled between Round One and Round Two.

**Table 11.1 Comparison of Modelled Road Lengths between Round One and Round Two**

| Round of Mapping | Length of Roads Modelled within Agglomeration and 3km Buffer |
|---|---|
| Round One | 937km |
| Round Two | 1020km |
| Change | +83km (+8.8%) |

Table 11.1 shows that there has been an increase in the length of modelled road in the order of 8.8%. Most of these roads have been modelled within residential areas which will have an affect upon population exposure. This effect is likely to be concentrated within the lower noise level reporting bands due to the relatively low noise emissions from these roads.

### 11.2.3 Factors Influencing Noise Propagation and Population Exposure

Where changes in the various data sources can result in changes in noise emissions and resulting population exposure, changes in factors affecting the propagation of noise from the emission source to the receiver can also have an effect on resulting noise exposure and therefore changes between Round One and Round Two population statistics. These are discussed in the following sections.

#### 3D Model

Changes in the topography and terrain model within the 3D model are likely to result in localised changes in noise exposure. For example, the demolition and construction of buildings between Round One and Round Two will significantly 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 population exposure.

#### Ground Cover

A key improvement of the Round Two model is the treatment of ground cover types. As discussed in the 3D modelling report, the Belfast Agglomeration was previously modelled as being 100% acoustically reflective in Round One. Using data from the NISRA Land Cover Map 2007 dataset, it has been possible to model urban green areas and different types of ground cover. This has resulted in areas of acoustically absorbent ground, such as parks and urban green areas, being modelled. This will in general result in increased ground cover corrections and lower noise levels.

### 11.2.4 Population and Building Data

As outlined in Section 10, there are a number of additional factors which complicate the direct comparison of population exposure analysis between Round One and Round Two. These factors include: differences in the age of the population datasets used in the analysis; changes and improvements in the OS Pointer address dataset since Round One; and 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.

## 11.3 Summary

As discussed in the previous sections, there are a number of factors which will affect a comparison between Round One and Round Two results. Some of these factors will result in increases or decreases in noise emissions whereas others may reduce noise exposure during propagation. For major roads, changes in the qualifying threshold between Round One and Round Two also make comparisons difficult.

Due to the number of factors, a genuine comparison between Round One and Round Two would require a site specific analysis. To this end, it is recommended that any detailed comparison between Round One and Round Two is undertaken as part of noise action planning and in relation to sites already examined by the Roads Service during Round One as part of noise management strategies or candidate Noise Management Areas (NMAs).

# Appendix A
# CRTN TRL Method 2 RDP Noise Dataset Specification

**Table A.1 RDP Object Overview**

| Layer Overview | Spatial Reference | Object Dimensions | Elevation Reference | Elevation Reference Position | Elevation Definition | Unit | LimA Object Type |
|---|---|---|---|---|---|---|---|
| RDP<br>CRTN Road Traffic Noise Emission Polyline in accordance with TRL Method 2 | Vector | 2.5D Polyline | Relative | Relative | Varies per object | Metre (m) | RDP |

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

**Table A.2 RDP Object Specification**

| Field/ Attribute Name | Full Description | Data Type | Status | Properties | | Special Values |
|---|---|---|---|---|---|---|
| L_BRT | Road Name | String | Data Input | Default Value | ROAD_2D | None |
| | | | | Max. Length | 20 | |
| L_ID | Unique ID Number | String | Data Input | Unique ID | | None |
| | | | | Max. Length | 16 | |
| L_RQ | Geometry Type | Floating Point | Data Input | Default Value | 1 | ”-“ ignore L_ RQ and use L_LNW only |
| | | | | Max. Length | 4 | |
| L_PED | 12-hour Daytime Noise Emission Level (CRTN $L_{Aeq, 0700-1900hrs}$) | String | Calculated | Default Value | 0.0 | None |
| | | | | Precision | 2 d.p. | |
| | | | | Max. Length | 6 | |
| L_PEN | 8-hour Night-time Noise Emission Level (CRTN $L_{Aeq, 2300-0700hrs}$) | String | Calculated | Default Value | 0 V | None |
| | | | | Precision | 2 d.p. | |
| | | | | Max. Length | 6 | |
| L_PEE | 4-hour Evening Noise Emission Level (CRTN $L_{Aeq, 1900-2300hrs}$) | String | Calculated | Default Value | 0 V | None |
| | | | | Precision | 2 d.p. | |
| | | | | Max. Length | 6 | |

**Table A.2 (continued) RDP Object Specification**

| Field/ Attribute Name | Full Description | Data Type | Status | Properties | | Special Values |
|---|---|---|---|---|---|---|
| L_LDAY | 18-hour Daytime Noise Emission Level (CRTN $L_{Aeq, 0600-0000hrs}$) | String | Calculated | Default Value | 0 V | None |
| | | | | Precision | 2 d.p. | |
| | | | | Max. Length | 6 | |
| L_Z | Height of Object in AMSL | String | Calculated | Default Value | 8.00 | 0.1 D (for roads on bridges) |
| | | | | Min Value. | 0.00 | |
| | | | | Max Value | 9999.99 | |
| | | | | Precision | 2 dp | |
| | | | | Max. Length | 10 | |
| L_GRD | Road Gradient | Floating Point | Calculated | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_DIR | Road Direction | Integer | Data Input | Default Value | 0 | +1, 0, -1 |
| | | | | Max. Length | 4 | |
| L_SRF | Surface Type | String | Data Input | Default Value | I | I, C, P |
| | | | | Max. Length | 4 | |
| L_TD | Texture Depth | Floating Point | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_LNW | Lane Width | String | Data Input | Default Value | - | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 10 | |
| L_QHD | Total Vehicle Flow (12-hour , 0700-19000) | String | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_PHN | %HGV (12-hour, 0700-1900) %age | Floating Point | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_VD | Average Traffic Speed (12-hour, 0700-1900) $Kmh^{-1}$ | Floating Point | Calculated | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |

**Table A.2 (continued) RDP Object Specification**

| Field/ Attribute Name | Full Description | Data Type | Status | Properties | | Special Values |
|---|---|---|---|---|---|---|
| L_QHN | Total Vehicle Flow (8-hour , 2300-0700) | String | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_PHN | %HGV (8-hour, 2300-0700) %age | Floating Point | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_VN | Average Traffic Speed (8-hour, 2300-0700) $Kmh^{-1}$ | Floating Point | Calculated | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_QHE | Total Vehicle Flow (4-hour , 1900-2300) | String | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_PHE | %HGV (4-hour, 1900-2300) %age | Floating Point | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_VE | Average Traffic Speed (4-hour, 1900-2300) $Kmh^{-1}$ | Floating Point | Calculated | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_QDAY | Total Vehicle Flow (18-hour , 0600-0000) | String | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_PDAY | %HGV (18-hour, 0600-0000) %age | Floating Point | Data Input | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_VDAY | Average Traffic Speed (18-hour, 0600-0000) $Kmh^{-1}$ | Floating Point | Calculated | Default Value | 0.0 | None |
| | | | | Precision | 1 d.p. | |
| | | | | Max. Length | 7 | |
| L_REG | Regulation | String | Data Input | Default Value | 18H 0 | None |
| | | | | Max. Length | 5 | |

**Table A.2 (continued) RDP Object Specification**

| Field/ Attribute Name | Full Description | Data Type | Status | Properties | | Special Values |
|---|---|---|---|---|---|---|
| L_MAJ | Major or Non-Major | Integer | Data Input | Max. Length | 3 | 0: Non-Major<br>1: Major |
| L_VAR | Calculation variant | String | Data Input | Default Value | + | - |
| | | | | Max. Length | 20 | |

# Appendix B
# Road Traffic Factors

**Table B.1 Road Service Traffic Factors for AADT (Applicable for Derived Flows)**

| Road Classification | 2010 Daytime 16-hour (0700-2300hrs) | 2010 Evening (1900-2300hrs) | 2010 Night (2300-0700hrs) | 2010 18-Hour (0600-0000hrs) | 2010 Daytime 12-hour (0700-1900hrs) |
|---|---|---|---|---|---|
| **Motorway** | 0.931 | 0.134 | 0.063 | 0.967 | |
| **A** | 0.930 | 0.140 | 0.069 | 0.959 | |
| **B** | 0.922 | 0.141 | 0.071 | 0.964 | |
| **C** | 0.945 | 0.157 | 0.062 | 0.968 | |

**Table B.2 Road Service Traffic Factors for HGV Flows (Applicable for Derived Flows)**

| Road Classification | 2010 Daytime 16-hour (0700-2300hrs) | 2010 Evening (1900-2300hrs) | 2010 Night (2300-0700hrs) | 2010 18-Hour (0600-0000hrs) | 2010 Daytime 12-hour (0700-1900hrs) |
|---|---|---|---|---|---|
| **Motorway** | 0.867 | 0.091 | 0.133 | 0.924 | |
| **A** | 0.920 | 0.100 | 0.080 | 0.957 | |
| **B** | 0.945 | 0.092 | 0.055 | 0.973 | |
| **C** | 0.960 | 0.105 | 0.040 | 0.985 | |

**Table B.3 Road Service Traffic Factors for Traffic Speeds (Applicable for Temporary ATC)**

| Road Classification | 2010 Daytime 16-hour (0700-2300hrs) | 2010 Evening (1900-2300hrs) | 2010 Night (2300-0700hrs) | 2010 18-Hour (0600-0000hrs) | 2010 Daytime 12-hour (0700-1900hrs) |
|---|---|---|---|---|---|
| **Motorway** | 1.009 | 1.049 | 1.037 | 1.013 | 1.009 |
| **A** | 1.004 | 1.038 | 1.129 | 1.016 | 1.004 |
| **B** | 1.003 | 1.032 | 1.130 | 1.015 | 1.003 |
| **C** | 1.011 | 1.048 | 1.308 | 1.032 | 1.011 |

**Table B.4 Rapid Transit Conversion Factors for AADT and %HGV**

| Conversion | Factor |
|---|---|
| **12hr AADT as a % of 24hr AADT** | 77.675% |
| **12hr HGV as a % of 24hr HGV** | 85.163% |

**Table B.5 Rapid Transit Diurnal Conversion Factors for 24-hour AADT**

| Time Period | Factor |
|---|---|
| **16-hour Daytime (0700-2300hrs)** | 93.693% |
| **4-hour Evening (1900-2300hrs)** | 16.018% |
| **8-hour Night (2300-0700hrs)** | 6.396% |
| **18-hour Daytime (0600-000hrs)** | 96.650% |
| **12-hour Daytime (0700-1900hrs)** | 77.675% |

**Table B.6 Rapid Transit Diurnal Conversion Factors for 24-hour HGV**

| Time Period | Factor |
|---|---|
| **16-hour Daytime (0700-2300hrs)** | 93.263% |
| **4-hour Evening (1900-2300hrs)** | 8.100% |
| **8-hour Night (2300-0700hrs)** | 6.737% |
| **18-hour Daytime (0600-000hrs)** | 96.342% |
| **12-hour Daytime (0700-1900hrs)** | 85.163% |

**Table B.7 BTM HGV Conversion Factors**

| Road Section | Factor |
|---|---|
| **M1 / Westlink** | 1.55 |
| **Other Routes** | 1.97 |

**Table B.8 Round Two Default Traffic Flows**

| Road Classification | Daytime 12-hour (0700-2300hrs) | Evening 4-hour (1900-2300hrs) | Night-time 8-hour (2300-0700hrs) | Daytime 18-Hour (0600-0000hrs) |
|---|---|---|---|---|
| **Motorway (Urban)** | 17331.3 | 3090.7 | 1500.7 | 21075.6 |
| **Motorway (Rural)** | 13329.2 | 2367.9 | 1160.7 | 16190.8 |
| **A Road (Urban)** | 7140.9 | 1307.6 | 617.4 | 8744.5 |
| **A Road (Rural)** | 7548.5 | 1337.6 | 618.3 | 9179.6 |
| **B Road (Urban)** | 6698.8 | 1225.6 | 574.2 | 8187.7 |
| **B Road (Rural)** | 4022.6 | 745.2 | 343.7 | 4928.0 |
| **C Road (Urban)** | 17331.3 | 3090.7 | 1500.7 | 21075.6 |
| **C Road (Rural)** | 13329.2 | 2367.9 | 1160.7 | 16190.8 |

**Table B.9 Round Two Default %HGV**

| Road Classification | Daytime 12-hour (0700-2300hrs) | Evening 4-hour (1900-2300hrs) | Night-time 8-hour (2300-0700hrs) | Daytime 18-Hour (0600-0000hrs) |
|---|---|---|---|---|
| **Motorway (Urban)** | 9.6% | 5.0% | 8.4% | 7.1% |
| **Motorway (Rural)** | 11.6% | 6.3% | 12.3% | 8.9% |
| **A Road (Urban)** | 10.4% | 3.1% | 4.5% | 4.5% |
| **A Road (Rural)** | 9.7% | 4.3% | 6.4% | 6.3% |
| **B Road (Urban)** | 12.5% | 3.0% | 4.4% | 4.4% |
| **B Road (Rural)** | 4.0% | 2.6% | 3.7% | 3.8% |
| **C Road (Urban)** | 9.6% | 5.0% | 8.4% | 7.1% |
| **C Road (Rural)** | 11.6% | 6.3% | 12.3% | 8.9% |

**Table B.9 Round Two Default Traffic Speeds (kmh$^{-1}$)**

| Road Classification | Daytime 12-hour (0700-2300hrs) | Evening 4-hour (1900-2300hrs) | Night-time 8-hour (2300-0700hrs) | Daytime 18-Hour (0600-0000hrs) |
|---|---|---|---|---|
| **Motorway (Urban)** | 33.3 | 55.6 | 60.3 | 54.4 |
| **Motorway (Rural)** | 46.2 | 77.0 | 83.7 | 75.3 |
| **A Road (Urban)** | 30.0 | 49.8 | 54.5 | 48.9 |
| **A Road (Rural)** | 39.1 | 65.0 | 70.9 | 63.8 |
| **B Road (Urban)** | 27.6 | 46.2 | 57.0 | 45.4 |
| **B Road (Rural)** | 35.9 | 60.1 | 75.0 | 59.2 |
| **C Road (Urban)** | 33.3 | 55.6 | 60.3 | 54.4 |
| **C Road (Rural)** | 46.2 | 77.0 | 83.7 | 75.3 |

**Table B.10 CRTN Traffic Speed Guidance**

| Road Classification | Traffic Speed |
|---|---|
| **Roads not subject to a speed limit of less than 60mph** | |
| Special Roads (rural) excluding slip roads | 108 kmh$^{-1}$ |
| Special Roads (urban) excluded slip roads | 97 kmh$^{-1}$ |
| All-purpose dual carriageways excluding slip roads | 97 kmh$^{-1}$ |
| Single carriageways, more than 9 metres wide | 88 kmh$^{-1}$ |
| Single carriageways, less than 9 metres wide | 81 kmh$^{-1}$ |
| **Roads subject to a speed limit of 50mph** | |
| Dual carriageways | 80 kmh$^{-1}$ |
| Single carriageways | 70 kmh$^{-1}$ |
| **Roads subject to a speed limit less than 50mph but more than 30mph** | |
| Dual carriageways | 60 kmh$^{-1}$ |
| Single carriageways | 50 kmh$^{-1}$ |
| **Roads subject to a speed limit of 30mph or less** | |
| All carriageways | 50 kmh$^{-1}$ |