NZTA Transport Noise Mapping
NZ Transport Agency
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National Land Transport (Road) Noise Map

2019 Project Report

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National Land Transport (Road) Noise Map

2019 Project Report

Client: NZ Transport Agency

Prepared by

AECOM New Zealand Limited
Level 2, 2 Hazeldean Road, Addington, Christchurch 8024, P O Box 710, Christchurch MC, Christchurch 8140, New Zealand
T +64 3 966 6000 F +64 3 966 6001 www.aecom.com

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Executive Summary

AECOM was engaged by NZTA to undertake noise emission modelling of their road networks. The noise mapping will allow the Transport Agency to make strategic level estimates of the social cost of health impacts on the population caused by road transport noise. The study focused on noise from road traffic but could be extended to include noise emission from the rail network operated by KiwiRail. The national noise model included State Highways, Regional and Arterial roads as defined by the One Network Road Classification (ONRC). AECOM developed the modelling project methodology in consultation with NZTA.

Input data for the models was collected by AECOM from multiple sources including NZTA, LINZ, StatsNZ and local territorial authorities. The highest quality available data was used to prepare nation-wide datasets for roads, terrain, building outlines, land parcel centroids and existing noise barriers. Noise level predictions were made using the SoundPLAN v8.0 modelling software which used the Calculation of Road Traffic Noise UK (CRTN) algorithms to make predictions of noise levels adjacent to the road corridor.

To enable efficient processing of the large datasets the country was modelled by district and within each district the models were divided into sections depending on the complexity and geographic size of the study area. AECOM modelled the roads in all 66 districts and the final model contained 161 situations.

Noise contour bands (in 1 decibel increments) were developed from Grid Noise Map calculations and used to assign noise levels to buildings within the study area which extended 600 m from both sides of all the modelled roads. If a building crossed more than one noise contour band it was assigned a noise level that correlated with the highest noise level band which it crossed. For parts of NZ where building outline data was not available, single receiver points were positioned at the centroid of truncated land parcels. Land parcels were truncated to 100 m from the road centreline and the receiver point located at the centroid of the truncated polygon.

The assessment of population noise exposures relied on the currently available census data and did not take into consideration the temporal dimension of the population growth or decline in specific regions. The StatsNZ 2013 census mesh block data was used to determine the number of people exposed to each specific noise level, as summarised in **Table ES2**. The population exposure data has been determined for each road type and organised according to the noise level criteria of interest to the NZTA. The summary includes population exposure counts based on New Zealand and European noise guideline values.

Until the preferred method for hosting the model data is agreed, AECOM has securely stored the model input and output data shown in **Table ES1**.

Table ES1 Stored model data

Data type	Data format	Details
Input	ESRI shapefile	Roads Bridges Terrain Calculation sections (including ground absorption areas) Receivers (including building and points) Noise barriers
Output	ESRI geodatabase	Contour areas Contour lines Colour coded buildings (Category A, B and C)
Output	Excel spreadsheet	Population exposure counts. Summary tables are also included in **Appendix B** of this report.

A glossary of terminology used in this report is included in **Appendix A**

Table ES2 Population Noise Exposure Summary by Region and Road Classification

Region	Category A $L_{Aeq(24 hour)} < 64$ dB			Category B 64 dB $\le L_{Aeq(24 hour)} < 67$ dB			Category C 67 dB $\le L_{Aeq(24 hour)}$			$L_{den} > 53$ dB equivalent[1] to: $L_{Aeq(24 hour)} > 50$ dB			$L_{night} > 45$ dB equivalent[1] to: $L_{Aeq(24 hour)} > 51$ dB		
	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total
Auckland	1,127,237	86,365	1,213,602	4,089	3,213	7,302	962	2,985	3,947	191,667	44,165	235,832	176,737	38,254	214,991
Bay of Plenty	75,786	59,398	135,184	248	862	1,110	6	247	253	8,599	14,778	23,377	7,991	13,093	21,083
Gisborne	6,286	10,511	16,797	0	19	19	0	3	3	2,658	6,490	9,149	2,121	5,515	7,637
Hawke's Bay	70,208	27,268	97,476	247	675	922	16	117	133	9,527	6,760	16,288	9,090	6,059	15,149
Manawatu-Wanganui	90,692	61,559	152,251	90	886	976	13	362	375	11,032	12,089	23,121	10,464	11,183	21,647
Northland	40,518	45,143	85,661	114	586	700	8	162	170	6,672	13,032	19,705	6,114	11,890	18,004
Taranaki	8,702	29,405	38,107	2	480	482	0	65	65	3,512	22,217	25,729	2,916	20,303	23,219
Waikato	134,494	108,048	242,542	581	1,710	2,291	140	601	741	17,834	24,020	41,854	16,866	21,789	38,656
Wellington	277,914	71,769	349,683	5,424	1,644	7,068	2,301	1,121	3,422	43,376	15,285	58,660	40,853	13,806	54,659
Canterbury	317,040	96,468	413,508	980	2,302	3,282	87	819	906	53,477	19,545	73,022	50,926	17,810	68,736
Marlborough	11,846	11,150	22,996	0	168	168	0	62	62	1,304	1,768	3,071	1,253	1,610	2,862
Nelson	22,290	14,996	37,286	71	344	415	7	184	191	2,161	2,967	5,128	2,049	2,561	4,610
Otago	28,641	55,888	84,529	30	852	882	13	256	269	11,997	21,944	33,941	9,968	20,531	30,499
Southland	17,905	32,382	50,287	3	602	605	1	181	182	2,043	5,203	7,246	1,993	4,784	6,776
Tasman	5,119	15,407	20,526	26	663	689	9	233	242	583	4,299	4,882	559	3,986	4,545
West Coast	745	19,220	19,965	0	82	82	0	17	17	121	4,066	4,187	121	3,713	3,833
Totals	**2,235,423**	**744,977**	**2,980,400**	**11,905**	**15,088**	**26,993**	**3,563**	**7,415**	**10,978**	**366,563**	**218,628**	**585,191**	**340,020**	**196,887**	**536,907**

Note 1 EU noise indices converted to NZ noise indices using TRL, Method for converting the UK road traffic noise index LA10(18h) to the EU noise indices for road noise mapping, 2006, (Method 3 for non-motorways).

1.0 Project overview

AECOM was engaged by the NZ Transport Agency to develop national land transport (road traffic) noise maps for the state highway network, regional and arterial roads. The noise mapping will allow the Transport Agency to make strategic level estimates of the social cost of health impacts on the population caused by land-based transport noise. This not routinely done in New Zealand but is common overseas with guidance provided by the European Union (EU) Environmental Noise Directive 2002/49/EC (END). Put simply, the purpose of the study was to model the emission of noise from road transport and quantify the levels of noise exposure within the study areas.

The Transport Agency has well-developed processes for managing the impact from transport noise for new and altered roads. This noise mapping process provides valuable data about the distribution of risk throughout the country from the existing road networks. The study focused on noise from road traffic but could be extended to include noise emission from the rail network operated by KiwiRail.

The assessment of noise exposure relied on the currently available census data and did not take into consideration the temporal dimension of the population growth or decline in specific regions.

The modelling was undertaken using the Calculation of Road Traffic Noise (CRTN) method, as implemented in SoundPLAN (8.0) noise modelling software. Noise maps were presented in graphical formats and population exposures provided in a raw format that can be interrogated by end-users. The inputs and the outputs of the modelling were provided in a standard GIS database format. It is expected that the modelling and database would be updated with new input data every two years.

1.1 Key functions of the mapping

The noise contour maps and noise exposure data will initially be an internal resource for Transport Agency staff and would likely be made available for access by other regulatory authorities (territorial authorities). Some expected uses of the database are listed below:

- Allow for the quantitative estimation of the population noise exposures for discrete regions of interest.
- Inform decision making around developing retrospective noise mitigation strategies. For example, the installation of a quieter pavement (road surface) or the construction of noise barrier adjacent to the road corridor. This mapping would be used in conjunction with the current noise improvement programme business case (PBC).
- Allow environmental staff to interrogate model data to assist when dealing with a complaint relating to road traffic noise from a state highway.
- Assist with the implementation and/or development of reverse sensitivity policy.
- Enable authorities to review the impact of changing existing noise planning levels and asses the suitability of existing noise barrier infrastructure when set against revised criteria.
- Allow road controlling authorities to collaborate when developing noise mitigation strategies.
- Encourage authorities to consider the acoustical amenity of naturally quiet spaces, and to consider transport noise impacts in terms of the health and biodiversity of ecosystems.
- May be used by Government planners and health officials to assess overall public amenity in terms of other environmental indicators such as air pollution, low housing standards and lack of green space.

A glossary of terminology used in this report is included in **Appendix A**.

1.2 Existing mapping methodologies

The push for city noise mapping is well established globally and an overview of existing relevant methodologies employed by other jurisdictions is given in **Appendix D** to provide some background and context for some readers.

A review of online, publicly available, noise mapping data was undertaken to observe the variety of presentation styles and to assess user functionality and map performances. A collection of information relating to the review and examples of maps with attractive attributes is shown in **Appendix D**.

2.0 Data acquisition

This project involved the collection of spatial and attribute data from a range of sources that was used to generate datasets which, layer by layer, were used as inputs to noise models that calculated the noise contours. The sources of input data, and any assumptions made, are detailed in **Section 5**.

2.1 Classification of roads

The scope of the noise mapping was based on the functional classifications contained in the One Network Road Classification (ONRC) system[1], with the following road types selected for modelling:

- National (including Typical and High Volume).
- Regional.
- Arterial.

In classifying roads, the ONRC considers functional road attributes such as typical daily traffic flows (AADT), number of heavy commercial vehicles and the number of buses. There are also economic and social criteria and thresholds such as regional connectivity and tourism and freight transport requirements.

2.2 Dataset licence(s)

The input data obtained for the modelling was all in the public domain with the exception of the CoreLogic centrelines and RAMM Surfaces centrelines. The CoreLogic dataset is licenced directly by the Transport Agency and provided to AECOM under a non-disclosure agreement. The RAMM data is owned by the Transport Agency.

[1] NZTA One Network Road Classification, https://www.nzta.govt.nz/roads-and-rail/road-efficiency-group/onrc/, viewed 12 November 2018.

3.0 Limitations and assumptions

Some aspects of the noise models included assumed values and the project methodology drew from multiple sources. This section outlines the model limitations and assumptions that were agreed prior to commencement of modelling.

3.1 Geometry

Noise contours were calculated at a 10 m grid size at a receiver height of 1.5 m above local ground level. Grid Noise Map (GNM) calculations were undertaken, which allowed for the prediction of noise levels at the building facades most exposed to road traffic noise, or at truncated land parcel centroids where no dwelling (building outline) was located within the study area. To assign noise levels to receiver locations (buildings or single points), the GNMs were used to derive 1 dB noise contours. A GIS tool was then used to assign a noise level to the receiver that correlated with the highest noise contour band within which the receiver was located. If a building outline crossed over several noise contour bands then the building was given a noise level that related to the highest noise contour band that crossed the building. That method effectively selected the part of the building that was most exposed to road traffic noise.

A summary of which model sections included predictions at land parcel centroids is included in **Section 5.1**.

3.2 Regions and extents

The country was modelled according to the boundaries of territorial authorities. Some of the models were divided into sections to enable efficient modelling and data management. The model extents of each section continued into the adjacent model section and the resultant noise contours for any divided sections were re-joined to form continuous datasets.

3.3 Uncertainty

The Transport Agency requested that AECOM undertake the noise mapping using the Calculation of Road Traffic Noise (CRTN) calculation method, which has been used extensively in NZ.

The Transport Agency requested that the assessment of population noise exposure be undertaken in consideration of the following noise level indicators:

- $L_{Aeq\ (24h)}$
- L_{den} and L_{night}

The *Environmental Noise Guidelines for the European Region* (dated 2018)[2] guideline value of 53 dB L_{den} for road traffic noise would approximately correlate with a noise level of 50 dB $L_{Aeq\ (24h)}$, the European guideline value of 45 dB L_{night} would approximately correlate with a noise level of 51 dB $L_{Aeq\ (24h)}$. These conversions are based on the non-motorway conversion Method 3, from the TRL report, *Method for converting the UK road traffic noise index $L_{A10(18h)}$ to the EU noise indices for road noise mapping, 2006*[3]. The model calculation areas were set accordingly.

The Transport Agency is aware that noise levels predicted at distances of greater than 300 m from the roadway using CRTN may put some result data outside the validity of the calculation method.

AECOM highlighted any modelling uncertainty at key points in the project and agreed the expected level of accuracy of various aspects of the modelling with the Transport Agency. AECOM applied default values to manage identified gaps in model input data. The default values were agreed with the Transport Agency and are detailed for each input type in **Section 5**. At this time, the noise models have not been verified against measured road traffic noise levels.

[2] Environmental Noise Guidelines for the European Region (2018), http://www.euro.who.int/en/publications/abstracts/environmental-noise-guidelines-for-the-european-region-2018

[3] For Defra by TRL and Casella, Method for converting the UK road traffic noise index $L_{A10(18h)}$ to the EU noise indices for road noise mapping, 2006, https://pdfs.semanticscholar.org/32b4/09d29b0d811f0c36afe4e01529beea802caa.pdf.

4.0 Inputs

The following section outlines issues relating to the specific model parameters that were used consistently in the modelling.

4.1 Buildings

4.1.1 Building footprints

The base of the building dataset contains the Land Information NZ (LINZ) "NZ building outlines", extracted from the LINZ data service. The state of this dataset, as determined by LINZ, is "Pilot" and therefore comes with the following caveat: "*This is a pilot dataset and is not complete for the whole of New Zealand. While some checks on the data have taken place, there are still errors present*". The dataset currently covers approximately 90% of NZ and is expected to extend its coverage in 2019."

For the remaining 10% of NZ (13 territorial authorities) not included in the LINZ dataset, or which had incomplete coverage in this dataset, AECOM used a two-stepped approach to develop the national dataset used in the modelling, as follows:

1. Retrieved the building outline data directly from regional council or territorial authority GIS open data portals.
2. Calculated the central point of the LINZ primary land parcel and assume that to be the location of the receptor. For parcels that extend beyond 100 m from the road centreline, the land parcels were truncated to 100 m from the road before the centroid was calculated.

After retrieving all the available building outlines and determining truncated parcel centroids, AECOM merged the data to form the national receiver dataset. It should be noted that the LINZ dataset included small buildings such as garages and small sheds that may not actually be identified as noise sensitive receivers. Therefore, while all the available building data was included in the noise modelling, to provide a more accurate representation of actual screening and reflection effects, building of less than 40 m^2 footprint were excluded from the national receiver dataset for the results analysis.

Further, a known uncertainty in the process of analysing population noise exposure was the ability to distinguish between residential and commercial buildings. An automated process was developed by Jacobs, using Feature Manipulation Engine (FME) software to refine the national receiver dataset to better identify residential buildings and to exclude commercial buildings from the receiver dataset for the results analysis.

4.1.2 Building heights

There were options available for populating building heights, the simplest of was to assume a notional building height and apply that to each of the buildings.

Building heights could also be calculated from a Digital Surface Model (DSM) although that method had potential limitations and require further feasibility testing to consider the following:

- The availability of adequate data coverage.
- Locating DSM datasets would have required extending data collection timeframes.
- LINZ did not plan to add this attribute to the current building footprint dataset soon.
- The planned LINZ national LiDAR dataset could be used to update the model when it becomes available.

The aim was to decide on a method that could be applied consistently in all the model regions. The buildings were connected to the SoundPLAN digital ground model (DGM) using the mean terrain height across the building footprint. Depending on the steepness of terrain, a significant part of some buildings would be "buried" under the terrain. As such, the building height was set notionally at 6 m and the method for connecting the buildings to the DGM was applied consistently in every model.

Table 1 Model data - Buildings

Data attribute	Data source	Data coverage	Dataset particulars
Building - Outline	LINZ	Available as complete datasets for all but six (6) districts: Kawerau District Opotiki District Gisborne District New Plymouth District South Taranaki District Dunedin City; And partial coverage for two (2) districts: Western Bay of Plenty District Stratford District	All building polygons with an area of less than 40 m^2 were excluded from the national receiver data set for the results analysis. Commercial buildings were excluded from the receiver dataset using an FME workbench. The filtering was undertaken by Jacobs during a parallel modelling project, based on the complete receiver dataset prepared by AECOM. The filtering relied on determination of residential status using LINZ property data to determine the size of building outlines and excluding buildings with a footprint of greater than 600 m.
Building – Point	LINZ	Contingency used for the districts listed above that did not have complete LINZ building outline coverage.	Land parcels within the calculation area that do not have available footprint had a point receiver applied at the parcel centroid. The receiver was set at a height of 1.5 m above the ground elevation. Land parcels were truncated to 100 m from the roadway before the centroid was calculated.
Building – Height	Notional	Complete	Notional 6 m building height with the building set to the model DGM according to the mean height of the terrain across the building footprint.

4.2 Terrain

There are various available datasets that describe the national ground terrain with varying degrees of accuracy and resolution. AECOM used various methods to access the terrain data available for each region, including:

- Downloading data from open source GIS portals.
- Cloud based file sharing by authorities.
- Retrieving physical data on hard drives.

The best available data for each jurisdiction was selected for modelling. Terrain data was generally available in contour line format or Digital Elevation Model format which AECOM transformed into contour line format.

To ensure efficient model processing, AECOM used filtering to limit the amount of data points on each terrain contour line that was imported to the noise models. The filter was set to provide no more than one data point per 0.5 m along the ground contour line.

Table 2 Model data - Terrain

Data attribute	Data source	Data coverage	Dataset particulars
Terrain – Elevation	Various	Complete	Detail of data source shown in **Appendix C**.

4.3 Ground cover

The Transport Agency Guide to state highway noise mapping recommends the use of a ground absorption factor of 1.0, which would infer the presence of soft absorptive ground cover conditions across the entire model extent. In contrast, a ground absorption factor of zero would indicate hard reflective surface cover in the ground plane of the model.

Table 3 Model data – Ground cover

Data attribute	Data source	Data coverage	Dataset particulars
Ground absorption factor (G)	Transport Agency guidance	Complete	AECOM applied the default value of 1.0 as recommend by the Transport Agency.

4.4 Roads

Due to the differing geometries between the CoreLogic, RAMM and the Transport Agency Open Data datasets, a processing algorithm was required to populate the collated road centrelines with the relevant attributes.

The road attribute datasets were combined into a single GIS database using the following method:

- Used the ONRC road classifications to select local roads (arterial and regional) and state highways.
- Defined road sections as urban and rural, according to StatsNZ 2019 Urban/Rural classification.
- Defined the road sections into surface type, according to CoreLogic surface dataset.
- Used the ONRC dataset to select the CoreLogic road geometry for the model and removed all but the following attributes:
  - Lane count
  - Speed
  - Bridge ID
  - Tunnel ID

(Note - CoreLogic had the best geometry (line shape) and included the direction of the road)

- Added the following attributes from the Open Data dataset to the CoreLogic roads:
  - AADT
  - HV%
  - ONRC road classification
  - Urban/rural
  - Lane width
  - Surface types for Arterial and Regional roads only. Surface types for State Highways was imported from RAMM.
- Added a road width field to the CoreLogic data and applied 3.5 m to those carriageway lanes that had no attribute available from Open Data.

- Included National Noise Model road classification fields to the CoreLogic dataset:
  - State Highway urban
  - State Highway rural
  - Regional urban
  - Regional rural
  - Arterial urban
  - Arterial rural

The available road and bridge data did not include height information. Assigning height to roads and bridges was largely automated. Quality assurance checking was undertaken during the modelling for each region. The road centrelines were draped onto the terrain models within SoundPLAN. AECOM developed an automated GIS process for setting the height of bridges using references to the terrain heights at each end abutment. The level of accuracy of bridge height assignment depended largely on the detail of the available terrain. Manual adjustments were made where the automated process did not provide the required level of accuracy, for instance if road or bridge emission lines were assigned heights that left them below the surrounding terrain level. The final modelled road and bridge heights are contained within the datasets for each model.

AECOM applied the CRTN calculation algorithms within the modelling software using the road and bridge object settings shown in **Table 4**. The CRTN method output the road traffic noise levels using the $Leq_{(24h)}$ noise level indicator. Further discussion of the model output parameters is included in **Section 6**.

Table 4 Model data - Roads

<table>
<tr><th>Data attribute</th><th>Data source</th><th>Data coverage</th><th>Dataset particulars</th></tr>
<tr><td>Road – Surface correction (Cr)</td><td>Transport Agency Road Assessment and Maintenance Management database (RAMM)</td><td>All state highways</td><td>The state highway road surface data from RAMM was used to calculate the appropriate surface correction (Cr) to apply to the sections of road.

Regional and Arterial roads received a default Cr value based on the assumption that urban roads had asphalt and rural roads had chip seal. The default Cr values were calculated according to the assumed surface parameters below:<table><tr><th>Surface</th><th>R_c</th><th>R_t</th></tr><tr><td>Chip seal</td><td>6</td><td>1</td></tr><tr><td>Asphalt</td><td>0</td><td>-2</td></tr></table>A default correction of -2 dB was applied within SoundPLAN to all Cr values for sections that were known to be NZ AC-10 pavement surface type.</td></tr>
<tr><td>Road – Classification</td><td>ONRC</td><td>All state highways
All regional and arterial roads</td><td></td></tr>
<tr><td>Road – AADT</td><td>Transport Agency Open</td><td>All state highways
Some regional and arterial roads</td><td>All available traffic flow data was compiled for all roads and input to the model as “February 2019” flow data. Future iterations of the</td></tr>
</table>

<table>
<tr><th>Data attribute</th><th>Data source</th><th>Data coverage</th><th colspan="3">Dataset particulars</th></tr>
<tr><td rowspan="6"></td><td rowspan="6">Data (Open Data)</td><td rowspan="6"></td><td colspan="3">modelling would likely include updated flow data.

Default values based on typical ONRC values were applied to fill any data gaps, as shown below:</td></tr>
<tr><th>ONRC</th><th>Area</th><th>AADT</th></tr>
<tr><td rowspan="2">Regional</td><td>Urban</td><td>15000</td></tr>
<tr><td>Rural</td><td>10000</td></tr>
<tr><td rowspan="2">Arterial</td><td>Urban</td><td>5000</td></tr>
<tr><td>Rural</td><td>3000</td></tr>
<tr><td>Road – Heavy vehicles (HV%)</td><td>Open Data</td><td>All state highways
Some regional and arterial roads</td><td colspan="3">Default value of 5% was used to fill any data gaps.</td></tr>
<tr><td>Road – Width</td><td>Open Data</td><td>All state highways
All regional and arterial roads</td><td colspan="3">Default road width value equal to Number of Lanes x 3.5 m, was used to fill any data gaps.</td></tr>
<tr><td>Road - Alignment</td><td>CoreLogic (2D only)</td><td>All state highways
All regional and arterial roads</td><td colspan="3"></td></tr>
<tr><td>Road – Section name</td><td>CoreLogic</td><td>All state highways
All regional and arterial roads</td><td colspan="3"></td></tr>
<tr><td>Road – Posted speed limit</td><td>CoreLogic</td><td>All state highways
All regional and arterial roads</td><td colspan="3"></td></tr>
<tr><td>Road – Number of lanes</td><td>CoreLogic</td><td>All state highways
All regional and arterial roads</td><td colspan="3"></td></tr>
<tr><td>Road – Tunnel</td><td>CoreLogic</td><td>All state highways
All regional and arterial roads</td><td colspan="3">Turned off road noise emission sources inside tunnels.</td></tr>
<tr><td>Road – Bridge</td><td rowspan="5">CoreLogic</td><td rowspan="5">All state highways
All regional and arterial roads</td><td rowspan="5" colspan="3"></td></tr>
<tr><td>Road – Bridge width left</td></tr>
<tr><td>Road – Bridge width right</td></tr>
<tr><td>Road – Bridge edge height left</td></tr>
<tr><td>Road – Bridge edge height right</td></tr>
</table>

4.5 Noise barriers

All the currently available noise barrier data from previous modelling (PBC) was included in the model.

Table 5 Model data – Noise barriers

Data attribute	Data source	Data coverage	Dataset particulars
Noise protection wall - Height	AECOM database	Auckland only.	Assumed barrier height of 3 m where barriers height data had gaps.
Noise protection wall – Reflectivity	AECOM database		Default hard reflective barrier settings were applied within SoundPLAN.

5.0 Outputs

The model output data was prepared in various formats, with the specific details in this section.

5.1 Presentation formats

The Transport Agency Guide to state highway noise mapping recommends the graphical presentation of model results in the format shown in **Table 6** and **Table 7**. The following table shows the range of values that are included in the individually coloured solid filled contours. Contour lines are also shown on the maps at 1 dB intervals.

Table 6 Contour colouring

Interval	Noise zone fill (Pastel colour)
55 dB ≤ $L_{Aeq(24\ hour)}$ < 60 dB	Light blue
60 dB ≤ $L_{Aeq(24\ hour)}$ < 65 dB	Light green
65 dB ≤ $L_{Aeq(24\ hour)}$ < 70 dB	Yellow
$L_{Aeq(24\ hour)}$ ≥ 70 dB	Pink

The following table shows the recommended colouring for sensitive receivers identified as Protected Premises and Facilities (PPF), classified according to NZS 6806. The colouring of PPFs indicates the noise category in which each dwelling is located.

Table 7 PPF colouring

Category	Interval	Residential footprint (Solid colour)
A	$L_{Aeq(24\ hour)}$ < 64 dB	Green
B	64 dB ≤ $L_{Aeq(24\ hour)}$ < 67 dB	Orange
C	67 dB ≤ $L_{Aeq(24\ hour)}$	Red

An example of the presentation format of the noise mapping results is shown in **Figure 1**. The figure shows a section of road in Hamilton City.

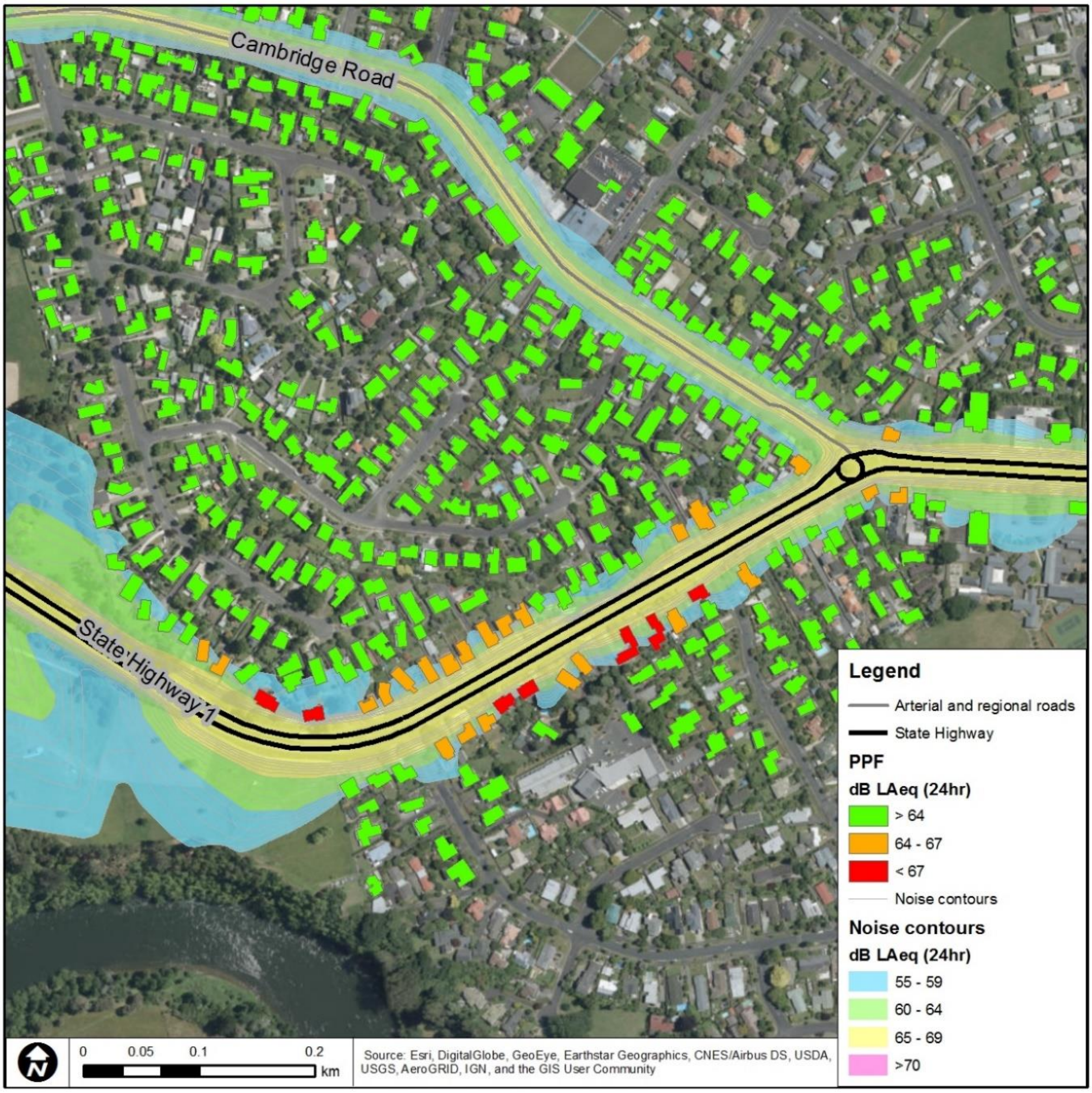


Figure 1 Noise contours example

The PPF locations in map example **Figure 2** have been filtered to restrict those shown to reduce clutter on the map and improve presentation.

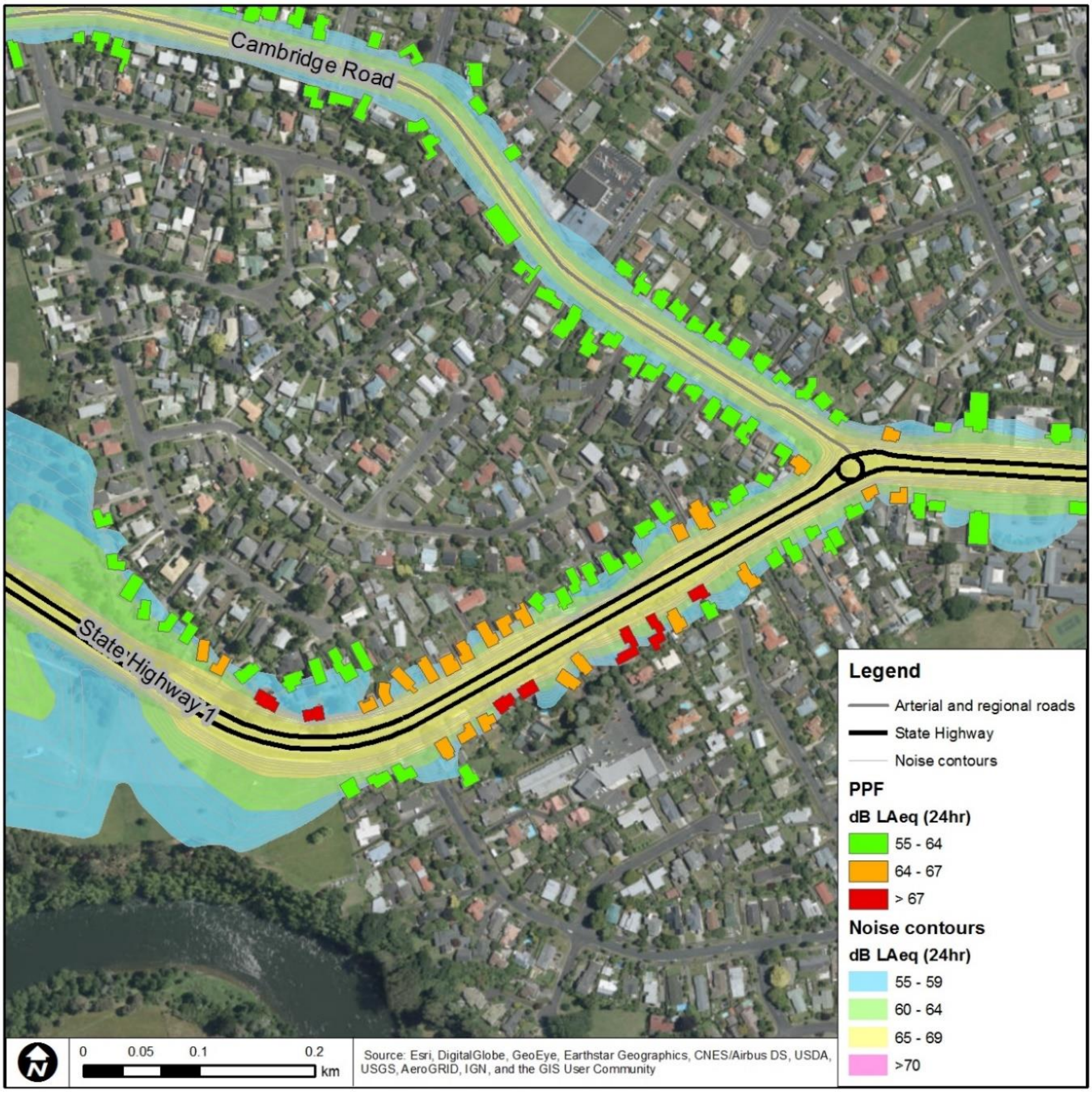


Figure 2 Noise contours example – Filtered for presentation

5.2 Population noise exposure

The current (2013) StatsNZ mesh block data was available as a GIS shapefile with population attributes linked to polygon areas. The population noise exposures statistics were calculated using the currently available census data but did not take into consideration the temporal dimension of the population growth or decline in specific regions.

A statistical breakdown of the population noise exposure was undertaken for each of the noise level indicators and summarised by District. The data analysis utilised the data parameters as shown in **Table 8**.

Table 8 Population exposure data analysis parameters

Parameter	Method	Comments
Sensitive receivers	The national receiver dataset was compiled from multiple sources and filtered to remove known commercial buildings.	Jacobs had been engaged to undertake air quality modelling for NZTA, however, they did not have a complete national dataset for buildings. Jacobs therefore used the AECOM compiled national receiver dataset and filtered the dataset to remove commercial buildings using a tool in FME software. The filtered national dataset was then used by AECOM when analysing the mapping results to determine the population noise exposure statistics.
Population per building (Entire mesh block)	Used StatsNZ 2013 census data to determine how many people live in each building within the filtered national receiver dataset.	AECOM understands that updated census data will be available from April 2018. That data may be used in additions iterations of data analysis. Included receiver points at land parcel centroids where required.
Population counts per modelled exposure level	Count the number of people exposed to levels that fall within each of the Transport Agency categories.	Assumed the residents were evenly distributed through each building. The most exposed facade (highest predicted facade noise level) noise level for the building was used for the statistical analysis.

A graphical example of the population noise exposure distribution for Hamilton City is shown in **Figure** 3. It should be noted that there were approximately 89,000 people predicted to be exposed to noise levels of less than 44 $L_{Aeq(24\ hour)}$.Those population count values have been excluded from the figure to allow better scaling for viewing by the reader.

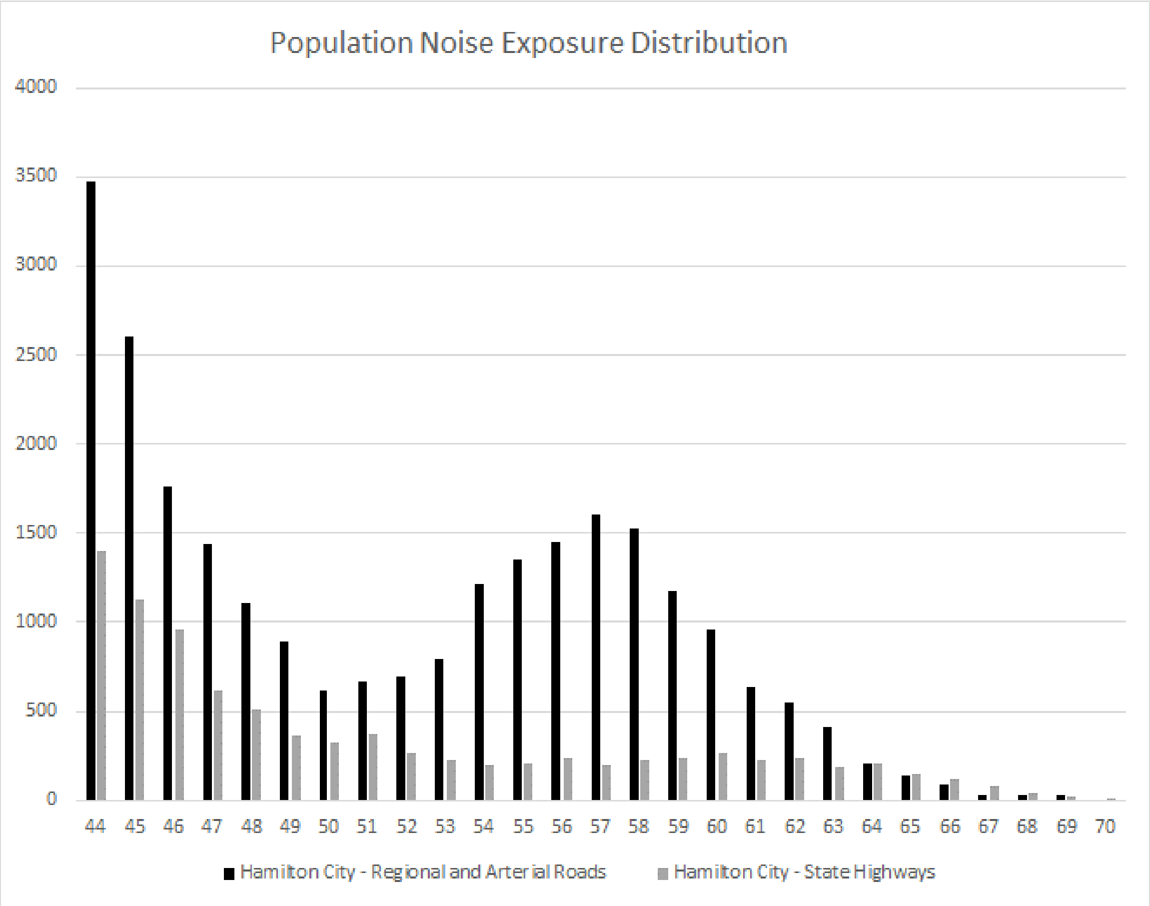


Figure 3 Hamilton City population noise exposure distribution

The number of people predicted to be exposed to particular noise levels from each of the modelled road type has been sorted in **Table 9** to correspond with the Categories shown in **Table 7**.

Table 9 Noise exposure population counts by NZTA Category – Hamilton City

	Category A		Category B		Category C	
	$L_{Aeq(24\ hour)}$ < 64 dB		64 dB ≤ $L_{Aeq(24\ hour)}$ < 67 dB		67 dB ≤ $L_{Aeq(24\ hour)}$	
	Regional and Arterial	State Highway	Regional and Arterial	State Highway	Regional and Arterial	State Highway
Hamilton City	101,179	21,114	439	480	90	146

The population noise exposure levels have been compared with the European Environmental Noise Guideline values in **Table 10**.

Table 10 European Environmental Noise Guideline data – Hamilton City

	L_{den} > 53 dB equivalent[1]:		L_{night} > 45 dB equivalent[1]:	
	$L_{Aeq(24\ hour)}$ > 50 dB		$L_{Aeq(24\ hour)}$ > 51 dB	
	Regional and Arterial	State Highway	Regional and Arterial	State Highway
Hamilton City	13,573	3,713	12,910	3,341

Note 1 EU noise indices converted to NZ noise indices using TRL Method 3 for non-motorways.

A summary of the population noise exposure data for all territorial authorities, and regions, is shown in **Appendix B**.

6.0 Data deliverables

AECOM has securely stored the model input and output data shown in **Table 11**.

Table 11 Stored model data

Data type	Data format	Details
Input	ESRI shapefile	Roads Bridges Terrain Calculation sections (including ground absorption areas) Receivers (including building and points) Noise barriers
Output	ESRI geodatabase	Contour areas Contour lines Colour coded buildings (Category A, B and C)
Output	Excel spreadsheet	Population exposure counts. Summary tables are included in **Appendix B** of this report.

7.0 Future updates

The noise model can be updated as updated input data becomes available, such as the planned update to the national LINZ building outline dataset and the release of the latest StatsNZ census data. The specific requirements relating to formats required for the submission of future model inputs would be decided based on lesson learnt throughout the 2019 modelling project. The data format protocols that were developed during the 2019 mapping project would be used to standardise and validate any new input data submitted for model updates.

7.1 Noise protection walls

To fill gaps in the national noise barrier geometry and attribute dataset, AECOM could undertake a field survey to establish the existing situation regarding location, height, construction and condition of purpose-built noise barriers, and those associated with residential developments. A field survey could be the most efficient method of accurate data capture for what is expected to be a small number of acoustically significant barriers in NZ. AECOM could develop a specification for the collection of noise barrier data during the surveys and plan the most efficient method for data collection. Alternatively, the data could be provided as a requirement of a Network Outcomes Contracts (NOC) and then recorded in RAMM going forward.

7.2 SoundPLAN

It is expected that the model will be maintained within the SoundPLAN v8.0 model environment. Periodic updates to a newer version of SoundPLAN would require consideration of the implications for the model results caused by the software updates. Any model migration to newer versions of the software would need to be managed by competent specialists and require a planned approach to quality assurance checking.

7.3 Electric vehicles

The expected increased take up of electric four-wheeled vehicles will be considered as part of the project, although the impact is likely to be negligible where speed limits in excess of 60 km/h, as the main source of noise emission at speeds above 60 km/h is noise generated at the tyre/road interaction.

Appendix A

Abbreviations and terminology

Appendix A Abbreviations and terminology

Abbreviation	Description
AADT	Annual Average Daily Traffic
HV%	Heavy vehicle percentage of the overall transport mode
CRTN	Calculation of Road Traffic Noise (UK)
RAMM	Road Assessment and Maintenance Management
ONRC	One Network Road Classification
LINZ	Land Information New Zealand
FME	Feature Manipulation Engine
GIS	Geographic Information System
NoR	Notice of requirement
NZS 6806	NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads
PPF	Protected premises and facilities, per NZS 6806
RMA	Resource Management Act 1991
DGM / DSM	Digital Ground Model / Digital Surface Model
GNM	Grid Noise Map
dB	Decibels – unit of sound level
A-weighted noise level	The unit of sound level which has been modified by a filter (A-weighting) to more closely approximate the noise level perceived by a listener.

Term	Definition
Alignment	The horizontal or vertical geometric form of the centre line of the carriageway.
Annual average daily traffic (AADT)	The total volume of traffic passing a roadside observation point over the period of a calendar year, divided by the number of days in that year (365 or 366 days). Measured in vehicles per day.
Carriageway	That portion of the road devoted particularly to the use of travelling vehicles, including shoulders.
Centreline	The basic line, at or near the centre or axis of a road or other work, from which measurements for setting out or constructing the work can conveniently be made.
Road surface correction (Cr)	The type of road surface has a bearing on the level of noise emitted from a roadway. The modelled values are corrected to more accurately reflect the identified road surfaces.
$L_{Aeq(24h)}$	Time-averaged A-weighted sound pressure level (over the period of 24 hours, measured in dB).
$L_{A10(18h)}$	The arithmetic average of the $L_{10(1hr)}$ sound pressure levels measured between 6am and midnight.
Notice of requirement	A notice given to a territorial authority (under section 168 of the RMA) or by a territorial authority (under section 168A of the RMA) of a requirement for land, water, subsoil or airspace to be designated.
Traffic volume	The number of vehicles flowing in both directions past a particular point in a given time (e.g. vehicles per hour, vehicles per day).
Receptor	A location where a noise level was predicted or measured. Usually this refers to a noise sensitive location such as a residential dwelling.

Appendix B

Population noise exposure

Table B1 Population Noise Exposure Summary by Region and Road Classification

Region	Category A $L_{Aeq(24\ hour)}$ < 64 dB			Category B 64 dB ≤ $L_{Aeq(24\ hour)}$ < 67 dB			Category C 67 dB ≤ $L_{Aeq(24\ hour)}$			L_{den} equivalent[1]: $L_{Aeq(24\ hour)}$ > 50 dB			L_{night} equivalent[1]: $L_{Aeq(24\ hour)}$ > 51 dB		
	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total	Regional & Arterial	State Highway	Total
Auckland	1,127,237	86,365	1,213,602	4,089	3,213	7,302	962	2,985	3,947	191,667	44,165	235,832	176,737	38,254	214,991
Bay of Plenty	75,786	59,398	135,184	248	862	1,110	6	247	253	8,599	14,778	23,377	7,991	13,093	21,083
Gisborne	6,286	10,511	16,797	0	19	19	0	3	3	2,658	6,490	9,149	2,121	5,515	7,637
Hawke's Bay	70,208	27,268	97,476	247	675	922	16	117	133	9,527	6,760	16,288	9,090	6,059	15,149
Manawatu-Wanganui	90,692	61,559	152,251	90	886	976	13	362	375	11,032	12,089	23,121	10,464	11,183	21,647
Northland	40,518	45,143	85,661	114	586	700	8	162	170	6,672	13,032	19,705	6,114	11,890	18,004
Taranaki	8,702	29,405	38,107	2	480	482	0	65	65	3,512	22,217	25,729	2,916	20,303	23,219
Waikato	134,494	108,048	242,542	581	1,710	2,291	140	601	741	17,834	24,020	41,854	16,866	21,789	38,656
Wellington	277,914	71,769	349,683	5,424	1,644	7,068	2,301	1,121	3,422	43,376	15,285	58,660	40,853	13,806	54,659
Canterbury	317,040	96,468	413,508	980	2,302	3,282	87	819	906	53,477	19,545	73,022	50,926	17,810	68,736
Marlborough	11,846	11,150	22,996	0	168	168	0	62	62	1,304	1,768	3,071	1,253	1,610	2,862
Nelson	22,290	14,996	37,286	71	344	415	7	184	191	2,161	2,967	5,128	2,049	2,561	4,610
Otago	28,641	55,888	84,529	30	852	882	13	256	269	11,997	21,944	33,941	9,968	20,531	30,499
Southland	17,905	32,382	50,287	3	602	605	1	181	182	2,043	5,203	7,246	1,993	4,784	6,776
Tasman	5,119	15,407	20,526	26	663	689	9	233	242	583	4,299	4,882	559	3,986	4,545
West Coast	745	19,220	19,965	0	82	82	0	17	17	121	4,066	4,187	121	3,713	3,833
Totals	**2,235,423**	**744,977**	**2,980,400**	**11,905**	**15,088**	**26,993**	**3,563**	**7,415**	**10,978**	**366,563**	**218,628**	**585,191**	**340,020**	**196,887**	**536,907**

Note 1 EU noise indices converted to NZ noise indices using TRL, Method for converting the UK road traffic noise index LA10(18h) to the EU noise indices for road noise mapping, 2006, (Method 3 for non-motorways).

Table 12 Summary by district – North Island

North Island	Category A		Category B		Category C		Lden equivalent[1]:		Lnight equivalent[1]:	
	$L_{Aeq(24\ hour)}$ < 64 dB		64 dB ≤ $L_{Aeq(24\ hour)}$ < 67 dB		67 dB ≤ $L_{Aeq(24\ hour)}$		$L_{Aeq(24\ hour)}$ > 50 dB		$L_{Aeq(24\ hour)}$ > 51 dB	
	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway
Auckland City	1,127 ,237	86,365	4,089	3,213	962	2,985	191,667	44,165	176,737	38,254
Carterton District	0	3,884	0	95	0	91	0	777	0	752
Central Hawke's Bay District	44	3,970	2	91	0	30	11	695	11	637
Far North District	6,677	21,643	13	212	0	41	734	6,075	667	5,567
Gisborne District	6,286	10,511	0	19	0	3	2,658	6,490	2,121	5,515
Hamilton City	101,179	21,114	439	480	90	146	13,573	3,713	12,910	3,341
Hastings District	30,673	7,142	168	141	9	46	3,926	1,798	3,747	1,623
Hauraki District	820	11,049	10	154	0	22	379	2,395	363	2,223
Horowhenua District	5,003	11,749	0	199	0	121	464	2,179	424	2,045
Kaipara District	953	6,070	0	59	0	18	140	1,910	111	1,746
Kapiti Coast District	19,975	11,756	24	162	5	85	2,117	1,843	1,964	1,668
Kawerau District	0	530	0	8	0	0	0	325	0	273
Lower Hutt City	57,037	6,501	12	122	5	132	5,379	1,261	4,978	1,110
Manawatu District	2,565	8,164	2	133	0	17	285	1,906	256	1,786
Masterton District	4,893	6,479	3	161	2	49	474	968	463	919
Matamata-Piako District	4,752	13,987	28	203	0	18	894	2,918	818	2,725
Napier City	39,492	12,935	76	433	7	40	5,590	3,677	5,332	3,261
New Plymouth District	7,161	14,339	2	343	0	40	3,038	12,499	2,504	11,781
Opotiki District	448	5,007	0	7	0	0	200	2,083	93	1,581
Otorohanga District	0	3,591	0	25	0	14	0	892	0	819
Palmerston North City	59,707	10,643	75	202	13	45	7,466	2,125	7,099	1,936

North Island	Category A		Category B		Category C		Lden equivalent[1]:		Lnight equivalent[1]:	
	$L_{Aeq(24\ hour)}$ < 64 dB		64 dB ≤ $L_{Aeq(24\ hour)}$ < 67 dB		67 dB ≤ $L_{Aeq(24\ hour)}$		$L_{Aeq(24\ hour)}$ > 50 dB		$L_{Aeq(24\ hour)}$ > 51 dB	
	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway
Porirua City	34,120	9,252	84	238	50	80	4,571	2,572	4,329	2,239
Rangitikei District	2,511	3,970	1	115	0	67	130	1,266	116	1,160
Rotorua District	17,810	21,452	13	396	0	40	1,772	3,629	1,692	3,326
Ruapehu District	0	6,656	0	23	0	3	0	869	0	754
South Taranaki District	1,541	11,118	0	45	0	13	475	7,529	412	6,488
South Waikato District	0	9,830	0	93	0	11	0	1,595	0	1,406
South Wairarapa District	0	5,179	0	110	0	48	0	923	0	885
Stratford District	0	4,026	0	93	0	12	0	2,193	0	2,034
Tararua District	357	8,805	1	81	0	57	43	1,550	36	1,457
Taupo District	4,983	6,062	0	35	0	15	260	911	240	798
Tauranga City	46,273	24,082	223	247	6	101	5,382	4,270	5,072	3,633
Thames-Coromandel District	0	12,678	0	158	0	38	0	2,851	0	2,614
Upper Hutt City	17,371	11,557	60	66	0	11	1,745	1,297	1,688	1,139
Waikato District	8,970	13,287	85	245	45	205	1,447	4,658	1,347	4,118
Waipa District	13,790	10,947	19	271	5	126	1,281	2,834	1,188	2,629
Wairoa District	0	3,217	0	10	0	2	0	590	0	540
Waitomo District	0	4,956	0	35	0	5	0	977	0	873
Wellington City	144,519	17,160	5,240	690	2,239	626	29,089	5,645	27,432	5,094
Western Bay of Plenty District	2,461	5,336	3	207	0	104	203	3,897	180	3,730
Whakatane District	8,795	3,592	9	6	0	2	1,042	865	953	809

North Island	Category A		Category B		Category C		Lden equivalent[1]:		Lnight equivalent[1]:	
	$L_{Aeq(24\,hour)}$ < 64 dB		64 dB ≤ $L_{Aeq(24\,hour)}$ < 67 dB		67 dB ≤ $L_{Aeq(24\,hour)}$		$L_{Aeq(24\,hour)}$ > 50 dB		$L_{Aeq(24\,hour)}$ > 51 dB	
	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway
Whanganui District	20,549	11,445	11	133	0	51	2,644	2,172	2,533	2,030
Whangarei District	32,888	17,430	100	315	8	103	5,799	5,047	5,337	4,576

Note 1 EU noise indices converted to NZ noise indices using TRL, Method for converting the UK road traffic noise index LA10(18h) to the EU noise indices for road noise mapping, 2006, (Method 3 for non-motorways).

It should be noted that the North Island districts shown in **Table B2** included receiver locations that were based on land parcel centroids as no building outline data was available at the time of modelling.

Table B3 Receiver location exceptions – North Island

District	Receiver location data source
Gisborne	Solely based on land parcel centroids
Kawerau	Solely based on land parcel centroids
Opotiki	Solely based on land parcel centroids
New Plymouth	Solely based on land parcel centroids
South Taranaki	Solely based on land parcel centroids
Stratford	Included a mix of building outlines and land parcel centroids
Western Bay of Plenty	Included a mix of building outlines and land parcel centroids

Table B4 Summary by district – South Island

South Island	Category A $L_{Aeq(24 hour)} < 64$ dB		Category B $64 dB \le L_{Aeq(24 hour)} < 67$ dB		Category C $67 dB \le L_{Aeq(24 hour)}$		Lden equivalent[1]: $L_{Aeq(24 hour)} > 50$ dB		Lnight equivalent[1]: $L_{Aeq(24 hour)} > 51$ dB	
	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway
Ashburton District	4,256	11,245	2	138	0	21	138	1,469	119	1,298
Buller District	0	7,303	0	3	0	0	0	1,398	0	1,283
Central Otago District	1,692	10,421	0	23	0	4	113	1,467	108	1,289
Christchurch City	269,323	45,424	925	1,481	76	494	47,989	9,153	45,889	8,425
Clutha District	0	7,844	00	243	0	66	0	1,874	0	1,763
Dunedin City[2]	25,207	17,629	26	212	13	85	11,764	14,546	9,745	13,796
Gore District	0	6,732	0	33	0	2	0	963	0	913
Grey District	745	7,385	0	65	0	11	122	1,770	121	1,675
Hurunui District	207	4,274	0	27	0	8	3	875	0	794
Invercargill City	17,905	14,250	3	513	1	172	2,043	2,345	1,993	2,199
Kaikoura District	0	1,929	0	24	0	2	0	639	0	599
Mackenzie District	0	2,008	0	2	0	0	0	292	0	245
Marlborough District	11,846	11,150	0	168	0	62	1,304	1,768	1,253	1,610
Nelson City	22,290	14,996	71	344	7	184	2,161	2,967	2,049	2,561
Queenstown-Lakes District	1,742	8,472	4	265	0	84	120	2,153	115	1,917
Selwyn District	12,283	9,348	33	119	6	106	1,739	1,990	1,590	1,772
Southland District	0	11,400	0	56	0	8	0	1,896	0	1,672
Tasman District	5,119	15,407	26	663	9	233	583	4,299	559	3,986
Timaru District	11,960	12,946	6	379	2	71	1,369	2,652	1,301	2,462
Waimakariri District	19,012	5,172	13	100	2	102	2,239	1,717	2,027	1,540
Waimate District	0	3,148	0	33	0	15	0	623	0	567
Waitaki District	0	12,496	0	110	0	17	0	2,039	0	1,875

South Island	**Category A**		**Category B**		**Category C**		**L_{den} equivalent[1]:**		**L_{night} equivalent[1]:**	
	$L_{Aeq(24\ hour)} < 64$ dB		**64 dB $\leq L_{Aeq(24\ hour)} < 67$ dB**		**67 dB $\leq L_{Aeq(24\ hour)}$**		**$L_{Aeq(24\ hour)} > 50$ dB**		**$L_{Aeq(24\ hour)} > 51$ dB**	
	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway	Regional & Arterial	State Highway
Westland District	0	4,533	0	14	0	6	0	897	0	755

Note 1 EU noise indices converted to NZ noise indices using TRL, Method for converting the UK road traffic noise index LA10(18h) to the EU noise indices for road noise mapping, 2006, (Method 3 for non-motorways).

Note 2 Dunedin City receiver locations that were solely based on land parcel centroids as no building outline data was available at the time of modelling.

Appendix C

Model terrain input data sources

Appendix C Model terrain input data sources

Table C1 Terrain input data sources

TA name	Type	Resolution	Coverage[1]	Provider	Retrieval process
Far North	Contour	20m	Full	LINZ	Download
Whangarei District	Contour	20m	Full	LINZ	Download
Kaipara District	Contour	20m	Full	LINZ	Download
Auckland	DEM	1m	Full	LINZ/Auckland Council	Download
Thames-Coromandel District	Contour	1m	Most	Waikato Regional Council	Download
Hauraki District	Contour	1m	Most	Waikato Regional Council	Download
Waikato District	Contour	1m	Most	Waikato Regional Council	Download
Matamata-Piako District	Contour	1m	Most	Waikato Regional Council	Download
Hamilton City	Contour	1m	Full	Waikato Regional Council	Download
Waipa District	Contour	1m	Full	Waikato Regional Council	Download
Otorohanga District	Contour	1m	Most	Waikato Regional Council	Download
South Waikato District	Contour	20m	Full	LINZ	Download
Waitomo District	Contour	1m	Most	Waikato Regional Council	Download
Taupo District	Contour	1m	Most	Waikato Regional Council	Download
Western Bay of Plenty District	Contour	1m	Full	Bay of Plenty Regional Council	Download
Tauranga City	Contour	1m	Full	Bay of Plenty Regional Council	Download
Rotorua District	Contour	1m	Full	Bay of Plenty Regional Council	Download
Whakatane District	Contour	1m	Full	Bay of Plenty Regional Council	Download

TA name	Type	Resolution	Coverage[1]	Provider	Retrieval process
Kawerau District	Contour	1m	Full	Bay of Plenty Regional Council	Download
Opotiki District	Contour	1m	Full	Bay of Plenty Regional Council	Download
Gisborne District	Contour	1m	Some	Gisborne District Council	Download
Wairoa District	Contour	20m	Full	LINZ	Download
Hastings District	Contour	1m	Most	Hastings District Council	Download
Napier City	Contour	1m	Full	Napier City Council	Download
Central Hawke's Bay District	Contour	20m	Full	LINZ	Download
New Plymouth District	Contour	10m	Full	Taranaki Regional Council	Download
Stratford District	Contour	10m	Full	Taranaki Regional Council	Download
South Taranaki District	Contour	10m	Full	Taranaki Regional Council	Download
Ruapehu District	Contour	20m	Full	LINZ	USB
Whanganui District	Contour	1m	Most	Horizons Regional Council	USB
Rangitikei District	Contour	1m	Most	Horizons Regional Council	USB
Manawatu District	Contour	1m	Most	Horizons Regional Council	USB
Palmerston North City	Contour	1m	Full	Horizons Regional Council	Download
Tararua District	Contour	1m	Most	Horizons regional council	USB
Horowhenua District	Contour	1m	Full	Horizons regional council	USB
Kapiti Coast District	Contour	5m	Full	Greater Wellington Council	Download
Porirua City	Contour	1m	Full	Porirua District Council	Download

TA name	Type	Resolution	Coverage[1]	Provider	Retrieval process
Upper Hutt City	Contour	5m	Full	Greater Wellington Council	Download
Lower Hutt City	Contour	5m	Full	Greater Wellington Council	Download
Wellington City	Contour	1m	Full	Wellington city council	Download
Masterton District	Contour	5m	Full	Greater Wellington Council	Download
Carterton District	Contour	5m	Full	Greater Wellington Council	Download
South Wairarapa District	Contour	1m	Full	Greater Wellington Council	Download
Tasman District	Contour	1m	Full	Tasman District Council	Dropbox
Nelson City	Contour	1m	Full	Tasman District Council	Dropbox
Marlborough District	Contour	1m	Most	Marlborough District Council	Download
Buller District	Contour	20m	Full	LINZ	Download
Grey District	Contour	20m	Full	LINZ	Download
Westland District	Contour	20m	Full	LINZ	Download
Kaikoura District	DEM	1m	Most	LINZ/Environment Canterbury	Download
Hurunui District	Contour	20m	Full	LINZ	Download
Waimakariri District	DEM	1m	Good	LINZ/Environment Canterbury	Download
Christchurch City	DEM	1m	Good	LINZ/Environment Canterbury	Download
Selwyn District	Contour	20m	Full	LINZ	Download
Ashburton District	Contour	20m	Full	LINZ	Download
Timaru District	Contour	20m	Full	LINZ	Download
Mackenzie District	Contour	20m	Full	LINZ	Download

TA name	Type	Resolution	Coverage[1]	Provider	Retrieval process
Waimate District	Contour	20m	Full	LINZ	Download
Waitaki District	Contour	20m	Full	LINZ	Download
Central Otago District	Contour	20m	Full	LINZ	Download
Queenstown-Lakes District	Contour	20m	Full	LINZ	Download
Dunedin City	Contour	20m	Full	LINZ	Download
Clutha District	Contour	20m	Full	LINZ	Download
Southland District	Contour	20m	Full	LINZ	Download
Gore District	Contour	20m	Full	LINZ	Download
Invercargill City	Contour	20m	Full	LINZ	Download
Far North	Contour	20m	Full	LINZ	Download

Note 1 Some areas filled in with LINZ 20m data.

Appendix D

Existing noise mapping methodologies

Existing noise mapping methodologies

New Zealand

Transport Agency and noise mapping

The Transport Agency undertakes noise mapping of the state highway network to quantify the received noise levels in the receptor catchment areas adjacent to the road infrastructure. The Transport Agency *Guide to state highway noise mapping (Draft)*[4] was developed to capture learning from the Auckland noise mapping in 2013, and to provide guidance for noise specialists when undertaking further noise mapping for Transport Agency controlled road network. The Transport Agency guide includes:

- an outline of the statutory context.
- recommendations for data management methods.
- suggested modelling processes.
- requirements for data communication, storage and presentation.
- A case study of modelling undertaken for the Auckland region.

The national noise mapping methodology was developed by AECOM in general accordance with the current draft Transport Agency noise mapping guide.

Transport Agency and reverse sensitivity

The Transport Agency *Guide to the management of the effects of noise sensitive land use near the state highway land network* (reverse sensitivity guide) indicates the Transport Agency has undertaken to update the local classification of buffer and effects areas every two years. The following **Figure B4** details the buffer and effects area definitions.

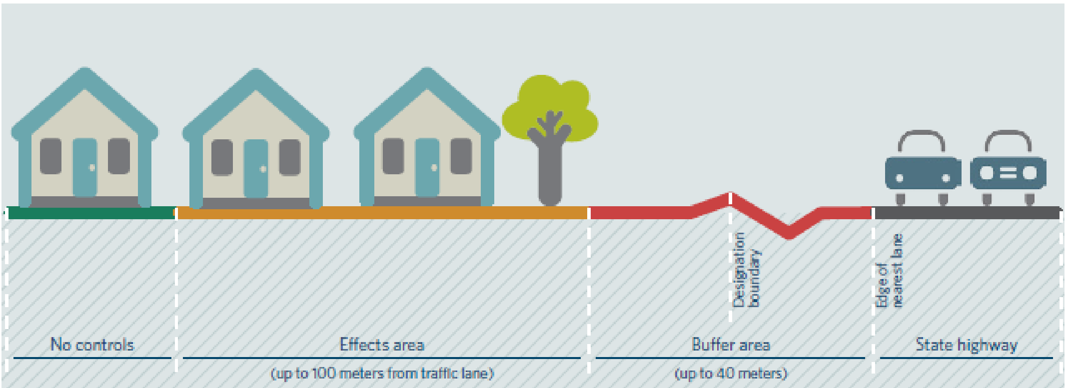


Figure B4 Transport Agency noise buffer and effects areas

The buffer distance is typically 40 m from the nearest lane and the effects area is typically 100 m from the edge of the nearest lane.

District plans should have the latest version of the buffer and effects area overlays, but these would not be updated until the next 10 yearly district plan review or when a specific plan change is requested by the Transport Agency. For example, this may occur in parallel with a Notice of Requirement (NOR) for a new state highway.

The reverse sensitivity guide recommends adding 3 dB to any predicted or measured noise levels to allow for future permitted use of the state highway. The adjusted value would then be used as a basis to predict the internal noise levels and analyse the required building facade design.

[4] NZTA Guide to state highway noise mapping, https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Noise-and-vibration/Standards/Guides/DRAFT-NZTA-guide-to-state-highway-noise-mapping-v1.0.pdf.

The Transport Agency does not enforce mandatory design guidance regarding noise sensitive uses adjacent to state highways. However, the Transport Agency regularly submits on District Plan reviews for the inclusions of reverse sensitivity provisions. Comprehensive noise mapping would assist with providing a more compelling case.

The guide recommends an internal noise goal of 40 dB $L_{Aeq(24h)}$ for living space and sleeping areas, ands suggests that limit is suitable for inclusion in district plans. If the noise sensitive development is planned to be within the buffer distance, then an external goal of 57 dB $L_{Aeq(24h)}$ would also be applied.

AECOM understands that the current state of the regulatory frameworks across the regions is not consistent when considering the assessment of reverse sensitivity for development within effects areas. As such, the noise contours produced by the mapping would be for information and may assist with planning for reverse sensitivity policy updates in the future.

NZ Standard 6806 Acoustics - Road traffic noise – New and altered roads (NZS 6806)

NZS 6806 recommends noise criteria to apply to an assessment position at the design year of a relevant road project. The noise criteria are nominated and categorised according to the type of road project and the ability of the project owner to apply the principles of best practicable option (BPO) as required by the Resource Management Act (RMA). This standard applies to new or altered road projects.

For the national noise mapping project, only existing traffic conditions on existing roads will be modelled. The resulting contours can be used to assess the 'do-minimum' situation but only for the latest available traffic flow dataset.

European Union Environmental Noise Directive 2002/49/EC (END)

The European Union (EU) member states have adopted the END as a key strategy for managing the potentially adverse effects of nuisance noise on their populations. To pursue its stated aims, the END focuses on three action areas:

- the determination of exposure to environmental noise.
- ensuring that information on environmental noise and its effects is made available to the public.
- preventing and reducing environmental noise where necessary and preserving environmental noise quality where it is good.

The *Environmental Noise Guidelines for the European Region* (dated 2018)[5] has been developed with the aim to provide recommendations for protecting human health from exposure to environmental noise originating from various sources, including roads and railways. The guideline development group conducted a systematic review and synthesis of noise related health-based evidence leading to the recommendations of guideline exposure levels for the populations. The recommendations for road traffic noise exposure are as follows:

- For average noise exposure, the guide strongly recommends reducing noise levels produced by road traffic below 53 dB L_{den} as road traffic noise above this level is associated with adverse health effects.
- For night noise exposure, the guide strongly recommends reducing noise levels produced by road traffic during night-time below 45 dB L_{night} as night-time road traffic noise above this level is associated with adverse effects on sleep.
- To reduce health effects, the guide strongly recommends that policy makers implement suitable measures to reduce noise exposures from road traffic in the population exposed to levels above the guideline values for average and night-time exposure. For specific interventions, the guide recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure.

[5] *Environmental Noise Guidelines for the European Region*, http://www.euro.who.int/en/publications/abstracts/environmental-noise-guidelines-for-the-european-region-2018.

The method for presenting the Transport Agency's noise mapping results in terms of the latest European guideline noise limits is included in **Section 6.2**.

Environmental Noise Guidelines for the European Region (2018)

As mentioned in **Section 1.2.2**, the 2018 Environmental Noise Guidelines for the European Region includes recommendations of guideline noise exposure levels for populations. The guideline values are presented in terms of L_{den} and L_{Night} noise level indicators, in addition to the $L_{Aeq(24h)}$.

There are established conversion methods to adapt values between noise indicators and, for information, a comparison of the applied adaptation methods is shown in **Table C8**.

It can be seen from **Table C8** there is considerable variance to the adapted values depending on the method selected. The Naish method was based on a study of road traffic noise under Australian conditions and the Defra TRL method was based on UK conditions. The Defra TRL adaptation method from $L_{A10(18h)}$ to $L_{Aeq(16h)}$ is available for use in SoundPLAN (8.0).

Table C8 Noise Level Indicator Adaption Comparison

$L_{A10(18h)}$ SPLAN	$L_{Aeq(24h)}$ SPLAN	$L_{Aeq(24h)}$ Naish	L_{Night} Naish	L_{den} Naish	L_{day} DefraTRL[6]	$L_{Evening}$ Defra TRL	L_{Night} Defra TRL Method 3	L_{den} Defra TRL Method 3
47	44	47	41	51	46	47	39	47
48	45	48	42	52	47	48	39	48
49	46	48	43	52	48	49	40	49
50	47	49	44	53	49	50	41	50
51	48	50	45	54	50	50	42	51
52	49	51	46	55	51	51	43	52
53	50	52	47	56	52	52	44	53
54	51	53	48	57	53	53	45	54
55	52	54	49	58	54	54	46	55
56	53	55	49	59	55	55	47	56
57	54	56	50	59	56	56	48	57
58	55	56	51	60	57	57	48	58
59	56	57	52	61	58	58	49	58
60	57	58	53	62	59	58	50	59
61	58	59	54	63	60	59	51	60
62	59	60	55	64	61	60	52	61
63	60	61	56	65	62	61	53	62
64	61	62	57	66	63	62	54	63
65	62	63	58	67	64	63	55	64
66	63	64	59	67	65	64	56	65
67	64	64	59	68	66	65	57	66
68	65	65	60	69	67	66	57	67
69	66	66	61	70	68	66	58	68
70	67	67	62	71	69	67	39	47

[6] For Defra by TRL and Casella, Method for converting the UK road traffic noise index $L_{A10(18h)}$ to the EU noise indices for road noise mapping, 2006.

The Defra TRL adaption method is applied by countries when noise mapping for END assessments and is appropriate for use in the Transport Agency mapping project. The resulting “adapted” contour values were rounded to the nearest dB contour line and used for quantifying the exposure according to the L_{den} and L_{Night} indicators.

CNOSSOS-EU

To improve consistency and comparability of methods used to assess environmental noise exposures, the EU has developed a standard method for noise mapping named CNOSSOS-EU. The CNOSSOS-EU will apparently become mandatory for all EU member states by 31 December 2018.

The CNOSSOS-EU includes five different classes of vehicles:

1. Light motor vehicles.
2. Medium heavy vehicles.
3. Heavy vehicles.
4. Powered two-wheel vehicles.
5. Open category – To be defined according to future needs.

CNOSSOS-EU provides a set of reference conditions and an extensive list of prescriptive methods for calculating sound power levels for road traffic noise and recommends a “source line” input type as opposed to a “line-source” input type.

The CNOSSOS-EU method is valid for determining noise in the frequency range of 125 Hz to 4 kHz for road traffic and rail noise. The method outputs the L_{den} and L_{Night} statistical parameters. The night-time period used for reference is 11:00 pm to 7:00 am.

It is expected that the calculation algorithm (CRTN) used for the Transport Agency noise mapping will generate outputs in terms of the $L_{10(18h)}$ noise indicator. There is an established method for indicator conversion for road traffic noise between $L_{10(18h)}$ and L_{den} and L_{Night}, that can be applied in the context of investigations into planning noise levels. However, it should be noted that the regression between $L_{10(18h)}$ and L_{Night} is less reliable than the conversion between $L_{10(18h)}$ and L_{den}[7].

CNOSSOS-EU requires that any input parameters that can yield a variation of the predicted results by 2 dB is considered essential and should be included in the calculations. The validity of the calculations in terms of distance is 800 m in the direction normal to the roadway.

The European Economic Area (EEA) has developed a harmonised method of communicating all data-related information associated with noise mapping, known as Electronic Noise Data Reporting Mechanism (ENDRM). Data from noise mapping is uploaded to the ENDRM and subjected to quality control before being included in the database.

[7] A review of road traffic noise indicators and their correlation with the $L_{A10(18\ hour)}$, Naish, Tan and Demirbilek, Acoustics 2011.

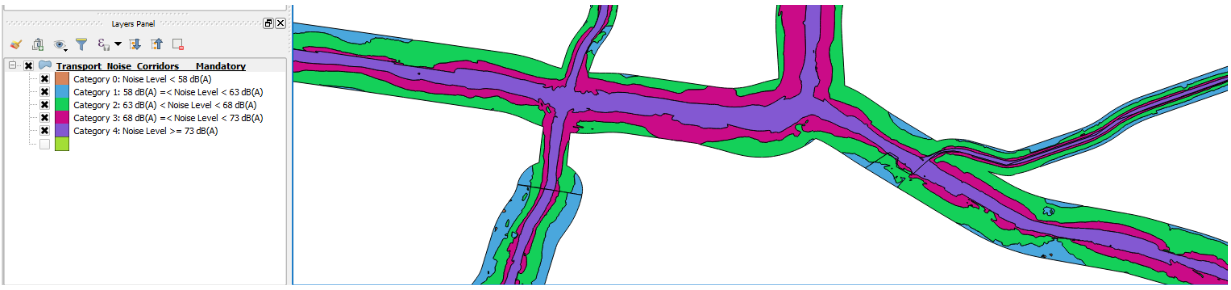
Interactive mapping interface review

The following list includes noise mapping results that were freely available online. AECOM has considered the functionality of the following mapping systems and would incorporate the most useful aspects into the database that will be hosted for the TA mapping project.

- In 2016 the Queensland Government issued updated noise contours for the state controlled and major local Government roads in the Queensland road network. The filled contours can be downloaded as .kmz or .shp file format from the following link:

  https://data.qld.gov.au/dataset/transport-noise-corridors-state-controlled-roads-mandatory

  An image of the $L_{10(18\ hour)}$ road traffic noise data is shown below.



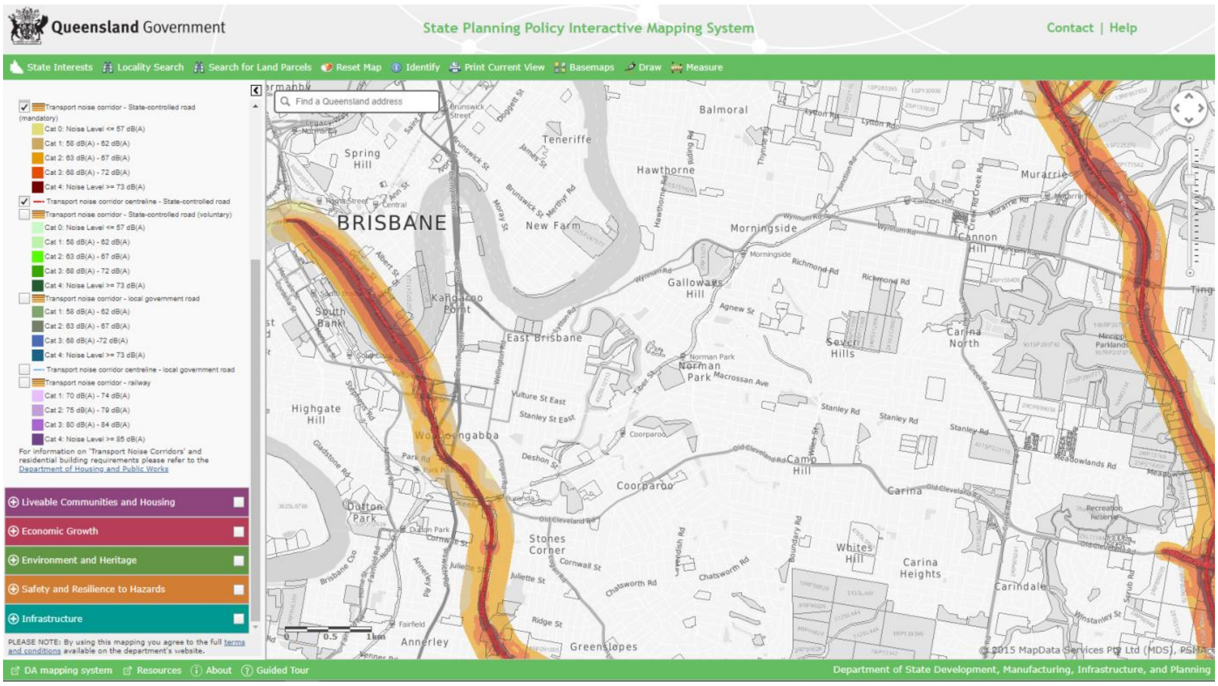
  The Queensland Government State Planning Policy Interactive Mapping System can be accessed here:

  https://spp.dsdip.esriaustraliaonline.com.au/geoviewer/map/planmaking

  The system includes the 5 dB solid fill noise contours as data layers showing the modelled $L_{A10(18h)}$ noise levels. The rail noise contours are also available in L_{Amax}.

  The user interface has some tools to allow for land parcel searches, measurement of distances and printing of search results.

  An image of the $L_{10(18h)}$ road traffic noise data is shown below.



- It is understood that VicRoads have conducted noise mapping of state-controlled roads in their jurisdiction. They have a searchable database of state road alignments, but the maps do not include layers that show any road traffic noise data. The road maps only can be viewed here:

  https://vicroadsmaps.maps.arcgis.com/apps/webappviewer/index.html?id=e8fa54687853433eb58e51584b36f681

- The UK Government prepared road traffic noise maps in 2012 as part of implementing the END, which has been transposed into English law. There was a cover document that explains the data.

  They have made the noise modelling results available to the public at the following link:

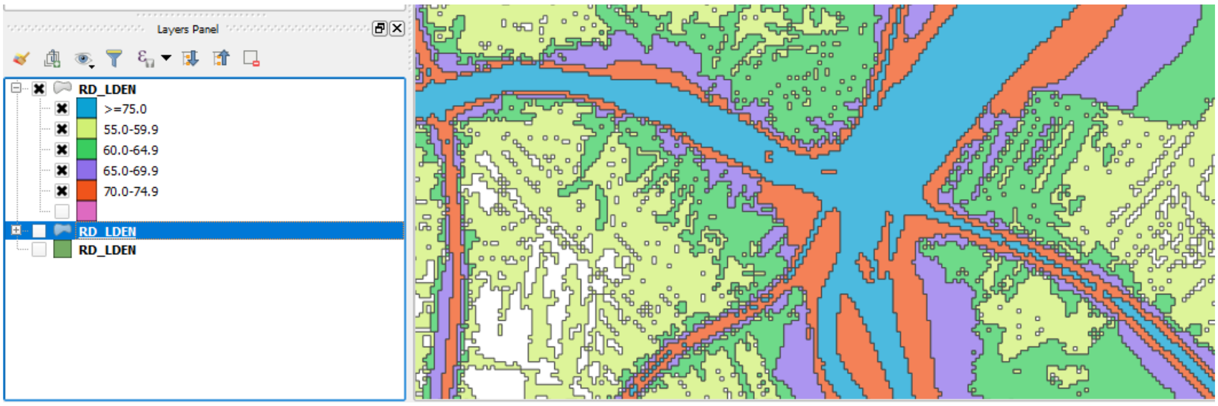
  https://www.gov.uk/government/publications/open-data-strategic-noise-mapping

  The road and rail noise data was available for download as 5 dB solid fill contours in $L_{Aeq(16h)}$, L_{den} and L_{Night}. Urban areas of higher populations were modelled as agglomerations which included the addition of airports and industrial noise sources.

  Noise exposure data is also available that shows the estimated number of people affected by noise from road traffic, railway and industrial sources:

  https://data.gov.uk/dataset/13dbf974-6646-4eef-878d-c1ba2039ead5/noise-exposure-data-england/datafile/60b89fb4-d3c4-4c32-94e2-c02fdb3ec979/preview

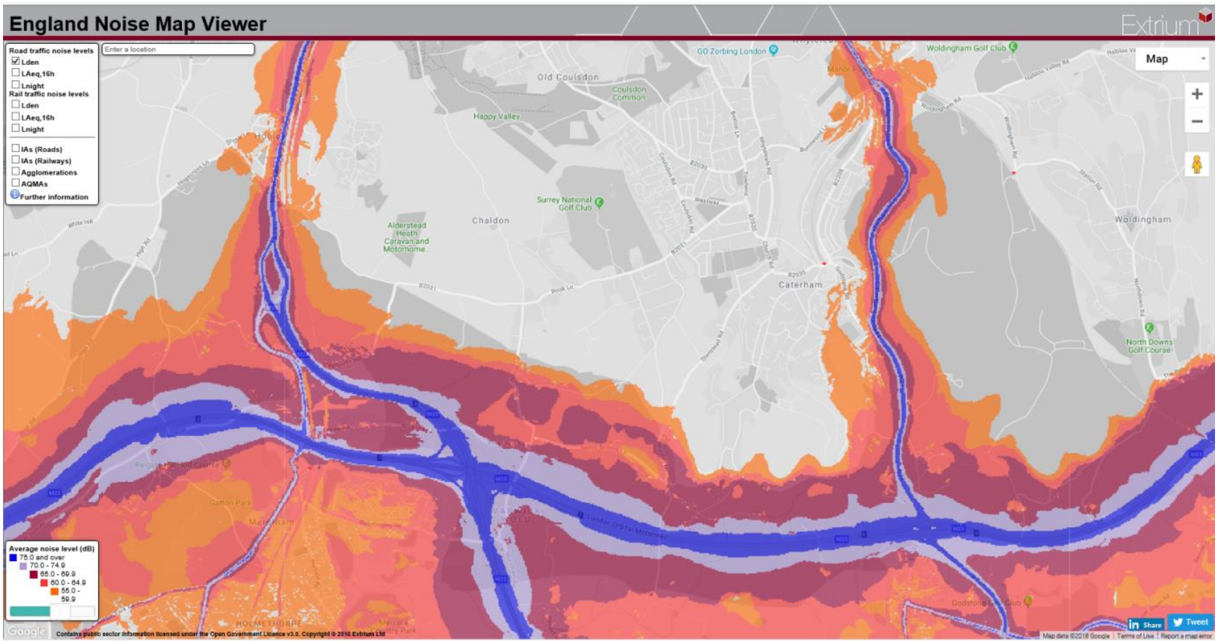
  An image of the L_{den} road traffic noise data is shown below.



  The data is also available on a free user searchable portal here:

  http://www.extrium.co.uk/noiseviewer.html

  An image of the publicly accessible database is shown below.



- The Wales Government prepared road traffic noise maps in 2017 as part of implementing the END. There is a cover page on the web portal that explains the data.

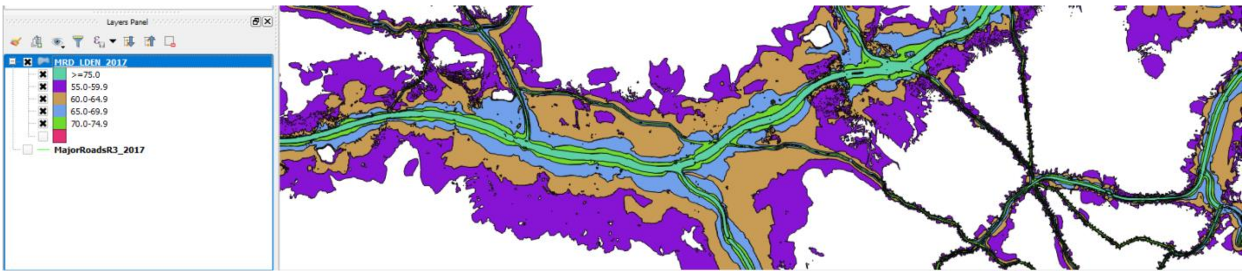
  They have made the noise modelling results available to the public at the following link:

  http://lle.gov.wales/catalogue/item/EnvironmentalNoiseMapping2017/?lang=en

  The road and rail noise model result data is available for download as 5 dB solid fill contours in $L_{A10(18h)}$, L_{den}, L_{day}. and $L_{Aeq(16h)}$(Rail).

  Bridge and tunnel locations were captured from aerial image interpretation.

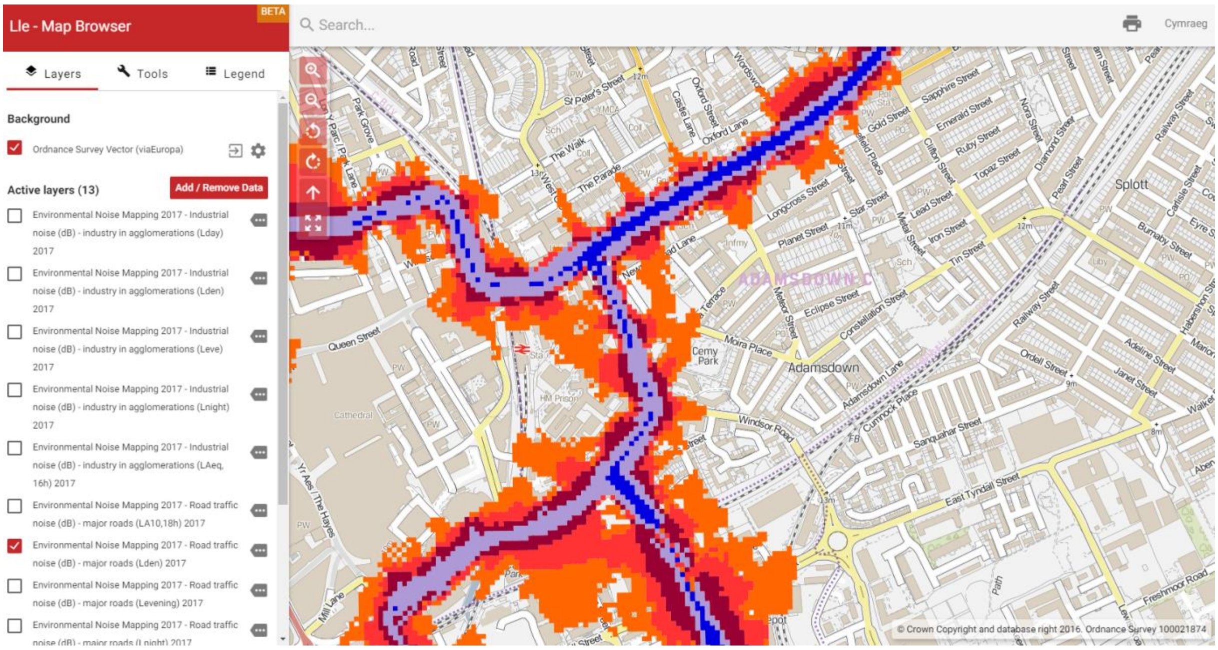
  An image of the L_{den} road traffic noise data is shown below.



  The database can be searched using the Map Browser function where the user can toggle layers of interest:

  http://lle.gov.wales/map#m=-3.15565,51.48164,13&b=europa&l=973;974h;975h;976h;977h;978h;979h;980h;981h;982h;983h;984h;985;

  An image of the L_{den} noise data for traffic noise from major roads is shown below.



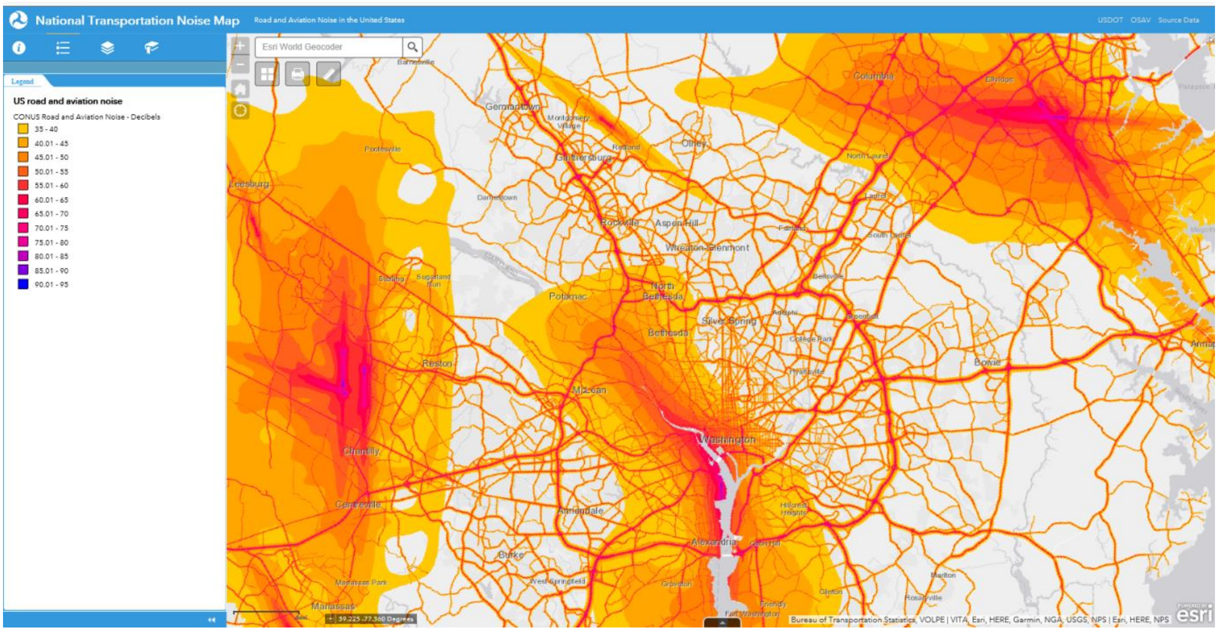
The map browser also has tools that allow the user to measure distance, navigate by coordinate, alter the layer opacity and to print graphics with some available customisation. The user can select a polygon and an interactive legend will present the predicted noise value range of the selected part of the map.

- The US has developed a National Transportation Noise Map that can be searched:

  https://maps.bts.dot.gov/arcgis/apps/webappviewer/index.html?id=a303ff5924c9474790464cc0e9d5c9fb

  The $L_{Aeq(24\ hour)}$ noise contours are presented for road and aviation noise. The model is a worst-case scenario and does not include shielding effects. A summary table of population exposure is also included for 2014.

  An image of the $L_{Aeq(24h)}$ noise data is shown below.



- The Norway Government has developed a searchable noise mapping system here:

  http://www.miljostatus.no/kart/?ma=BDEEF

  The database shows the L_{den} road traffic noise levels for major roads and includes many of the local roads in the highly populated urban areas. It appears that not all the major roads have been included in the modelling.

  An image of the L_{den} noise data for traffic noise is shown below.