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Noise and vibration assessment

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Roads and Maritime Services

Coffs Harbour Bypass

Noise and Vibration Assessment Report

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Executive Summary

This report provides an assessment of operational and construction noise and vibration associated with the development of the proposed Coffs Harbour Bypass. Assessment has been undertaken in accordance with the provisions of the Secretary Environmental Assessment Requirements (SEARs) and supplemented where required with national and international guidance.

Attended and unattended noise monitoring has been conducted across the project area at a total of 25 sites. Noise monitoring data has been used to establish baseline ambient noise levels and to validate the acoustic model. The existing sound environment was observed to be characteristic of rural areas with the Pacific Highway having a significant influence on the prevailing soundscape.

A total of 2310 noise sensitive receivers were included in the noise model for the project. Of the total number of receivers, 2295 are residential and 15 are other noise sensitive receivers out of which 5 are outdoor recreational spaces. To facilitate analysis, noise sensitive receivers were grouped together into 28 noise catchment areas (NCAs) based on areas that are expected to receive similar exposure to future noise from operation and construction of the project.

Development applications for proposed developments within the study area were sought from relevant approval authorities. A total of 6 residential subdivisions have been included in the assessment of at-source noise mitigation requirements for the project. Specific eligibility for at-property treatments with at-source noise mitigation in place vary depending on approval conditions and these have been summarised for each subdivision.

Operational noise and vibration has been assessed within a study area of 600 m for the project. This distance is based on the limit of accuracy of the road traffic noise model used for the assessment and is in accordance with the NSW Road Noise Policy (RNP). For receivers beyond this distance that have the potential to exceed operational noise criteria, further traffic noise monitoring and modelling will be undertaken during detailed design of the project to confirm requirements for additional mitigation including at property treatments.

Road traffic data derived as part of the traffic assessment for the project has been used to predict operational and construction traffic noise impacts. Tube count traffic data obtained during each of the noise monitoring periods has been used to validate the operational noise model.

A base case pavement surface of concrete was assessed for the mainline bypass with existing dense graded asphalt being maintained for the redevelopment of the Pacific Highway north of the Korora Interchange. Ramps at interchanges were also identified as dense graded asphalt.

Operational road traffic noise impacts with and without the project have been assessed for the year of opening (2024) and design year (2034). It is noted that while the full extents of the existing Pacific Highway have not been included in the acoustic model, a reduction in noise impacts through the centre of Coffs Harbour is expected as a result of the introduction of the project.

Exceedances of operational noise criteria have been assessed in accordance with the provisions of the Roads and Maritime Noise Criteria Guideline. Noise mitigation measures have been assessed in accordance with the principles summarised in the Roads and Maritime Noise Mitigation Guideline. A total of 1316 noise sensitive receivers qualify for consideration of mitigation with the introduction of the project.

A low noise pavement alternative to concrete was investigated as a preferred noise mitigation measure to address these receivers. As part of the design, it was a project decision based on community concerns to adopt low noise pavement for the full length of the project. A total of 1009 noise sensitive receivers still qualify for at-property treatment with low noise pavement in place.

A full barrier analysis was undertaken initially, the results of which were coordinated with the design team to identify areas where the installation of earth berms was considered feasible to further reduce noise impacts. An updated terrain model with the earth berms in place was then used to re-analyse optimum noise wall heights and resulting at-property treatment requirements. A full barrier analysis was undertaken with low noise pavement in place where there were groups of four or more closely spaced receivers to identify feasible and reasonable heights and extents to address residual exceedances of the noise criteria. A total of 9 design noise walls of varying heights were identified for the project. 478 noise sensitive receivers, out of which 10 are non-residential noise sensitive receivers, still qualify for at-property treatment with low noise pavement and design height barriers in place.

A qualitative analysis was undertaken of potential change in maximum noise impacts due to the project. Key features such as steep gradients, changes in speed, and changes in geometry were investigated. Noise monitoring data obtained during the environmental noise surveys was also analysed to quantify existing maximum noise level exposure. The overall magnitude of maximum road traffic noise events is not expected to change significantly along existing road corridors where alterations to geometry are minimal. It should be noted that the maximum noise assessment should be used as a tool to help prioritise and rank mitigation strategies but should not be applied as a decisive criterion in itself.

An industrial noise assessment has been undertaken for the proposed relocation of the bus interchange at Korora Public School. Noise impacts have been based on existing timetable information and an expected maximum of eight school buses during morning and afternoon peaks. Predicted noise levels are expected to be below target criteria as derived in accordance with the Noise Policy for Industry with a minor exceedance of 1 dB during the evening period being deemed a negligible residual noise level.

The in-tunnel jet fans for the Gatelys Road and Shephards Lane tunnels have also been considered as part of the industrial noise assessment. These have been assessed considering the infrequent, short duration routine testing. It is expected that testing would be undertaken during daytime periods. The predicted noise level from operation is expected to be below target criteria at all nearby noise sensitive receivers to the tunnel portals.

No development is proposed to the existing North Coast Railway line as a part of the project. An assessment was undertaken of the potential changes in rail noise exposure due changes to the surrounding terrain as a result of construction of the project. A criterion of 2 dB change in noise level was adopted as the assessment criterion as this represents what would be just noticeable difference in noise level. There are no instances of changes greater than 2 dB expected to the train noise levels at nearest affected noise sensitive receivers due to the introduction of the project.

Construction noise and vibration impacts have been based on constructability information available at this stage of development. This includes anticipated zoning, construction activities and equipment, staging, and associated construction traffic.

Construction of the project has been separated into three main zones and seven main stages. Worst case noise impacts to noise sensitive receivers have been calculated using the acoustic model for the project. Construction works are anticipated to take place mostly within standard construction hours across most of the alignment. However, some work may be required during evening and night-time periods due to technical, safety and/or community amenity reasons.

Comparison against standard and out of hours works criteria has been provided for each construction zone and stage along with potential sleep disturbance. Significant exceedances of the Roads and Maritime Construction Noise and Vibration Guideline noise management levels are predicted and have been presented in 5 and 10 dB bands to indicate potential intrusiveness. Exceedances of the criteria are relative to the existing ambient noise level; areas which are further away from the urban centre of Coffs Harbour would experience a greater exceedance of the noise management levels.

A comparison has been made of predicted construction traffic on haulage routes identified for the project against existing traffic flows on those links. Analysis has been contained to within the 600 m study area. Comparative assessment has been undertaken during the daytime period for areas of project remote from the existing Pacific Highway and during the night-time period for areas on the existing Pacific Highway. This is due to the likelihood that out of hours work will be required for these upgrade works.

Construction traffic is expected to increase significantly on collector road links that currently carry very few vehicles. The additional impact of construction vehicles on the existing Pacific Highway is not expected to be as significant due to relatively high existing traffic volumes. A summary of expected noise level increases due to construction traffic noise impacts across the study area is provided to inform planning of management measures once further detail is understood for construction of the project.

Construction groundborne noise has also been assessed to determine an estimate of the likely noise and vibration levels generated by future mechanised bored tunnelling works. This assessment provided indicative distances at which the predicted noise levels are expected to be below the criteria.

A qualitative analysis of potential cumulative impacts due to concurrent construction of other nearby developments has been included. Ten main projects have been identified as potentially occurring adjacent to the project. Specific details of staging and construction for each are not currently known. Should concurrent activities occur, there is a potential that receivers may be exposed to higher cumulative construction noise levels. This would need to be reviewed on a case by case basis once further detail is known.

Vibration screening criteria have been established for both structural damage and human perception along with safe working distances. Further information is provided for heritage structures and other potentially vibration sensitive receivers. Monitoring and condition surveys will be required by the contractor once specific detail is known to ensure structures are adequately protected.

Assessment has been made of potential air blast overpressure and ground vibration associated with blasting. Maximum instantaneous charges have been provided based on distances to the nearest potentially impacts sensitive receivers. This assessment has been undertaken in accordance with the requirements of the SEARs. Further information is provided for consideration regarding more detailed international guidance on blasting for consideration by the contractor where proximity to vibration sensitive structures is expected.

A standard suite of mitigation measures is summarised in accordance with the provisions of the Roads and Maritime Construction Noise and Vibration Guideline. A detailed construction noise and vibration management plan will be required to be developed by the successful contractor once full details of construction methodology and staging are known.

1 Introduction

1.1 The proposed project

Roads and Maritime Services (Roads and Maritime) is seeking approval for the Coffs Harbour Bypass (the project). The approval is being sought under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as Critical State Significant Infrastructure (CSSI).

The project includes a 12 km bypass of Coffs Harbour from south of Englands Road to Korora Hill in the north and a two-kilometre upgrade of the existing highway between Korora Hill and Sapphire. The project would provide a four-lane divided highway that bypasses Coffs Harbour, passing through the North Boambee Valley, Roberts Hill and then traversing the foothills of the Coffs Harbour basin to the west and north to Korora Hill.

The key features of the project include:

- Four-lane divided highway from south of Englands Road roundabout to the dual carriageway highway at Sapphire
- Bypass of the Coffs Harbour urban area from south of Englands Road intersection to Korora Hill
- Upgrade of the existing Pacific Highway between Korora Hill and the dual carriageway highway at Sapphire
- Grade-separated interchanges at Englands Road, Coramba Road and Korora Hill
- A one-way local access road along the western side of the project between the southern tie-in and Englands Road, connecting properties to the road network via Englands Road
- A new service road, located east of the project, connecting Solitary Islands Way with James Small Drive and the existing Pacific Highway near Bruxner Park Road
- Three short tunnels through ridges at Roberts Hill (around 190 m long), Shephards Lane (around 360 m long), and Gatelys Road (around 450 m long)
- Structures to pass over local roads and creeks as well as a bridge over the North Coast Railway
- A series of cuttings and embankments along the alignment
- Tie-ins and modifications to the local road network to enable local road connections across and around the alignment
- Pedestrian and cycling facilities, including a shared path along the service road tying into the existing shared path on Solitary Islands Way, and a new pedestrian bridge to replace the existing Luke Bowen footbridge with the name being retained
- Relocation of the Kororo Public School bus interchange

- Noise attenuation, including low noise pavement, noise barriers and at-property treatments as required
- Fauna crossing structures including glider poles, underpasses and fencing
- Ancillary work to facilitate construction and operation of the project, including:
- Adjustment, relocation and/or protection of utilities and services
- New or adjusted property accesses as required
- Operational water quality measures and retention basins
- Temporary construction facilities and work including compound and stockpile sites, concrete/asphalt batching plant, sedimentation basins and access roads (if required).

1.2 Purpose of this report

This operational and construction noise and vibration assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the Coffs Harbour Bypass for the purpose of seeking project approval under Division 5.2 of the EP&A Act. Table 1 outlines the requirements relevant to this assessment and where they are addressed in the report.

Table 1: SEARS relevant to operational and construction noise and vibration

Secretary's requirement	**Where addressed in this report**
2. Noise and vibration – Amenity	
1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration.	Section 3 Section 4 Section 5

Secretary’s requirement	Where addressed in this report
2. An assessment of construction noise and vibration impacts which must address: (a) the nature of construction activities (including transport, tonal or impulsive noise - generating works and the removal of operational noise barriers, as relevant) (b) the intensity and duration of noise and vibration impacts (both air and ground borne) (c) the nature, sensitivity and impact to receivers (including Bishop Druitt College and Kororo Public School) (d) the need to balance timely conclusion of noise and vibration generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management) (e) the potential for extended standard construction hours and/or works outside standard construction hours, including predicted levels, exceedances and number of potentially affected receivers and justification for the activity in terms of the Interim Construction Noise Guideline (DECCW, 2009) (f) a cumulative noise and vibration assessment inclusive of impacts from other major development projects preparing for or commencing construction in the vicinity of the proposal.	Section 5
3. Noise and vibration – Structural	
1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Section 3 Section 5
2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Section 5.4

The assessment is prepared in accordance with the *Roads and Maritime Services Procedure for Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report* [1].

A glossary of acoustic terminology is provided in Appendix A.

2 Existing ambient noise environment

The project is to be located through predominantly rural areas around the outskirts of Coffs Harbour. The topography of Coffs Harbour is formed such that the bulk of the township is surrounded by steep hills aligning the west and northwest.

The existing Pacific Highway dissects the existing township and passes Coffs Harbour Airport that is located close to the eastern coastline. The North Coast train line also traverses the proposed bypass and accommodates freight train haulage. Aircraft and train passbys contribute transient events to the overall soundscape.

The existing sound environment is characteristic of rural areas with the Pacific Highway having a significant influence on the prevailing soundscape. Depending on proximity to the existing highway, overall daytime ambient noise levels are generally higher than night-time noise levels. This is due to daytime levels being driven up by the volume of light vehicles but significantly reduced during the night-time. The volume of long-haul road freight vehicles becomes proportionally more significant during the night-time period and hence the determinant of road traffic noise disturbance.

With distance from road traffic noise sources, typical rural soundscape elements dominate the soundscape included flora and fauna and the difference between daytime and night-time ambient noise levels is reduced.

2.1 Noise survey

Noise surveys were undertaken at various locations along the proposed route corridor. Noise monitoring locations were selected in coordination with Roads and Maritime noise specialists to establish the following:

- Existing road traffic noise levels for validation of the EIS operational noise model
- Existing baseline noise levels for assessment of relative increases in road traffic noise and to set industrial and construction noise criteria

Locations were chosen taking into account representative areas of potential construction and operational noise impact as well as specific areas of the project raised by the community as particularly sensitive to noise.

Noise monitoring locations are summarised on aerial imagery in Appendix B. A more detailed description of the prevailing sound environment at each monitoring location is provided in Appendix C.

2.1.1 Equipment

The equipment used to survey the existing sound environment is outlined in Table 2. Logger numbers are provided for ease of reference to the information provided in the Appendices.

The L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} noise indices were measured in free-field conditions (i.e. away from noise reflecting structures) with a sample period of 15 minutes.

Environmental noise loggers and sound level meters used in the survey were mounted at 1.5 m above ground level and set to fast time response for all measurements.

All equipment carried current calibration certification at the time of monitoring and was checked for any drift in calibration before and after the monitoring period and no significant deviation had occurred.

Table 2: Summary of noise measurement equipment

Manufacturer	**Equipment**	**Type**	**Logger Number**	**Serial No.**
Brüel & Kjær	Type 1 sound level meter	2250	N/A	2449851
		2270	N/A	2754328
	Sound level calibrator	4231	N/A	2445716
Acoustic Research Laboratories	Environmental noise logger	Ngara Type 1	1	8780D0
			2	8780E6
			3	8780D3
			4	8780E5
			5	87807F
			6	87809E
			7	878012
			8	878060
			9	878079
			10	8780EA
			11	87807B
			12	8780C7
			13	8780E8
			14	8780E6
			15	8780D0
			16	8780D1
			17	878042
			18	878000
			19	878061
			20	87809F
			21	8780D1

2.2 Unattended noise monitoring

Two rounds of long term noise monitoring were conducted during 2016 at a total of 21 locations. The first survey period was carried out between Tuesday 21 June 2016 and Thursday 30 June 2016 with the intention of recording a representative 7-day week prior to the school holiday period commencing Friday 1 July 2016. The second survey was carried out between Monday 28 November 2016 and Monday 12 December 2016 to provide information on the traffic noise impacts to educational institutions and to provide further insight into the impacts of compression braking along the Pacific Highway. The noise monitoring data collected is considered representative of current noise environment and is applicable for the purposes of the noise assessment.

Results of the unattended noise survey have been processed to derive the Rating Background Level (RBL) and L_{Aeq} noise levels for the time periods defined in Section 3 for the assessment of operational noise (in accordance with the NSW Road Noise Policy (RNP)) and construction noise (in accordance with the Roads and Maritime Construction Noise Vibration Guideline (CNVG)).

Weather conditions as recorded at the Coffs Harbour airport weather station throughout the measurement periods were used to exclude noise measurement data where adverse weather was noted as being unsuitable for noise monitoring (i.e. rain > 0 mm, wind speed > 5m/s). Periods of excluded data are clearly identified on noise monitoring results graphs presented in Appendix D. Table 3 provides a tabulated summary of processed long term unattended noise monitoring results.

Table 3: Summary of unattended noise monitoring results

Logger Number	Noise Catchment Area	Logger Purpose	Lot/DP	Property Address	Measured Noise Level (dB(A))							
					CNVG Defined Time Periods[1]						RNP Defined Time Periods[2]	
					RBL			L_{Aeq}			L_{Aeq}	
					Day	Evening	Night	Day	Evening	Night	Day	Night
1	NCA02	Validation	Lot 2311 / DP 1201335	498c-498d Pacific Highway, Boambee, NSW 2450	47	45	39	55	53	51	54	51
2	NCA06	Validation	Lot 101 / DP134857	North Boambee Road, North Boambee Valley, NSW 2450	32	32	31	54	45	44	53	44
3	NCA08	Baseline	Lot 100 / DP1145073	170 North Boambee Road, North Boambee Valley, NSW 2450	42	40	38	54	57	46	56	51
4	NCA13	Validation	Lot 36 / DP865042	12 Tamora Close, Coffs Harbour, NSW 2450	39	32	27	60	56	52	59	52
5	NCA12	Validation	Lot 221 / DP 1049858	20 Bennetts Road, Coffs Harbour, NSW 2450	37	31	30	48	43	42	47	41
6	NCA15	Baseline	Lot 22 / DP819245	263c Shephards Lane, Coffs Harbour, NSW 2450	28	28	28	47	47	47	47	47
7	NCA18	Baseline	Lot 10 / DP 807125	191 Mackays Road, Coffs Harbour, NSW 2450	28	39	28	46	40	38	45	40
8	NCA21	Validation	Lot 22 / DP716144	Opal Shop, 429a-429b Pacific Highway North, Coffs Harbour, NSW 2450	66	59	40	75	74	71	75	71
9	NCA25	Validation	Lot 5 / DP270145	16 Fern Tree Place, Korora, NSW 2450	48	40	34	57	56	54	57	54
10	NCA28	Validation	Lot 7 / DP834748	1 Coachmans Close, Sapphire Beach, NSW 2450	60	50	42	68	67	64	68	65
11	NCA01	Validation	Lot 12 / DP546173	539 Pacific Highway, Boambee, NSW 2450	58	51	39	65	64	61	65	61

Logger Number	**Noise Catchment Area**	**Logger Purpose**	**Lot/DP**	**Property Address**	**Measured Noise Level (dB(A))**							
					CNVG Defined Time Periods[1]						**RNP Defined Time Periods**[2]	
					RBL			**L_{Aeq}**			**L_{Aeq}**	
					Day	**Evening**	**Night**	**Day**	**Evening**	**Night**	**Day**	**Night**
12	NCA14	Baseline	Lot 110 / DP1066077	19 Gillon Street, Coffs Harbour, NSW 2450	28	30	30	44	43	42	45	42
13	NCA18	Baseline	Lot 1 / DP884279	14 Jensen Close, Coffs Harbour, NSW 2450	31	31	29	48	45	48	48	48
14	NCA27	Validation	Lot 1 / DP270147	Paradise Palms, 675 Pacific Highway, Korora, NSW 2450	55	51	42	65	65	62	65	63
15	NCA26	Validation	Lot PT191 / DP752817	Kororo Public School, 3 Korora School Road, Korora, NSW 2450	52	46	37	59	59	55	59	56
16	NCA16	Baseline	Lot 57 / DP1182038	23 Rigoni Crescent, Coffs Harbour, NSW 2450	27	27	25	51	51	53	52	53
17	NCA19	Baseline	Lot 2381 / DP600581	170 West Korora Road, Coffs Harbour, NSW 2450	30	37	30	55	45	42	49	42
18	NCA23	Baseline	Lot 1 / DP1152336	111 Bruxner Park Road, Coffs Harbour, NSW 2450	43	38	34	51	47	46	50	45
19	NCA19	Baseline	Lot 162 / DP1033912	133b Mackays Road, Coffs Harbour, NSW 2450	26	29	28	56	37	45	54	45
20	NCA10	Baseline	Lot 2 / DP 1109067	20 Anniversary Place, Coffs Harbour, NSW 2450	31	30	30	44	38	39	45	39
21	NCA06	Baseline	Lot 1 / DP 1184888	Bishop Druitt College, 111 N Boambee Road, North Boambee Valley, NSW 2450	41	38	35	58	62	52	60	56

[1] Monday to Saturday, Day, 7.00am to 6.00pm; Evening 6.00pm to 10.00pm; Night 10.00pm to 7.00am

Sundays & Public Holidays, Day 8.00am - 6.00pm; Evening 6.00pm - 10.00pm; Night 10.00pm - 8.00 am.

[2] Day, 7.00am to 10.00pm; Night 10.00pm to 7.00am

2.3 Attended noise monitoring

Short term attended noise measurements were undertaken during both the daytime and night-time periods at all long term unattended noise monitoring locations. In addition, attended noise measurements were undertaken at the following 4 locations:

- 38 Korora Basin Road, Korora NSW 2450
- 83 Old Coast Road, Korora NSW 2450
- 111 Spagnolos Road, Coffs Harbour NSW 2450
- 77 Spagnolos Road, Coffs Harbour NSW 2450

This measurement data is used to confirm and further analyse long term measurement data. A summary of measured results is provided in Appendix C along with site observations.

3 Noise and vibration criteria

Assessment criteria for this type of development are generally related to the following noise and vibration characteristics brought about by a scheme;

- Change in the level or character of ambient noise or vibration,
- The average level of noise and vibration exposure,
- The maximum level of the noise or vibration (e.g. during transient events), and
- The duration and time of day at which noise or vibration occurs.

The following sections summarise relevant assessment criteria that address each of these characteristics for both operation and construction.

3.1 Operational noise and vibration

Noise impacts from the ongoing operation of the project are assessed under the criteria summarised in the following:

- Road Noise Policy, NSW Environment Protection Agency, 2011 [2]
- Noise Criteria Guideline, Roads and Maritime Services, December 2014 [3]
- Application Notes – Noise Criteria Guideline [4]
- Noise Mitigation Guideline, Roads and Maritime Services, December 2014 [5]
- Model Validation Guideline, Roads and Maritime Services, May 2018 [6]
- Environmental Noise Management Manual, Roads and Maritime Services, 2001 [7]
- Noise Wall Design Guideline, Roads and Maritime Services, 2007 [8]

3.1.1 Noise Criteria Guideline

Noise criteria are assigned to sensitive receivers using Roads and Maritime Noise Criteria Guideline (NCG). The NCG provides guidance on how to implement the NSW Road Noise Policy (RNP). The NCG sets out the following four key principles aimed to guide the assessment:

- Criteria are based on the road development type that a receiver would be affected by due to the project
- Adjacent and nearby residences should not have significantly different criteria for the same road
- Criteria for the surrounding road network are assessed where a road project generates an increase in traffic noise greater than 2 dB on the surrounding road network

- Existing quiet areas are protected from excessive changes in amenity due to traffic noise

Residences may be assigned new, redeveloped, transition zone or relative increase criteria depending on how the project will influence noise levels. For each façade of the residence the most stringent applicable criteria will be used in the assessment.

Criteria are based on the road development type a residence is affected by due to the project. In some instances, residences may be exposed to noise from both new and redeveloped roads. In this instance, the proportion of noise from each road is used to establish transition zone criteria. A further check is made to prevent large increases in noise level using the relative increase criteria.

The project consists of multiple alternating new and redeveloped road segments as shown in Appendix E with transition zones at the southern tie in of the project at Englands Road and at the interchanges at Coramba Road and Korora Hill. Note that a road is new where the road is a tunnel/bypass or has been substantially realigned (outside the NCG tolerance band and/or existing grade). However, consideration can be given to whether a road has been substantially realigned for distances less than six times the existing lane width using local context for guidance.

Table 4 and Table 5 present a summary of operational noise criteria from the NCG relevant to the project for residential land uses. Where these criteria are exceeded, consideration for mitigation is assessed against criteria presented in Section 4.8.

Table 4: Road traffic noise assessment criteria for residential land uses

Road category	**Type of project/development**	**Total traffic noise level increase – (dB)**	
		Day (7am–10pm)	**Night (10pm–7am)**
Freeway / arterial / sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
	Existing residences affected by noise from new and redevelopment of existing freeway/arterial/sub-arterial roads (Transition zones)1	$L_{Aeq, (15\ hour)}$ 55 - 60 (external)	$L_{Aeq, (9\ hour)}$ 50 - 55 (external)
	New road corridor/ redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq, (15\ hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq, (9\ hour)}$ + 12 dB (external)

Road category	**Type of project/development**	**Total traffic noise level increase – (dB)**	
		Day (7am–10pm)	**Night (10pm–7am)**
Local roads	Existing residences affected by noise from new local road corridors Existing residences affected by noise from redevelopment of existing local roads. Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq, (15 hour)}$ 55 (external)	$L_{Aeq, (9 hour)}$ 50 (external)

The NCG also implements incremental transition zone criteria, identified from the contribution difference in noise from each road type using information provided in Table 5.

Table 5: Assignment of new and redeveloped transition zone criteria

Contribution difference, (dB(A)) New minus redeveloped segments	**Total noise levels, (dB(A))**	
	Daytime criteria	**Night time criteria**
Contribution difference ≥ +3.0	55	50
+3.0 > Contribution difference ≥ +1.5	56	51
+1.5 > Contribution difference ≥ 0	57	52
0 > Contribution difference ≥ -1.5	58	53
-1.5 > Contribution difference ≥ -3.0	59	54
-3.0 > Contribution difference	60	55

Noise contour difference plots that correspond to the corrections above are provided in Appendix E for all transition zones on the project.

Table 6 summarises NCG criteria for non-residential land uses. Where these criteria are exceeded, consideration of mitigation is assessed in accordance with exceeded, consideration for mitigation is assessed against criteria presented in Section 4.8.

Table 6: Road traffic noise assessment criteria for non- residential land uses

Existing sensitive land use	**Assessment criteria – (dB)**		**Additional considerations**
	Day (7am–10pm)	**Night (10pm–7am)**	
School classrooms	$L_{Aeq, (1 hour)}$ 40 (internal) when in use	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the ‘maximum’ levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Hospital wards	$L_{Aeq, (1 hour)}$ 35 (internal)	$L_{Aeq, (1 hour)}$ 35 (internal)	

Existing sensitive land use	**Assessment criteria – (dB)**		**Additional considerations**
	Day (7am–10pm)	**Night (10pm–7am)**	
Places of worship	$L_{Aeq, (1 hour)}$ 40 (internal)	$L_{Aeq, (1 hour)}$ 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria may be applied.
Open space (active use)	$L_{Aeq, (15 hour)}$ 60 (external) when in use	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, e.g. school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
Open space (passive use)	$L_{Aeq, (15 hour)}$ 55 (external) when in use	-	
Childcare facilities	Sleeping rooms $L_{Aeq, (1 hour)}$ 35 (internal) Indoor play areas $L_{Aeq, (1 hour)}$ 40 (internal) Outdoor play areas $L_{Aeq, (1 hour)}$ 55 (external)	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.

For the purpose of assessment, where internal noise targets are stipulated, the corresponding external criterion is taken as 10 dB higher. This is a conservative estimate of the sound attenuation assumed to be provided by the facade of typical buildings when the facade glazing is open for the purpose of ventilation.

The Environmental Noise Management Manual (ENMM) provides a summary of indicative building noise reduction for various construction types. This information is reproduced in Table 7 for reference. Conservative assumptions for noise attenuation across building facades will need to be refined during detailed design.

Table 7: Indicative building noise reduction (ENMM Table 4.2)

Building type	**Windows**	**Internal noise reduction (dB(A))**
All	Open	10
Light frame	Single glazed (closed)	20
Masonry	Single glazed (closed)	25
	Double glazed (closed)	35

3.1.2 Noise Mitigation Guideline

A consistent approach to assessing whether a receiver should be considered for additional mitigation measures as a result of the traffic noise impacts from a road development is provided by Roads and Maritime in the Noise Mitigation Guideline (NMG).

The following principles take precedence over the procedure outlined in the NMG:

- Communities should receive reasonable and equitable outcomes
- Noise mitigation should be designed to reduce noise levels to the criteria at qualifying receivers
- Priority should be first given to reducing noise during corridor planning and road design where there may be greater opportunity to provide cost effective and integrated outcomes with better urban design
- Following corridor and road design residual exceedances of noise criteria may be addressed at qualifying receivers using in order of preference quieter road surfaces, barriers and at-property treatments
- Incidental benefits from the noise mitigation designed for qualifying receivers should be recognised at all receivers within a community where noise levels exceed WHO guidelines (Façade noise levels of 50 dB(A) during day and 45 dB(A) during night-time)
- Noise barrier evaluation processes must:
- Give preference to reducing outdoor noise levels and the number of at-property treatments, and

- Provide efficient barrier heights and extents without disregarding lengths of effective noise barrier in front of eligible groups of receivers
- Noise mitigation shall be evaluated and installed where feasible and reasonable.

Feasible and reasonable definitions as per Roads and Maritime are provided in the NMG.

Table 8 presents a summary of noise mitigation criteria relevant to the project. These criteria are as per the NMG. Receivers that exceed these criteria qualify for consideration of additional mitigation.

Table 8: Road traffic noise assessment criteria for residential land uses

Assessment	**Road type**	**Noise criteria**	
		Day (7am-10pm) **dB $L_{Aeq, (15 hour)}$**	**Night (10pm-7am)** **dB $L_{Aeq, (9 hour)}$**
Cumulative limit	New Road	60	55
	Redeveloped Road	65	60
	Transition Zone	60 – 65[1]	55 – 60[1]
Acute	New and Redeveloped	65	60

[1] Dependant on source contribution as per Section 7.1 of the NCG.

The procedure to determine whether a receiver qualifies for consideration of additional mitigation requires analysis of the specific contribution from new, redeveloped and existing roads is required at each façade. A receiver is to be considered for additional noise mitigation if any of the following three conditions are met during the daytime or night-time periods:

Condition 1:

- The total noise level at the receiver in the build scenario is equal to or greater than the NCG controlling criterion plus 5dB, and
- The total noise level at the receiver in the build scenario minus the contribution from only existing roads in the build scenario at the receiver is greater than 2 dB.

Condition 2:

- The cumulative noise level contribution from all new and redeveloped roads part of the project is equal to or greater than the acute level.

Condition 3:

- The total noise level at the receiver in the build scenario is greater than the NCG controlling criterion, and
- The total noise level at the receiver in the build scenario minus the total noise level at the receiver in the no-build scenario is greater than 2 dB.

3.1.3 Maximum noise level

Maximum noise events, including compression braking, are assessed against the provisions of Practice Note (iii) of the *Environmental Noise Management Manual (ENMM)*. An assessment of the 'emergence' of the A-weighted maximum noise level above the 1-hour equivalent traffic noise level is used as a screening criterion for the assessment of potential sleep disturbance as follows:

$$L_{Amax} \geq L_{Aeq\ (1hour)} + 15\ \mathrm{dB(A)}$$

The following is also noted in the ENMM:

- Maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions
- One or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing.

3.1.4 Industrial noise

The relocation of the Kororo Public School bus interchange and installation of in-tunnel jet fans at the Shephard Lane and Gatelys Road tunnels have been identified as industrial noise sources requiring assessment. Assessment of industrial noise sources is made against the *NSW Noise Policy for Industry (NPI)* [9] which is primarily concerned with controlling short-term intrusive noise impacts for residences and maintaining long-term noise level amenity for residences and other noise sensitive land uses.

The NPI sets out the procedure to determine the project noise trigger levels relevant to an industrial development. The project noise trigger level is a level that, if exceeded would indicate a potential noise impact on the community and so 'trigger' a management response.

3.1.4.1 Intrusive Noise Trigger Level

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5 dB

  (where $L_{Aeq,15minute}$ represent the equivalent continuous noise level of the source)

As the Intrusive Noise Trigger Level is established from the prevailing background noise levels at the residential receiver location, the existing background noise level is to be measured.

3.1.4.2 Recommended and Project Amenity Noise Level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the NPI where feasible and reasonable. An extract from the policy is given below in Table 9.

Table 9: NPI Recommended Amenity Noise Levels (RANLs)

Receiver	**Noise amenity area**	**Time of Day**[1]	**Recommended amenity noise levels (RANLs) L_{Aeq}, dB(A)**[2]
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward			
Internal	All	Noisiest 1-hour	35
External	All	Noisiest 1-hour	50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, gold course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70

Receiver	Noise amenity area	Time of Day[1]	Recommended amenity noise levels (RANLs) L_{Aeq}, dB(A)[2]
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

[1] The NPI defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

(These periods may be varied where appropriate. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$

[2] The Recommended Amenity Noise Levels (RANLs) refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

The Recommended Amenity Noise Levels (RANL) represent the objective for total industrial noise at a receiver location, whereas the Project Amenity Noise Level (PANL) represents the objective for noise from a single industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

- Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A)

The NPI also provides the following exceptions to the above method for deriving the project amenity noise level:

1. In areas with high traffic noise levels.
2. In proposed developments in major industrial clusters.
3. Where the resultant project amenity noise level is equal to or lower than 10 dB than the existing industrial noise level and it can be demonstrated that existing industrial noise levels are unlikely to reduce over time, the project amenity noise levels can be set at 10 dB below existing industrial noise levels.
4. Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.

The NPI also sets the PANLs to $L_{Aeq(period(traffic))}$ minus 15 dB(A) in the case that the level of transport $L_{Aeq(period(traffic))}$ exceeds the RANL by 10 dB or more. This may be applied only if all the following apply:

- Traffic noise is identified as the dominant noise source at the site.
- The existing traffic noise level is 10dB or more above the recommended amenity noise level for the area.
- It is highly unlikely that traffic noise levels will decrease in the future.

The Kororo Public School bus interchange would be located in an area best represented as an urban environment in accordance with the NPI.

The NPI characterises an urban environment as an area that:

- Is dominated by ‘urban hum’ or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources,
- Has through traffic with characteristically heavy and continuous traffic flows during peak periods,
- Is near commercial or industrial districts, or
- Has any combination of the above.

The acoustic environment in the vicinity of the proposed Kororo Public School bus interchange is best described by Logger Location 9 identified in Table 3 and Appendix B. Processed noise logging results from this location are reproduced in Table 10 for reference.

The tunnels would be located at areas identified as rural environments characterised by the NPI as areas with:

- An acoustical environment that is dominated by natural sounds,
- Having little or no road traffic noise,
- Generally characterised by low background noise levels, or
- Settlement patterns would be typically sparse.

The acoustic environment around Gatelys Road tunnel and Shephards Lane tunnel are best described by logger locations 16 and 7 respectively, these are identified in Table 3. Table 10 also includes the processed noise logging results from these locations.

Table 10: Unattended noise monitoring results

Logger location	**Representa-tive Period**	**Rating background level[1]**			**Average L_{Aeq} levels**		
		Day	**Evening**	**Night**	**Day**	**Evening**	**Night**
Residential around bus interchange Logger 9	Weekday	48	41	34	58	57	55
	Weekend	44	38	32	56	54	50
	Week	48	40	34	57	56	54
Residential around Gatelys tunnel Logger 7	Weekday	31	30	28	46	40	39
	Weekend	25	27	26	47	38	36
	Week	28	30	28	46	40	38
Residential around Shephards tunnel Logger 16	Weekday	27	27	25	52	51	53
	Weekend	29	26	24	49	50	53
	Week	27	27	25	51	51	53

[1] where the rating background noise level is found to be less than 30 dB(A) for the evening and night periods, then it is set to 30 dB(A); where it is found to be less than 35 dB(A) for the daytime period, then it is set to 35 dB(A).

Note: Week day is considered the worst-case scenario due to the high frequency of school buses running during the week days.

As discussed in Section 2 and Appendix C, the ambient noise levels at the sensitive receivers near to the proposed bus interchange are characterised by heavy vehicle traffic flows along the existing Pacific Highway. The measured L_{Aeq} ambient noise levels are therefore representative of the L_{Aeq} traffic noise levels experienced in the area.

There are no industrial noise sources in the area and it is unlikely that there will be apart from the proposed bus interchange. Therefore, as stated in item 4 above, the -5 dB(A) correction to the recommended amenity levels does not apply.

Table 11 summarises the RANLs and the PANLs applicable for the project.

Table 11: NPI Recommended and Project Amenity Noise Levels

Receiver	**Indicative Noise Amenity Area**	**Time of day**[1]	**Recommended Amenity Noise Level (RANL) $L_{Aeq(period)}$**	**Existing traffic $L_{Aeq(period)}$ exceeds RANL by 10 dB or more?**	**Other industrial noise sources present?**	**Project Amenity Noise Level (PANL) $L_{Aeq(period)}$**
Residential around bus interchange Logger 9	Urban	Day	60	No	No	60
		Evening	50	No	No	50
		Night	45	Yes (during week days)[2]	No	40[2]
Residential around Gatelys tunnel Logger 7	Rural	Day	50	No	No	50
		Evening	45	No	No	45
		Night	40	No	No	40
Residential around Shephards tunnel Logger 16	Rural	Day	50	No	No	50
		Evening	45	No	No	45
		Night	40	Yes	No	35

Notes

[1] The NPI defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

[2]: Traffic noise levels might decrease in the future in this area due to noise mitigation introduced for the project; in this case, traffic $L_{Aeq(period)}$ would not exceed the RANL by more than 10 dB(A) and the PANL would be equal to the RANL. As a conservative approach it is assumed that traffic noise might still be 10 dB or above RANL and therefore the PANL = RANL – 5 dB(A) for the night-time period

3.1.4.3 Correction factors

The NPI recommends correction factors be implemented for one-off events, such as the testing of in-tunnel fans, where a single noise event is continuous for a period of less than two and a half hours in any assessment period. Table 13 shows the relevant correction factors for each allowable duration of noise as per the NPI.

Table 12: Adjustment for duration

Allowable duration of noise (one event in any 24-hour period)	**Allowable exceedance of $L_{Aeq,15min}$ equivalent project noise trigger level at receptor for the period of the noise event, dB(A)**	
	Daytime and evening (7 am–10 pm)	**Night-time (10 pm–7 am)**
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
Less than 1.5 minutes	20	10

It is anticipated that any testing of in-tunnel ventilation fans will occur during the daytime period and for a period not longer than one hour. Therefore, the project noise trigger level may be increased by +5 dB.

3.1.4.4 Sleep disturbance

The NPI also recommends the following screening criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is greater, and/or;
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is greater.

3.1.4.5 NPI Project specific noise levels

The project specific noise levels are the lower of the Intrusive Noise Trigger Levels and the Project Amenity Noise Levels. However, it is noted that the Intrusive Noise Trigger Levels apply for a 15-minute period while the Project Amenity Noise Levels apply for the whole daytime period (11 hours), evening period (4 hours) and night time period (9 hours). To enable a direct comparison between the two criteria, the NPI aims to standardise the assessment period and assumes that the intrusive noise emissions (over 15 minutes) are generally higher by 3 dB(A) than the amenity noise emissions (over a whole period of the day). Therefore, a 3 dB(A) correction factor is applied to the project amenity noise level ($L_{Aeq, period}$) to get to a project amenity noise level ($L_{Aeq, 15min}$).

The project specific noise levels in accordance with the NPI are highlighted in Table 13.

Table 13: NPI project specific noise levels

Receiver	**Time Period**[1]	**Project Specific Noise Levels**			
		Intrusive Noise Trigger Levels $L_{Aeq(15min)}$	**Project Amenity Noise Level (PANL)**[3] $L_{Aeq(15min)}$	**Sleep Disturbance** $L_{Aeq(15min)}$	**Sleep Disturbance** $L_{Amax(night)}$
Residential around bus interchange Logger 9	Day	**53**	63	N/A[2]	N/A[2]
	Evening	**45**	53	N/A[2]	N/A[2]
	Night	**39**	43	**40**	**52**
Residential around Gatelys tunnel Logger 7[4]	Day	**40**	53	N/A[2]	N/A[2]
	Evening	**35**	48	N/A[2]	N/A[2]
	Night	**35**	43	**40**	**52**
Residential around Shephards tunnel Logger 16[4]	Day	**40**	53	N/A[2]	N/A[2]
	Evening	**35**	48	N/A[2]	N/A[2]
	Night	**35**	38	**40**	**52**

Notes

[1] The NPI defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

[2] N/A Not Applicable

[3] In accordance with NPI, PANLs ($L_{Aeq, period}$) adjusted up by 3 dB for comparison with Intrusive Noise Trigger Levels ($L_{Aeq,15 min}$)

[4] Adjustment for duration not applied

3.2 Construction noise and vibration

Construction noise and vibration is assessed in accordance with the NSW Roads and Maritime Services *Construction noise and vibration guideline* (CNVG) [10], which superseded Section 5 and Practice Note (vii) of the ENMM. The CNVG is to be considered for all Roads and Maritime projects including minor works and maintenance projects but excluding emergency works. It is noted that construction vehicle traffic and traffic diversions are to be assessed and mitigated using standard road traffic noise processes.

The CNVG summarises all criteria to be applied to construction noise and vibration for road projects with reference to the following guidelines:

- Interim Construction Noise Guideline (ICNG), DECC, 2009 [11]
- Road Noise Policy (RNP), 2011 [2]
- Noise Policy for Industry (NPI), 2017 [9]
- Assessing Vibration: a technical guideline, DEC, 2006 [12]

- BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993 [13]
- DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 1999 [14]
- AS 2187:Part 2 - Explosives Storage and Use: Use of explosives 2006 [15]
- BS 6472: Part 2 - Guide to evaluation of human exposure to vibration in buildings. Blast induced vibration 2008 [16]
- Australia and New Zealand Environment Conservation Council (ANZECC) Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration 1990 [17]
- Swedish Standard SS 460 48 66 - Vibration and shock – Guidance Levels For Blasting-Induced Vibration In Buildings 2011 [18]
- Report 429: Groundborne vibration caused by mechanised construction works. Transport Research Laboratory 2000 [19]

3.2.1 Recommended hours of construction

The CNVG recommends construction activities (including the delivery of plant and equipment) should be limited to within the standard hours described in Table 14 below wherever feasible and reasonable.

Table 14: CNVG recommended construction hours

Construction hours	Monday to Friday	Saturday	Sunday / Public holiday
Standard construction hours	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work
Construction activities with impulsive or tonal noise emissions[2]	8:00 am to 5:00 pm[1]	9:00 am to 1:00 pm[1]	No work
Blasting	9:00 am to 5:00 pm	9:00 am to 1:00 pm	No blasting

[1] Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. 'Continuous' includes any period during which there is less than a one-hour respite between ceasing and recommencing any of the work the subject of this condition.

[2] Examples include but are not limited to jackhammers, rock breakers, power saws, rock drilling, vibratory rollers, milling and profiling machines and impact piling

3.2.2 Airborne construction noise

In accordance with the CNVG, construction noise management levels (NMLs) are to be established in accordance with the ICNG. These NMLs are then used to determine the construction noise mitigation measures and control the noise amenity at residences, other sensitive land uses and, commercial and industrial premises.

The following sections discuss NML screening criteria for noise sensitive receiver types.

3.2.2.1 Residential receivers

The ICNG provides an approach for determining the construction NMLs for residential receivers based on the measured Rating Background Level (RBL). The ICNG establishes "Noise affected" and a "Highly noise affected" construction NMLs to determine the noise management requirements necessary to minimise the construction noise impacts upon noise sensitive residential receivers.

Table 15 summarizes the construction noise NMLs for residential receivers.

Table 15: Construction NMLs for residential receivers

Time of day	**Construction NMLs** [1] $L_{Aeq\,(15\,min)}$	**How to apply**
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\,(15\,min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of day	**Construction NMLs** [1] **$L_{Aeq\ (15\ min)}$**	**How to apply**
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Notes:

[1] Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

3.2.2.2 Other sensitive land uses

The CNVG provides recommended noise management levels for sensitive land uses not classified in previous sections. These recommended limits are reproduced in Table 16.

Table 16: ICNG Construction NMLs for other sensitive receivers

Sensitive Land Use	**Management level, $L_{Aeq,15min}$ (applies when properties are being used)**
Classrooms at schools and other educational institutions.	Internal noise level 45 dB(A)
Child care facilities	Internal noise level 45 dB(A) (based on the maximum internal noise level for nurseries in AS 2107)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of Worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Internal noise levels 45 dB(A) (based on the maximum internal noise level for Reading Areas in public libraries in AS2107)

Sensitive Land Use	Management level, $L_{Aeq,15min}$ (applies when properties are being used)
Commercial premises	External noise level 70 dB(A)
Industrial premises	External noise level 75 dB(A)
Other business that may be noise sensitive (such as theatres, etc)	Internal noise level – Project Specific

For sensitive receivers such as hospitals, child care facilities, schools and places of worship, the NMLs presented in Table 16 are based on internal noise levels. For this assessment, it is conservatively assumed that these receivers have openable windows. On the basis that external noise levels are typically 10 dB higher than internal noise levels when windows are open, an external NML of 55 dB $L_{Aeq(15minute)}$ has been adopted. As noted in Section 3.1.1 this is a conservative estimate of the sound attenuation assumed to be provided by the facade of typical buildings when the facade glazing is open for the purpose of ventilation.

For work within standard construction hours, if after implementing all ‘feasible and reasonable’ noise levels still exceed the noise affected level, no further action is required.

For out-of-hours work, a noise level 5 dB above the noise-affected level as a threshold where the proponent should negotiate with the community. While there is no ‘highly-noise affected level’ outlined in the ICNG for out-of-hours work, this report adopts the terminology where the construction noise level is 5 dB above the noise affected level.

3.2.2.3 Sleep disturbance

Factors that are important in assessing the extent of noise impact include how often high noise events occur at night, the predicted maximum noise levels at night, whether there are times when there is a clear change in the noise environment, and the extent of noise emergence above the background noise. EPA's management level for assessing and managing construction noise is established with reference to a single digit rating background noise level (RBL) for the day, evening and night-time period. Using RBL is a conservative assessment approach as RBL is derived based on time periods where the lowest 10th percentile background noise level might occur.

For the assessment of noise disturbance during waking hours, the assessment adopts the equivalent sound pressure level indicator, L_{Aeq}. For screening potential awakening reactions, the assessment adopts the maximum noise level indicator, L_{Amax}. Both the L_{Aeq} and L_{Amax} assessment indicators are consistent with EPA's ICNG, and noise impact is assessed with reference to the RBL. The outcome of this approach coupled with worst case construction noise prediction is that the emergence above background noise will be conservatively over-estimated to ensure that the noise management level can be met for at least 90% of the time periods over which disturbance can occur.

3.2.2.4 CNVG

Appendix E of the CNVG refers to a 65 dB L_{Amax} external noise level as a sleep disturbance criterion which corresponds to the now superseded ENMM criteria (considering a 10 dB reduction from external level to internal level with windows open). For reference, the ENMM stated the following:

- Maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions
- One or two noise events per night with maximum internal noise levels of 65-70 dB(A) are not likely to significantly affect health and wellbeing.

The CNVG describes the L_{Amax} as:

> "The L_{Amax} represents the "Maximum Noise Level" for an event, used in the assessment of potential sleep disturbance during night-time periods. The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristic (i.e. A-weighted). "Fast" time constant is used for this measurement."

3.2.2.5 ICNG

The ICNG also states the above-mentioned criteria and refers to the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA 1999) for assessment of sleep disturbance. The ECRTN discusses a guideline aimed at limiting the level of sleep disturbance due to environmental noise – that the $L_{AF1,1\text{-minute}}$ level of any noise should not exceed the ambient L_{AF90} noise level by more than 15 dB. The $L_{AF1,1\text{-minute}}$ descriptor is meant to represent a maximum noise levels equivalent to the L_{Amax} for the assessment of sleep disturbance.

The ICNG indicates that important factors to look at in assessing the extent of impact on sleep disturbance is how often high noise events occur at night, whether there are times when there is a clear change in the noise environment and the degree of maximum noise levels above the background noise level at night.

It is noted that most receiver locations across the project study area currently experience very low ambient background noise levels, particularly during the night-time period. Considering this and to protect the community against significant health impacts, this assessment has been undertaken using the ICNG and CNVG 'screening criterion' of RBL + 15 dB and maximum external 65 dB(A) criterion (Awakening reaction) as being the most stringent of the quoted literature.

3.2.2.6 Project specific construction NMLs

Measured noise data obtained at the logger location most representative of each noise catchment area has been used to derive appropriate construction NMLs for the project. These are summarised in Table 17.

The noise monitoring locations were selected to capture background noise levels at the typically most affected receiver locations in the various catchments along the alignment. The most affected receivers are usually front row receivers which have a direct line of sight to the construction works.

Refer to Appendix B for the location of the Noise Catchment Areas (NCAs).

Table 17: Construction NMLs during intended working hours

Location	**Logger ID**	**RBL, dB(A) (Refer to Section2.2)1**			**Construction NMLs, $\text{dBL}_{\text{Aeq 15minute}}$**					**Sleep Disturbance, dBL_{Amax}**	
					Standard Hours		**Outside of Standard Hours**				
		Daytime	**Evening**	**Night-time**	**Highly noise affected**	**Noise affected (RBL + 10 dB)**	**Noise affected (RBL + 5dB)**			**Screening criterion RBL + 15**	**Max**
					Standard Hours - Day[3]	**Standard Hours – Day[3]**	**OOSH – Day[4]**	**OOSH – Evening[5]**	**OOSH – Night-time[6]**		
Residential											
NCA 1	11	58	51	39	75	68	63	56	44	54	65
NCA 2	1	47	45	39	75	57	52	50	44	54	65
NCA 3	1	47	45	39	75	57	52	50	44	54	65
NCA 4	1	47	45	39	75	57	52	50	44	54	65
NCA 5	2	35	32	31	75	45	40	37	36	46	65
NCA 6	2	35	32	31	75	45	40	37	36	46	65
NCA 7	3	35	34	36	75	45	40	39	41	51	65
NCA 8	3	35	34	36	75	45	40	39	41	51	65
NCA 9	20	35	30	30	75	45	40	35	35	45	65
NCA 10	20	35	30	30	75	45	40	35	35	45	65
NCA 11	4	39	32	30	75	49	44	37	35	45	65
NCA 12	5	37	31	30	75	47	42	36	35	45	65
NCA 13	4	39	32	30	75	49	44	37	35	45	65
NCA 14	12	35	30	30	75	45	40	35	35	45	65
NCA 15	6	35	30	30	75	45	40	35	35	45	65
NCA 16	16	35	30	30	75	45	40	35	35	45	65

Location	Logger ID	RBL, dB(A) (Refer to Section2.2)1			Construction NMLs, dBL$_{Aeq\ 15minute}$					Sleep Disturbance, dBL$_{Amax}$	
					Standard Hours		Outside of Standard Hours				
		Daytime	Evening	Night-time	Highly noise affected	Noise affected (RBL + 10 dB)	Noise affected (RBL + 5dB)			Screening criterion RBL + 15	Max
					Standard Hours - Day[3]	Standard Hours – Day[3]	OOSH – Day[4]	OOSH – Evening[5]	OOSH – Night-time[6]		
NCA 17	19	35	30	30	75	45	40	35	35	45	65
NCA 18	13-72	35	31	30	75	45	40	36	35	45	65
NCA 19	19	35	30	30	75	45	40	35	35	45	65
NCA 20	13-72	35	31	30	75	45	40	36	35	45	65
NCA 21	8	65	53	38	75	75	70	58	43	53	65
NCA 22	8	65	53	38	75	75	70	58	43	53	65
NCA 23	18	43	38	34	75	53	48	43	39	49	65
NCA 24	9	48	40	34	75	58	53	45	39	49	65
NCA 25	9	48	40	34	75	58	53	45	39	49	65
NCA 26	15	52	46	37	75	62	57	51	42	52	65
NCA 27	14	56	47	38	75	66	61	52	43	53	65
NCA 28	10	60	50	42	75	70	65	55	47	57	65
NCA29	14	56	47	38	75	66	61	52	43	53	65
Commercial	-	Use hours			-	70				-	-
Educational	-	Use hours			-	55				-	-
Hospital	-	Use hours			-	45				-	-
Place of worship	-	Use hours			-	55				-	-
Child care facilities	-	Use hours			-	45				-	-

Note 1: The RBLs have been adjusted in accordance with the NPI definition of minimum RBLs (daytime – 35 dB(A), Evening – 30 dB(A), Night-time – 30 dB(A))

Note 2: Minimum of monitoring location 7 and 13

Note 3 - 07:00-18:00 Monday to Friday, 08:00-13:00 Saturday

Note 4 - Outside Standard hours – Day 13:00-18:00 Saturday, 08:00-18:00 Sunday

Note 5 - Outside Standard hours – Evening: 18:00-22:00 Monday to Sunday

Note 6 - Outside Standard hours – Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

3.2.3 Ground-borne construction noise

Ground-borne noise is generated from underground vibration-intensive works which may be transmitted through the ground into a building structure. This is a potential impact of the works involved in the construction of tunnels. The CNVG establishes criteria for ground-borne construction noise which is presented in Table 18.

Table 18: Ground-borne noise criteria

Time of day	**Ground-borne noise objectives $L_{Aeq(15minute)}$**
Daytime 7.00 am to 6.00 pm	Human comfort vibration objectives only
Evening 6.00 pm to 10.00 pm	40 dB(A) - Internal
Night-time 10.00 pm to 7.00 am	35 dB(A) - Internal

3.2.4 Construction road traffic noise

Noise emissions from trucks and other vehicles when travelling on a construction site are included in the overall construction site emissions which are assessed against the CNVG (which refers to the ICNG).

Noise emissions from trucks and other vehicles when travelling on the public roads are considered as additional road traffic noise and are assessed against the CNVG (which refers to the RNP).

When assessing noise impact from construction vehicles using the existing road network, an initial screening test is first undertaken by evaluating whether noise levels are expected to increase by more than 2 dB(A) due to construction traffic or a temporary reroute due to a road closure.

Where noise levels are predicted to increase by more than 2 dB(A) (i.e. 2.1 dB or greater) further assessment is required to be conducted in accordance with the RNP. The relevant section of the RNP is given below in Table 19.

Table 19: RNP criteria for assessing construction vehicles on public roads

Road Category	**Type of Project/Land Use**	**Assessment Criteria (dB(A))**	
		Daytime (7 am - 10 pm)	**Night-time (10 pm - 7 am)**
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

3.2.5 Ground-borne construction vibration

Criteria for construction vibration must address:

- The potential for disturbance and annoyance to building occupants (Human comfort vibration, Section 3.2.5.1)
- The potential damage to contents within a building, and
- The potential for damage to buildings and other structures.

Ground vibration is assessed in accordance with the CNVG which refers to the NSW “Assessing Vibration; a technical guideline” with regards to human comfort and to BS 7385 and DIN 4150 for damage to buildings.

3.2.5.1 Human comfort

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC ‘*Assessing Vibration; a technical guideline*’. The criteria outlined in the guideline is based on the British Standard BS 6472-1992 ‘*Evaluation of human exposure to vibration in buildings (1-80Hz)*’. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 20.

Table 20: Types of vibration – Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers, crushing. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Table 21 reproduces the ‘Preferred’ and ‘Maximum’ values for continuous and impulsive vibration from Table 2.2 of the Guideline.

Table 21: Preferred and maximum vibration acceleration levels for human comfort, m/s^2

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration (weighted RMS acceleration, m/s2, 1-80Hz)					
Critical areas2	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s2, 1-80Hz)					
Critical areas2	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes

[1] Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

[2] Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Alternative criteria are outside the scope of the policy and other guidance documents should be referred to.

Table 22 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration from Table 2.4 of the Guideline.

It is noted that the VDV is dependent upon the level and duration of the vibration episode and the number of vibration episodes occurring during the assessment period.

Table 22: Acceptable vibration dose values (VDV) for intermittent vibration ($m/s^{1.75}$)

Location	**Daytime[1]**		**Night-time[1]**	
	Preferred value	**Maximum value**	**Preferred value**	**Maximum value**
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

[1] Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

[2] Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous of impulsive criteria for critical areas.
Source: BS 6472-1992

3.2.5.2 Structural damage

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with BS7385-2. BS7385-1, defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 and section 7.4.2 of BS7385-2 sets limits for the protection against the different levels of structural damage and those levels are reproduced below.

Table 23: BS 7385-2 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes:

[1] Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

[2] Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

The guide values in Table 23 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 23 may need to be reduced by up to 50%.

Monitoring should be undertaken at strategic locations before and during construction to measure the Peak Particle Velocity at the structure and to check that the Peak Particle Velocity remains below the guide values in Table 23. Exceedances of those guide values might indicate that resonance has been activated in the structure. Reduction of the guide value and potential further investigations would then be required.

3.2.5.3 Heritage Buildings

Regarding heritage buildings, British Standard 7385 Part 2 (1993, p.5) notes that heritage buildings should be assessed on a case by case basis and that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*".

If a heritage building has been identified as potentially sensitive to vibrations, the German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure*' (DIN 4150-3), which is more conservative than BS 7385 criteria, should be applied.

The DIN 4150 criteria for short term vibration are presented in Table 24. For heritage buildings, criteria associated with group 3 should be used.

Table 24: DIN 4150-3 structural damage criteria – Short term vibration

Group	**Type of structure**	**Vibration velocity, mm/s**			
		At foundation at frequency of			**Vibration at horizontal plane of highest floor**
		1 Hz to 10 Hz	**10 Hz to 50 Hz**	**50 Hz to 100 Hz**	**All frequencies**
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3 to 8	8 to 10	8

Note that short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated.

Buried Services

DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework and reproduced in Table 25 below.

Table 25: Guideline values for short-term vibration impacts on buried pipework

	Pipe material	**Guideline values for vibration velocity measured on the pipe, mm/s**
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Note: For gas and water supply pipes within 2m of buildings, the levels given in Table 25 should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

The guideline values above may be reduced by 50% without further analysis when evaluating the effects of long-term vibration on buried pipework.

Note that short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated.

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid’s *Specification for Safe Working in the Vicinity* *of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties* (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/s the ground vibration is required to be monitored.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out to identify and manage impacts on potentially vibration sensitive infrastructure.

3.2.6 Blasting

In accordance with the CNVG, preliminary assessment of ground vibration and blast over pressure is to be undertaken where blasting is anticipated. The CNVG refers to AS2187, BS6472 and BS7385-2 for assessment.

Ground vibration and air blast (also called blast overpressure) are two environmental impacts from blasting. Ground vibration from blasting is the radiation of mechanical energy within a rock mass or soil. Air blast is the pressure wave (sound) produced by the blast and transmitted through the air.

The air blast is generally more noticeable than the ground vibration and the cause of more complaints than ground borne vibration. High levels of vibration transmitted through the ground and the air blast could annoy residents, or in the extreme, cause damage to buildings or structures.

Appendix J of AS2187.2:2006 provides general guidance on appropriate limits for ground vibration and air blast overpressure from blasting.

With respect to the criteria presented, AS2187 notes the following:

- A sensitive site includes houses and low rise residential buildings, theatres, schools, and other similar buildings occupied by people
- The table does not cover high-rise buildings, buildings with long-span floors, specialist structures such as reservoirs, dams and hospitals, or buildings housing scientific equipment sensitive to vibration
- The recommendations are informative only.

Building damage is unlikely to be caused below these vibration levels and below the overpressure limits. Studies and experience show that well designed and controlled blasts are unlikely to create ground vibrations of a magnitude that causes damage. Also, it is noted that cracks in buildings may be attributable to causes other than ground vibration, including ground or foundation movements (settlement and swell) associated with reactive clay soils during periods of prolonged dry or wet weather.

The Maximum Instantaneous Charge (MIC) will typically be limited to prevent unacceptable levels of air overpressure and noise.

Should levels be predicted to increase beyond those outlined below, written agreements would be sought with affected landowners.

3.2.6.1 Ground vibration limits

AS2187 recommended limits for ground vibration associated with blasting are summarised in Table 26.

Table 26: AS2187 recommended ground vibration limits for blasting

Category	Type of blasting operations	Peak component particle velocity (mm/s)
Human comfort limits		
Sensitive site*	Operations lasting longer than 12 months or more than 20 blasts	5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Sensitive site*	Operations lasting for less than 12 months or less than 20 blasts	10 mm/s maximum unless agreement is reached with occupier that a higher limit may apply
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	25 mm/s maximum unless agreement is reached with occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer’s specifications or levels that can be shown to adversely affect the equipment operation
Structural control limits		
Other structures or architectural elements that include masonry, plaster and plasterboard in their construction	All blasting	Frequency-dependent damage limit criteria Tables J4.4.2.1 and J4.4.4.1 of the standard.
Unoccupied structures of reinforced concrete or steel construction	All blasting	100 mm/s maximum unless agreement is reached with the owner that a higher limit may apply
Service structures, such as pipelines, powerlines and cables	All blasting	Limit to be determined by structural design methodology

3.2.6.2 Air blast overpressure limits

AS2187 recommended limits for air blast overpressure associated with blasting are summarised in Table 27.

Table 27: AS2187 recommended air blast overpressure limits for blasting

Category	**Type of blasting operations**	**Peak component particle velocity (mm/s)**
Human comfort limits		
Sensitive site*	Operations lasting longer than 12 months or more than 20 blasts	115 dBL for 95% blasts per year. 120 dBL maximum unless agreement is reached with occupier that a higher limit may apply
Sensitive site*	Operations lasting for less than 12 months or less than 20 blasts	120 dBL mm/s for 95% blasts. 125 dBL maximum unless agreement is reached with occupier that a higher limit may apply
Occupied non-sensitive sites, such as factories and commercial premises	All blasting	125 dBL maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation
Damage control limits		
Structures that include masonry, plaster and plasterboard in their construction and also unoccupied structures of reinforced concrete or steel construction	All blasting	133 dBL maximum unless agreement is reached with the owner that a higher limit may apply
Service structures, such as pipelines, powerlines and cables	All blasting	Limit to be determined by structural design methodology

The ANZECC document acknowledges that there could be some exceedance of the overpressure limit of 115 dB and the ground vibration limit of 5 mm/s on infrequent occasions. This should be limited to not more than 5% of total blasts. During this time, the overpressure level should not exceed 120 dB at any time and the ground vibration limit should not exceed 10 mm/s at any time.

3.2.6.3 Swedish standard SS 460 48 66

Swedish Standard SS460 48 66 [18] summarises a method for a more detailed calculation of vibration from blasting for different types of buildings and ground conditions. The guidance levels are for the peak particle velocity monitored in vertical direction. The Swedish Standard accounts for the type of frequencies generated by the blast, travelling through the ground and within the structures.

Screening criteria and calculations provided in AS2187 have been used as the basis of this assessment in alignment with SEARs requirements for the EIS. For locations where a more detailed understanding of potential vibration impacts from blasting is required due to proximity to sensitive structures, it is recommended that the Swedish standard SS 460 48 66 be referenced with assistance from a specialist consultant.

4 Operational noise and vibration assessment

4.1 Study area

The project assessment area extends to a maximum width of about 600 metres either side of the project. This distance is based on the limit of accuracy of the road traffic noise model used for the assessment and is in accordance with the RNP. For the rural areas of the project, the criteria provided in Section 3 may still be exceeded beyond 600 metres. The potential for these exceedances will be investigated during detailed design with further traffic and noise monitoring and modelling being undertaken to confirm requirements for additional mitigation including at property treatments. The project assessment area is shown in Appendix B.

4.2 Noise sensitive receivers

Noise sensitive receivers aligning the project area are predominantly residential with a limited number of non-residential noise sensitive receivers. Non-residential receiver locations have been summarised in Table 28. Where these receivers are within the study area, they have been summarised in Appendix G and shown on the maps in Appendix B. To assist with identification, building IDs have also been provided in Table 28 for cross reference against Appendices.

Table 28: Non-residential noise sensitive receiver locations

Receiver type	**Description**	**Building ID**	**Address**
Education	Kororo Public School	NCA26.SCH.0001.01	3 Korora School Road, Korora NSW 2450
	Bishop Druitt College	NCA06.SCH.0001.01	111 N Boambee Road, North Boambee Valley NSW 2450
	Coffs Harbour Montessori Preschool	NCA26.SCH.0002.01	27 James Small Dr, Korora NSW 2450
	NSW School of Natural Medicine[1]	NCA08.SCH.0008.01	202 N Boambee Road, North Boambee Valley NSW 2450
Health	Coffs Harbour Health Campus	NCA05.HOS.0001.01	345 Pacific Hwy, Coffs Harbour NSW 2450
	Coffs Harbour GP Super Clinic	NCA03.HOS.0001.01	51 Stadium Drive, Coffs Harbour NSW 2450
Places of Worship	The Foursquare Church Australia	NCA05.POW.0001.01	10/12 Elswick Pl, North Boambee Valley NSW 2450

Receiver type	Description	Building ID	Address
	Bishop Druitt School Chapel	NCA06.POW.0001.01	111 N Boambee Road, North Boambee Valley NSW 2450
Active recreation	Coffs coast sport and leisure field	NCA03.ARA.0001.01 To NCA03.ARA.0004.01	Stadium Drive, Coffs Harbour NSW 2450
	Boambee equestrian Centre (Outdoor grassed riding area)	NCA02.ARA.0001.01	498a Pacific Highway, Coffs Harbour NSW 2450
	Pacific Bay Resort Golf Course	NCA22.ARA.0001.01	Cnr Pacific Hwy and Bay Drive, Coffs Harbour NSW 2450
	Elite Training Centre Pacific Bay Resort	NCA21.ARA.0001.01	Lot 5 DP 820652, West Korora Road, Coffs Harbour NSW 2450
Passive recreation	Kororo Nature Reserve	NCA23.PAS.0001.01	Korora NSW 2450
Child care facilities	Petit Early Learning Journey Coffs Harbour	NCA05.CCF.0001.01	1 Kiddell Pl, North Boambee Valley NSW 2450
	Cow & Koala Professional Child Care	NCA13.CCF.0001.01	15 William Sharp Dr, Coffs Harbour NSW 2450

[1] It is noted that this receiver is no longer operational, however, has been retained for the purpose of this assessment.

Appendix B provides an aerial image that depicts all receivers within the study area classified by type.

4.3 Noise catchment areas

Noise sensitive receiver locations within the study area were determined using a combination of the following resources:

- Aerial imagery (captured July 2018);
- Council databases (March 2018);
- Noise survey site visits (June/November 2016); and
- Ground truthing of temporary accommodation sites at Koala Villas & Caravan Park and Bananacoast Caravan Park (August 2018)

Noise sensitive receivers within the study area are predominantly rural residential. There are a small number of non-residential receivers in proximity to the proposed alignment which are summarised in Table 28.

To facilitate analysis, noise sensitive receivers were grouped together into 28 noise catchment areas (NCAs) based on areas that receive similar exposure to future noise from operation and construction of the project. Noise catchment areas are numbered and clearly identified on aerial images in Appendix B along with identification of individual receiver types.

4.3.1 Approved Development Applications

Development Applications for proposed developments within the study area were sought from relevant approval authorities. Available applications lodged to date have been considered in the assessment and are discussed in this section. The responsibility to provide at-property treatments to mitigate traffic noise impacts from the project varies in each case depending on the approved DA conditions.

The five approved residential subdivisions considered as part of this assessment are:

- Elements Estate, near the Englands Road Interchange
- Highlands Estate, near North Boambee Road
- The Lakes Estate, near North Boambee Road
- Sunset Ridge Estate, near Shephards Lane;
- Pacific Bay Eastern Lands, near James Small Drive; and
- Korora Residential Subdivision, near Opal Boulevard

Each of the above listed subdivisions is shown on aerial imagery for the project in Figure 1 and on corresponding noise prediction maps in Appendix G.

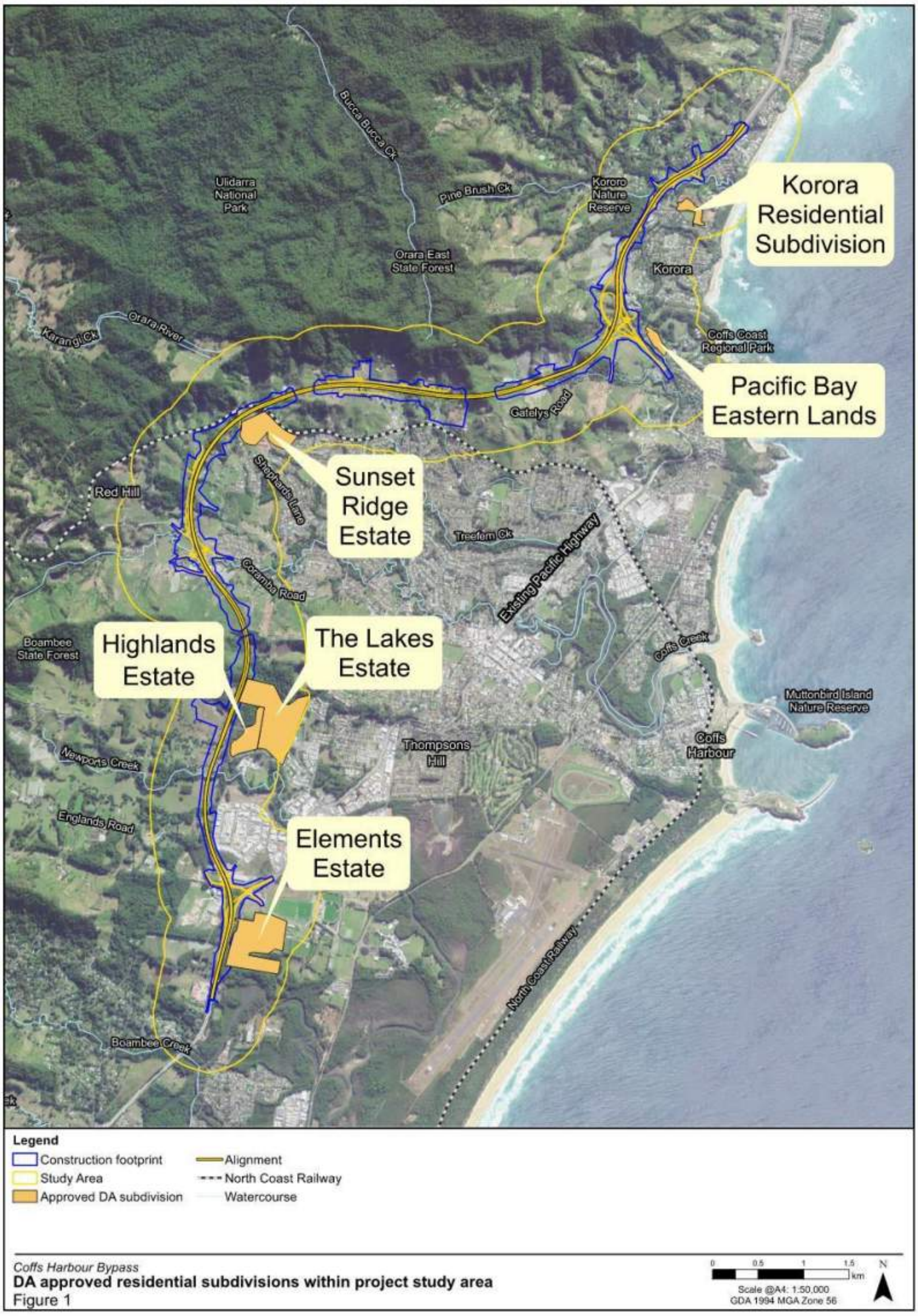


Figure 1: DA approved residential subdivisions within project study area

For reference, each approved subdivision is depicted in Figure 2 through Figure 7.

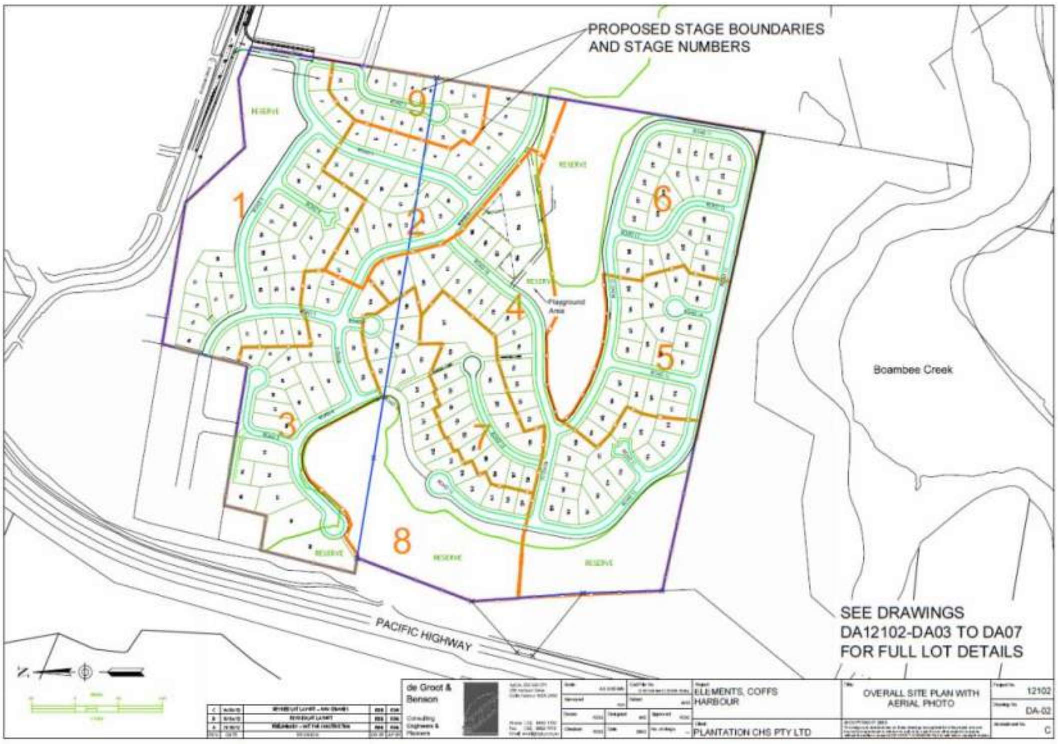


Figure 2: Approved residential subdivision – Elements Estate

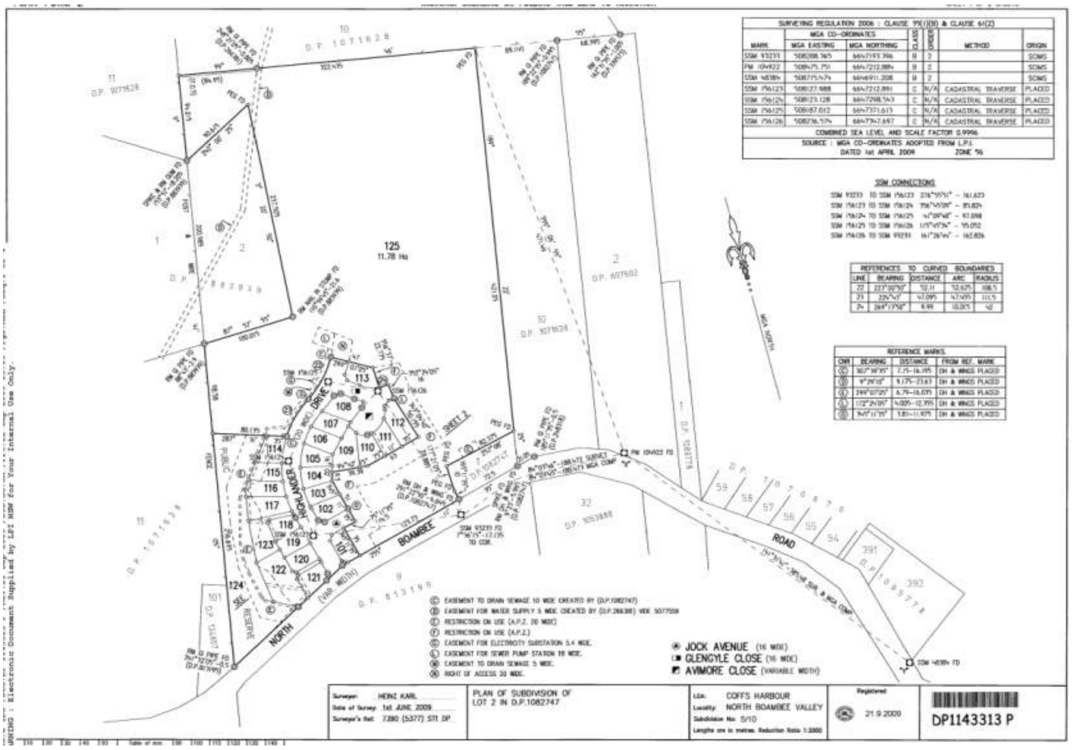


Figure 3: Approved residential subdivision – Highlands Estate

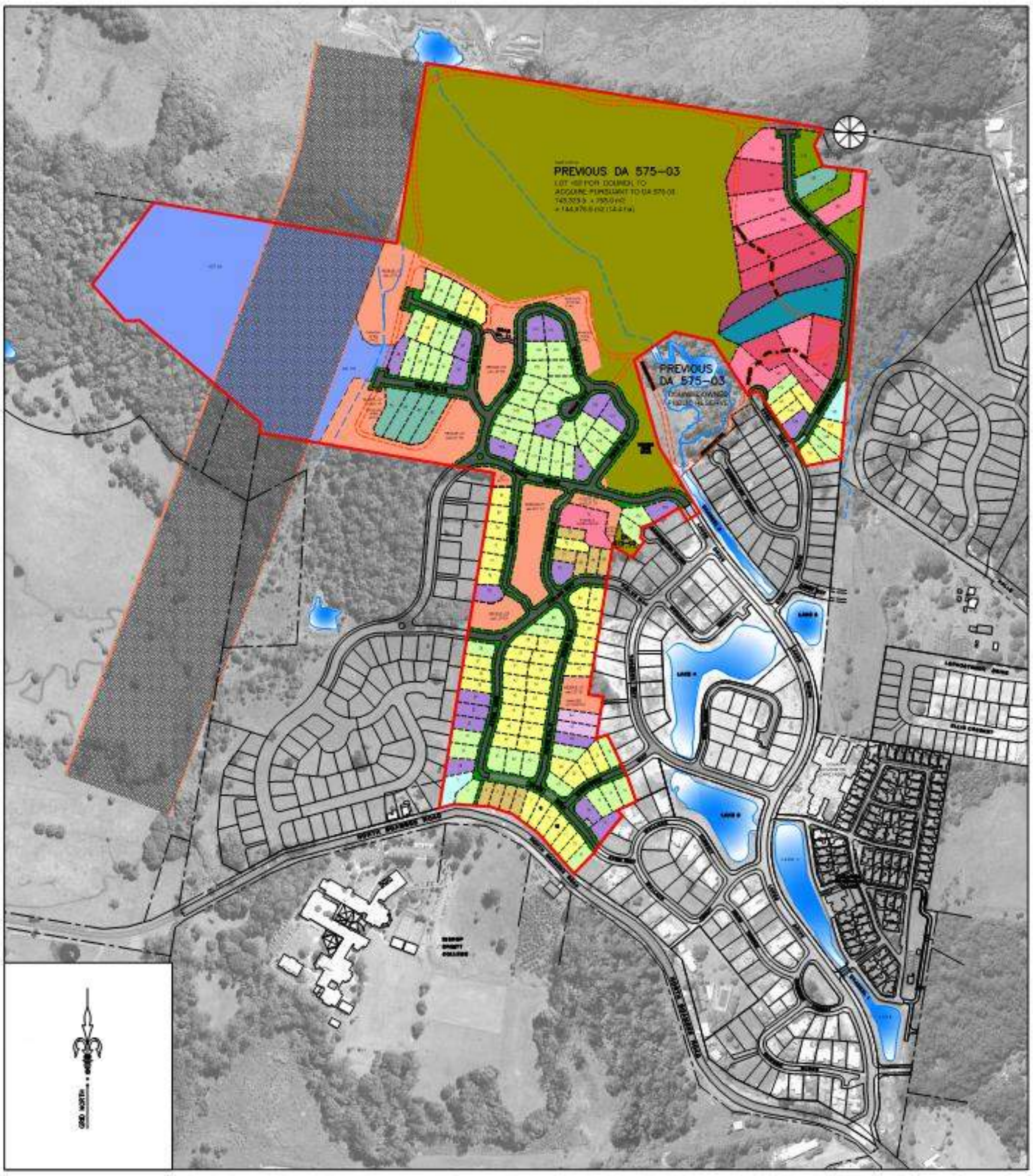


Figure 4: Approved residential subdivision – The Lakes Estate

Figure 5: Approved residential subdivision – Sunset Ridge Estate

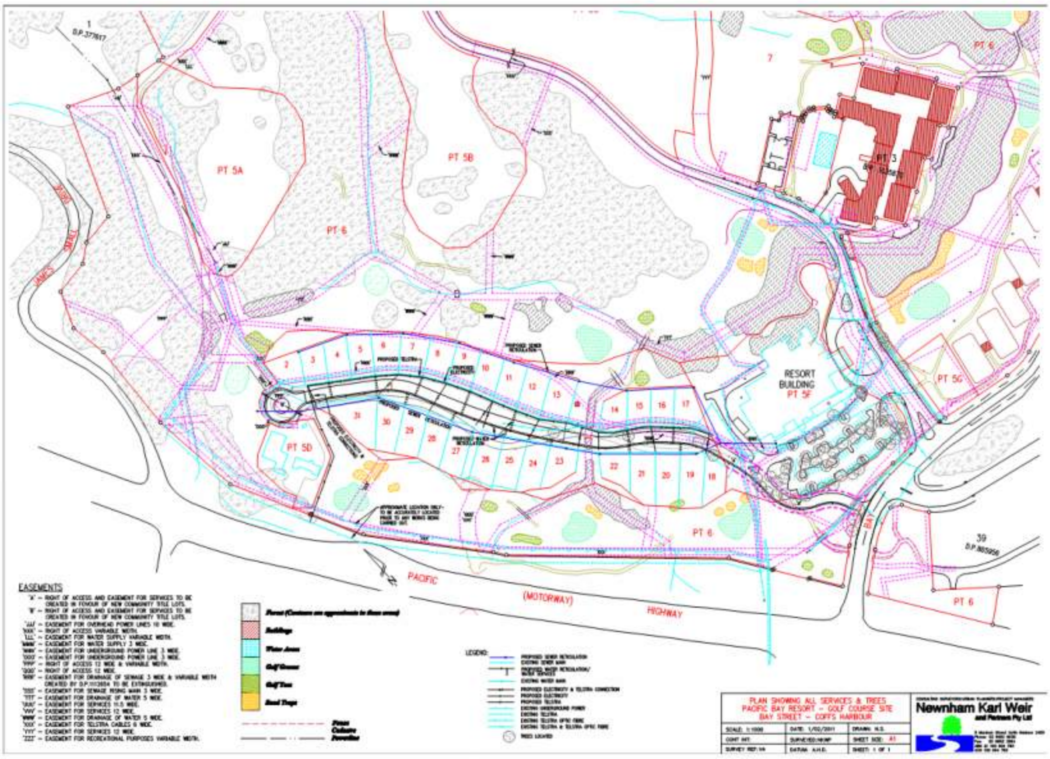


Figure 6: Approved residential subdivision – Pacific Bay Eastern Lands

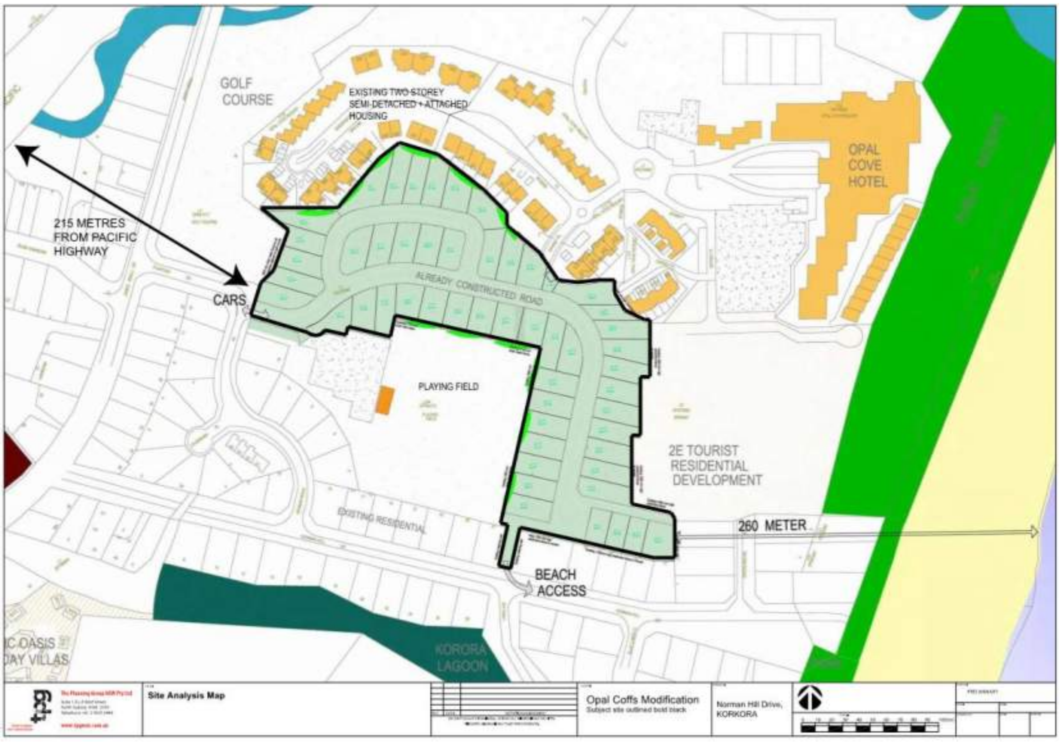


Figure 7: Approved residential subdivision – Korora Residential Subdivision

Future residential dwellings were included in the noise assessment. A notional single storey building outline has been included in the SoundPLAN model for the project per cadastral boundary for each of the residential subdivisions listed. The results were used to inform the design of operational at-source noise mitigation design (i.e. noise barrier and/or low noise pavement).

Details of approval conditions are summarised in Table 29 for reference. At-property treatments within each subdivision are identified as part of this assessment for developments where architectural noise mitigation requirements are excluded from the DA conditions of approval.

Table 29: Residential subdivision DA approval conditions

Location	**DA conditions**	**Project response**
Elements Estate	Northern Joint Regional Planning Panel approved the subdivision in 18/09/13 subject to conditions which included consideration of road traffic noise from the highway. Condition of Consent 41 required each lot title to include: *"An acoustic report is to be prepared in association with each house design to address traffic and sports field noise impacts and mitigation measures in accordance with the relevant provisions of NSW EPA Environmental Guidelines. The measures detailed in the acoustic report are to be implemented in the house design and construction."*	Any noise sensitive receivers that are still predicted to exceed the noise criteria should have adequate at-property treatment based on the requirements set out in the DA consent conditions.
Highlands Estate	Development consent for DA 711/06 included the following requirement regarding road traffic noise from the highway: *4. "A covenant shall be created for the lots within the Subdivision pursuant to Section 88B of the Conveyancing Act 1919 and must be registered on the title of each such lot. Registration must be effected in conjunction with registration of the Plan of Subdivision. The restriction requires Council's approval to variation or removal.* *The covenant shall require the preparation of an acoustic report prior to the issue of Development Consent for any future dwellings on the affected lots. The acoustic report shall have regard to the design, internal layout, materials and ventilation of any proposed dwelling relative to traffic noise impacts (from North Boambee Road and the future Pacific Highway).* *Note, where the EPA external noise criteria would not feasibly or reasonably be met, the RTA recommends the following internal noise objectives for all habitable rooms under ventilated conditions complying with the Building Code of Australia:*	Any noise sensitive receivers that are still predicted to exceed the noise criteria should have adequate at-property treatment based on the requirements set out in the DA consent conditions.

Location	DA conditions	Project response
	- All habitable rooms other than sleeping rooms: 45 dB(A) Leq *(5hr), 40 dB(A) Leq (9hr), and;* *- Sleeping rooms: 35 dB(A) Leq (9hr).”*	
The Lakes Estate	DP&E approved MP05_0129 on 07/06/13. A modification for 160 additional residential allotments as part of Stage 2 and 3 approved in 07/08/15. Both the original conditions of approval and instrument of modification append the project’s statement of commitments (SoC) in Schedule 3. SoC C11 states: *“The proponent commits to initiating discussion with Roads and Maritime Services (RMS) for the construction of the Pacific Highway Bypass for the provision of noise mitigation measures. These measures should be undertaken by the RMS as part of the design and construction of the bypass.”*	At-property treatment if required would only apply to dwellings that have DA approval and have been built to a stage that would allow the installation of the architectural treatment prior to project completion as per Practice Note ii of ENMM.
Pacific Bay Eastern Lands	Development consent for DA 1209/10 includes the following requirement regarding road traffic noise from the highway: *“32. A restriction as to user shall be created for all lots within the subdivision pursuant to Section 88B of the Conveyancing Act 1919 and must be registered on the title of each such lot. Registration must be effected in conjunction with registration of the Plan of Subdivision. The restriction requires Council’s approval to variation or removal.* *The restriction is to state that all future dwellings within the subdivision are to be constructed to meet “Category 2 construction under Australian Standard AS3671:1989 Acoustics - Road Traffic Noise Intrusion – Building Siting and Construction.* *Details of this restriction are to be submitted with the application for construction certificate.*	Construction of the residential lots subject to DA 1209/10 has not commenced. Notwithstanding, it is considered that any noise sensitive receivers that are predicted to exceed the noise criteria should have adequate at-property treatment based on the requirements set out in the DA consent conditions.
Sunset Ridge Estate	Development consent for DA 351/05 includes the following requirement regarding road traffic noise from the highway: *“31. The proponent is encouraged to incorporate measures into the subdivision to achieve the external noise target levels identified in the May 1999 Environmental Criteria for Road Traffic Noise produced by the Department of Environment and*	At-property treatment if required would only apply to dwellings that have DA approval and have been built to a stage that would allow the installation of the architectural treatment prior to project completion as per Practice Note ii of ENMM.

Location	DA conditions	Project response
	Conservation's (DEC-ex Environment Protection Authority). For the Preferred Route for the Strategy in the vicinity of the subdivision, the target levels are Leq(9hr) and 50 dB(A). *If the above DEC external noise targets are not achieved by the proponent, the RTA recommends that residences within the subdivision be designed to achieve the following internal noise objectives for all habitable rooms under ventilated conditions (refer to the Building Code of Australia).* *a. All habitable rooms other than sleeping areas: 45 dB(A) Leq(1hr) and 40 dB(A).* *b. Sleeping rooms: 35 dB(A) Leq(9hr)"*	
Korora Residential Subdivision	The original approval was for 85 community strata title lots. However, Modification No. 1 reduced this to 52 torrens title lots. Preliminary review of the conditions didn't find any related to mitigating road traffic noise. The EA prepared for Modification No. 1 states: *"The subject site and the proposed housing lots are not in a direct line-of-sight from the Pacific Highway. The site is separated from the Highway by more than 200m of housing, local roads, open space and dense vegetation. The site is located over 200m from the Pacific Highway at its closest western point and 500m from the Highway at its far eastern end, and it sits approximately 10m lower in elevation than the Highway. TPG NSW has inspected the site and observed that the background noise on the site is dominated by coastal wave noise, and Highway noise is not audible. Given these circumstances, an acoustic assessment and noise attenuation from the Highway is not warranted according to the new Development near Rail Corridors and Busy Roads - Interim Guidelines."*	At-property treatment if required would only apply to dwellings that have DA approval and have been built to a stage that would allow the installation of the architectural treatment prior to project completion as per Practice Note ii of ENMM.

Other development applications which have not received approval are not considered as part of this assessment and are no longer discussed in this report. These include but are not limited to:

- North Boambee Valley (West) – Urban Release Area
- Korora Large Lot Residential – Urban Release Area

It is not considered feasible or reasonable to assess dwellings that have received approval after the project approval, or prior to the approval but have not yet been built to a stage allowing installation of at-property treatment at project completion, and as such these dwellings have not been included in this assessment. Responsibility of treatment for these properties would be the responsibility of the Developer. A review of the stage of development of these areas is recommended during detailed design to detemine whether it would be resonable to consider at-source treatment to be considered as part of the project.

4.3.2 Temporary accommodation

Where locations containing temporary accommodation have been identified (e.g. caravan parks), analysis of noise mitigation has been restricted to permanent residential accommodation buildings (e.g. cabin manager and permanently residing caravan users) when assessing eligibility for consideration of additional noise mitigation. This approach to assessment is in accordance with standard Roads and Maritime procedure and takes into account reasonable mitigation being provided for residents experiencing long term road traffic noise exposure and further acknowledges limitations associated with opportunities for at-property treatment of temporary accommodation structures such as caravans and cabins. Identification of permanent accommodation has been provided as the outcome of ground truthing exercise in August 2018.

4.4 Traffic modelling parameters

Measured and modelled traffic data was used as the basis of the operational noise impact assessment for the project.

Classified traffic counts were taken concurrently with noise monitoring at locations relevant to the validation procedure. This includes locations on:

- The existing Pacific Highway;
- North Boambee Road;
- Coramba Road; and,
- Bennetts Road.

Noise model validation of the existing scenario is discussed further in Section 4.6.

To assess the future road traffic noise impacts for the project, projected traffic flow data for both the No-Build and Build scenarios have been used. For both scenarios, modelling has been undertaken for the assumed year of opening (i.e. 2024) and ten years after operation (i.e. 2034).

The extents of road traffic noise modelling include existing main road noise sources identified within the study area. In accordance with the provisions of the NCG, additional analysis was also undertaken to identify roads where the project increases the noise level contribution from the existing road by more than 2 dB(A) (e.g. 2.1 dB(A) or more) following the upgrade and relative to the No-Build situation.

Full details of all traffic modelling parameters used for existing, No-Build and Build scenarios are summarised in Appendix F.

4.5 Modelling methodology

The operational noise model is based upon the 50% Concept Design alignment for the proposed bypass and road system.

The following methodology was followed for the operational noise impact assessment. Each stage is described in more detail in the following sections:

1. Construction of an acoustic model based on the 50% Concept Design
2. Validation of modelled traffic noise levels against measured results at all validation noise monitoring locations
3. Identification of noise sensitive receivers which qualify for consideration of mitigation through prediction of traffic noise levels for year of opening and design year (ten years after opening), for both daytime and night-time periods and comparison between the build and no build scenarios
4. Design of noise mitigation strategies to meet performance requirements for the project

Noise modelling was undertaken by using the noise modelling software package SoundPLAN version 8.0 to implement the *Calculation of Road Traffic Noise (CoRTN)* [20] methodology.

Whilst there is no strict requirement under the RNP that noise levels be met under adverse meteorological conditions, it is noted that the CoRTN algorithm predicts noise impacts under moderately adverse wind conditions. As observed from other bypass projects, the effect of temperature inversion can increase the predicted noise level by up to 3 dB at any receiver near the noise source during the period of temperature inversion. While a noticeable increase in noise level may be observed during the period of the temperature inversion, the effect over the entire 9-hour period of night-time will only likely result in an increase of up to 1 dB at some receivers. Therefore, temperature inversion is not expected to significantly increase the operational noise from the project.

Further to considering adverse meteorological conditions, members of the community have raised through public consultation sessions the perception of a subjective sound phenomenon termed an “amphitheatre effect”. The term has been used to describe reflections from surrounding topographical features. The acoustic model for the project incorporates distribution of relevant ground absorption parameters to represent absorptive and reflective surfaces throughout the study area. Combined with the analysis of meteorological effects on sound propagation, the predictions of operational road traffic noise are considered to be robust within the constraints of modelling algorithms available.

Specific design inputs are provided in Table 30.

Table 30: Acoustic model input data

Input	**Description**
Traffic data	Traffic volumes and % heavy vehicles based on: • Classified traffic counts undertaken concurrently with noise monitoring; and • Projected traffic model results Refer to Appendix F for details.
Traffic speeds	Validation speed – Measured 85th percentile Design speed – Posted • 110 km/h for light vehicles and 100 km/h for heavy vehicles on the highway; • 40-80 km/h on all other roads Refer to Appendix F for details.
Topography	1 m elevation LiDAR information
Road alignment	50 % Concept Design
Road surface	Existing road surface based on site observations and input information from Roads and Maritime. Project road segments as follows: • Main carriageway – concrete as base case, OGA is assessed as part of at-source noise mitigation strategies • Highway ramps (between the edge of gore and edge of shoulder) – concrete • Highway ramps and all other roads – flexible pavement (DGA).
Buildings	Building footprints based on aerial photography and building heights based on street view. Storey heights will be as follows: 1 storey residential 4 m 2 storeys residential 6 m Large commercial 8 m
Noise barriers	Existing noise barrier locations and heights have been based on as-built information where available and supplemented with street-view and site observations as required. General locations include: • In front of Koala Villas & Caravan Parks • In front of Kororo Public School and extending south past the residences accessed by Fern Tree Place Refer to Appendix G for detail.
Source heights	0.5m for light vehicles 1.5m for heavy vehicle engines 3.6m for heavy vehicle exhaust

Input	Description
Tunnel portals	Incorporated into the model via implementation of four point sources at the tunnel openings. Sound power levels calculated in accordance with the *NORD2000* [21] methodology Propagation as per ISO 9613-2 [22]
Ground absorption	Global factor of 0.75 with the exception of water which is set at 0.
Model search radius	2500 m
Receiver height	Ground floor - 1.5 m First floor – 4.5 m Mitigation governed by 1st and 2nd storey only
Contour output	Set at 1.5 m height with 20m grid spacing.

Table 31 summarises the corrections and adjustments applied to the CoRTN calculation methodology in the acoustic model.

Table 31: Acoustic model corrections and adjustments

Correction, dB(A)	Description
-3	Conversion from L_{10} to L_{eq}
+2.5	Façade reflection
+3 concrete 0 dense graded asphalt (DGA) 0 stone mastic asphalt (SMA10) -2 open graded asphalt (OGA)	Pavement corrections
0 tyre source -0.6 truck engine -8.6 truck exhaust	Split height corrections

In addition to the corrections listed in Table 31, specific corrections to CoRTN for Australian conditions were calculated based on traffic mix and prevailing temperature. These corrections were as provided by Roads and Maritime noise specialists and were then applied to all traffic strings for all stages of modelling.

The calculation of project specific corrections considers traffic mix by separating Aust Road classified traffic data by light (1-2), medium (3-5) and heavy (6+) classifications. This information is then used to derive corrections to be applied to the heavy vehicle road string within the SoundPLAN implementation of the CoRTN algorithm. This is done in an attempt to account for the difference in sound power level produced by larger multi-axel trucks as compared with rigid heavy vehicles on which CoRTN empirical data is based. The specific equation used to calculate corrections is as follows:

$$L_{WA(6-category)} = 10log_{10} \sum_{i=1}^{6} \left(r_{HVi} 10^{L_{WA(HVi)}/_{10}} \right)$$

The correction applied to the modelled heavy vehicles is the difference between the sound power level calculated using the six-category model and the predicted sound power levels using CoRTN and are dependent on the ratio of medium to heavy vehicles as a function of travel speed.

A full list of correction factors for each road string and scenario are included with traffic data presented in Appendix F.

4.6 Modelling validation

The acoustic model has been validated against measured noise monitoring data using concurrently measured road traffic data. Model validation has been undertaken in general accordance with the *Noise Model Validation Guideline* [6]. Modelled results that are within 2 dB of measured levels at validation noise monitoring locations are considered to be validated.

Modelled and measured operational road traffic noise results for the existing scenario are provided in Table 32.

Table 32: Acoustic model validation results

Logger number	**Day $L_{Aeq\ (15h)}$ dB(A)**			**Night $L_{Aeq\ (9h)}$ dB(A)**		
	Measured	**Predicted**	**Difference**	**Measured**	**Predicted**	**Difference**
Pacific Highway north of Coffs Harbour						
8	75.1	74.4	-0.7	71.3	69.1	-2.2
9	57.2	59.5	2.3	53.8	55.9	2.1
10	67.9	69.8	1.9	64.5	64.5	0.0
14	65.5	66.6	1.1	62.9	62.4	-0.5
15	59.3	60.3	1.0	55.7	56.3	0.6
Median difference			1.1			1.0
Pacific Highway south of Coffs Harbour						
1	54.1	56.7	2.6	50.9	51.2	0.3
11	64.9	66.1	1.2	61.2	60.5	-0.7
Median difference			1.9			-0.2
North Boambee Road						
2	52.6	52.9	0.3	43.8	42.9	-0.9
Coramba Road						
4	59.1	58.0	-1.1	51.9	49.1	-2.8
5	47.2	51.3	4.1[1]	41.4	42.3	0.9
Median difference			1.5			-0.9

[1] Daytime traffic volumes on Coramba Road west of Bennetts Road have been based on traffic counts undertaken at Bishop Druitt college. Over predictions in road traffic noise levels are considered due to vehicles diverting to the residential subdivision particularly during the daytime period.

4.7 Predicted noise levels

The validated acoustic model detailed in Section 4.6 was used to predict traffic noise levels for the eight scenarios presented in Table 33.

Table 33: Project stages, summary design scope

No.	Scenario	Year	Period	Index (dB)
1	No-Build	Year of Opening	Daytime	$L_{Aeq, (15\ hour)}$
2			Night-time	$L_{Aeq, (9\ hour)}$
3		Design Year	Daytime	$L_{Aeq, (15\ hour)}$
4			Night-time	$L_{Aeq, (9\ hour)}$
5	Build	Year of Opening	Daytime	$L_{Aeq, (15\ hour)}$
6			Night-time	$L_{Aeq, (9\ hour)}$
7		Design Year	Daytime	$L_{Aeq, (15\ hour)}$
8			Night-time	$L_{Aeq, (9\ hour)}$

Appendix G summarises specific operational noise results and contours for each of the above scenarios at all noise sensitive receivers with and without additional noise mitigation in place.

A summary of noise sensitive receivers per catchment area that exceed NCG and NMG criteria is presented in Table 34 for reference. This is provided for the unmitigated Build scenario in the design year (2034) with no additional noise mitigation in place.

Table 34: Number of noise sensitive receivers that exceed design year operational noise criteria with no additional noise mitigation in place

NCA	Receiver type	Number of exceedances						
		NCG	NMG					
			Number of exceedances			Eligibility Triggers		
			Total	Existing receivers	Non-existient approved residential subdivisions	Cumulative Limit	Acute	>+2dB and >NCG
NCA01	Residential	27	16	16	0	14	14	4
NCA02	Residential	13	13	13	0	9	9	10
	Active recreation	1	1	1	0	0	0	1
NCA03	Residential	169	108	1	107	69	39	75
	Hospital	1	1	1	0	1	0	0
	Active recreation	1	0	0	0	0	0	0
NCA04	N/A[1]	0	0	0	0	0	0	0
NCA05	Hospital	1	1	1	0	1	0	0
	Place of worship	1	1	1	0	1	0	1

NCA	Receiver type	Number of exceedances						
		NCG	NMG					
			Number of exceedances			Eligibility Triggers		
			Total	Existing receivers	Non-existient approved residential subdivisions	Cumulative Limit	Acute	>+2dB and >NCG
	Child care facility	1	1	1	0	1	0	0
NCA06	Residential	317	317	102	215	215	5	316
	School	1	1	1	0	1	1	1
	Place of worship	1	1	1	0	0	0	1
NCA07	Residential	4	4	4	0	4	1	4
NCA08	Residential	7	7	7	0	7	2	7
	School	1	1	1	0	1	1	1
NCA10	Residential	4	4	4	0	4	1	4
NCA11	Residential	23	9	9	0	2	0	9
NCA12	Residential	29	25	25	0	12	5	23
NCA13	Residential	117	95	95	0	9	0	95
	Child care facility	1	1	1	0	0	0	1
NCA14	Residential	109	106	106	0	14	0	106
NCA15	Residential	15	15	15	0	12	4	15
NCA16	Residential	187	182	126	56	86	2	182
NCA17	Residential	3	3	3	0	3	1	3
NCA18	Residential	217	214	214	0	110	4	214
NCA19	Residential	11	11	11	0	11	7	11
NCA20	Residential	8	8	8	0	5	2	8
NCA21	Residential	12	3	3	0	2	2	1
	Active recreation	0	0	0	0	0	0	0
NCA22	Residential	27	0	0	0	0	0	0
	Active recreation	0	0	0	0	0	0	0
NCA23	Residential	8	6	6	0	4	3	6
	Passive recreation	1	1	1	0	1	0	0
NCA24	Residential	55	26	26	0	22	6	10
NCA25	Residential	17	1	1	0	1	1	0
NCA26	Residential	73	56	55	1	39	39	24
	School	2	2	2	0	2	2	1
NCA27	Residential	22	14	14	0	10	10	11
NCA28	Residential	86	56	56	0	20	20	41
NCA29	Residential	9	5	5	0	4	3	3
Total Residential		1569	1304	925	379			

NCA	**Receiver type**	**Number of exceedances**						
		NCG	**NMG**					
			Number of exceedances			**Eligibility Triggers**		
			Total	**Existing receivers**	**Non-existient approved residential subdivisions**	**Cumulative Limit**	**Acute**	**>+2dB and >NCG**
Total non-residential		13	12	12	0			
TOTAL		1582	1316	937	379			

[1] Only commercial / industrial receivers located in NCA04

[2] Note the identifier NCA09 has not been used for any of the noise sensitive receivers

There are 1582 noise sensitive receivers which are predicted to be exposed to road traffic noise levels exceeding the traffic noise assessment criteria of which 1316 qualify for consideration for additional noise mitigation.

A receiver is eligible for consideration of additional noise mitigation by triggering any of the conditions listed in Section 3.1.2. These eligibility triggers are also summarised in Table 34.

Approximately 60% of the total number of noise sensitive receivers (residential and non-residential) identified within the study area qualify for consideration of additional noise mitigation. Generally, noise catchment areas located further away from the existing Pacific Highway (e.g. NCA06 to NCA20) will experience a greater change in the sound environment as a new sound source would be introduced. The change in noise level varies on a case-by-case basis as the exposure from each receiver to the project relies on specific features in the terrain, including tunnels, as well as shielding from adjacent buildings. Details of the change in noise level for each receiver are presented in the results in Appendix G1.

Section 4.8 summarises the analysis of operational road traffic noise mitigation requirements for the project.

4.7.1 Existing Pacific Highway

The existing highway is the main street through the town which currently accommodates significant heavy vehicle usage. The project is being proposed to improve road safety, freight productivity and reliability for travel as well as to minimise social impact on the community.

In addition to the predicted operational noise impacts for the future design, a significant reduction of noise impacts from vehicles using the existing Pacific Highway would also be expected. Traffic mix is predicted to change significantly with the introduction of a new bypass. It is expected that a significant portion of heavy vehicle traffic would be bypassed around the town centre, reducing the number of heavy vehicle movements through the centre of town.

This reduction in noise impacts through the more populated area of Coffs Harbour is not quantitatively captured in the noise modelling. Focus is instead placed on opportunities to ameliorate increases in noise impact. The benefits of this noise reduction through the town centre, however would be significant and are worth noting.

4.8 Design of noise mitigation measures

Options for noise mitigation were assessed in the following order of preference as per the NMG:

- Low noise pavement surfaces
- Noise mounds
- Noise walls
- At-property treatments.

In accordance with the NMG, analysis is undertaken of overall noise mitigation benefit taking into account feasible and reasonable implementation. The analysis is undertaken where the existing road network contributes to the overall road traffic noise level experienced at residences. In accordance with the NMG, in instances where the project was not a significant contributor to exceedance of trigger levels at any façade, these receivers do not qualify for consideration of additional mitigation.

Noise mitigation measures should be reasonable and feasible to implement. Factors such as roadway and stormwater flow obstruction, access requirements, space limitations as well as wind loading, and unsuitable ground conditions should be considered when introducing noise mitigation measures as part of the design. As such, these non-acoustical design factors are to be evaluated at each assessed location and the appropriate allowable barrier heights recommended for further consideration during detailed design.

Once the project is operational, a noise review will be undertaken in accordance with Roads and Maritime Preparing a Post Construction Noise Assessment Report brief. The review will:

- Assess actual noise performance compared to predicted noise performance
- Assess the performance and effectiveness of noise and vibration mitigation measures
- Where deficiencies in performance are identified, provide recommendations for additional feasible and reasonable measures in accordance with the RMS Noise Mitigation Guideline.

4.8.1 Low noise pavement

In accordance with the NMG, a low noise pavement surface was investigated where groups of four or more closely spaced receivers were identified to qualify for consideration of additional noise mitigation, prior to investigating the implementation of noise barriers. In addition, a project decision was made to adopt low noise pavement for the full length of the project in order to address community concerns.

Investigation of the benefits of installing low noise pavement was undertaken and limited to an overall correction of -2 dB as compared with dense graded asphalt (DGA) based on the recommended correction for open grade asphalt (OGA) as per the Noise Model Validation Guideline [6]. This correction was applied within the noise model to both light and heavy vehicle road strings at the direction of Roads and Maritime noise specialists.

The proposed concrete pavement surface was replaced with a low noise pavement (OGA) alternative in the operational acoustic model between chainages CH 9700, at the southern roadworks tie in, to CH 23650, at the northern extent of the project, excluding the extents of the tunnels. The extent is depicted in Figure 8.

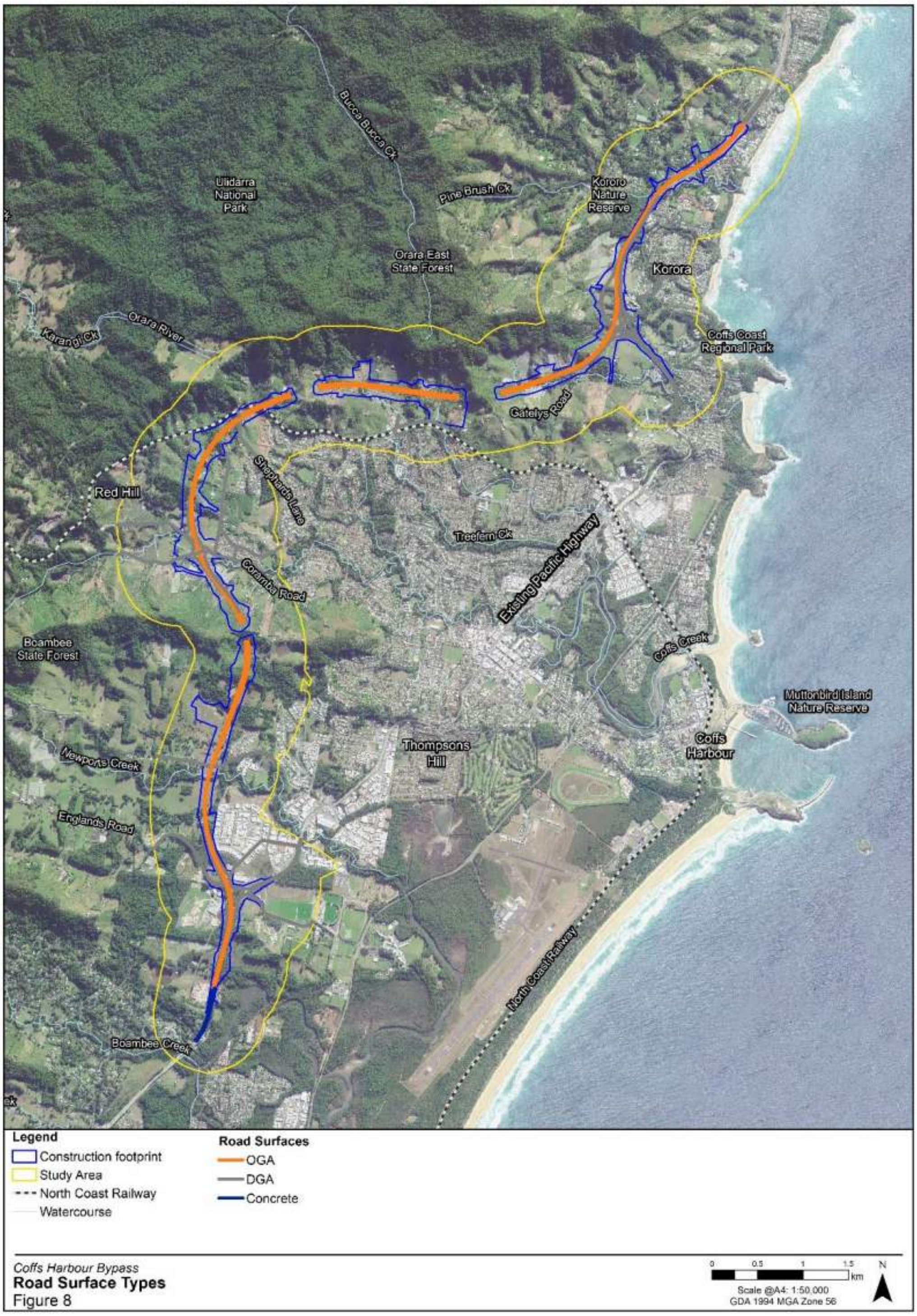


Figure 8: Extents of low noise pavement along the bypass

It is noted that the Pacific Highway north of the Korora Hill interchange is currently a combination of DGA and stone mastic asphalt (SMA10) for which the correction is already 0 dB.

The acoustic benefit of installing low noise pavement is summarised in Appendix G. A summary of noise sensitive receivers that exceed NCG criteria for the mitigated Build scenario in the design year (2034) with low noise pavement in place is presented in Table 35 for reference. These receivers would qualify for consideration of at-property treatment should there be no implementation of further at-source noise mitigation measures (i.e. noise barriers).

Table 35: Number of noise sensitive receivers that exceed design year operational noise criteria with low noise pavement in place

NCA	**Receiver type**	**NCG Exceedances**			
		Total	**<5 dB**	**5-10 dB**	**>10 dB**
NCA01	Residential	16	4	12	0
NCA02	Residential	12	4	5	3
	Active recreation	0	0	0	0
NCA03	Residential	93	71	22	0
	Hospital	1	0	0	1
	Active recreation	0	0	0	0
NCA04	N/A[1]	0	0	0	0
NCA05	Hospital	1	0	0	1
	Place of worship	1	0	1	0
	Child care facility	1	0	0	1
NCA06	Residential	275	144	127	4
	School	1	0	0	1
	Place of worship	0	0	0	0
NCA07	Residential	4	0	3	1
NCA08	Residential	7	0	7	0
	School	1	0	1	0
NCA10	Residential	4	1	2	1
NCA11	Residential	5	2	3	0
NCA12	Residential	17	8	6	3
NCA13	Residential	47	36	11	0
	Child care facility	1	0	0	1
NCA14	Residential	87	81	6	0
NCA15	Residential	14	2	6	6
NCA16	Residential	122	53	43	26
NCA17	Residential	3	0	2	1
NCA18	Residential	153	114	32	7
NCA19	Residential	11	0	1	10

NCA	**Receiver type**	**NCG Exceedances**			
		Total	**<5 dB**	**5-10 dB**	**>10 dB**
NCA20	Residential	8	5	3	0
NCA21	Residential	2	0	2	0
	Active recreation	0	0	0	0
NCA22	Residential	0	0	0	0
	Active recreation	0	0	0	0
NCA23	Residential	6	3	2	1
	Passive recreation	1	1	0	0
NCA24	Residential	23	5	16	2
NCA25	Residential	1	1	0	0
NCA26	Residential	44	17	24	3
	School	2	0	0	2
NCA27	Residential	10	3	7	0
NCA28	Residential	30	20	8	2
NCA29	Residential	5	2	3	0
Total Residential		999	576	353	70
Total non-residential		10	1	2	7
TOTAL		1009	577	355	77

[1] Only commercial / industrial receivers located in NCA04

[2] Note the identifier NCA09 has not been used for any of the noise sensitive receivers

With low noise pavement in place, 1009 noise sensitive receivers still exceed the road traffic noise criteria and hence still qualify for consideration of additional noise mitigation. This is 573 less receivers than were identified as exceeding the road traffic noise criteria for the unmitigated scenario, however only 307 less than the number of receivers that qualify for consideration of additional mitigation.

Further investigation into the effectiveness of noise barriers as an additional noise mitigation measure is summarised in the following section.

4.8.2 Noise barriers

Following the use of at-source noise control measures, a combination of noise barrier (i.e. noise mounds and noise walls) and at-property noise treatment can provide the most reasonable overall reduction for an affected community when consideration is given to urban design, visual impact and engineering constraints. It is noted that while most types of at-property noise treatment do not provide any external noise reduction benefit; the achievable internal noise reduction may be higher than for most external noise barrier solutions. The process of deriving the most effective combination of noise barrier height and at-property noise treatment is given in Roads and Maritime's NMG, whereby the process gives preference to a hierarchy of noise control measures that reduce outdoor noise levels as per EPA's NSW Road Noise Policy.

When optimising the noise barrier height in the noise mitigation design, the process described in the NMG identifies three heights. These are the maximum barrier height, initial design barrier height and design barrier height. The maximum barrier height is the barrier height that strives to result in external noise criteria being met at all receivers. Roads and Maritime's policy is that barrier heights above 8 metres will not be assessed as part of the noise abatement design. Next, the initial barrier height is defined at a height between zero and maximum barrier height, where the trend in noise benefit is characterised by a rapid reduction in the number of properties that are eligible for consideration of additional noise mitigation. Subsequently in the noise mitigation design process, between the initial barrier and maximum design barrier heights, the design barrier height is identified by also taking into consideration the area of noise barrier and noise reduction benefits across the broader community. This barrier height forms the acoustic recommendation and is further evaluated in a multi-criteria decision-making process to determine the feasible and reasonable combination of noise mitigation measures.

As a guide, a noise barrier is considered to be a reasonable noise mitigation option where it is capable of providing an insertion loss of 5 dB(A) for heights up to 5 metres or 10 dB(A) for heights above 5 metres and up to 8 metres high. It is also important to note that where the predicted total diffraction attenuation exceeds 20 dB(A) for single diffraction, further increase in noise barrier height is not considered in the aforementioned process as this level of noise reduction is nearly impossible to attain in practice.

The higher the barrier, the greater the level of noise reduction, however; as identified in Roads and Maritime's Noise Wall Design Guideline, noise barriers that are excessively high can cause visual intrusion, reduction of sunlight, loss of character and view and social alienation, compromising on urban design and resulting in unacceptable visual impact. In addition, a noise barrier that is reasonable may not always be feasible to build, which can be attributed to roadway and stormwater flow obstruction, access requirements, space limitations as well as wind loading and unsuitable ground conditions. As such, these non-acoustical design factors are evaluated at each assessed location and the appropriate allowable barrier heights recommended for further consideration during detailed design. Considering community preferences, the final design barrier height with acceptable visual impact will be confirmed during detailed design for construction.

In addition to the investigation of low noise pavement, further analysis of the benefits of noise barriers was undertaken in accordance with the NMG. A full noise wall analysis was undertaken initially, the results of which were coordinated with the design team to identify areas where the installation of earth berms was considered feasible to further reduce noise impacts. An updated terrain model with the earth berms in place was then used to re-analyse optimum noise wall heights and resulting at-property treatment requirements.

A total of 13 locations were assessed to determine the benefit of a noise barrier to further mitigate operational traffic noise impacts out of which:

- Nine are new barriers,

- Two existing barriers are to be relocated due to the project;
- One of which is recommended to be supplemented in height; and
- One is recommended to be relocated and set to the same top of height as the existing barrier
- Three noise barrier analyses resulted in the barriers being considered unreasonable in accordance with the provisions of the NMG.

In addition, as described above, it is important to apply a reasonable and feasible analysis to noise barriers due to a number of environmental, social, engineering and cost factors. Two barriers initially evaluated that are not considered reasonable or feasible include:

- NW_NCA01_SB_01 – located at the southern end of the project adjacent Koala Villas & Caravan Park
- NW_NCA27_NB_02 – located at the northern end of project adjacent Seaview Close

Further discussion on these barriers is provided below.

NW_NCA01_SB_01

In accordance with the NMG, this barrier was recommended at a height of 8.0 m to replace the existing 3.0 m high noise wall located adjacent the Koala Villas & Caravan Park within NCA01. While this noise barrier would mitigate sensitive receivers behind the barrier, this noise barrier was not considered feasible or reasonable due to the following considerations:

- The height of this barrier was considered to result in high visual impacts and would cause significant overshadowing issues to the residences immediately to the east of the existing barrier. The receivers are unlikely to receive significant noise attenuation at the detriment of the overshadowing impacts
- Construction of an 8.0 m high barrier including the substantial supporting structure and footings would result in clearing vegetation identified as koala habitat
- Construction of an 8.0 m high barrier at this location would have substantial constructability challenges and safety issues due to the proximity of the existing Pacific Highway
- It would require removal of the existing barrier.

Following consideration of the above it was concluded that sensitive receivers within NCA01 should be subject to at-property noise mitigation only in consultation with the owner of Koala Villas & Caravan Park.

NW_NCA27_NB_02

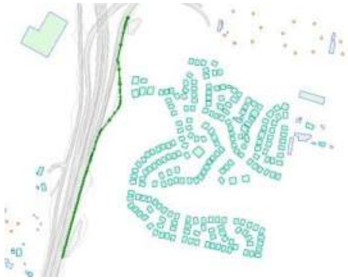
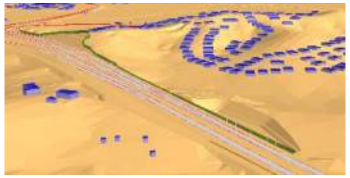
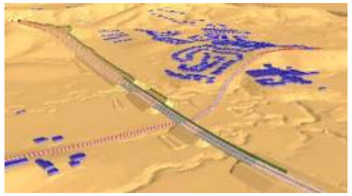
This barrier was recommended at a height of 4.5 m for receivers within NCA27. While this noise barrier would mitigate sensitive receivers behind the barrier, this noise barrier was not considered feasible or reasonable due to the following considerations:

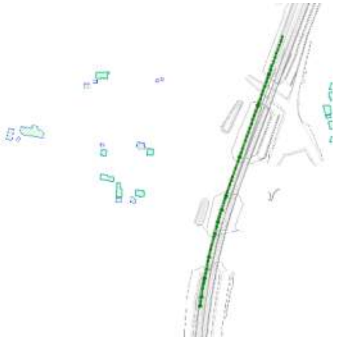
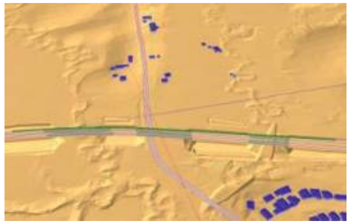
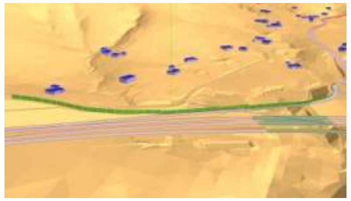
- The barrier would be required to be located on western side of the upgraded Pacific Highway above the service road and built on top of a retaining wall between 3.3 m and 7.2 m in height. Construction of 4.5 m high barrier at this location would not be safe for construction or maintenance personnel
- The barrier would not effectively treat all sensitive receivers within NCA27 with three of the five receivers still requiring at-property mitigation
- Due to the number of utility adjustments in this location, there is likely to be a number of conflicts with the barrier alignment and utility design which would result in safety risks for construction and maintenance personnel and could result in a public hazard
- The height of this barrier would impact existing ocean views to residences to the west of the project which would unlikely be able to be mitigated with the inclusion of transparent panels. A high visual impact was identified.

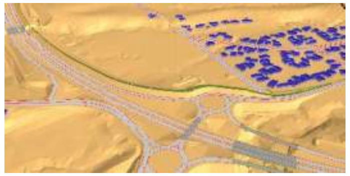
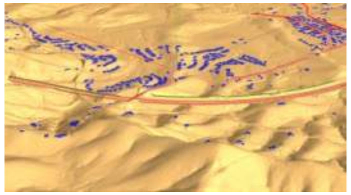
Following consideration of the above it was concluded that sensitive receivers within NCA27 should be subject to at-property noise mitigation only.

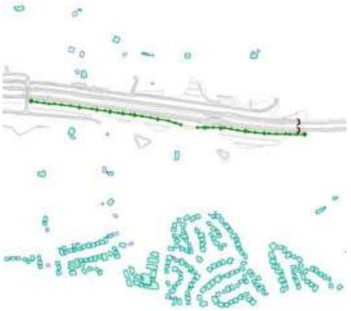
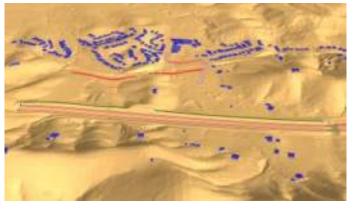
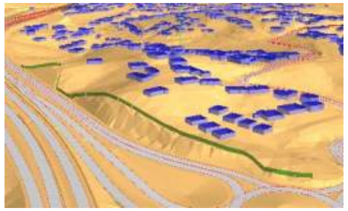
Table 36 summarises the location and extent of design noise barriers, and te allowable barrier height for each length of noise barrier. Full analysis of noise barrier results is summarised in Appendix H.

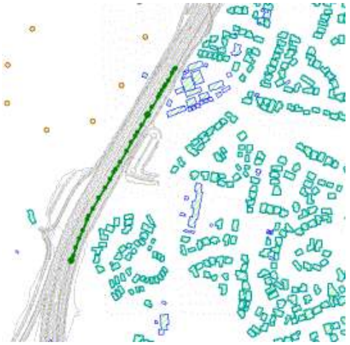
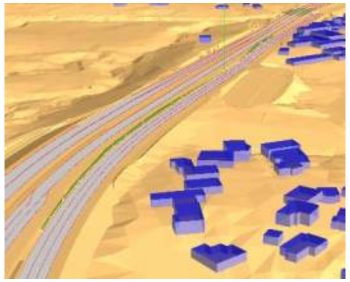
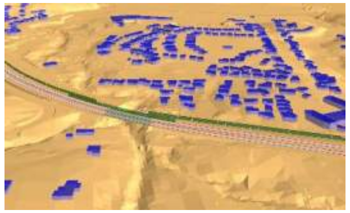
Table 36: Noise barrier summary

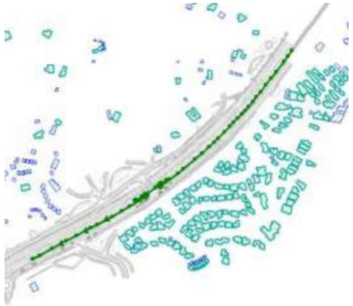
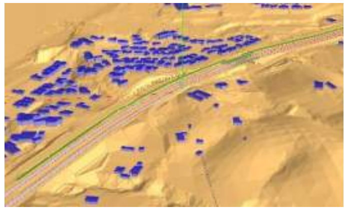
Barrier Name	**Chainages**	**Barrier height (m)**				**Insertion loss (dB)**				**Recommended design height**	**Notes**	**Indicative noise barrier extent (plan view)**	**Indicative recommended design height barrier (axonometric view)**
		Existing	**Maximum**	**Initial design**	**Final design**	**Existing**	**Maximum**	**Initial design**	**Final design**				
NW_NCA03_SB_01	9830 to 10590	-	8.0m	6.0m	6.5m	-	7.6	5.5	6.1	5.0m	*5m barrier is recommended because final design height does not achieve more than 10dB insertion loss.		
NW_NCA06_SB_01	11900 to 13610	-	8.0m	5.0m	6.0m	-	9.0	6.9	7.7	5.0m	*5m barrier is recommended because final design height does not achieve more than 10dB insertion loss.		

Barrier Name	**Chainages**	**Barrier height (m)**				**Insertion loss (dB)**				**Recommended design height**	**Notes**	**Indicative noise barrier extent (plan view)**	**Indicative recommended design height barrier (axonometric view)**
		Existing	**Maximum**	**Initial design**	**Final design**	**Existing**	**Maximum**	**Initial design**	**Final design**				
NW_NCA08_NB_01	11890 to 12520	-	8.0m	0.0m	0.0m	-	3.0	0.0	0.0	0.0m	*Maximum barrier height does not provide more than 10dB insertion loss at most benefiting receiver; *Initial design height is 0m due to points weighting; *Noise barrier not recommended at this location.		
NW_NCA12_NB_01	14300 to 14680	-	8.0m	0.0m	0.0m	-	7.4	0.0	0.0	0.0m	*Maximum barrier height does not provide more than 10dB insertion loss at most benefiting receiver; *Initial design height is 0m due to points weighting; *Noise barrier not recommended at this location.		

Barrier Name	Chainages	Barrier height (m)				Insertion loss (dB)				Recommended design height	Notes	Indicative noise barrier extent (plan view)	Indicative recommended design height barrier (axonometric view)
		Existing	Maximum	Initial design	Final design	Existing	Maximum	Initial design	Final design				
NW_NCA13_SB_01	14580 to 15430	-	8.0m	3.5m	3.5m	-	11.8	7.2	7.2	3.5m	*Final design height barrier is recommended because it provides more than 5dB insertion loss.		
NW_NCA14_SB_01	15430 to 16970	-	8.0m	4.0m	4.5m	-	9.2	5.7	6.2	4.5m	*Final design height barrier is recommended because it provides more than 5dB insertion loss.		

Barrier Name	Chainages	Barrier height (m)				Insertion loss (dB)				Recommended design height	Notes	Indicative noise barrier extent (plan view)	Indicative recommended design height barrier (axonometric view)
		Existing	Maximum	Initial design	Final design	Existing	Maximum	Initial design	Final design				
NW_NCA18_SB_01	17810 to 18900	-	8.0m	4.5m	4.5m	-	6.3	3.9	3.9	4.5m	*Design barrier is considered as two thirds of the residences no longer require at-property treatments.		
NW_NCA24_SB_01	20950 to 21340	-	8.0m	3.5m	3.5m	-	7.7	3.8	3.8	0.0m	*Final design height does not provide more than 5dB insertion loss at most benefiting receiver; * Receivers exceed the noise criteria by more than 5dB *Noise barrier not recommended at this location.		

Barrier Name	Chainages	Barrier height (m)				Insertion loss (dB)				Recommended design height	Notes	Indicative noise barrier extent (plan view)	Indicative recommended design height barrier (axonometric view)
		Existing	Maximum	Initial design	Final design	Existing	Maximum	Initial design	Final design				
NW_NCA25_SB_01		3.0m	-	-	-	-	-	-	-	Relocated and set to the same top of height as existing	*Barrier assessment not required as there are no receivers that qualify for consideration of additional noise mitigation however, it is recommended that the existing barrier is relocated and set to the same top of height as the existing noise barrier.		
NW_NCA26_SB_01	22150 to 22725	-	8.0m	4.5m	5.0m	-	12.3	8.0	8.8	5.0m	*Final design height barrier is recommended because it provides more than 5dB insertion loss.		

Barrier Name	Chainages	Barrier height (m)				Insertion loss (dB)				Recommended design height	Notes	Indicative noise barrier extent (plan view)	Indicative recommended design height barrier (axonometric view)
		Existing	Maximum	Initial design	Final design	Existing	Maximum	Initial design	Final design				
NW_NCA28_SB_01	22725 to 23650	3.0m	8.0m	4.0m	4.0m	6.2	12.2	8.0	8.0	4.0m	*Final design height barrier is recommended because it provides more than 5dB insertion loss; *Supplemented height is recommended due to road widening.		

4.8.3 At-property treatments

At-property treatments would be considered at sensitive receivers where low noise pavement and noise barriers do not result in the NCG being met. At this stage in the assessment, the identification of at-property treatments is indicative only, as further consideration would be given to the following points at the detailed design stage to confirm the final extent of treatments required:

- The build date of the property and the related conditions of consent which may require that the property has been built to account for existing high levels of road traffic noise
- The condition of the property, as treatment would be less effective and may not provide any appreciable noise reduction benefit where the building is in a poor state of repair, so caution needs to be exercised
- Heritage advice should be sought if the treatments have the potential to impact the heritage significance of a property. In extreme cases this could result in a decision not to proceed with a treatment on the grounds that it was not considered to be a reasonable or feasible mitigation option.

The NMG identifies that at-property noise mitigation measures such as façade treatments and localised screens may replace at-source mitigation, subject to a reasonable and feasible assessment, only in the following circumstances:

- Isolated single residences or isolated groups of closely spaced residences
- Where the affected community expresses a preference for at-property treatment and the cost is less than a combination of a barrier and at-property treatment
- Where noise barriers cannot achieve the level of noise mitigation (insertion loss) required
- Where the only applicable noise criteria are internal (e.g. places of worship, hospitals or schools and child care facilities where play areas meet external criteria)
- Where other noise mitigation measures have been shown not to be feasible or reasonable.

These treatments are generally limited to acoustic treatment of the building elements and the installation of acoustic screen walls close to the receiver where they also protect outdoor living spaces. Such treatments would be considered based on Roads and Maritime guidance.

With low noise pavement and noise barriers in place, at-property treatments are still required for some noise sensitive receiver locations. These locations are summarised in Appendix G in both mitigated results tables and noise contour plots.

A summary of noise sensitive receivers that exceed NCG criteria for the mitigated Build scenario in the design year (2034) with low noise pavement and recommended design noise barriers in place is presented in Table 37 for reference. These receivers would qualify for consideration of at-property treatment.

Table 37: Number of noise sensitive receivers that exceed design year operational noise criteria with low noise pavement and design height noise barriers in place

NCA	**Receiver type**	**NCG Exceedances**			
		Total	**<5 dB**	**5-10 dB**	**>10 dB**
NCA01	Residential	15	3	12	0
NCA02	Residential	12	4	5	3
	Active recreation	0	0	0	0
NCA03	Residential	0	0	0	0
	Hospital	1	0	0	1
	Active recreation	0	0	0	0
NCA04	N/A[1]	0	0	0	0
NCA05	Hospital	1	0	0	1
	Place of worship	1	0	1	0
	Child care facility	1	0	0	1
NCA06	Residential	107	88	18	1
	School	1	0	0	1
	Place of worship	0	0	0	0
NCA07	Residential	4	0	3	1
NCA08	Residential	7	0	7	0
	School	1	0	1	0
NCA10	Residential	3	2	0	1
NCA11	Residential	5	2	3	0
NCA12	Residential	17	8	6	3
NCA13	Residential	30	24	6	0
	Child care facility	1	0	0	1
NCA14	Residential	13	12	1	0
NCA15	Residential	14	2	6	6
NCA16	Residential	93	50	33	10
NCA17	Residential	3	0	2	1
NCA18	Residential	62	45	12	5
NCA19	Residential	11	0	1	10
NCA20	Residential	8	5	3	0
NCA21	Residential	2	0	2	0
	Active recreation	0	0	0	0
NCA22	Residential	0	0	0	0
	Active recreation	0	0	0	0

NCA	Receiver type	NCG Exceedances			
		Total	<5 dB	5-10 dB	>10 dB
NCA23	Residential	5	2	2	1
	Passive recreation	1	1	0	0
NCA24	Residential	23	5	16	2
NCA25	Residential	1	1	0	0
NCA26	Residential	9	7	2	0
	School	2	0	1	1
NCA27	Residential	10	3	7	0
NCA28	Residential	9	7	2	0
NCA29	Residential	5	2	3	0
Total Residential		468	272	152	44
Total non-residential		10	1	3	6
TOTAL		478	273	155	50

[1] Only commercial / industrial receivers located in NCA04

[2] Note the identifier NCA09 has not been used for any of the noise sensitive receivers

4.9 Maximum noise level assessment

Various road design features have the potential to alter maximum noise level events due to road traffic. Main areas of interest include:

- Steep gradients
- Changes in speed; and
- Changes in geometry.

Each of these components is discussed qualitatively in the following sections. Receivers are located in proximity to areas of identified impacts have the potential to experience a change in maximum noise levels. As per the NMG,. It should be noted that the maximum noise assessment should be used as a tool to help prioritise and rank mitigation strategies but should not be applied as a decisive criterion in itself.

4.9.1 Gradient

One of the major causes of maximum noise level events is the use of engine brakes on heavy vehicles. Engine compression braking (ECB) is a secondary braking system which is present on most heavy vehicles. Engine compression brakes dissipate the vehicle’s kinetic energy by opening the exhaust valves near the top of the compression stroke, releasing stored energy in the cylinder, which causes the characteristic sound. Engine compression brakes are used to reduce the strain placed on the vehicle’s conventional braking system and are commonly used when descending steep grades. Reduced usage of the conventional braking system also lowers maintenance costs through reduced brake wear. The fitting of

ECB systems to heavy vehicles leads to higher vehicle efficiency, productivity and safety.

However, ECB noise is a significant source of community complaint regarding the heavy vehicle industry. This is due to the low-frequency nature of the noise, which has relatively low attenuation with propagation distance, and also the characteristic sound.

In 2006, Arup undertook an investigation into compression braking noise levels on behalf of Roads and Maritime. The aim of the study was to quantify the incidence of engine braking events and loudness on roads of varying gradient.

A brief summary of mean measured maximum noise levels for all downhill events is provided in Figure 9 below for reference.

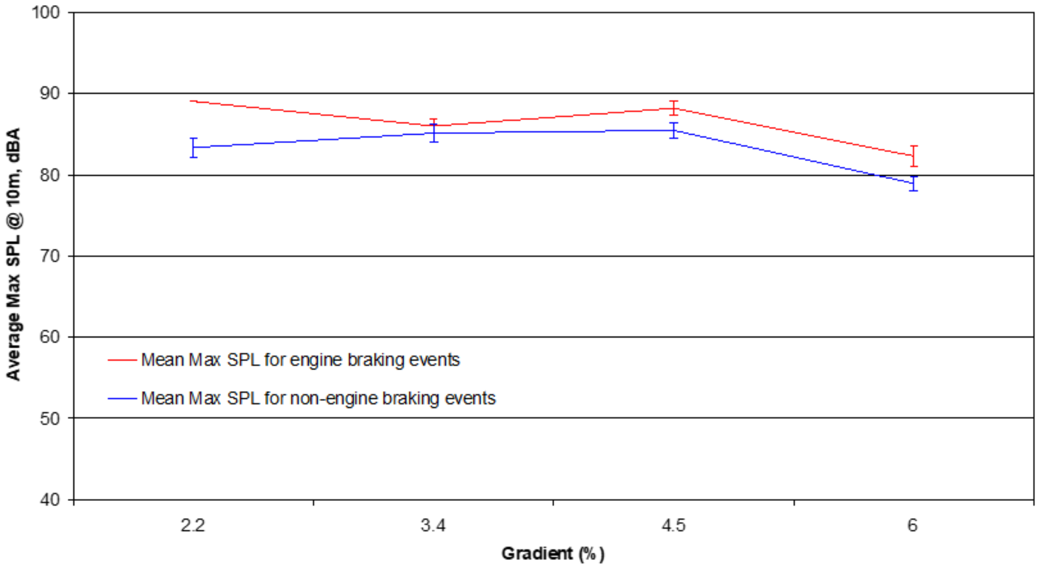


Figure 9: Mean max SPL for all downhill events

Figure 9 shows that there is typically, little difference (around 1–3 dB) between noise levels from engine braking events and non-engine braking events. This shows good correlation with a study which was carried out by the Environmental and Resource Management Group of HDR in Minneapolis, USA, which concluded that peak noise levels due to engine compression braking were 2 dB higher than typical heavy vehicle pass-by noise levels. Further, there is no obvious correlation between increased gradients and higher maximum noise levels.

4.9.2 Acceleration and deceleration

Maximum noise events also occur with acceleration and deceleration of heavy vehicles due to the significant contribution of engine noise. Further to the previous section of this report, it is noted that steep gradients coupled with changes in speed may also have the potential to result in an increased number of compression braking events.

Road design features that have the potential to influence truck acceleration and deceleration include:

- Small radii curves
- Changes in posted speed limit
- Turning bays
- Heavy vehicle inspection bays
- Rest areas
- Intersections / interchanges
- Signalisation.

A review of strategies to minimise potential impacts from these features was undertaken at an early stage of the project. Of the listed road design items, those relevant to the project are located around intersections, ramps and interchanges at four main locations:

- Southern tie-in to Pacific Highway
- Englands Road Interchange from roundabout to signalised intersection
- Coramba Road Interchange
- Korora Hill Interchange near James Small Drive.

On approach and departure to and from these interchanges, trucks would be required to accelerate and decelerate accordingly. In addition, the regular changes in maximum noise level events due to engine noise, there is the potential that compression brakes would be used in place of standard braking.

For areas where new interchanges are proposed in relatively green field areas, future road traffic noise impacts would be significantly altered as a result of the project. The emergent maximum noise level impact would be determined relative to future overall operational road noise impact from the project. A discussion of maximum noise level events as compared with free-flow traffic is provided in Section 4.9.3.

At locations where interchanges tie into the existing Pacific Highway, maximum noise level exposure is expected to currently be reasonably high due to existing heavy vehicle flows in these areas. Analysis of measured maximum noise levels is discussed further in Section 4.9.4.

4.9.3 Maximum noise level data

NCHRP REPORT 635 *Acoustic Beamforming: Mapping Sources of Truck Noise* [23], produced by the Transportation Research Board includes detailed measurement results for a total of 59 heavy truck passbys using acoustic beamforming as the measurement method. The results of this research are presented in Table 38. Data is considered commensurate with the type of heavy vehicles currently in use on NSW highways and likely to be in use on the proposed Coffs Harbour Bypass.

Table 38: NCHRP Heavy vehicle noise level measurement data

Truck type	Speed (km/h)	RPM	Gear	Notes	L_A (dB(A)) at	
					7.5 m	15 m
9200i	0	1100	Neutral	Stationary	74.6	68.2
		1400			78.8	72.2
		1500			78.6	71.7
		1800			81.1	74.1
	56	1400	8th		77.8	72.3
	74	1800	8th		84.2	77.9
	80	1500	9th		83.0	77.5
	80	1100	10th		82.6	76.5
	From 80	*	9th	Coast down	81.4	74.7
	From 80	*	9th	Compression brake	83.6	77.3
9200i Eagle Truck (modified exhaust, no muffler)	0	Idle	Neutral	Stationary	68.6	63.5
		1500			77.6	72.8
		1600			89.6	74.9
		1900			81.7	76.7
	56	1900	7th		85.2	79.9
	56	1500	8th		82.6	76.7
	72	1900	8th		89.2	84.3
	80	1600	9th		89.6	82.1
	From 80	*	*	Coast down	80.0	75.6
	From 80	1400	9th	Compression brake	96.2	90.9

Table 38 shows that noise levels from compression brake events are noted to be within 9 dB of passby events at 80 km/hr. This difference would be expected to be less at higher speeds such as on the project, however this would potentially be greater at larger distances due to the low frequency nature of compression braking.

4.9.4 Noise monitoring data analysis

Maximum noise level analysis has been undertaken of existing noise exposure derived from noise logger data for the project. Analyses have been restricted to locations where maximum noise level events are considered clearly attributable to road traffic noise events.

In accordance with Practice Note iii of the ENMM, an assessment of the impact of sleep disturbance on residents is made in terms of likely maximum noise levels from road traffic, the extent to which these maximum noise levels exceed the ambient level, and the expected number of noise events from road traffic during the night.

Appendix I presents graphs of the analysis results based on current exposure to maximum noise level events from road traffic.

The overall magnitude of maximum road traffic noise events is not expected to change significantly along existing road corridors where alterations to geometry are minimal. Change in maximum noise impact from the existing road network in these locations is therefore expected to be limited to an alteration in number of events commensurate with the change in projected traffic flows.

For locations where the road geometry is being significantly altered in either vertical or horizontal profile, there is a potential that maximum noise impacts would be either increased or reduced depending on changes to distance attenuation or shielding. This predominantly occurs near to the southern and northern tie-ins to the existing Pacific Highway where the main alignment is raised or lowered in locations to accommodate the bypass.

For sections of the existing Pacific Highway through Coffs Harbour, this would likely result in a reduction in number of maximum noise events due to the reduction in overall traffic flow as discussed in Section 4.7.1. Where an increase in traffic flow is predicted on the existing road network, an increase in number of events would be expected to occur.

4.10 Operational vibration

Operational vibration arises from vehicles travelling on an uneven pavement (bumps, old joints etc) which would not be the case with a brand-new pavement. Further, operational vibration from road traffic movements is low because the vehicles are generally well isolated from the ground by pneumatic tyres and vehicle suspension systems. Operational vibration due to the project is therefore not expected to be above perceptible levels at any of the sensitive receivers.

4.11 Industrial noise assessment

4.11.1 Kororo Public School bus interchange

The current Kororo Public School bus interchange is located directly west of Kororo Public School. The bus interchange is proposed to be relocated approximately 190 m south of Kororo Public School.

Traffic investigations and information provided by Roads and Maritime indicate that up to eight buses are likely to be on the site during the morning and afternoon school peak periods. Seven buses are school buses operating drop-off / pick-up services. An additional non-school bus is also expected to use the interchange during this period.

The existing bus timetable indicates that a maximum of two buses per 15 minutes are operating during daytime hours and up to one bus per 15 minutes is operating during the early evening. There are no buses using the bus interchange during night-time hours.

Buses travelling on site were modelled using SoundPLAN 8.0 with ISO 9613 [22] algorithm. Assumptions and data used in this assessment are summarised below:

- Bus sound power level of 104 dB(A) derived from measurements of STA buses travelling at 40 km/hr
- One buses entering and one bus exiting the site and four buses idling within a 15-minute period during the daytime
- One bus entering and exiting the site within a 15-minute period during the evening time
- A speed limit of 5 km/hr for buses travelling on site
- Distance travelled from entrance to exit of 345 m.

For the daytime assessment, noise levels predicted at the nearest residential receivers are 48 dB(A) at ground floor and 50 dB(A) at first floor. Daytime predicted noise levels are below the project specific trigger levels of 53 dB(A).

For the evening assessment, noise levels predicted at the nearest residential receivers are 45 dB(A) at ground floor and 47 dB(A) at first floor. Evening predicted noise levels meet the project specific trigger levels of 46 dB(A) at ground floor and are above the project specific trigger levels of 46 dB(A) by up to 1 dB(A) at first floor. An exceedance of 1dB(A) residual noise level is deemed to represent a negligible impact and not subjectively discernible. Further, calculations undertaken are conservative and based on measurements of buses traveling at greater speed than will be experienced on site.

Based on compliance with NPI target criteria, no further mitigation is required for industrial noise emissions associated with operation of the relocated Kororo Public School bus interchange.

4.11.2 In-tunnel ventilation fans

In-tunnel ventilation fans are installed for smoke management in the rare case of a tunnel fire incident. This equipment is not intended for routine operation however, periodic testing is likely to be required. It is anticipated that Shephards Lane tunnel would have a maximum of three banks of jet fans and Gatelys Road tunnel would have a maximum of four banks of jet fans. Typically, the jet fan banks are spaced on average 110 m apart with the first set of fans located around 80 to 100 m inside the portal.

It is understood from Roads and Maritime that the Scope of Works and Technical Criteria for in-tunnel fans will state that the ventilation design achieves a maximum sound of 85dB(A) so that the emergency systems / responders can be heard and that people in the tunnel can use the emergency phones to communicate effectively.

A desktop assessment has been carried out taking into account the following assumptions:

- The measured sound pressure level from the bank of jet fans does not exceed 85 dB(A) measured at 1.5 m above the centreline of the road
- The nearest set of fans is located 80 m from the tunnel portal
- Fan testing can be carried out in a period between 15 minutes to 1 hour during the daytime period.

The sound power level for a single in-tunnel fan was back calculated assuming a maximum reverberant sound pressure level of 85 dBA within the tunnel and a typical spectrum for an axial fan. This information was then used to predict potential impacts to the nearest receiver taking into account direct and reverberant contribution from the tunnel portal to the nearest noise sensitive receiver.

The distance to the nearest noise sensitive receiver from the Shephards Lane and Gatelys Road tunnel portals is approximately 180 m and 190 m respectively. The predicted noise level at each of the nearest noise sensitive receivers was found to be within 1 dB of the assessment criteria of 45 dBA, taking into account the correction factors for duration as defined in the NPI.

No further mitigation is recommended for industrial noise emissions associated with operation of the in-tunnel ventilation fans at this stage however, all assumptions and inputs should be reviewed once further detail becomes available specific to the project.

4.12 Rail noise assessment

While there are no proposed alterations to the North Coast Railway, changes in topography surrounding the train line may have the potential to alter train noise impacts to the community.

Therefore, an analysis was undertaken of the change in topography adjacent to the railway due to the project to ascertain whether a significant increase in rail noise impacts would be expected to occur due to construction of the project. A notional broadband line source was included in the acoustic model aligning the railway and a direct comparison plot between Build and No-Build terrain models was made using ISO 9613 [22].

Figure 10 shows localised areas where there would be a change greater than 2 dB in the noise level, however there are no instances where these areas encompass noise sensitive receivers due to the introduction of the project. A further analysis was undertaken with a finer grid noise map spacing which resulted in even fewer areas of impact.

Generally, receivers near the railway are identified as qualifying for consideration of noise mitigation due to increased exposure to road traffic noise from the project. No noise mitigation measures are considered for these receivers additional to those recommended as outcomes of the road operational noise assessment.

Figure 10: Change in noise level exposure from existing rail corridor due to changes in terrain topography (from SoundPLAN 8.0)

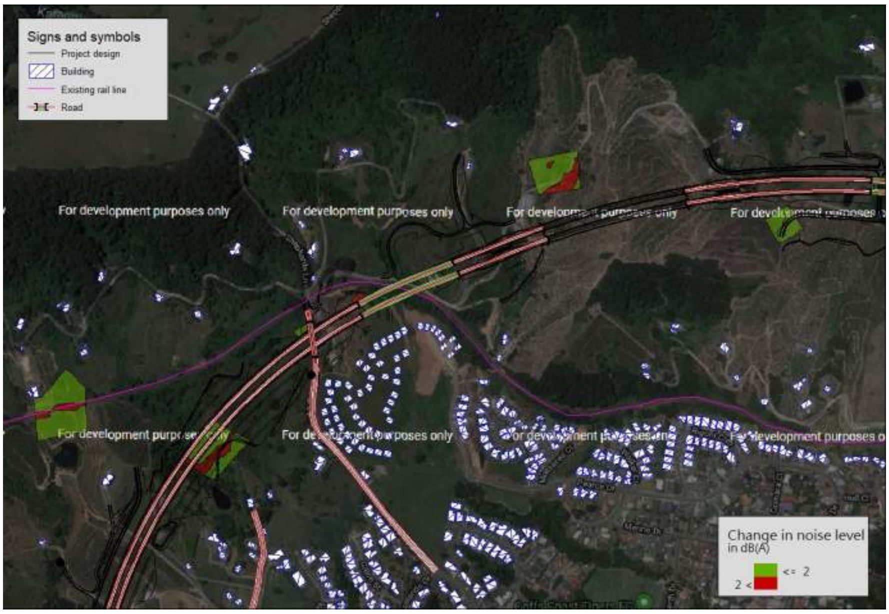


Figure 11: Detailed grid map for identified areas which presented a >2 dB change in noise level exposure from existing rail corridor due to changes in terrain topography (from SoundPLAN 8.0)

5 Construction noise and vibration assessment

This section assesses the potential noise and vibration impacts associated with the activities likely to be required for construction of the project.

Construction noise and vibration impacts will vary depending on factors such as the proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken and the character of the noise and vibration emissions.

Chapter 6 of the EIS identifies the construction footprint for the project which has been used to assess potential noise and vibration impacts from the construction. The construction footprint is indicative only and would be subject to refinement during detailed design and construction. Some factors that could affect the final construction footprint include the location and size of sedimentation basins, the construction methodology and arrangements made with potentially affected land owners.

At this stage of the project detailed constructability information (such as construction methodology, selection of plant and equipment and construction staging) is not currently available. This assessment provides guidance on the likely noise and vibration impacts on nearby receivers and potential feasible and reasonable mitigation based upon a combination of information provided in the project description, standard construction methodologies and scenarios expected for this type of project and available information provided by Roads and Maritime.

According to the CNVG, an additional Construction Noise and Vibration Impact Assessment (CNIA) may be required for each major construction stage or key activity. The CNIA would be included or referenced in the Construction Noise and Vibration Management Plan (CNVMP) to be prepared by the contractor.

5.1 Description of Works

In addition to new road works associated with construction of the bypass, modifications and additions to various sections of the existing Pacific Highway and Coramba Road will also be made.

In addition to major roadworks, the project will likely include:

- Setup of construction sites compounds
- Areas of onsite manufacturing / storage
- Development of ancillary services / utilities.

The constructability report identifies three major construction zones that have been defined based on separating the project into sections where significant construction issues or differences in construction methods are likely to be undertaken. It is noted that this approach has mainly been developed as a planning tool and may be altered during construction. The construction zones and associated significant features are reproduced below.

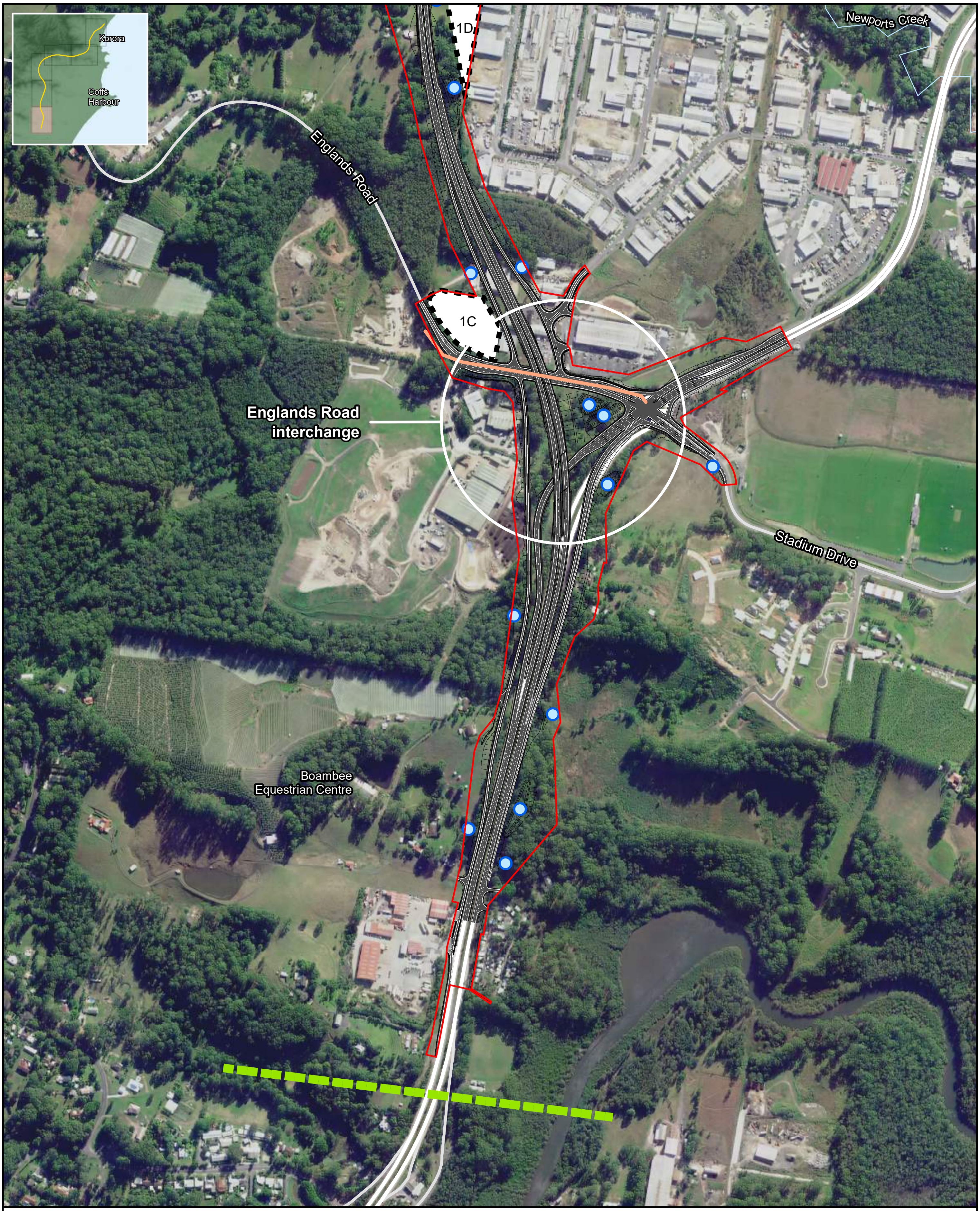
5.1.1 Zone 1 – Englands Road to Roberts Hill ridge

This construction zone covers the area of the project from the southern tie-in to the existing Pacific Highway, south of Englands Road, to the north of Roberts Hill ridge. Most of this construction zone would be constructed away from the existing Pacific Highway and across the Newports Creek floodplain. It includes the Englands Road interchange and the Roberts Hill tunnel.

Key features of this construction zone are discussed in Table 39 and shown in Figure 12 and Figure 13.

Table 39: Zone 1 construction features

Key features	**Comments**
Zone length	• Around 4.4 km
Construction access	• Via the existing Pacific Highway and Englands Road • Via North Boambee Road.
Earthworks	• Potential excess of material when comparing cut and fill volumes • Project largely in fill across the North Boambee Valley floodplain.
Tie in to existing Pacific Highway south of Englands Road	• Connects to the existing dual carriageway highway about 1.1 km south of Englands Road • Includes extension to existing koala underpass south of Englands Road • Includes converting Englands Road roundabout to a traffic light intersection • Bridge over the proposed northbound exit ramp (BR01) • Bridge over Englands Road (BR02).
Newports Creek bridge (BR23)	• Bridge to minimise impacts on Newports Creek, which would require minor realignment to reduce potential impacts on habitat.
North Boambee Road bridge (BR04)	• Clearance to North Boambee Road to be suitable for possible future raising of North Boambee Road.
Roberts Hill tunnel	• Twin tunnels about 190 m long and about 35 to 40 m below the crest of Roberts Hill ridge • May require drill and blast to excavate material.

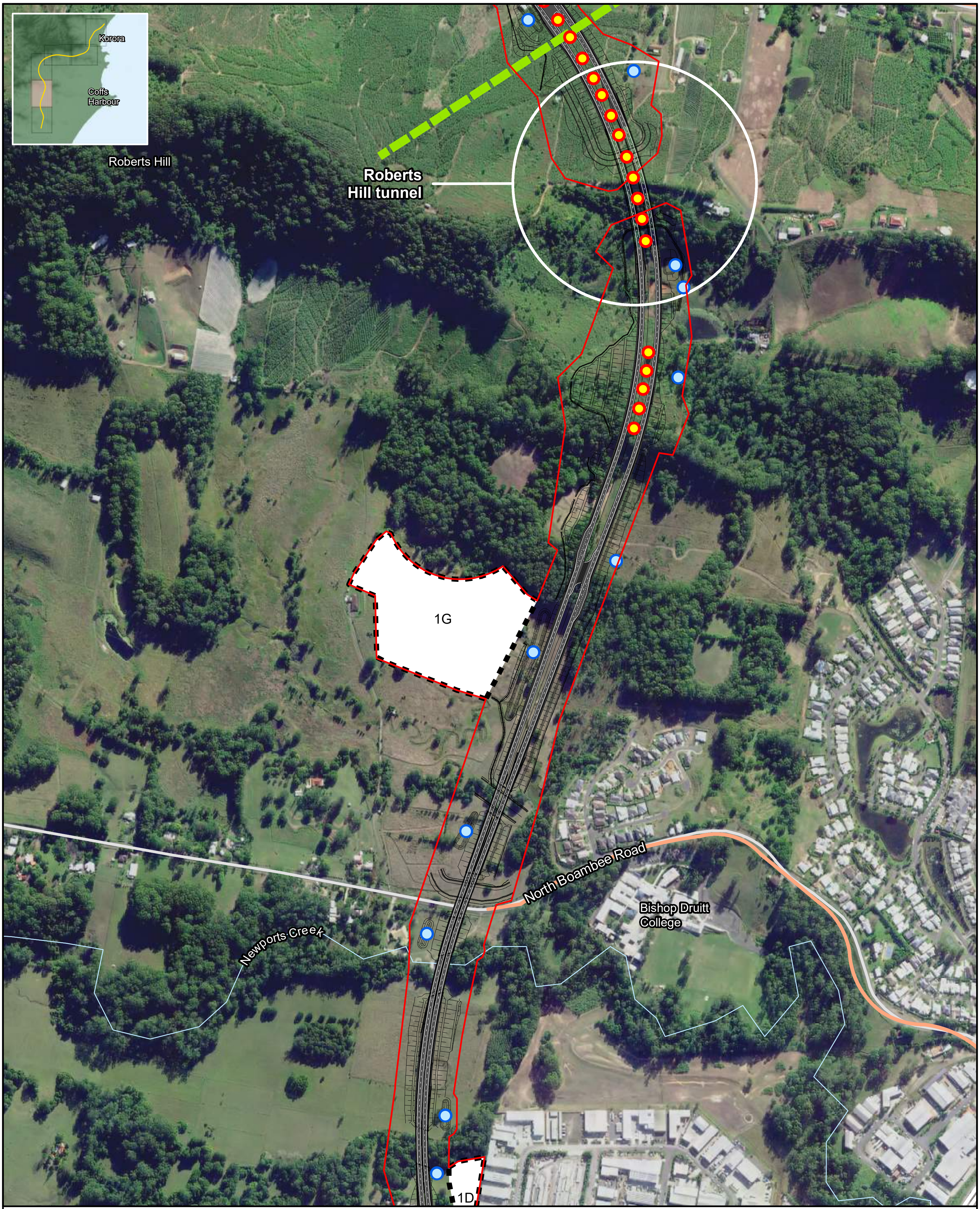


Legend

- 🟥 Construction footprint
- Alignment
- 🟩 Construction zone
- Potential construction access
- Potential ancillary sites
- ● Potential controlled blasting sites
- North Coast Railway
- Watercourse
- ○ Indicative construction sediment basin location

Coffs Harbour Bypass
Construction Zone 1 (Map 1)
Figure 12

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Legend

- ▭ Construction footprint
- — Alignment
- ▬ ▬ Construction zone
- ▬ Potential construction access
- ▚ Potential ancillary sites
- ● Potential controlled blasting sites
- ▬ ▬ North Coast Railway
- — Watercourse
- ○ Indicative construction sediment basin location

Coffs Harbour Bypass
Construction Zone 1 (Map 2)
Figure 13

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

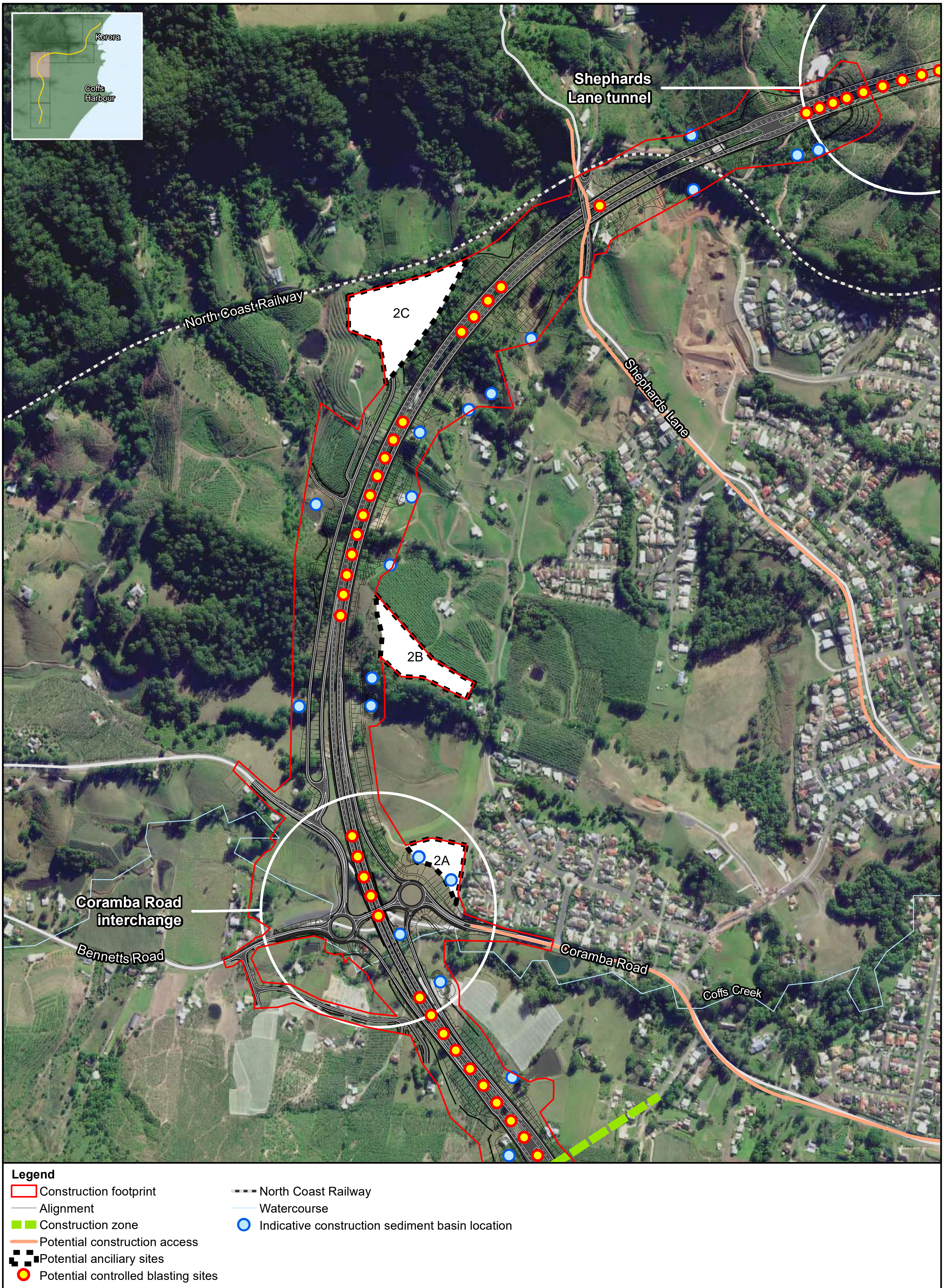
5.1.2 Zone 2 – Roberts Hill ridge to Korora Hill

This construction zone covers the area of the project north of Roberts Hill ridge to south of the Korora Hill interchange. It traverses a number of minor ridges, with a series of cuts and fills along the project and includes the Shephards Lane and Gatelys Road tunnels. This construction zone also includes the Coramba Road interchange and a crossing of the North Coast Railway.

Key features of this construction zone are discussed in Table 40 and shown in Figure 14 and Figure 15.

Table 40: Zone 2 construction features

Key features	Comments
Zone length	• Around 6.2 km
Construction access	• Via Coramba Road • Via Shephards Lane • Via Bray Street and Mackays Road • Via West Korora Road.
Earthworks	• Potential shortfall of material when comparing cut and fill volumes • Series of cuts and fills along the zone length.
Coramba Road interchange	• Includes diversion of Coramba Road to pass over the project alignment and ramps to provide access to and from the project.
Shephards Lane bridge (BR11)	• Bridge over the project to reconnect Shephards Lane. Temporary diversion of Shephards Lane needed to construct the bridge • Bridge would be constructed next to the existing North Coast Railway tunnel currently below Shephards Lane and west of the project.
Bridge over North Coast Rail Line (BR12)	• Bridge spanning the North Coast Railway and a local access road.
Shephards Lane tunnel	• Twin tunnels about 360 m long and about 60 m below the crest of Shephards Lane ridge • May require drill and blast to excavate material.
Mackays Road underpass (BR13)	• Underpass south of Mackays Road to provide access to properties west of the project. This would require realignment of Mackays Road
Gatelys Road tunnel	• Twin tunnels about 450 m long and about 70 m below the crest of Gatelys Road ridge • May require drill and blast to excavate material.
West Korora Road underpass (BR16)	• Underpass along the existing alignment of West Korora Road to provide access to properties west of the project.



Coffs Harbour Bypass
Construction Zone 2 (Map 1)
Figure 14

Coffs Harbour Bypass
Construction Zone 2 (Map 2)
Figure 15

5.1.3 Zone 3 – Korora Hill to Sapphire

This construction zone covers the area of the project from south of Korora Hill interchange to the northern tie-in to the existing Pacific Highway at Sapphire. This construction zone is largely located along the existing Pacific Highway between Bruxner Park Road and the northern tie-in. It is located in a tightly constrained corridor, with key pinch points at the Kororo Nature Reserve and Kororo Public School. It comprises a continuation of the existing service road to the east (built as part of the Sapphire to Woolgoolga upgrade) from south of Sapphire to James Small Drive, and a local access road proposed to the west of the project to provide access to Old Coast Road and Seaview Close.

Key features of this construction zone are discussed in Table 41 and shown in Figure 16 and Figure 17.

Table 41: Zone 3 construction features

Key features	Comments
Zone length	• Around 3.4 km
Construction access	• Via the existing Pacific Highway and Bruxner Park Road • Via Old Coast Road • Via James Small Drive.
Earthworks	• Potential excess of material when comparing cut and fill volumes.
Korora Hill interchange	• Interchange located west of the existing Pacific Highway and provides a connection between the project and the existing Pacific Highway to the south (towards Coffs Harbour), Bruxner Park Road, James Small Drive and the proposed service road • Bridge over a realignment of the existing Pacific Highway (BR17) • Bridge over a connection to James Small Drive (BR19).
Upgrade along existing Pacific Highway corridor	• Tightly constrained corridor between Kororo Nature Reserve and Kororo Public School • Existing Pacific Highway traffic to be managed during construction • Bridge over Pine Brush Creek (BR21).
Proximity to Kororo Public School	• Construction activities are likely to occur in Zone 3 over a three and half year period, including in areas next to the school.
Luke Bowen footbridge relocation (BR24)	• Existing pedestrian bridge to be replaced with a new pedestrian bridge to be built about 200 m north of the existing bridge, near Old Coast Road.
Kororo Public School bus interchange	• Existing bus interchange to be relocated, near Kororo Public School. Access to the bus interchange to be from James Small Drive.
Local access underpass (BR22)	• Local access underpass, near Fernleigh Avenue, to provide access to Old Coast Road and Seaview Close.
Tie-in to existing dual carriageway at Sapphire	• Connects to the existing dual carriageway highway at Sapphire. • Service road east of the project connects directly to Solitary Islands Way.

Legend

- 🟥 Construction footprint
- Alignment
- 🟩 Construction zone
- Potential construction access
- Potential ancillary sites
- ● Potential controlled blasting sites
- North Coast Railway
- Watercourse
- ○ Indicative construction sediment basin location

Coffs Harbour Bypass
Construction Zone 2 (Map 3) / Construction Zone 3 (Map 1)
Figure 16

Legend

- Construction footprint
- Alignment
- 🟩 Construction zone
- Potential construction access
- Potential ancillary sites
- ● Potential controlled blasting sites
- North Coast Railway
- Watercourse
- ○ Indicative construction sediment basin location

Coffs Harbour Bypass
Construction Zone 3 (Map 2)
Figure 17

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

5.1.4 Construction activities

Anticipated construction activities for the project are likely to involve conventional road construction equipment such as rock breakers, earth moving equipment, concreting equipment, paving plant, concrete and asphalt batching plant, cranes, and blasting.

These methods may be modified during the detailed design or construction stages to address site-specific environmental or engineering constraints. The typical pre-construction, construction and activities shown in Table 42 are based on standard construction practices and are informed by the concept design for the project.

The activities and typical construction plant and equipment listed in Table 42 have been used as the basis of assessment of the likely nature and extent of environmental impacts during construction. These activities are indicative and would be refined by the construction contractor based on the site constraints and in accordance with any conditions of approval.

Table 42: Typical construction activities and associated plant and equipment

Component	Typical activities	Typical plant and equipment
Pre-construction and site establishment	• Property acquisition and adjustments, including property access changes • Detailed investigations and survey work including investigative drilling, contamination investigations and excavations • Condition surveys • General site clearance, site establishment work, fencing and signage • Establishment of temporary ancillary facilities and compound sites including the site office • Temporary traffic management arrangements including construction of minor access roads • Progressive installation of environmental controls including temporary or permanent fencing, and erosion and sediment control measures • Construction of temporary drainage controls including temporary creek crossings • Clearing and removal of vegetation (non-threatened species) • Relocation and/or protection of utilities.	• Trucks • Generators • Light vehicles • Excavators • Chainsaws • Mulchers • Water carts • Cranes • Drilling rigs.
Site preparation and bulk earthworks	• Clearing and grubbing of vegetation • Mulching of vegetation for re-use in landscaping activities, where possible • Stripping topsoil and stockpiling it for reuse in landscaping • Excavation of cuttings, including processing, stockpiling or haulage of material, and stabilisation of batters • Drilling of blast holes • Establishment of crushing plant • Crushing and screening excavated material • Hauling materials from excavated cuttings, borrow sites and external sources to fill embankment locations • Construction of fill embankments and earth mounds, including foundation drainage	• Trucks • Bulldozers • Excavators • Compactors • Graders • Scrapers • Loaders • Water carts • Compactors • Vibratory rollers • Rock breakers/ hammers

Component	Typical activities	Typical plant and equipment
	• Benching and stabilising cut and fill batter slopes.	• Drilling and blasting equipment for hard rock cuttings.
Drainage and structures	• Construction of drainage, including kerb and gutter (where required) • Installation of cross-drainage, including culverts and inlet and outlet work, such as channel diversions and scour protection • Installation of longitudinal and vertical drainage in cuttings and embankments • Construction of diversion and catch drains along the formation and sedimentation control basins or swales (where required) • Construction of subsurface drainage • Construction of any retaining walls • Installation of fauna connectivity structures.	• Trucks • Bulldozers • Excavators • Concrete pumps • Concrete trucks • Cranes.
Bridge work	• Preparation of bridge work areas including temporary piling pads, access platforms • Installation of rock caissons or cofferdams or temporary access roads across waterways • Installation of bridge foundations (driven or bored piles, pile caps and footings) • Construction of new bridge abutments and piers • Construction of bridge superstructure including deck and road surface work (cast in situ or precast bridge elements) • Construction of scour protection (where required) • Construction of noise walls (where required).	• Piling rigs • Concrete pumps • Concrete trucks • Cranes • Excavators • Trucks • Cherry pickers • Welding equipment.
Tunnel work	• Establishment of portal sites in preparation for tunnel excavation, including provision of temporary tunnel services • Excavation of tunnel portals • Excavation of mined tunnels using drilling and blasting equipment for hard rock • Excavation of cross passages • Finishing works in tunnel and provision of permanent tunnel services	• Drilling and blasting equipment for hard rock • Trucks • Excavators • Bulldozers • Graders

Component	Typical activities	Typical plant and equipment
	• Test tunnel plant and equipment.	• Paving machines • Light vehicles • Small cranes • Elevated working platform • Generators
Demolition	• Demolition of bridges (Luke Bowen footbridge and northbound carriageway bridge over Pine Brush Creek) • Demolition of buildings (properties and sheds).	• Trucks • Bulldozers • Excavators • Light vehicles • Concrete saws • Jack hammers.
Road work and road surfacing	• Construction of temporary local traffic management diversions • Construction of base and select layers of materials • Construction of road surface layers • Construction of road surface drainage, including kerb and gutter (where required) • Construction of concrete barriers, wire rope fencing and guardrails • Installation of traffic lights, road markings, signposting, roadside furniture and lighting • Progressive landscaping and tree planting.	• Graders • Backhoes • Trucks • Water carts • Vibratory compactors • Bitumen sprayers • Rollers • Concrete trucks • Concrete pumps • Concrete saws • Compressors • Bitumen sprayers • Generators

Component	Typical activities	Typical plant and equipment
		• Milling machines • Paving machines • Asphalt trucks • Curing machines.
Finishing work	• Remove temporary work • Restoration and landscaping of temporary sites • General site clean-up • Restoration of topsoil and revegetation of batters • Removal of temporary environmental controls • Site clean-up and demobilisation, including restoration of ancillary sites and construction access roads (where required).	• Trucks • Generators • Light vehicles • Cranes.

5.1.5 Ancillary Facilities

In order to build the project, ancillary facilities would be required including:

- Site Compounds
- Concrete batching plant
- Asphalt batching plant
- Crushing plant and screening
- Stockpile areas
- Precast facilities.

The ancillary facilities activities are presented below in Table 43 and their potential locations are shown in Figure 12 to Figure 17.

Table 43: Proposed use of ancillary facilities

Site no.	**Proposed use**					
	Main site compound	**Secondary site compound**	**Concrete batch plant**	**Asphalt batch plant**	**Crushing plant**	**Stockpile site**
1C	✓	✓	✓	✓	✓	✓
1D	✓	✓		✓		✓
1G	✓	✓	✓	✓	✓	✓
2A	✓	✓				✓
2B					✓	✓
2C		✓			✓	✓
2D		✓			✓	✓
2E		✓			✓	✓
2G		✓				✓
3B	✓	✓			✓	✓
3C		✓				✓
3D						✓
3E		✓				✓
3G						✓

5.1.6 Construction timing

Subject to planning approval and the progress of property acquisition, construction of the project is anticipated to start in 2020 and take around four years. The actual timing of construction, opening to traffic and completion would depend on the availability of construction funding, the preferred procurement method and wet weather.

The construction program shown in Table 44 is indicative only and may change based on further work during detailed design and changes to construction methods and/or materials as well as wet weather periods. The community would be kept informed of timing as the construction program is refined after project approval.

Table 44: Indicative construction timeline

Principal activities	**Year 1**				**Year 2**				**Year 3**				**Year 4**			
Preliminary activities and site establishment	■	■	■	■												
Site preparation and bulk earthworks		■	■	■	■	■	■	■	■	■						
Drainage and structures			■	■	■	■	■	■	■	■	■	■	■	■	■	
Bridges			■	■	■	■	■	■	■	■	■	■				
Tunnels				■	■	■	■	■	■	■	■					
Road work and road surfacing			■	■	■	■	■	■	■	■	■	■	■	■	■	
Finishing work					■	■	■	■	■	■	■	■	■	■	■	■

Construction works are anticipated to take place mostly within standard construction hours in accordance with the CNVG and the ICNG. However, construction works might need to be undertaken during evening and night-time periods due to special requirements (e.g. deliveries of oversized equipment, minimisation of traffic disruption, safety reasons, emergencies, reduction in construction timeframe).

The following are the categories of work that may be carried out outside the recommended standard hours:

- Delivery of oversized plant or structures that the police or other authorities determine require special arrangement to transport along public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the duration of construction and are supported by the affected community
- Work where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.

Potential activities associated with the last category of work are summarised in Table 45 including likely locations in regard to the construction zones identified in Section 5.1.1, 5.1.2 and 5.1.3 and justification for the work. Most of these activities would be carried out in the Korora Hill to Sapphire section (Zone 3) due to the need to coordinate work with existing Pacific Highway traffic (about 30,000 vehicles per day at this location), Road Occupancy Licence (ROL) restrictions necessary to minimise road user delays and traffic queuing and the need to consider safety of construction personnel and road users.

Table 45: Proposed out of hours work

Activity	**Location**	**Justification**
Bridge construction	All zones	A number of bridges would require construction in close proximity to or over the existing Pacific Highway between Korora Hill to Sapphire. Activities would include lifting and setting bridge spans and girders. Due to the potential safety risks to road users and construction personnel associated with working near the existing heavily trafficked highway, this work would need to be carried out outside peak traffic hours or at night when there are lower traffic flows. Avoiding peak periods would also significantly minimise the disruption to traffic. In addition, it is likely that bridges over Englands Road and North Boambee Road would also require to lifting and setting bridge spans and girders during out of hours to reduce the potential safety risks to road users and construction personnel. During construction of the bridge over the North Coast Railway, there may also be a need to undertake pier construction or lifting and setting bridge spans and girders outside of the recommended standard construction hours to minimise disturbance to railway operations. This work would also need to be in accordance with fixed Track Possession periods issued by Australian Rail Track Corporation when only certain works are permitted to occur with the rail corridor. This may include working over public holidays/long weekends, eg Easter when tracks are officially closed to rail traffic for a defined window so as to minimise impacts on rail freight and passenger traffic as well as the associated safety risks.
Bridge demolition	Zone 3	The existing Luke Bowen footbridge would require demolition as part of the project. It is expected the main bridge span would be required to be lifted out in a single piece, necessitating a full stoppage of the Pacific Highway and or detour of traffic. To avoid potential safety risks to road users and construction personnel associated with demolishing the existing bridge over live traffic, this work would need to be carried out at night when there are lower traffic flows. Avoiding peak periods would also minimise the disruption/delays to traffic.

Activity	**Location**	**Justification**
Concrete paving and saw-cutting	All zones	Roads and Maritime has specifications for concrete paving that relate to temperature and rainfall. For jointed concrete base, the specifications prohibit the placement of concrete during rain or when the ambient air temperatures are below 5ºC or above 32ºC. As hot weather affects the quality of the concrete surface, paving in the early evening and into the night is preferred as it takes advantage of cool night-time temperatures. In some places, the project would use plain concrete pavement, which is an unreinforced pavement. To manage cracking associated with drying and shrinkage, saw cutters are used to cut the pavement. The timing of concrete cutting is governed by the hydration rate of the concrete and may require cutting at any time within four and 24 hours after paving, with a 'cutting window' as short as 30 minutes. As the timing of the cutting is critical to the quality of the pavement and acceptance of the finished product, concrete saw-cutting may be needed at any time including outside standard construction hours. Concrete saw-cutting is a construction activity that is transient in nature, and each saw cut would be of a short duration.
Structural concrete work	All zones	Roads and Maritime has specifications for structural concrete work that relate to temperature and rainfall. For structures, the specifications prohibit the placement of concrete during rain or when the ambient air temperatures are below 5ºC or above 32ºC. During hydration of the concrete, significant temperatures can be generated. Additionally, for large size members (minimum dimension of 1 m), the maximum allowable internal temperature of the concrete must not exceed 70ºC. The temperature differential between the centre of the element and the surface must not exceed 25ºC. As hot weather affects the temperature of the concrete constituents and hence the mix, as well as the ambient conditions under which the work is exposed and ultimately the quality of the concrete, placing concrete at night and in the early morning is preferred as it takes advantage of the coolest part of the day. These would generally be concrete pours for specific, large sized critical elements of the project. Additionally, some bridge construction techniques, concrete work and stressing operations need to occur at times of the day when the temperature effects are relatively stable or minimised to achieve the required design intent.

Activity	Location	Justification
Traffic management, tie-ins, line marking and traffic switches	All zones	Road surface work, including milling and re-sheeting with asphalt and the removal and replacement of concrete carried out on the existing Pacific Highway associated with traffic management, tie-ins, line marking and traffic switches would need to be coordinated with live traffic. While this work would be completed in stages, it may require lane closures to safely carry out the work. This work would need to occur during evening and night-time periods during periods of lower traffic volumes. Carrying out this work outside the recommended standard construction hours would reduce inconvenience to road users, avoid traffic delays during daytime or peak traffic periods and better manage the safety of construction personnel working on the existing highway. Similarly, traffic switches associated with the new alignment of Coramba Rad would also need to be undertaken outside of the recommended standard construction hours to reduce inconvenience to road users, avoid traffic delays during daytime or peak traffic periods and better manage the safety of construction personnel. Intersection works including the installation and commissioning of traffic lights would also be programmed to occur outside peak traffic hours or at night when there are lower traffic flows. Avoiding peak periods would also significantly minimise the disruption to traffic.
Utility relocations and protection	All zones	Public utility providers typically require ‘cut over’ work to be carried out outside of peak demand periods to avoid or minimise potential disruptions for utility customers. This is also the case for utility supply to critical infrastructure. This would result in some utility work needing to be carried out outside of the recommended standard construction hours. In addition, carrying out utility relocations or protection near the existing Pacific Highway would require construction close to live traffic. Due to the potential safety risks to road users and construction personnel associated with working near the existing highway and to minimise the duration, this work would need to be carried out outside peak traffic hours or at night when there are lower traffic flows.

Activity	Location	Justification
General construction on or near the existing highway	Zone 1 Zone 3	A ROL would be required for all work on the existing Pacific Highway between Korora Hill and Sapphire and between the southern tie-in and Englands Road interchange. An ROL is required for any activity that would or is likely to cause delay including obstruct, restrict, close, interfere with, slow or stop the free flow of traffic on any lane or shoulder of the existing highway. Due to the importance of the existing Pacific Highway in the State road network and traffic volumes experienced (between 30,000 to 32,000 vehicles per day for the above locations), ROL requirements would likely restrict the majority of work outside peak traffic hours or at night when there are lower traffic flows. As such, a number of general construction activities would be required to be carried out outside of the standard construction hours for the Korora Hill to Sapphire section and southern tie-in to Englands Road interchange section of the project. This would include earthworks, drainage and structures, road work and finishing work (eg installation of road furniture). Additionally, some general construction activities directly next to the Korora Public School may be also be best carried out outside of school hours to minimise impacts on the operations of the school including the safe drop off and pick up of children.
Operation of construction ancillary facilities	All zones (ancillary sites only)	Operation of construction ancillary facilities would be required to support proposed out of hours work.
Deliveries to batching plants	All zones (batching plants only)	A number of batch plants are proposed as part of the project (see Section 5.8.3). In addition to normal daytime operation, the batch plants would need to operate in conjunction with paving work during the evening and night time. There may also be a need to cast some bridges in situ, which would require the plant to operate continuously for up to 24 hours. To keep up with the materials demand during these peak periods of concrete production, the batch plant would also require material deliveries outside normal working hours.
Refuelling operations and maintenance	All zones	To maximise plant and machinery operations and therefore reduce the overall duration of the project.
Tunnel excavation	Zone 1 and Zone 2	To maximise program efficiency and reduce the overall duration of the project. Reducing the overall duration of the project would provide a benefit to the affected community by reducing exposure to potential construction related impacts such as noise and vibration.

Additional activities and/or locations for out of hours work (OOHW) may be required as further construction staging and methodologies are developed during detailed design. Out of hours work would occur in accordance with the project approval and notification requirements of any Environment Protection Licence for construction of the project. Specifically, this would be managed through an OOHW procedure which would be included as part of the CNVMP.

Table 46 summarises the anticipated construction scenarios and corresponding anticipated timing for the project.

Table 46: Indicative construction scenarios and timing

Scenario ID	Scenario	Indicative duration[1] (months)	Hours of works			
			Day (Standard)	Day (OOH[2])	Evening	Night
1	Preliminary activities and site establishment	12	Yes	Yes	Yes	Yes
2	Site preparation and bulk earthworks	27	Yes	No	No	No
3	Drainage and structures	39	Yes	Yes	Yes	Yes
4	Bridges	33	Yes	Yes	Yes	Yes
5	Tunnels	24	Yes	Yes	Yes	Yes
7	Road work and road surfacing	39	Yes	Yes	Yes	Yes
8	Finishing work	36	Yes	Yes	Yes	Yes

[1] Durations should be regarded as indicative and represent typical works. The durations will differ at the various sites and the longest duration is presented.

[2] OOH = Out of hours. During the daytime, this refers to the period on Saturday between 7am – 8am and 1pm – 6pm, on Sunday and public holidays between 8am – 6pm.

5.1.7 Construction traffic

The construction of the project will generate an increase in vehicle movements on the Pacific Highway and the collector road network (including the proposed identified construction access roads). Additional vehicle movements will be generated by:

- The arrival and departure of construction plant, equipment and vehicles; this is likely to require off-peak movement of construction plant and equipment to/from work areas
- The haulage and delivery of road work materials, and removal of waste to and from the construction zones
- The arrival and departure of construction workers at the start and end of each work day and night shift, which will result in an increased traffic demand and turning manoeuvres to and from the construction site access.

It is noted that a minor temporary realignment of Shephards Lane is also proposed to enable bridge construction. This realignment is not considered a significant diversion and is not expected to significantly alter the traffic noise impact in this location during construction.

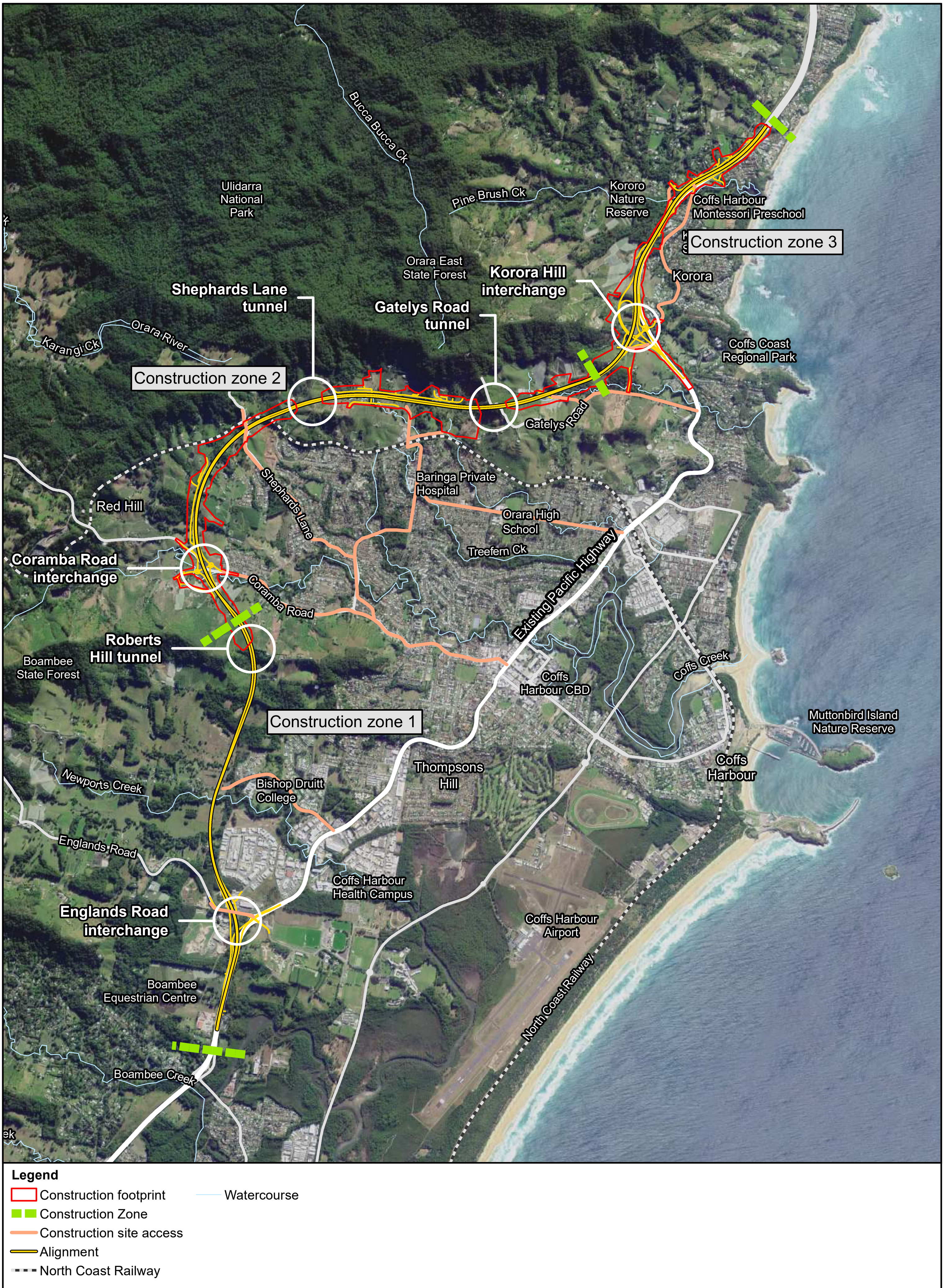
Construction access roads have been identified in Table 47.

Table 47: Construction access roads

Construction zone	**Construction access**
Zone 1 – Englands Road to Roberts Hill	Englands Road North Boambee Road
Zone 2 – Roberts Hill ridge to Korora Hill	Coramba Road/West High Street[1] Shephards Lane Bray Street[1] Mackays Road
Zone 3 – Korora Hill to Sapphire	West Korora Road Bruxner Park Road James Small Drive Old Coast Road

[1] Road extent is outside 600 m assessment boundary and therefore is not included as part of the construction traffic noise assessment

The construction access roads are shown on Figure 18.



Coffs Harbour Bypass
Construction access routes
Figure 18

5.2 Construction noise

Consistent with the requirements of the CNVG, this assessment provides a ‘realistic worst-case’ noise impact assessment based on the required construction works within any 15-minute period. This is typically associated with works located nearest to a particular receiver. In reality, the potential construction noise impacts at any particular location can vary greatly depending on factors including the following:

- The position of the works within the site and distance to the nearest sensitive receiver
- The overall duration of the works
- The intensity of the noise levels
- The time at which the works are undertaken
- The character of the noise.

Noise levels at sensitive receivers can also be significantly lower than the worst-case scenario when the construction works move to a more distant location in a works area.

5.2.1 Construction activities and scenarios

In order to assess the likely noise impacts associated with the construction of the project, a number of scenarios comprising typical plant and equipment frequently used on similar road developments have been developed based on the current understanding of the project. The scenarios are based on the information contained in Section 5.1. The scenarios assessed in this report, including the construction activities and plant and equipment, are likely to change during the detailed design when additional information regarding construction activities, plant and equipment and staging is available.

The scenarios are presented in Table 48 are considered representative of the noisiest construction activities likely to occur across the project. Anticipated plant and equipment used during each of the scenarios is also provided, together with the associated sound power levels (L_W) which have been sourced from:

- AS2436: Guide to noise and vibration control on construction, demolition and maintenance sites [24]
- BS 5228-1 – 2009: Code of Practice for noise and vibration control on construction and open sites [25];
- Roads and Maritime Construction Noise Estimator Tool database [26]
- Construction Noise and Vibration Strategy, Transport for NSW, 2018 [27].

Sound power data provided includes an estimated time correction of the plant and equipment use in 15 minutes. A 5 dB penalty has also been included to the sound power levels of equipment identified as particularly annoying to nearby residents in accordance with the ICNG, such as jackhammers, rock breakers, power saws, rock drilling, vibratory rollers, milling and profiling machines and impact piling.

Table 48: Construction activities and equipment

Plant and equipment	**Plant and equipment characteristics**			**Construction Activities**																	
				Preliminary activities and site establishment/Earthworks				**Bulk earthworks**			**Drainage and structures**		**Bridge and tunnel works**				**Demolition**	**Road work and road surfacing**			**Finishing works**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
				Mobilisation and Site Establishment	**Utility, Property, service adjustment**	**Corridor Clearing**	**Construction Compound Site Establishment**	**Bulk Earthworks**	**Rock Crushing**	**Compounds**	**Drainage Infrastructure**	**Retaining walls/Noise walls**	**Bridge Works**	**Compounds**	**Tunnel works**	**Compounds**	**Demolition**	**Paving/asphalting (incl concrete sawing)**	**Re-surfacing works**	**Compounds**	**Road Furniture Installation**
	Plant item SWL, dB(A)	**% of use in a 15 minute period1**	**Plant Item Max SWL, dB(A)**	**Installing construction boundary hoardings/fences and traffic barriers**	**Adjustment of property boundaries (where required); relocation of services**	**General land clearing, tree and stump removal, topsoil stripping, loading**		**Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage,**	**Crushing and screening of building waste/rock material for re-use on site**	**Deliveries. Plant and equipment. Maintenance. Office areas. Storage areas.**	**Excavation of trenches and pits; delivery and placement of precast pipes and pits; filling and compacting**		**Casting; concrete pours; placement of pre-cast elements; piling (mainly bored); and demolition**	**Deliveries. Plant and equipment. Maintenance. Office areas.**		**Deliveries. Plant and equipment. Maintenance. Office areas.**	**Demolition of existing structures**	**Delivery of raw materials. Placement of surface material. Saw cutting.**	**Milling the asphalt to expose the underlying concrete, then laying the new asphalt**	**Deliveries. Plant and equipment. Maintenance. Office areas. Storage areas. Batching plant**	**Signposting and line marking**
Air track drill[1]	129	25	124									1									
Asphalt truck & sprayer	106	100	112															1	1		
Backhoe	106	50	111																		
Batching plant	115	100	118																		
Batching plant (Asphalt)	114	100	117																	1	

Bulldozer D9	116	100	120			1		1	1												
Chainsaw 4-5hp	114	25	117			1															
Compactor	113	25	115					1										1	1		
Compressor	109	100	110				1						1	1		1				1	
Concrete pump	109	50	112									1	1								
Concrete saw[1]	122	25	122		1													1			
Concrete truck	109	50	112		1						1		1					1			
Concrete vibrator	113	100	115									1									
Crane (Fixed)	105	100	113																		
Crane (Franna 20t)	105	100	113	1	1						1		1		1						1
Crane (Mobile)	105	100	113									1									
Crushing Plant	118	100	124							1											
Daymakers	98	100	98																1		
Drill (Hydraulic)[1]	118	100	115					1							1						
Drill (Percussive)[1]	121	100	121																		
Excavator (tracked) 35t	100	100	110		1	1		1	1		1	1					1				
Excavator (tracked) 35t + hydraulic hammer[1]	123	50	123					1									1				
Front end loader 23t	113	100	115				1			1				1		1	1			1	
Grader	110	100	115																		
Light vehicles (e.g.	103	100	108				3			3				3		3				3	
Line marking truck	108	100	108																		1
Pavement laying	110	100	114															1	1		
Pavement profiler[1]	118	100	117																1		
Piling rig - bored	108	50	112									1	1								
Piling rig - impact[1]	128	50	133																		
Pneumatic hammer	115	50	117																		

Power generator	103	100	105		1		1					1	1	1	1	1				1	
Rock crusher	115	100	118						1												
Scraper 651	110	100	116																		
Smooth drum roller	107	100	111															1	1		
Truck compressor	75	100	78								1										
Truck (Dump truck)	110	100	112		1	1		2	1					1		1	1	1	1	1	
Truck (medium rigid)	108	100	110	1						1											
Truck (Road truck)	108	100	111	1			1				1										1
Truck (Vacuum truck)	109	100	111																		
Tub grinder/ mulcher 40-	116	100	118			1															
Vibratory roller[1]	114	100	113								1										
Water cart	107	100	108	1				1													
Welding equipment	105	100	110				1							1		1				1	
TOTAL NUMBER OF EQUIPMENT				5	6	5	8	8	4	6	6	7	6	8	3	8	4	7	7	9	4
TOTAL SWL				113	118	120	117	124	119	120	116	124	114	116	118	116	121	120	121	119	112
MAX SWL				113	122	120	115	123	120	123	113	124	113	115	115	115	123	122	117	117	113

Note 1: A 5 dB penalty has been included to the sound power levels of equipment identified as particularly annoying to nearby residents in accordance with the ICNG (such as jackhammers, rock breakers, power saws, rock drilling, vibratory rollers, milling and profiling machines and impact piling).

Note 2: Correspond to an estimated time correction of the plant and equipment use in 15 minutes.

The predicted loudest construction activities likely to occur over the whole project include bulk earthworks, construction of retaining walls and pavement tie-ins and overlay, which are potentially occurring during the night-time period. Predicted loudest construction activities are also likely to occur during the construction of the bridges depending of the equipment to be used.

5.2.2 Construction noise impact assessment

Four scenarios have been modelled in accordance with Table 42. The scenarios correspond to a representative worst-case scenario of the activities listed in Table 42.

The four scenarios modelled are:

- Bulk earthworks (Activity ID5) – occurring over the whole length of the project, see Table 49
- Bridges construction (Activity ID10), see Table 50
- Tunnels construction (Activity ID11), see Table 51
- Road works (Activity ID 14) – occurring over the whole length of the project, see Table 52
- Site compounds activities (Activity ID4, ID 7, ID11, ID 13, ID 17) – modelled in accordance with Table 48, see Table 53.

Construction noise impacts have been modelled using the validated SoundPLAN 8.0 acoustic model developed for assessment of operational noise impacts from the project. Environmental noise emissions are predicted based on the ISO 9613-2:1996 algorithm.

Each of the three construction zones defined in Section 5.1 were divided into smaller construction areas in the acoustic model. The cumulative sound power level emitted by the smaller sub-construction areas was determined using the sound power level per activity in Table 48.

It is noted that in Table 48, the total SWL represents the total L_{Aeq} SWL radiated by an area within a construction zone. The max SWL correspond to the L_{Amax} SWL of one piece of equipment working at the closest location on the construction boundary from a receiver. The assessment presents the anticipated maximum noise impacts likely to be experienced at the nearest receivers for each scenario.

The precise locations and types of equipment that will be used to undertake the construction of the project is not known in detail at this stage. Furthermore, the typical construction plant and equipment provided in Table 48 are unlikely to operate at the same time but may be used sequentially across each part of the construction zones. The predicted construction noise impacts presented are therefore considered to be conservative and in practice for most construction activities, it is expected that the construction noise levels would frequently be lower than predicted as the noise levels presented in this report are based on a realistic worst-case assessment.

Appendix J summarises results tables and noise contour plots of construction noise impacts based on the scenarios and sound power levels summarised in Table 48. Tabulated results also identify exceedances of CNVG criteria and form the basis of recommendations for mitigation discussed in Section 5.5.

An overall summary of number of noise sensitive receivers that exceed NMLs per catchment area is provided in Table 49, Table 50, Table 51 and Table 52.

For all modelled scenarios, assessment during all periods has been undertaken.

Furthermore, the assessment includes buildings built and buildings not yet built (subdivisions identified in Section 4.3.1) as it is not known if those buildings will be built before or after construction of the project. The buildings have been differentiated in the tables of results as well as on the map in Appendix J.

Table 49: Summary of NML exceedances per catchment area for construction activity ID 5 (Bulk earthworks)

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID5																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
Residential																		
NCA01.RES	1	6	0	0	3	7	0	0	12	5	6	0	0	13	8	6	27	27
NCA02.RES	0	5	1	0	5	6	1	0	3	6	3	0	0	8	5	0	12	7
NCA03.RES	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
NCA03.RES (unbuilt)	0	38	2	0	47	56	2	0	42	82	3	0	28	113	30	0	143	40
NCA05.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA06.RES	0	17	14	9	23	19	14	9	10	37	12	12	6	41	11	13	50	20
NCA06.RES (unbuilt)	0	98	55	0	37	104	55	0	12	99	89	3	7	97	91	8	176	22
NCA07.RES	0	2	1	1	0	2	1	1	0	2	1	1	0	3	0	1	4	1
NCA08.RES	0	1	6	0	0	1	6	0	0	0	7	0	0	2	5	0	7	2

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID5																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA09.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA10.RES	0	3	1	0	0	3	1	0	0	2	1	1	0	2	1	1	4	1
NCA11.RES	0	19	4	0	9	22	4	0	0	20	16	1	0	14	21	2	37	3
NCA12.RES	0	20	10	6	0	23	10	6	0	19	7	13	0	14	12	13	39	14
NCA13.RES	0	105	24	2	0	105	24	2	0	11	109	11	0	0	113	18	131	31
NCA14.RES	0	88	16	1	4	89	16	1	0	33	68	9	0	33	68	9	109	12
NCA15.RES	0	6	6	0	2	6	6	0	0	7	7	2	0	7	7	2	14	3
NCA16.RES	0	23	2	0	20	31	2	0	29	48	8	1	29	48	8	1	60	1
NCA16.RES (Unbuilt)	0	22	24	9	3	27	24	9	0	15	34	14	0	15	34	14	63	38
NCA17.RES	0	0	3	0	0	0	3	0	0	0	1	2	0	0	1	2	3	3
NCA18.RES	0	149	12	3	28	158	12	3	10	124	73	4	12	108	91	4	183	3
NCA19.RES	0	2	7	2	0	2	7	2	0	0	5	6	0	0	5	6	11	5

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID5																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA20.RES	0	3	5	0	0	3	5	0	0	1	5	2	0	0	5	3	8	3
NCA21.RES	0	0	0	0	0	0	0	0	0	3	0	0	2	27	4	1	34	20
NCA22.RES	0	0	0	0	0	0	0	0	5	0	0	0	7	14	5	0	19	7
NCA23.RES	0	0	0	0	0	0	0	0	15	15	0	0	0	0	30	0	30	30
NCA24.RES	1	4	1	1	4	4	1	1	0	5	3	2	0	4	4	2	9	4
NCA25.RES	0	26	0	0	6	27	0	0	43	25	21	0	17	64	29	4	96	27
NCA26.RES	0	17	2	0	37	21	2	0	26	75	17	0	42	83	52	8	128	44
NCA27.RES	1	19	2	0	23	23	2	0	25	49	13	0	32	105	48	7	132	53
NCA28.RES	0	1	0	0	3	2	0	0	6	11	1	0	16	34	11	0	45	12
NCA29.RES	1	4	1	0	13	11	1	0	39	31	11	1	22	79	30	2	130	99
Commercial																		
NCA02.COM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID5																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA03.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA04.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.COM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA07.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA11.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA18.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA19.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA21.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA22.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA23.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA24.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA25.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID5																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA26.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA27.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA28.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Industrial																		
NCA04.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Hospital																		
NCA03.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Educational																		
NCA06.SCH	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA08.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID5																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA26.SCH	0	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Place of worship																		
NCA05.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA06.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Child Care Facilities																		
NCA05.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA13.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

Table 50: Summary of NML exceedances per catchment area for construction activity ID10 (Bridge works)

NCAs and receiver types	**Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID10**																	
	All Hours	**Standard Hours**			**Outside of Standard Hours**												**Sleep Disturbance**	
		Daytime			**Daytime**				**Evening**				**Night**				**Night**	
	Highly noise affected >75dB(A)	**Clearly audible <NML+10**	**Moderately intrusive <=NML+20**	**Highly intrusive >NML+20**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Screening criterion RBL+15**	**Awakening criterion >65 dB(A)**
Residential																		
NCA01.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA02.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES (Unbuilt)	0	0	0	0	3	0	0	0	10	0	0	0	18	16	0	0	7	0
NCA05.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA06.RES	0	14	9	0	2	14	9	0	0	11	14	0	2	8	17	0	24	0
NCA06.RES (Unbuilt)	0	21	0	0	53	25	0	0	69	54	0	0	61	77	1	0	21	0
NCA07.RES	0	1	1	0	1	2	1	0	0	3	1	0	2	1	1	0	1	0
NCA08.RES	0	4	2	0	0	5	2	0	0	4	3	0	1	5	1	0	5	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID10																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA09.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA10.RES	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
NCA11.RES	0	0	0	0	1	0	0	0	18	7	0	0	17	16	0	0	3	0
NCA12.RES	0	10	0	0	11	14	0	0	7	25	7	0	4	27	8	0	15	0
NCA13.RES	0	7	0	0	26	9	0	0	32	93	5	0	7	117	7	0	61	0
NCA14.RES	0	0	0	0	2	0	0	0	69	4	0	0	69	4	0	0	0	0
NCA15.RES	0	4	0	0	3	4	0	0	6	8	2	0	6	8	2	0	6	0
NCA16.RES	0	8	0	0	24	9	0	0	10	34	2	0	10	34	2	0	11	0
NCA16.RES (Unbuilt)	0	20	15	0	6	21	15	0	20	16	26	1	20	16	26	1	40	7
NCA17.RES	0	2	0	0	1	2	0	0	0	3	0	0	0	3	0	0	2	0
NCA18.RES	0	4	1	0	4	5	1	0	20	8	2	0	32	10	2	0	8	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID10																
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance
		Daytime			Daytime				Evening				Night				Night
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA19.RES	0	4	3	0	1	4	3	0	1	3	5	0	1	3	5	0	8	0
NCA20.RES	0	1	0	0	2	3	0	0	3	5	0	0	0	7	1	0	3	0
NCA21.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA22.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA23.RES	0	0	0	0	0	0	0	0	0	0	0	0	15	6	0	0	0	0
NCA24.RES	0	1	0	0	1	1	0	0	1	1	1	0	4	2	1	0	2	0
NCA25.RES	0	0	0	0	2	0	0	0	5	15	0	0	21	21	2	0	19	0
NCA26.RES	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
NCA27.RES	0	9	0	0	4	10	0	0	17	20	1	0	58	46	17	0	50	10
NCA28.RES	0	0	0	0	1	0	0	0	4	2	0	0	21	11	2	0	8	1
NCA29.RES	0	0	0	0	2	0	0	0	15	7	0	0	23	44	6	0	31	7

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID10																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
Commercial																		
NCA02.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA03.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA04.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA07.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA11.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA18.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA19.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA21.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA22.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	**Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID10**																	
	All Hours	**Standard Hours**			**Outside of Standard Hours**												**Sleep Disturbance**	
		Daytime			**Daytime**				**Evening**				**Night**				**Night**	
	Highly noise affected >75dB(A)	**Clearly audible <NML+10**	**Moderately intrusive <=NML+20**	**Highly intrusive >NML+20**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Screening criterion RBL+15**	**Awakening criterion >65 dB(A)**
NCA23.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA24.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA25.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA27.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA28.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Industrial																		
NCA04.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Hospital																		
NCA03.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	**Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID10**																	
	All Hours	**Standard Hours**			**Outside of Standard Hours**												**Sleep Disturbance**	
		Daytime			**Daytime**				**Evening**				**Night**				**Night**	
	Highly noise affected >75dB(A)	**Clearly audible <NML+10**	**Moderately intrusive <=NML+20**	**Highly intrusive >NML+20**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Screening criterion RBL+15**	**Awakening criterion >65 dB(A)**
NCA05.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Educational																		
NCA06.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA08.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Place of worship																		
NCA05.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA06.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Child Care Facilities																		
NCA05.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA13.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

Table 51: Summary of NML exceedances per catchment area for construction activity ID11 (Tunnel works)

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID11																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
Residential																		
NCA01.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA02.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES (Unbuilt)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA05.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA06.RES	0	2	0	0	37	6	0	0	34	30	0	0	24	43	0	0	0	0
NCA06.RES (Unbuilt)	0	32	0	0	81	54	0	0	71	110	0	0	52	135	0	0	1	0
NCA07.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA08.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID11																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA09.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA10.RES	0	1	1	0	2	1	1	0	0	3	1	0	0	3	1	0	2	0
NCA11.RES	0	2	0	0	16	3	0	0	7	24	2	0	6	27	2	0	17	0
NCA12.RES	0	0	0	0	1	0	0	0	9	4	0	0	10	6	0	0	0	0
NCA13.RES	0	0	0	0	30	0	0	0	45	86	0	0	8	123	0	0	4	0
NCA14.RES	0	0	0	0	28	0	0	0	30	79	0	0	30	79	0	0	0	0
NCA15.RES	0	1	0	0	4	2	0	0	5	7	0	0	5	7	0	0	2	0
NCA16.RES	0	5	1	0	12	10	1	0	36	25	1	0	36	25	1	0	6	0
NCA16.RES (Unbuilt)	0	46	0	0	6	54	0	0	2	53	8	0	2	53	8	0	52	0
NCA17.RES	0	0	2	0	1	0	2	0	0	1	1	1	0	1	1	1	2	0
NCA18.RES	0	50	1	0	78	63	1	0	50	140	2	0	42	156	4	0	79	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID11																
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance
		Daytime			Daytime				Evening				Night				Night
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA19.RES	0	4	4	0	1	6	4	0	0	6	4	1	0	6	4	1	7	1
NCA20.RES	0	1	0	0	5	1	0	0	2	6	0	0	1	7	0	0	0	0
NCA21.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA22.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA23.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA24.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA25.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA26.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA27.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA28.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA29.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID11																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
Commercial																		
NCA02.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA03.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA04.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA07.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA11.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA18.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA19.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA21.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA22.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID11																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA23.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA24.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA25.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA27.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA28.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Industrial																		
NCA04.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Hospital																		
NCA03.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID11																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA05.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Educational																		
NCA06.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA08.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Place of worship																		
NCA05.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA06.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Child Care Facilities																		
NCA05.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA13.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

Table 52: Summary of NML exceedances per catchment area for construction activity ID14 (Road Works)

NCAs and receiver types	**Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID14**																
	All Hours	**Standard Hours**			**Outside of Standard Hours**												**Sleep Disturbance**
		Daytime			**Daytime**				**Evening**				**Night**				**Night**
	Highly noise affected >75dB(A)	**Clearly audible <NML+10**	**Moderately intrusive <=NML+20**	**Highly intrusive >NML+20**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Screening criterion RBL+15**	**Awakening criterion >65 dB(A)**
Residential																		
NCA01.RES	0	0	0	0	0	0	0	0	6	1	0	0	1	20	6	0	27	24
NCA02.RES	0	5	0	0	2	5	0	0	6	4	1	0	1	7	5	0	12	6
NCA03.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES (Unbuilt)	0	9	0	0	44	13	0	0	54	26	0	0	32	105	5	0	127	17
NCA05.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA06.RES	0	17	7	0	1	17	7	0	1	8	17	0	4	5	20	0	27	15
(Unbuilt)	0	83	0	0	28	87	0	0	34	102	7	0	41	96	19	0	161	6
NCA07.RES	0	2	1	0	1	2	1	0	0	3	1	0	1	2	1	0	4	1
NCA08.RES	0	5	2	0	0	5	2	0	0	5	2	0	0	6	1	0	7	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID14																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA09.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA10.RES	0	1	0	0	1	1	0	0	2	1	1	0	2	1	1	0	2	0
NCA11.RES	0	1	0	0	5	2	0	0	14	18	0	0	9	25	1	0	25	0
NCA12.RES	0	7	10	2	14	8	10	2	0	23	9	7	0	22	8	9	39	13
NCA13.RES	0	38	6	0	53	50	6	0	0	111	15	5	0	87	38	6	131	21
NCA14.RES	0	15	0	0	64	21	0	0	15	92	2	0	15	92	2	0	102	0
NCA15.RES	0	6	1	0	4	7	1	0	2	8	4	0	2	8	4	0	13	1
NCA16.RES	0	3	0	0	11	4	0	0	21	18	1	0	21	18	1	0	43	0
NCA16.RES (Unbuilt)	0	29	11	0	6	32	11	0	8	29	26	0	8	29	26	0	63	29
NCA17.RES	0	1	2	0	0	1	2	0	0	1	2	0	0	1	2	0	3	3
NCA18.RES	0	7	3	0	48	7	3	0	99	53	4	1	74	84	5	1	130	2

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID14																		
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA19.RES	0	4	7	0	0	4	7	0	0	1	8	2	0	1	8	2	11	3
NCA20.RES	0	3	2	0	1	5	2	0	0	5	3	0	0	5	3	0	8	2
NCA21.RES	0	0	0	0	0	0	0	0	1	1	0	0	21	10	2	0	34	14
NCA22.RES	0	0	0	0	0	0	0	0	0	0	0	0	6	8	0	0	11	6
NCA23.RES	0	0	0	0	0	0	0	0	10	0	0	0	0	15	15	0	30	26
NCA24.RES	0	3	2	0	2	4	2	0	2	5	3	0	0	5	5	0	9	3
NCA25.RES	0	9	0	0	13	13	0	0	23	29	6	0	26	51	26	0	71	21
NCA26.RES	0	5	1	0	21	7	1	0	42	52	6	0	43	87	26	3	120	34
NCA27.RES	0	11	1	0	12	14	1	0	24	38	5	0	61	80	32	3	123	43
NCA28.RES	0	0	0	0	2	0	0	0	4	8	0	0	31	16	5	0	35	9
NCA29.RES	0	1	0	0	4	1	0	0	15	23	1	0	41	53	20	1	127	85

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID14																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
Commercial																		
NCA02.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA03.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA04.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA07.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA11.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA18.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA19.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA21.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA22.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID14																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA23.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA24.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA25.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA27.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA28.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Industrial																		
NCA04.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Hospital																		
NCA03.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID14																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA05.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Educational																		
NCA06.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA08.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.SCH	0	6	7	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Place of worship																		
NCA05.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA06.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Child Care Facilities																		
NCA05.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA13.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

Table 53: Summary of NML exceedances per catchment area for construction activity (Ancillary Sites)

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID13 – Ancillary Sites																	
	All Hours	**Standard Hours**			**Outside of Standard Hours**												**Sleep Disturbance**	
		Daytime			**Daytime**				**Evening**				**Night**				**Night**	
	Highly noise affected >75dB(A)	**Clearly audible <NML+10**	**Moderately intrusive <=NML+20**	**Highly intrusive >NML+20**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Noticeable <NML+5**	**Clearly audible <NML+15**	**Moderately intrusive <=NML+25**	**Highly intrusive >NML+25**	**Screening criterion RBL+15**	**Awakening criterion >65 dB(A)**
Residential																		
NCA01.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA02.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA03.RES (Unbuilt)	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0
NCA05.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA06.RES	0	19	6	0	0	19	6	0	9	14	11	0	15	12	13	0	16	0
NCA06.RES (Unbuilt)	0	94	0	0	49	106	0	0	33	136	12	0	37	129	26	0	32	0
NCA07.RES	0	2	1	0	1	2	1	0	1	2	1	0	1	2	1	0	1	0
NCA08.RES	0	6	0	1	0	6	0	1	0	5	1	1	0	6	0	1	2	1

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID13 – Ancillary Sites																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA09.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA10.RES	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0
NCA11.RES	0	0	0	0	0	0	0	0	19	10	0	0	9	26	0	0	0	0
NCA12.RES	0	4	0	0	16	5	0	0	6	32	1	0	3	34	2	0	8	0
NCA13.RES	0	43	14	1	24	52	14	1	20	75	27	9	7	66	45	13	79	14
NCA14.RES	0	72	12	1	8	89	12	1	0	75	34	1	0	75	34	1	37	0
NCA15.RES	0	4	5	0	1	4	5	0	0	4	7	1	0	4	7	1	8	1
NCA16.RES	0	0	0	0	11	1	0	0	49	20	0	0	49	20	0	0	0	0
NCA16.RES (Unbuilt)	0	7	0	0	14	13	0	0	12	32	0	0	12	32	0	0	7	0
NCA17.RES	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0
NCA18.RES	0	54	2	0	30	62	2	0	46	64	30	0	72	64	34	1	87	2
NCA19.RES	0	4	2	0	1	6	2	0	2	6	3	0	2	6	3	0	9	0

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID13 – Ancillary Sites																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA20.RES	0	2	0	1	5	2	0	1	0	6	1	1	0	6	1	1	7	1
NCA21.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA22.RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA22.RES (Unbuilt)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCA23.RES	0	2	2	0	1	2	2	0	3	2	2	1	1	4	2	2	6	3
NCA24.RES	0	0	0	0	0	0	0	0	8	0	0	0	13	17	0	0	4	0
NCA25.RES	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
NCA26.RES	0	0	0	0	0	0	0	0	6	2	0	0	40	33	0	0	10	0
NCA27.RES	0	0	0	0	2	0	0	0	4	6	0	0	17	9	6	0	10	3
NCA28.RES	0	0	0	0	0	0	0	0	3	0	0	0	8	5	0	0	3	0
NCA29.RES	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0	3	0
Commercial																		

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID13 – Ancillary Sites																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA02.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA03.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA04.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.COM	0	4	0	0	1	3	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA07.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA11.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA18.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA19.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA21.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA22.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA23.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA24.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID13 – Ancillary Sites																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA25.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA27.COM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA28.COM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Industrial																		
NCA04.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.IND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Hospital																		
NCA03.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA05.HOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Educational																		
NCA06.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

NCAs and receiver types	Number of receivers exceeding NMLs and sleep disturbance criteria – Construction Activity ID13 – Ancillary Sites																	
	All Hours	Standard Hours			Outside of Standard Hours												Sleep Disturbance	
		Daytime			Daytime				Evening				Night				Night	
	Highly noise affected >75dB(A)	Clearly audible <NML+10	Moderately intrusive <=NML+20	Highly intrusive >NML+20	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Noticeable <NML+5	Clearly audible <NML+15	Moderately intrusive <=NML+25	Highly intrusive >NML+25	Screening criterion RBL+15	Awakening criterion >65 dB(A)
NCA08.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA26.SCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Place of worship																		
NCA05.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA06.POW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
Child Care Facilities																		
NCA05.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A
NCA13.CCF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	N/A

Results show significant exceedances are expected to occur during the four construction activities modelled and are also anticipated during remaining typical activities, particularly if those activities are to be undertaken during night-time. This is largely due to the proximity of residences to the construction work sites, which extend along the entire length of the project area.

Also note that in the project description, impact piling rig might be used during the construction of the bridges. The use of an impact piling rig instead of a bored piling rig would greatly increase noise impacts (approximately 20 dB(A)) at the nearest receivers and is therefore not recommended where possible.

The noise impact of the construction of the project to nearby receivers depends on the level of noise, distance to the nearest receiver, and the duration of the works. The assessment has been based on representative worse case scenarios and noise levels at nearby receivers are likely to be lower than predicted. Noise levels will be greater when plant and equipment are working close to a sensitive receiver and will decrease when plant and equipment moves away from the sensitive receiver. Some activities/scenarios are also likely to be undertaken simultaneously (i.e. activities that use the ancillary facilities) which also have the potential to increase noise levels at nearby receivers.

Actual impact durations are likely to vary depending on site conditions. Finalised construction methodology will be considered in the CNVMP to be developed for the project.

5.2.3 Cumulative construction noise impact assessment

Cumulative construction noise impacts are associated with the project related noise emissions from activities undertaken concurrently as well as the cumulative noise emissions of all the developments occurring in the same area and within the same timeframe as the project.

Major developments potentially creating additional construction noise and vibration impacts to nearby receivers within the same timeframe as the project have been identified as follows:

- Moonee Beach Residential Subdivision (Involving the construction of 159 residential lots, 12 public streets and associated public infrastructure) – Not yet approved
- Korora Urban Release Area (no available information regarding the number of subdivisions) – Not yet approved
- Sunset Ridge Estate in NCA 16 (Involving construction of 57 residential lots for Stage 2, Stage 1 under construction)
- Senior Housing, Arthur Street (Involving construction of 120 bed residential facility, 183 self-contained dwellings, community centre) – Project approved, exact construction period not known
- Coffs Central Shopping centre extension (Involving the construction of an 80-room hotel with restaurant, pool and commercial/retail area) – currently under construction and close to completion

- Coffs Harbour Hospital Campus Extension (Involving the refurbishment of parts of the existing hospital building and construction of new acute services building) – Not yet approved
- Elements Estate in NCA 03 (Stages 1 and 2 under construction, 17 completed residential dwellings, 202 vacant lots)
- North Boambee Valley East Masterplan Urban Release Area in NCA 06 (Involving construction of 2 estates, the Lakes estate with 198 residential lots and the Highlands Estate with 25 vacant residential lots, 3 currently under construction, 38 complete)
- North Boambee Valley (West) residential Investigation area (no available information regarding the number of subdivisions) – Not yet approved
- Woolgoolga to Ballina Pacific Highway Upgrade (Involving the upgrade of 155 km of highway) – currently under construction and works area expected to be complete by 2020.

5.2.3.1 Noise impacts from the project

The project construction will occur in stages; one activity is likely to occur at one location while another activity is likely to occur at another location. Depending on the nature of the activities and locations, noise impacts from one activity might dominate over the noise generated by another activity (without increasing noise levels) or, noise levels emitted from both activities might add up. Detailed staging of the project is unknown at this stage.

From a general perspective, construction works for the project will occur over a certain number of days at one particular location then move over to another location for another period of time and so on across the whole length of the project.

However, sensitive receivers located in the vicinity of the ancillary sites are likely to experience construction impacts noise for longer periods as the ancillary sites will be used for different activities during the construction of the project.

5.2.3.2 Cumulative noise impacts from the construction of approved nearby developments

Construction start date and end date and details on construction staging for the approved nearby developments listed in Section 4.3.1 is unknown at this stage. If construction of those developments is overlapping with the construction of the project, increase in noise levels at nearest receivers is likely to occur.

In addition, haulage roads are likely to be shared between the project and major developments if occurring within the same timeframe. Nearby receivers are likely to notice an increase in noise levels on local roads identified in Section 5.1.7.

5.2.4 Construction groundborne noise

Groundborne noise levels are calculated using Transport Research Laboratory Report 429: "*Groundborne vibration caused by mechanised construction works*" (2000) [19], Equation 24.

$$v_{res} = 180 \cdot r^{-1.3}$$

where:

- r is the slope (shortest) distance (m) from the vibration source to the measurement location
- v_{res} is the predicted upper bound resultant peak particle velocity (mm/s)

Similarly, for the prediction of ground-borne noise:

$$L_p = 127 - 54\log_{10} r$$

Where L_p is the predicted groundborne noise level in dB(A).

This provides a useful first estimate of the likely noise and vibration levels generated by future mechanised tunnelling works.

It is predicted that the ground-borne noise levels would be below the criteria established in Section 3.2.3 for receivers further than 41 m from the point of emission during daytime and 51 m during night-time. These buffer nes are depicted in Appendix J5.

These distances have been calculated to establish relevant screening buffer zones around the tunnelling sites. These limits are indicative only and will need to be confirmed by the construction contractor.

5.2.5 Construction traffic noise assessment

Construction traffic will generate noise over a relatively wide area and beyond the construction site itself. It would be expected that traffic noise would be greatest where there is a concentration of vehicle movements, such as at ancillary sites, batching plant locations and where construction is occurring at a given time.

Relative increases in road traffic noise impacts are not expected to be significant for haulage routes that use established arterial roads such as the existing Pacific Highway. For sub-arterial roads located within the project assessment area an analysis has been undertaken of expected change in overall traffic volumes due to construction of the project.

Existing traffic and projected increases in traffic volumes due to construction have been derived from a traffic study undertaken for the project and taking into account the haulage routes shown in Figure 18.

Table 54 and Table 55 present a summary of the daily average existing traffic volumes and expected peak daily construction traffic volumes over the duration of construction activities across the construction area based on the following assumptions respectively:

- For works in greenfield areas and not on the Pacific Highway, 90% of predicted daily peak construction traffic would travel along construction access roads during the daytime and 10% during night-time (for deliveries), and
- For works on the existing Pacific Highway, 100% of daily peak construction traffic are expected during night-time on the existing Pacific Highway.

The assessment was undertaken using the CoRTN algorithm to predict potential increases in road traffic noise as well as potential overall noise level along the haulage routes due to construction of the project. For existing traffic flows, a range from lowest to highest number of vehicles is presented due to varying capacity per road link.

As defined in the CNVG, an initial screening test was applied to evaluate whether noise levels were predicted to increase by more than 2 dB(A) due to construction traffic. Where increases of more than 2 dB(A) were predicted, the predicted overall noise levels were assessed against the RNP criteria for sub-arterial roads summarised in Table 19. The minimum distance at which the RNP assessment criteria are met was then calculated. Noise sensitive receivers within this buffer zone have the potential to exceed noise assessment criteria.

Table 54 and Table 55 summarise the results of the assessment for each construction scenario.

Table 54: Construction traffic noise assessment

Road Name	Speed	Daytime							Night-time						
		Traffic volumes[1]				Noise level increase (dB)	Relative increase screening criterion exceeded?	Minimum distance from the road at which the daytime RNP criterion is met (m)	Traffic volumes[1]				Noise level increase (dB)	Relative increase screening criterion exceeded?	Minimum distance from the road at which the daytime RNP criterion is met (m)
		Existing		Existing + Construction Traffic					Existing		Existing + Construction Traffic				
		Total number of vehicles	% Heavy vehicles	Total number of vehicles	% Heavy vehicles				Total number of vehicles	% Heavy vehicles	Total number of vehicles	% Heavy vehicles			
Englands Road	50	203	8.6	265	13.3	2.4	Yes	85	82	7.1	94	9.7	1.4	No	N/A[2]
	50	16	3.5	78	23.4	11.7	Yes	45	8	2.8	19	18.2	9.9	Yes	33
North Boambee Road	50	240	1.5	287	7.9	3.4	Yes	71	94	1.4	103	4.7	2.0	No	N/A[2]
	50	12	8.2	60	34.0	11.5	Yes	48	6	5.4	15	26.2	11.2	Yes	34
Coramba Road	70	350	7.6	432	14.4	2.3	Yes	145	153	6.0	168	9.4	1.2	No	N/A[2]
	70	404	6.7	487	12.9	2.1	Yes	155	178	5.2	193	8.2	1.1	No	N/A[2]
Shephards Lane	50	54	2.6	64	8.0	2.8	Yes	22	24	2.0	26	4.6	2.7	Yes	21
	40	0	0	10	37.3	57.3	Yes	12	0	0.0	2	37.3	50.5	Yes	6
Mackays Road	50	72	6.7	82	10.3	1.7	No	N/A[2]	31	6.2	33	7.9	0.9	No	N/A[2]
	40	14	13.5	24	23.1	4.3	Yes	20	6	10.6	8	16.7	3.0	Yes	9
West Korora Road	50	11	7.8	41	38.5	11.1	Yes	39	4	5.0	10	30.4	11.6	Yes	27
	40	0	0	31	49.2	63.2	Yes	36	0	0.0	6	49.2	56.9	Yes	29
Bruxner Park Road	50	26	4.2	82	20.3	9.1	Yes	44	11	5.0	22	15.9	6.1	Yes	33
	50	26	5.0	82	20.5	8.8	Yes	44	11	5.9	22	16.3	5.7	Yes	34

Road Name	Speed	Daytime							Night-time						
		Traffic volumes[1]				Noise level increase (dB)	Relative increase screening criterion exceeded?	Minimum distance from the road at which the daytime RNP criterion is met (m)	Traffic volumes[1]				Noise level increase (dB)	Relative increase screening criterion exceeded?	Minimum distance from the road at which the daytime RNP criterion is met (m)
		Existing		Existing + Construction Traffic					Existing		Existing + Construction Traffic				
		Total number of vehicles	% Heavy vehicles	Total number of vehicles	% Heavy vehicles				Total number of vehicles	% Heavy vehicles	Total number of vehicles	% Heavy vehicles			
James Small Drive	50	193	1.0	201	1.6	0.5	No	N/A[2]	71	2.8	72	3.1	0.2	No	N/A[2]
Old Coast Road	60	60	1.7	64	2.9	2.1	Yes	21	22	0.0	23	2.9	1.3	No	N/A[2]
Pacific Highway (South of Englands Road)	60	1650	9.5	1711	10.1	0.3	No	N/A[2]	703	12.0	714	12.3	0.1	No	N/A[2]
	60	1303	11.2	1364	11.9	0.3	No	N/A[2]	499	16.5	510	16.8	0.1	No	N/A[2]
Pacific Highway (South of West Korora Road)	60	1882	8.4	1913	9.0	0.2	No	N/A[2]	743	11.8	749	12.1	0.1	No	N/A[2]
	60	1875	8.4	1906	9.0	0.2	No	N/A[2]	741	11.8	746	12.1	0.1	No	N/A[2]
Pacific Highway (South of Bruxner Park Road)	80	1846	8.5	1902	9.1	0.2	No	N/A[2]	731	11.9	741	12.1	0.1	No	N/A[2]
	80	1652	9.4	1708	10.0	0.2	No	N/A[2]	665	13.1	675	13.3	0.1	No	N/A[2]
Pacific Highway (South of Opal Boulevard)	80	1660	9.3	1716	9.9	0.2	No	N/A[2]	669	12.8	679	13.0	0.1	No	N/A[2]
	80	1598	9.5	1654	10.1	0.2	No	N/A[2]	648	13.1	659	13.4	0.1	No	N/A[2]

[1] Average hourly flow

[2] Relative increase screening criteria not exceeded therefore overall assessment of noise impact not required in accordance with CNVG

Table 55: Construction traffic noise assessment for Pacific Highway works

Road Name	**Speed**	**Night-time**						
		Traffic volumes[1]				**Noise level increase (dB)**	**Relative increase screening criterion exceeded?**	**Minimum distance from the road at which the daytime RNP criterion is met (m)**
		Existing		**Existing + Construction Traffic**				
		Total number of vehicles	**% Heavy vehicles**	Total number of vehicles	**% Heavy vehicles**			
Pacific Highway (South of Englands Road)	60	703	12.0	817	14.3	1.1	No	N/A[2]
Pacific Highway (North of Englands Road)	60	499	16.5	612	18.8	1.3	No	N/A[2]
Pacific Highway (South of West Korora Road)	60	743	11.8	800	14.4	0.9	No	N/A[2]
Pacific Highway (North of West Korora Road)	60	741	11.8	797	14.5	0.8	No	N/A[2]
Pacific Highway (South of Bruxner Park Road)	80	731	11.9	834	13.9	0.9	No	N/A[2]
Pacific Highway (North of Bruxner Park Road)	80	665	13.1	769	15.0	0.9	No	N/A[2]
Pacific Highway (South of Opal Boulevard)	80	669	12.8	773	14.8	1.0	No	N/A[2]
Pacific Highway (North of Opal Boulevard)	80	648	13.1	752	15.1	1.0	No	N/A[2]

[1] Average hourly flow

[2] Relative increase screening criteria not exceeded therefore overall assessment of noise impact not required in accordance with CNVG

Table 54 shows that a 2 dB increase is predicted on the existing collector road network in areas remote from the existing Pacific Highway. Noise sensitive receivers situated within the minimum offset distances identified also have the potential to exceed RNP noise criteria for existing roads.

Table 55 shows that for construction works on or near the existing Pacific Highway, increases in road traffic noise due to construction traffic are expected to remain below 2 dB.

A detailed construction traffic noise impact assessment would be carried out during detailed design once the contractor has a more detailed understanding of haulage routes, staging and scheduling, and specific construction traffic volumes assessment is available.

Feasible and reasonable noise mitigation measures are summarised in Section 5.5.2 to reduce construction noise impacts due to construction traffic to nearby residential receivers.

5.3 Construction vibration

5.3.1 Safe working distances

The CNVG provides, as a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant. The minimum working distances are reproduced in Table 56.

Table 56: CNVG recommended minimum working distances for vibration intensive plant

Plant Item	**Rating/Description**	**Safe Working Distance**	
		Cosmetic Damage (BS 7385)	**Human Response (NSW EPA Vibration Guideline)**
Vibratory Roller	< 50 kN (Typically 1-2t)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4t)	6 m	20 m
	< 200 kN (Typically 4-6t)	12 m	40 m
	< 300 kN (Typically 7-13t)	15 m	100 m
	> 300 kN (Typically 13-18t)	20 m	100 m
	> 300 kN (Typically > 18t)	25 m	100 m
Small Hydraulic Hammer	300 kg - 5 to 12t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg - 12 to 18t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg - 18 to 34t excavator	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	4 m

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	**Human Response (NSW EPA Vibration Guideline)**
Jackhammer	Hand held	1 m (nominal)	2 m

The minimum distances in Table 56 are quoted for both “cosmetic” damage (as per BS 7385) and for human comfort (as per EPA Assessing vibration – a technical guideline). It is noted that more stringent conditions may apply to heritage or other sensitive structures and would need to be treated on a case by case basis. Appendix J4 shows a worst-case screening buffer for safe working distances. Safe working distances do not relate to heritage sites; however, they have been identified on the aerial maps for reference.

The minimum working distances for cosmetic damage should be complied with at all times. Because the minimum working distances in Table 56 are indicative only and will vary depending on the particular item of plant and local geotechnical conditions, vibration monitoring is recommended to confirm the minimum working distances at specific sites with specific geotechnical conditions.

In relation to human comfort (response), the minimum working distances in Table 56 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason higher vibration levels, occurring over shorter periods are considered allowable. Table 57 presents a summary of receivers within each NCA which may experience potential construction vibration impacts.

Mitigation will need to be considered where sensitive receivers are located within the safe working distances. This information should be read in conjunction with maps provided in Appendix J4.

Table 57: Potential construction vibration impacts

NCA	Potential impacts
1	Most residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at some receivers.
2	Four residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at two receivers.
3	There are no receivers within the 100 m boundary around construction activities. It is not expected receivers would perceive vibration levels from construction activities.

NCA	Potential impacts
4	A commercial and an industrial receiver are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers.
5	A few commercial receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
6	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
7	There are no receivers within the 100 m boundary around construction activities. It is not expected receivers would perceive vibration levels from construction activities.
8	A residential receiver is located within the 100 m boundary around construction activities. It is possible that this receiver may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receiver closest to the construction footprint around the ancillary site.
10	A residential receiver is located within the 100 m boundary around construction activities. It is possible that this receiver may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers.
11	Three residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receiver closest to the construction footprint.
12	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
13	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.

NCA	Potential impacts
14	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at a receiver closest to the construction footprint.
15	A couple of residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers.
16	There are no receivers within the 100 m boundary around construction activities. It is not expected receivers would perceive vibration levels from construction activities.
17	A residential receiver is located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers.
18	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at a receiver closest to the construction footprint.
19	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at a receiver closest to the construction footprint.
20	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at a receiver closest to the construction footprint.
21	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
22	A few residential receivers and a commercial receiver are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at a receiver closest to the construction footprint.

NCA	Potential impacts
23	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at a receiver closest to the construction footprint.
24	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
25	A few residential receivers and a commercial receiver are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
26	A few residential receivers, an education facility and a commercial receiver are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
27	A few residential receivers and a few commercial receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint or the timber bridge heritage structure
28	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.
29	A few residential receivers are located within the 100 m boundary around construction activities. It is possible that some receivers may perceive the construction vibration above the human comfort level when construction activities include the use of equipment including heavy vibratory rollers or large hydraulic hammers. Depending on the type of equipment used, the cosmetic damage vibration criteria could be exceeded at receivers closest to the construction footprint.

5.3.2 Safe working distances - Heritage Structures

Heritage structures in the vicinity of the project have been identified below and are shown in Appendix B.

- Two timber bridges located on Old Coast Road and located adjacent to the construction footprint
- The North Coast Railway crossing the construction area near Shephards Lane

No other heritage buildings have been identified in the vicinity of the project.

It is noted that while the North Coast Railway has been identified as a heritage item, it is not considered sensitive to potential vibration damage; vibration created by operation of trains are likely to be greater than vibration created by construction works.

The timber bridges are likely to be impacted by vibration activities due to their proximity to the construction works. Vibration from vehicles traversing the bridges is likely to generate a more significant vibration impact than those created by construction works.

Notwithstanding, heritage structures are to be considered on a case by case basis, and detailed inspections of heritage listed structures should be undertaken for each potentially affected heritage structure prior to the commencement of works.

The heritage structures should not (unless it is structurally unsound) be assumed to be more sensitive. However, if those structure are considered to be sensitive to damage from vibration following inspection, it is recommended to reduce the vibration criteria. As an initial screening criterion, it is possible to implement the screening limits summarised in Section 3.2.5.2, noting that these screening criteria are particularly conservative.

Therefore, the structural integrity of the heritage structures should be confirmed at detailed design by a suitably qualified structural engineer and results from inspection will be used to verify the applicable vibration criteria and associated impacts, and potentially feasible and reasonable mitigation options to be implemented.

5.3.3 Safe working distances - Other vibration sensitive receivers

Vibration impacts to other species (e.g. horses at the Boambee Equestrian Centre) have been considered under the same criteria as that established for human comfort. These are not expected to result in adverse impacts provided that horses are being kept/trained outside of the human comfort buffer zone in Table 56.

5.4 Blasting

Calculations have been undertaken based on methodologies provided in AS 2187.2 to determine potential groundborne vibration and air blast overpressure from proposed blasting. In lieu of detailed information, average conditions as recommended in the standard have been assumed. In order to inform distances to nearest potentially affected sensitive receivers, the extents of excavation have been used as a guide and will need to be confirmed once detailed methodologies have been defined by the contractor.

5.4.1 Groundborne vibration

Groundborne vibration levels from blasting have been calculated using the formula:

$$V = K_g \cdot (\frac{R}{Q^{1/2}})^{-B}$$

Where:

V is the ground vibration as vector peak particle velocity, mm/s
R is the distance between charge and point of measurement, m|
Q is the maximum instantaneous charge (effective mass per delay), kg
Kg and *B* are constants related to site and rock properties for estimation purposes.

For the purposes of assessment, the following average conditions have been assumed:

$$Kg = 1140$$

$$B = 1.6$$

The following Maximum Instantaneous Charge (effective charge mass per delay) have been calculated to achieve the relevant assessment criteria at the nearest affected vibration sensitive receiver locations. These limits are indicative only and will need to be confirmed by the construction contractor.

Table 58: Indicative maximum instantaneous charge limits for vibration

Noise Catchment Area	Receiver ID	Type	Distance (m)	PPV Criterion (mm/s)	Max MIC (kg)
NCA06	NCA06.RES.0163.01	Residential	100	5	12
NCA10	NCA10.RES.0004.01	Residential	178	5	36
NCA10	NCA10.RES.0006.01	Residential	81	5	7
NCA11	NCA11.COM.0001.01	Commercial	333	25	938
NCA11	NCA11.RES.0039.01	Residential	82	5	8
NCA12	NCA12.RES.0034.01	Residential	31	5	1
NCA13	NCA13.CCF.0001.01	Child Care Facility	494	5	275
NCA13	NCA13.RES.0057.01	Residential	143	5	23
NCA14	NCA14.RES.0031.01	Residential	108	5	13
NCA14	NCA14.RES.0110.01	Residential	128	5	19
NCA14	NCA14.RES.0114.01	Residential	190	5	41
NCA15	NCA15.RES.0002.01	Residential	76	5	7

Noise Catchment Area	Receiver ID	Type	Distance (m)	PPV Criterion (mm/s)	Max MIC (kg)
NCA15	NCA15.RES.0012.01	Residential	136	5	21
NCA16	NCA16.RES.0115.01	Residential	157	5	28
NCA16	NCA16.RES.0218.01	Residential	28	5	<1
NCA17	NCA17.RES.0004.01	Residential	116	5	15
NCA17	NCA17.RES.0007.01	Residential	155	5	27
NCA19	NCA19.COM.0001.01	Commercial	499	25	2101
NCA19	NCA19.RES.0001.01	Residential	240	5	65
NCA19	NCA19.RES.0010.01	Residential	144	5	23
NCA20	NCA20.RES.0011.01	Residential	130	5	19
NCA21	NCA21.COM.0005.01	Commercial	412	25	1432
NCA22	NCA22.COM.0005.01	Commercial	381	25	1228
NCA23	NCA23.COM.0015.01	Commercial	380	25	1219
NCA23	NCA23.RES.0014.01	Residential	113	5	14

5.4.2 Air blast overpressure

Air blast overpressure levels have been calculated using the formula:

$$P = K_a \cdot (\frac{r}{Q^{1/3}})^a$$

Where:

P is the calculated pressure, kPa
Q is the mass of the explosive charge, kg
r is the distance from the explosive charge, m
K_a is the site constant
a is the site exponent

For the purposes of assessment, the following average conditions have been assumed:

$$A = -1.45$$

$$K_a = 100$$

The following Maximum Instantaneous Charge (effective charge mass per delay) have been calculated to achieve the relevant assessment criteria at the nearest vibration sensitive receiver locations. These limits are indicative only and will need to be confirmed by the construction contractor.

Table 59: Indicative maximum instantaneous charge limits for air blast overpressure

Noise Catchment Area	**Receiver ID**	**Type**	**Distance (m)**	**Overpressure Criterion (dBL)**	**Max MIC (kg)**
NCA06	NCA06.RES.0163.01	Residential	100	120	1
NCA10	NCA10.RES.0004.01	Residential	178	120	15
NCA10	NCA10.RES.0006.01	Residential	81	120	3
NCA11	NCA11.COM.0001.01	Commercial	333	125	<1
NCA11	NCA11.RES.0039.01	Residential	82	120	1
NCA12	NCA12.RES.0034.01	Residential	31	120	8
NCA13	NCA13.CCF.0001.01	Child Care Facility	494	120	318
NCA13	NCA13.RES.0057.01	Residential	143	120	314
NCA14	NCA14.RES.0031.01	Residential	108	120	1
NCA14	NCA14.RES.0110.01	Residential	128	120	3
NCA14	NCA14.RES.0114.01	Residential	190	120	5
NCA15	NCA15.RES.0002.01	Residential	76	120	18
NCA15	NCA15.RES.0012.01	Residential	136	120	10
NCA16	NCA16.RES.0115.01	Residential	157	120	<1
NCA16	NCA16.RES.0218.01	Residential	28	120	10
NCA17	NCA17.RES.0004.01	Residential	116	120	7
NCA17	NCA17.RES.0007.01	Residential	155	120	4
NCA19	NCA19.COM.0001.01	Commercial	499	125	1065
NCA19	NCA19.RES.0001.01	Residential	240	120	8
NCA19	NCA19.RES.0010.01	Residential	144	120	36
NCA20	NCA20.RES.0011.01	Residential	130	120	4
NCA21	NCA21.COM.0005.01	Commercial	412	125	476
NCA22	NCA22.COM.0005.01	Commercial	381	125	471
NCA23	NCA23.COM.0015.01	Commercial	380	125	6
NCA23	NCA23.RES.0014.01	Residential	113	120	599

Note that blasting should not be ruled out on the basis of the closeness of the receivers. Blasting can be undertaken at very close distances from receivers.

In the event that blasting is to be undertaken at locations less than 50 m away from the receivers and that blasting would significantly reduce construction timeframe, it is recommended to seek advice from a blasting professional consultant.

5.5 Construction noise and vibration mitigation

The following sections discuss noise and vibration mitigation measures to ameliorate exceedances of CNVG criteria. The mitigation measures discussed are considered to represent all feasible and reasonable options available for the project.

The ICNG acknowledges that due to the nature of construction activities it is inevitable that there will be noise impacts from construction sites. The NMLs identified in this report have been applied to determine measures for the control of potential construction noise impacts at the nearest affected noise sensitive receivers.

All feasible and reasonable work practices should be applied to meet the project NMLs where possible. This includes informing all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and to provide contact details during construction.

A Construction Environmental Management Plan (CEMP) should be prepared during the detailed design phase. A Construction Noise and Vibration Management Plan (CNVMP) would be included in the CEMP to provide the framework and mechanisms for the management and mitigation of all potential noise and vibration impacts from the project.

5.5.1 Standard noise and vibration mitigation measures

Appendix B of the CNVG details a number of standard actions and mitigation measures to be implemented on all construction projects where NML exceedances are predicted. These are reproduced in Table 60.

Table 60: CNVG Standard noise mitigation measures

Action Required	**Applies to**	**Details**
Management Measures		
Implementation of any project specific mitigation measures required	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures	Airborne noise Ground-borne noise and vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone numbers. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required.

Action Required	Applies to	Details
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: All project specific and relevant standard noise and vibration mitigation measures relevant, licence and approval conditions, permissible hours of work, any limitations on high noise generating activities, location of nearest sensitive receivers, employee parking areas, designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures
Behavioural practices	Airborne noise	No unnecessary shouting or loud stereos/radios onsite. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise and vibration	Where specified, a noise verification programme is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Environmental Management Plans	Airborne noise Ground-borne noise and vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage.
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite periods during normal hours and out-of-hours work	Ground-borne noise and vibration Airborne noise	Use of respite measures

Action Required	Applies to	Details
Equipment selection.	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant, including the silencer, is well maintained.
Rental plant and equipment.	Airborne noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used onsite unless compliant with the criteria in Table 2 of the CNVG.
Use and siting of plant.	Airborne noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently is to be throttled down or shut down. Noise-emitting plant is to be directed away from sensitive receivers. Only have necessary equipment onsite.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers discourage access from local roads Plan traffic flow, parking and loading / unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noisy activities should be scheduled for normal working hours. If the work cannot be undertaken during the day it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher educational semesters. If programmed night work is postponed, the work should be re-programmed and the approaches in the CNVP apply again.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power

Action Required	Applies to	Details
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used onsite and for any out-of-hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise out-of-hours movements where possible.
Blasting regime	Airborne noise Ground-borne vibration	The noise and vibration impacts of blasting operations can be minimised by: • Choosing the appropriate blast charge configurations • Ensuring appropriate blast-hole preparation • Optimising blast design, location, orientation and spacing • Selecting appropriate blast times, ad • Utilising knowledge of prevailing meteorological conditions AS 2187.2 Explosives-Storage, transport and use, Part 2: Use of Explosives provides more detailed advice on ground vibration and air blast overpressure impact minimisation options.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436: 2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

Action Required	Applies to	Details
Receptor Controls		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high risk receptors, vibration monitoring should be conducted during the activities causing vibration.

Further mitigation measures to be considered include:

- Contact potentially noise affected neighbours at the earliest possible time before any site work begins and keep up to date with works progress
- Inform potentially noise affected neighbours about the nature of the construction stages and the duration of noisier activities – for example, blasting, excavation, rock-breaking and piling
- Provide contact details on a site board at the front of the site, maintain a complaints register suited to the scale of works, and maintain a copy of the noise management plan
- Turn off plant that is not being used
- Examine, and implement where feasible and reasonable, alternative work practices which generate less noise or silenced equipment
- Ensure plant is regularly maintained, and repair or replace equipment that becomes noisy
- Where possible, conduct jackhammering or excavation during the middle of the day when noise sensitivity is not as high
- Keep staff who receive telephone complaints informed regarding current and upcoming works and the relevant contacts for these works
- Where there are complaints about noise from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise output.
- Undertake building of noise barriers as early as possible to provide shielding of noise construction noise
- Where possible, provide at-property treatments prior to project opening where possible to assist with amelioration of construction noise
- Replace impact drilling with bore drilling
- Use hydraulic drills instead of percussive drills
- Consider reducing the construction timeframe by using blasting method instead of excavation method if possible and in consultation with community and potentially a blasting expert
- Schedule activities in consultation with nearby developments
- Provide shielding of noisy plant on ancillary plant if possible or orientate plant away from nearest receivers

- Carry out a detailed inspection and a written and photographic report to document the condition of buildings and structures, including the Number 1 Bridge, Old Coast Road. Provided a copy of the report to the relevant land owner or land manager.

5.5.2 Construction traffic noise mitigation

Management of construction related traffic noise should as a minimum include the following controls:

- Scheduling and routing of vehicle movements
- Driver behaviour and avoidance of the use of engine compression brakes
- Ensuring vehicles are adequately silenced before allowing them to access the site

5.5.3 Out of hours works noise impact categories

The project would require several activities to be carried out outside the recommended standard construction hours for day, evening and night-time periods. In acknowledgment of the extent of out of hours work proposed, at-property noise treatments will be implemented during the pre-construction phase of the project before the main construction activities begin, where reasonable and feasible. This would include at-property treatments to reduce potential noise impacts associated with construction (including out of hours work (OOHW)). In addition, an Out of Hours Work Procedure would include specific management measures to minimise or mitigate potential noise impacts and consider the need to balance the out of hours work with periods of receiver respite.

A risk assessment process will be adopted for the application of the Out of Hours Work Procedure to identify the risk of intrusive noise impacts at sensitive receivers where construction noise levels are predicted to exceed the Noise Management Level (NML). The noise impact category (A to E) is defined by calculated noise levels and broadly identifies the potential for intrusive noise impacts. The noise impact levels also guide the level of consultation and noise mitigation measures required to manage these impacts at sensitive receivers.

Considering experience on other Pacific Highway upgrade projects, the rating background level (RBL) and the highly noise affected criterion in the CNVG of 75 dB(A), the noise impact categories in Table 61 have been adopted for determining the applicability of OOHW mitigation measures.

Table 61: Noise impact categories for OOHW

OOHW Category	Noise level	Potential for intrusive noise impacts
A	No exceedance above the NML	Very low
B	1-5 dBA above NML	Low
C	6-15 dBA above NML	Medium
D	16-25 dBA above NML	High
E	>25 dBA above NML	Very high

Depending on the applicable noise impact category, the relevant mitigation measures will be assessed and implemented where reasonable and feasible. Feasible work practices are practical to implement, while reasonable work practices consider the balance of costs and benefits and community views.

There are a number of additional mitigation measures that could be applied to manage OOHW noise impacts from the project. These mitigation measures will be implemented where reasonable and feasible and will directly relate to the extent of noise impact of the proposed. The higher the noise impact from the proposed activities, the greater the level of mitigation and consultation required for the proposed works. OOHW mitigation measures to be applied are outlined in Table 62.

An adaptive management approach will be applied to the implementation of mitigation measures to minimise impacts on the community. It should be noted that there may be personal circumstances among the sensitive receivers where the below approach to specific additional mitigation measures is not best suited.

Table 62: OOHW mitigation measures

Mitigation measure	**OOHW Category**				
	A	**B**	**C**	**D**	**E**
Scheduling of noise intensive or high noise impact work to evening periods where feasible		X	X	X	X
Use of alternative plant and equipment and/or construction techniques to minimise noise		X	X	X	X
Notification and consultation requirements including preparation of a six-month ‘look ahead’ program for likely out of hours work	X	X	X	X	X
Use of temporary noise barriers			X	X	X
Acoustic sheds will be included around tunnel portals to shield noise from within the tunnel during evening and night periods			X	X	X
Respite periods				X	X
Representative noise monitoring					X
Offers of reasonable and temporary alternative accommodation or an act of good will					X
Use of negotiated agreements					X

6 Conclusion

Noise and vibration from the construction and operation of the proposed Coffs Harbour Bypass project has been assessed in accordance with the Secretary’s Environmental Assessment Requirements.

Operational noise modelling indicates that up to 1582 out of 2310 noise sensitive receivers within the project study area will exceed operational road noise criteria under the Roads and Maritime NCG. Of those affected properties, 1316 noise sensitive receivers have been identified as qualifying for consideration of additional mitigation in accordance with the Roads and Maritime NMG.

An analysis of ‘feasible and reasonable’ noise mitigation options was undertaken in accordance with the Roads and Maritime Services Noise Mitigation Guideline. An investigation of low noise pavement alternative was explored for the future bypass between chainages CH9700 and CH23650, excluding the extents of road surface inside tunnels. 1009 receivers still exceed NCG criteria with these extents of low noise pavement in place.

Further reductions in operational noise impact were investigated via installation of noise barriers. A full barrier analysis was undertaken in accordance the NMG in a total of 11 locations. Recommended design heights as calculated in accordance with the NMG have been provided at a total of 9 locations following investigation of feasible and reasonable analysis.

A total of 478 remaining noise sensitive receiver locations, out of which 10 are non-residential noise sensitive receivers, still qualify for consideration of additional mitigation with final design mitigation measures in place and have been identified as requiring investigation into appropriate at-property treatment.

Key features such as steep gradients, changes in speed, and changes in geometry have been qualitatively analysed to identify potential change in maximum noise impacts due to the project. Noise monitoring data obtained during the environmental noise surveys was also analysed to quantify existing maximum noise level exposure. It should be noted that the maximum noise assessment should be used as a tool to help prioritise and rank mitigation strategies but should not be applied as a decisive criterion in itself.

An industrial noise assessment has been undertaken for the bus interchange at Kororo Public School and the in-tunnel fans for the Gatelys Road and Shephards Lane tunnels. The predicted noise levels at the nearest noise sensitive receivers were found to be generally in compliance with the project criteria.

No development is proposed to the existing North Coast Railway as a part of the project. However, noise level changes due to the changes in the surrounding terrain after construction of the project were assessed against a criterion of 2 dB change in noise level, representing what could be just noticeable difference in noise level. There are no instances of changes greater than 2 dB expected to the train noise levels at nearest affected noise sensitive receivers due to the introduction of the project.

The construction noise and vibration assessment has been based on constructability information provided by the design team and Roads and Maritime. Noise management level exceedances and corresponding noise mitigation strategies have been provided. Construction groundborne noise has also been assessed to determine indicative distances at which the predicted noise levels are below the criteria.

An analysis was undertaken of existing and future increase in traffic on the existing road network during construction of the project. Areas with greater than 2 dB increase have been identified and predictions against RNP existing road criteria have been made. Reasonable and feasible mitigation measures have been provided to be implemented by the contractor once further detail is available for haulage routes and construction vehicle staging.

Construction groundborne noise has also been assessed to estimate of potential structureborne noise levels generated by future mechanised tunnelling works. This assessment provided indicative distances at which the predicted noise levels are expected to be below the criteria. Detailed requirements are recommended to be confirmed by the construction contractor.

Where blasting is required for the project, there is a potential that ground vibration and air blast overpressure will adversely impact noise sensitive receivers. This is a function of proximity to the proposed blasting works and would need to be controlled via reduction in maximum instantaneous charges used. It is noted that blasting should not be ruled out on the basis of the closeness of the receivers. In the event that blasting is to be undertaken at close distances to receivers and that blasting would significantly reduce construction timeframe, it is recommended to seek advice from a blasting professional consultant.

Vibration from the construction work, and particularly from blasting works have the potential to adversely impact on sensitive receivers. Safe working distances provided should be observed at all times and confirmed via condition surveys and monitoring strategy.

Construction work will generally be undertaken during standard hours however, some work may be required during evening and night-time periods due to technical, safety and/or community amenity reasons. Detailed construction noise and vibration management plans will be required to be prepared by the construction contractor for each stage of works.

SUB-APPENDIX

A

Sub-Appendix A

Glossary

Appendix A

Glossary

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / $minL_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and $minL_{A90,1hour}$ in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore, a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L_{10}

The L_{10} statistical level is often used as the “average maximum” level of a sound level that varies with time.

Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dB(A) or higher for 10% of the 18-hour measurement period.

L_{90}

The L_{90} statistical level is often used as the “average minimum” or “background” level of a sound level that varies with time.

Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15-minute measurement period.

L_{eq}

The ‘equivalent continuous sound level’, L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the “average” level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB $L_{Aeq.}$ Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15-minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the “absolute maximum” level of a sound or vibration level that varies with time.

Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as “pitch”. Sounds towards the lower end of the human hearing frequency range are perceived as “bass” or “low-pitched” and sounds with a higher frequency are perceived as “treble” or “high pitched”.

Peak Particle Velocity (PPV)

Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure *root mean squared* (RMS) values; it is common to approximate the PPV based on an RMS measurement.

PPV is commonly used as a vibration criterion, and is often interpreted as a PPV based on the L_{max} or $L_{max,spec}$ index.

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Structureborne Noise

The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.

Vibration

Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

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SUB-APPENDIX

B

Sub-appendix B

Receiver and noise monitoring locations

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Appendix B

Receiver and noise monitoring locations

Legend

- 🟦 Construction footprint
- — Alignment
- ▬ Bridge
- ▬ Tunnel
- 🟨 Study Area
- ▭ Noise catchment area
- ▭ Approved DA subdivision
- ● Noise monitoring location (validation)
- ● Noise monitoring location (baseline)
- ● Noise monitoring location (attended only)

Building Classification

- ● Active Recreation
- ● Passive Recreation
- ▬ Child care facility
- ▬ Commercial
- ▬ Places of worship
- ▬ Hospital
- ▬ Industrial
- ▬ Residential
- ▬ School

Coffs Harbour Bypass

Noise catchment areas, sensitive land uses and noise monitoring locations

Map page - 01

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

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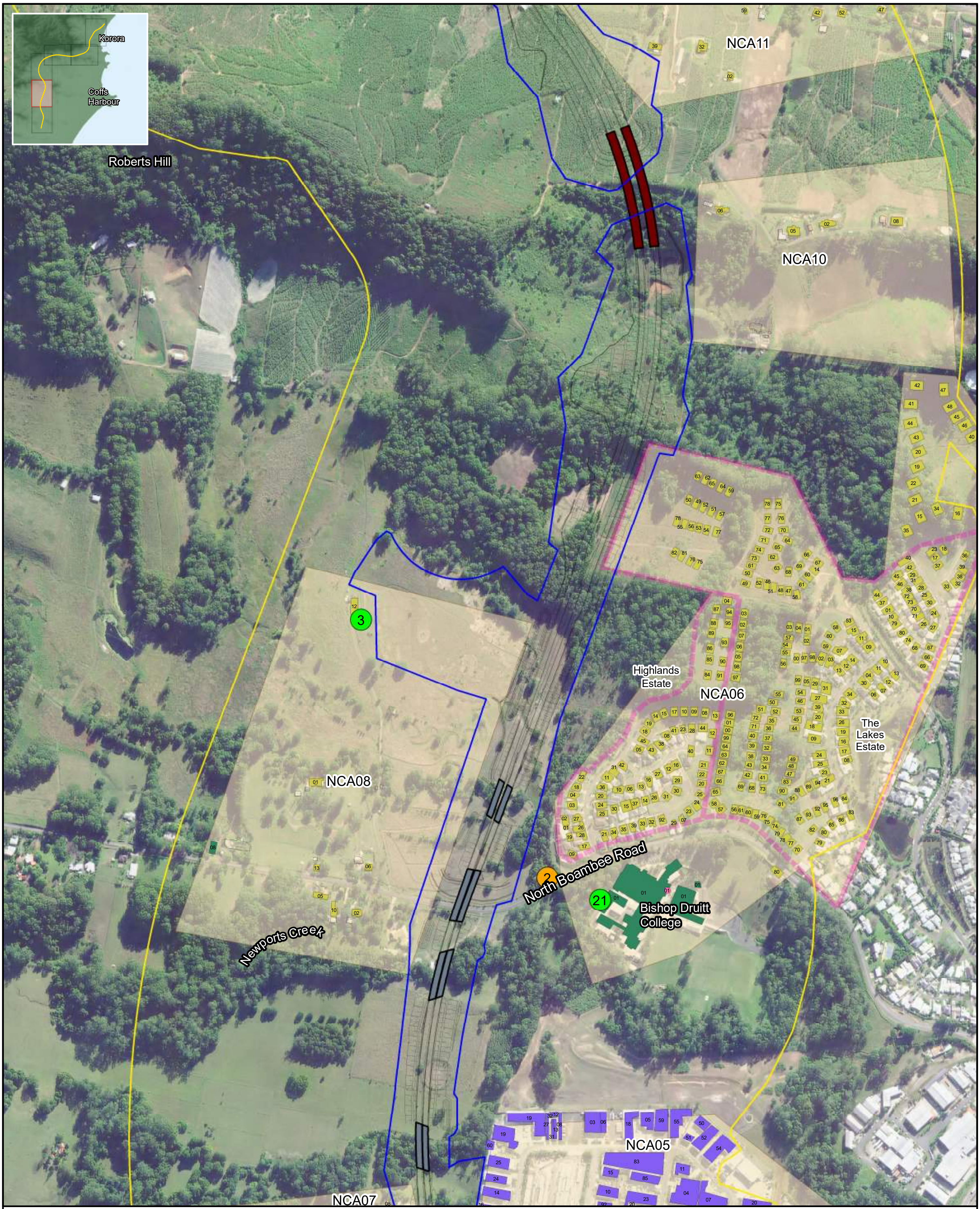


Legend

▭ Construction footprint
— Alignment
▬ Bridge
▬ Tunnel
▭ Study Area
▭ Noise catchment area
▭ Approved DA subdivision
● Noise monitoring location (validation)
● Noise monitoring location (baseline)
● Noise monitoring location (attended only)

Building Classification

● Active Recreation
● Passive Recreation
■ Child care facility
■ Commercial
■ Places of worship
■ Hospital
■ Industrial
■ Residential
■ School

Coffs Harbour Bypass

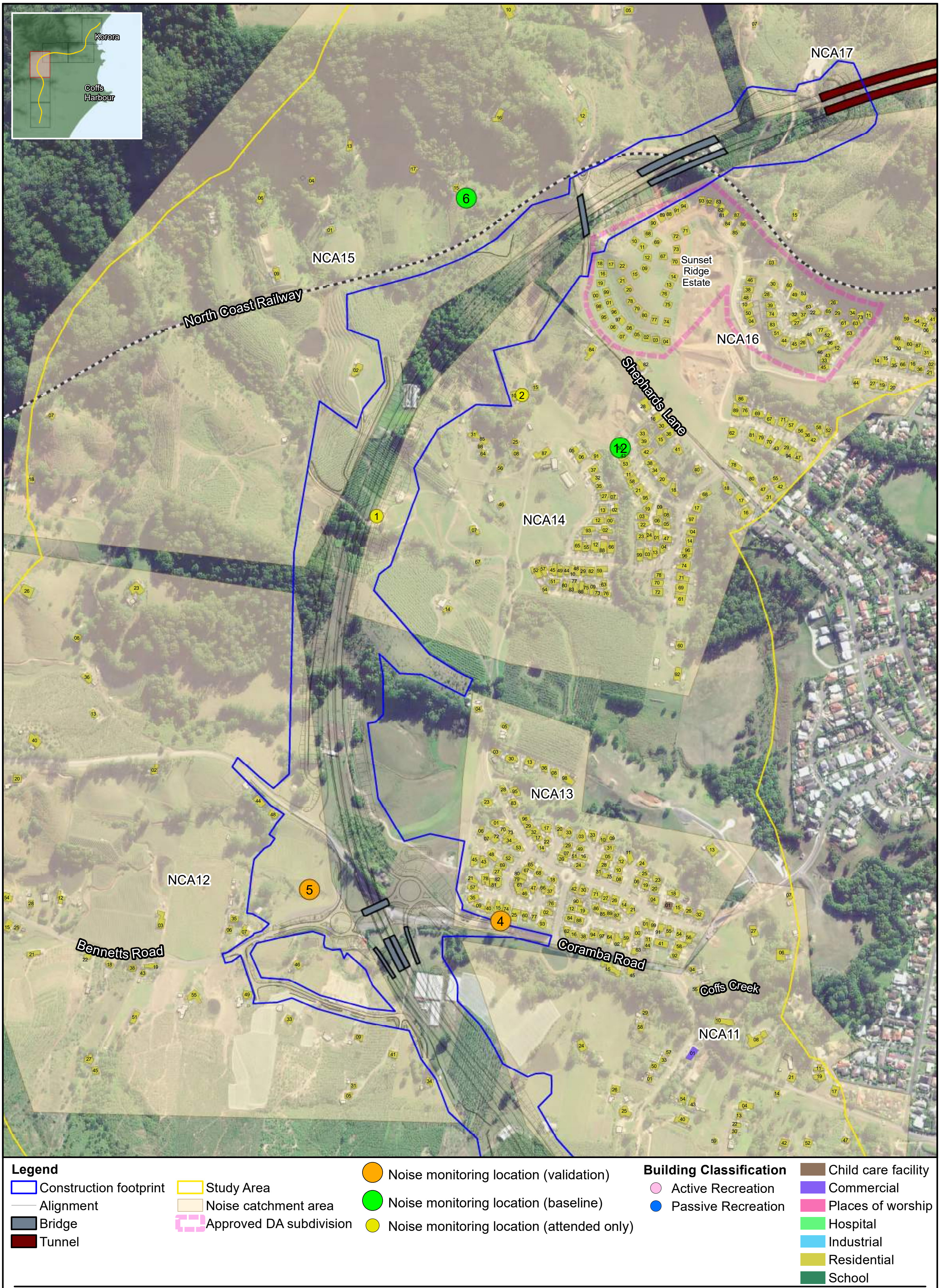
Noise catchment areas, sensitive land uses and noise monitoring locations

Map page - 02

0 0.1 0.2 0.3 km

N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Coffs Harbour Bypass

Noise catchment areas, sensitive land uses and noise monitoring locations

Map page - 03

0 0.1 0.2 0.3 km

N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

Legend

- ▭ Construction footprint
- — Alignment
- ▬ Bridge
- ▬ Tunnel
- ▭ Study Area
- ▭ Noise catchment area
- ▭ Approved DA subdivision
- ● Noise monitoring location (validation)
- ● Noise monitoring location (baseline)
- ● Noise monitoring location (attended only)

Building Classification

- ● Active Recreation
- ● Passive Recreation
- ■ Child care facility
- ■ Commercial
- ■ Places of worship
- ■ Hospital
- ■ Industrial
- ■ Residential
- ■ School

Coffs Harbour Bypass

Noise catchment areas, sensitive land uses and noise monitoring locations

Map page - 04

0 0.1 0.2 0.3 km N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

Coffs Harbour Bypass

Noise catchment areas, sensitive land uses and noise monitoring locations

Map page - 05

0 0.1 0.2 0.3 km N

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

Legend

- 🟦 Construction footprint
- — Alignment
- ▬ Bridge
- ▬ Tunnel
- 🟨 Study Area
- ▭ Noise catchment area
- ▭ Approved DA subdivision
- 🟠 Noise monitoring location (validation)
- 🟢 Noise monitoring location (baseline)
- 🟡 Noise monitoring location (attended only)

Building Classification

- ● Active Recreation
- 🔵 Passive Recreation
- 🟫 Child care facility
- 🟪 Commercial
- ▬ Places of worship
- 🟩 Hospital
- ▬ Industrial
- 🟨 Residential
- 🟩 School

Coffs Harbour Bypass

Noise catchment areas, sensitive land uses and noise monitoring locations

Map page - 06

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

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Sub-appendix C

Noise survey summaries

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Appendix C

Noise survey summaries

Noise Monitoring Location:	Validation 1		
Noise Monitoring Address:	498C-498D Pacific Highway, Boambee NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780D0		
Noise Monitoring Period:	22/06/2016	To	30/06/2016

Map of Noise Monitoring Location

- Main noise source is combined traffic from the Pacific Highway,
- Industrial noise can be heard from the industrial development north of the measurement location ~400m away maximum levels of 68 dB.
- Background noise environment is characterized by insects and birds noises.
- The main noise source are heavy vehicles driving by on Pacific Highway. Maximum noise levels between 55-60dB from compression breaking.
- Heavy vehicles driving on Pacific Highway cause maximum noise levels of 68-75dB.

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	47	45	39
L_{Aeq}	55	53	51

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	54	52
Weekend L_{Aeq}	53	48
Weekly L_{Aeq}	54	51

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	3:45PM	15 minutes	52	54	69
23/06/2016	12:15AM	15 minutes	41	50	61

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 2		
Noise Monitoring Address:	North Boambee Road, North Boambee Valley NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780E6		
Noise Monitoring Period:	22/06/2016	To	28/06/2016

Map of Noise Monitoring Location

- Main noise source is the traffic on N Boambee Road.
- Motor vechicles driving on N Boambee Road cause peaks of ~65dB.
- Compression breaking can be heard causing noise levels ~40 dB.
- At ~30m from N Boambee Road, light vehicles caused a measured Leq ~ 61 dB and heavy vechicles ~65 dB.
- At ~380m of N Boambee Road, a motor bike caused a noise level of ~56 dB and heavy vehicles measure around 40-50 dB.

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	32	32	31
L_{Aeq}	54	45	44

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	53	44
Weekend L_{Aeq}	51	43
Weekly L_{Aeq}	53	44

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	5:30PM	15 minutes	37	49	69
23/06/2016	1:02AM	15 minutes	33	36	52

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 3		
Noise Monitoring Address:	170 North Boambee Road, North Boambee Valley NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780D3		
Noise Monitoring Period:	28/11/2016	To	12/12/2016

- Distant traffic from N.Boambee Rd with occassional truck pass by.
- Cicadas in background
- Occassional bird noise (faint)
- Distant announcement from PA.
- Constant cricket and cicada noise >40 dB
- Tree rustle distant, thunder in distance
- Dog barks

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	42	40	38
L_{Aeq}	54	57	46

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	57	52
Weekend L_{Aeq}	55	48
Weekly L_{Aeq}	56	51

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
28/11/2016	3:00PM	15 minutes	41	43	55
29/11/2016	10:30PM	15 minutes	42	48	74

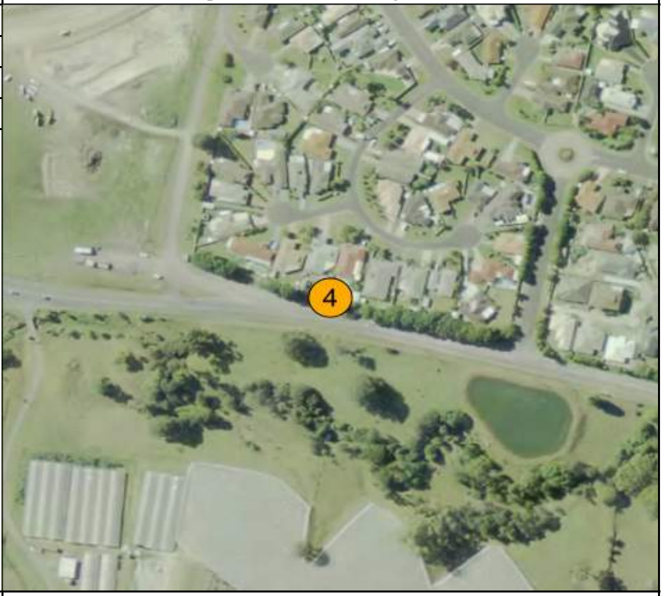
Map of Noise Monitoring Location

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 4		
Noise Monitoring Address:	12 Tamora Close, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780E5		
Noise Monitoring Period:	21/06/2016	To	28/06/2016

- A solid lightweight barrier limits the property boundary and separates the backyard from Coramba Road.
- Main noise nource at the location during daytime is the traffic of heavy and light vehicles on Coramba Road. Maximum noise levels from heavy traffic are measured at 72 - 75 dB(A).
- Residential mechanical services equipment generates intermittent loud peaks of noise.
- Distant traffic noise is audible but indistinguishable. Light vehicles cause maximum noise levels between 65 - 72 dB(A).

Map of Noise Monitoring Location



Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	39	32	27
L_{Aeq}	60	56	52

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	59	52
Weekend L_{Aeq}	58	51
Weekly L_{Aeq}	59	52

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	1:00PM	15 minutes	41	59	74
22/06:2016	12:15AM	15 minutes	33	49	72

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 5		
Noise Monitoring Address:	20 Bennetts Road, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	87807F		
Noise Monitoring Period:	21/06/2016	To	23/06/2016

- Main noise nource at the location is the traffic of heavy and light vehicles on Coramba Road.
- Maximum noise levels from heavy traffic on Coramba Road register 52 - 57 dB(A).
- At least 2 distant plane flyovers were registered during the attended measurement.
- Background noise is characterized by local fauna.
- A train pass-by was heard in the distance during attended measurement.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	37	31	30
L_{Aeq}	48	43	42

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	47	41
Weekend L_{Aeq}	-	-
Weekly L_{Aeq}	47	41

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	12:01PM	15 minutes	38	46	58
21/06/2016	11:31PM	15 minutes	33	38	54

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 6		
Noise Monitoring Address:	263c Shephards Lane, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	87809E		
Noise Monitoring Period:	22/06/2016	To	29/06/2016

- Local traffic and fauna are characteristic of the background noise consistent of rural areas.
- Occasional dog barking was observed with peak levels 46 – 50 dB (A).
- Tyre squeal was observed to originate from the south east with peak levels of 53 dB(A).
- Continuous propellar noise from an aircraft in the distance was observed from 6:40 PM – 6:43 PM, with noise levels of 40-45 dB(A).
- Attended measurement of background noise ranging from 32 - 33 dB(A).
- Occasional compression braking was observed in the distance from the east, contributing to peak noise levels of 35 dB(A).
- Truck engine noise from the residential area to the south east resulted in occasional peaks of 40 dB(A).

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	28	28	28
L_{Aeq}	47	47	47

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	47	48
Weekend L_{Aeq}	47	46
Weekly L_{Aeq}	47	47

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	6:30PM	15 minutes	30	36	65
22/06/2016	11:30PM	15 minutes	32	34	42

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 7		
Noise Monitoring Address:	191 Mackays Road, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	878012		
Noise Monitoring Period:	22/06/2016	To	30/06/2016

- Traffic noise generally east of location measured at 37dB(A). Occasional vehicle noise on gravel driveway was observed from the neighbouring property to the west at 40dB(A).
- Occasional peaks of 70-76 dB(A) were recorded from a dog barking
- Attended measurement of background noise generally between 32 -35 dB(A)
- Occasional traffic noise from the residential area to the south east, resulting in levels of 38 dB(A).
- The dominant noise source was mid to high frequencies consistent with tyre noise. Distant low frequency (80Hz and below) noise was observed, arriving from the east.
- Occasional animal noises in the surrounding area introduce peak levels of 43 dB(A).
- Freight train travelling west on the railway to the south. Three minutes of train noise was observed ranging from 45-50 dB(A) with a peak of 57 dB(A) corresponding to an air horn blast.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	28	30	28
L_{Aeq}	46	40	38

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	45	41
Weekend L_{Aeq}	45	36
Weekly L_{Aeq}	45	40

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	3:30PM	15 minutes	35	52	77
22/06/2016	10:15PM	15 minutes	33	42	63

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 8		
Noise Monitoring Address:	429A-429B Pacific Highway North, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	878060		
Noise Monitoring Period:	29/06/2016	To	6/12/2016

- Constant traffic noise from pacific hwy
- Truck pass-by
- Crickets in background
- High number of truck pass-bys

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	66	59	40
L_{Aeq}	75	74	71

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	75	72
Weekend L_{Aeq}	74	68
Weekly L_{Aeq}	75	71

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
29/11/2016	10:45AM	15 minutes	65	74	95
30/11/2016	1:00PM	15 minutes	44	70	87

Map of Noise Monitoring Location

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 9		
Noise Monitoring Address:	25 Fern Tree Place, Korora NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	878079		
Noise Monitoring Period:	21/06/2016	To	29/06/2016

- The main noise source was traffic on the Pacific Highway and included tyre noise from light vehicles (generally 58 -61 dB (A)) as well as engine noise from heavy vehicles generally 65-70 dB (A) predominantly from southbound traffic .
- A peak noise level of 76 dB (A) was recorded from a southbound heavy vehicle.
- Peak levels of 74 and 77 dB (A) were recorded from heavy vehicles in the southbound lanes.
- Attended measurements observed peak levels from heavy vehicles generally 64-68 dB(A).
- A peak level of 72 dB(A) was recorded from a heavy vehicle in the southbound lane.
- Compression braking was observed from heavy vehicles travelling northbound (62 – 67 dB(A)).
- Ambient noise consisted of traffic to the north.
- Additional attended measurement observed typical noise levels from heavy vehicles of 65 – 73 dB(A).

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	48	40	34
L_{Aeq}	57	56	54

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	58	55
Weekend L_{Aeq}	56	50
Weekly L_{Aeq}	57	54

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	6:00PM	15 minutes	49	58	76
22/06/2016	12:30AM	15 minutes	41	54	72

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 10		
Noise Monitoring Address:	1 Coachmans Close, Sapphire Beach NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780EA		
Noise Monitoring Period:	21/06/2016	To	29/06/2016

- The main noise source is traffic on the Pacific Highway with a greater proportion of heavy vehicles with maximum noise levels ranging from 75-80 dB (A).
- Heavy vehicles generally peaked 77-78 dB (A) in both directions
- Peak recorded, 84 dB (A), from a semi trailer in the Northbound centre lane.
- Compression braking was observed with a truck slowing towards a right hand turning lane (northbound) to the north. Peak of 76 dB (A).
- Tyre noise from light vehicles was generally at 60 – 65 dB (A) with heavy vehicles typically at 64 – 68 dB (A).
- Peak levels of 69 and 70 dB (A) were recorded from heavy vehicles travelling in the North bound lanes.
- 82 dB (A) was recorded from a heavy vehicle travelling along the northbound lanes.
- A peak level of 82 dB(A) was due to heavy vehicle compression braking travelling in the southbound lane.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	60	50	42
L_{Aeq}	68	67	64

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	68	65
Weekend L_{Aeq}	67	61
Weekly L_{Aeq}	68	65

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	11:45AM	15 minutes	61	69	84
21/06/2016	11:45PM	15 minutes	45	65	82

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 11		
Noise Monitoring Address:	539 Pacific Highway, Boambee NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	87807B		
Noise Monitoring Period:	22/06/2016	To	28/06/2016

- The main noise source is vehicle traffic on Pacific Highway. Heavy vehicle causes maximum noise levels at around 74-80 dB.
- Vibration from heavy vehicles can be perceived at the noise monitoring location.
- Background noise is influenced by noise of cars driving away from the measurement location and a constant traffic hum is part of the noise environment.
- The road surface in front of the caravan park is concrete.
- During night-time attended measurements, Pacific Highway is the main noise source with truck pass-bys causing maximum noise levels at 70-75dB.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	58	51	39
L_{Aeq}	65	64	61

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	65	62
Weekend L_{Aeq}	64	58
Weekly L_{Aeq}	65	61

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	1:00PM	15 minutes	56	63	80
22/06/2016	11:30PM	15 minutes	47	62	76

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 12		
Noise Monitoring Address:	19 Gillon Street, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780C7		
Noise Monitoring Period:	22/06/2016	To	28/06/2016

Map of Noise Monitoring Location

- Background noise was characterized by animal sounds (insects and domestic animals from the neighbouring properties).
- Maximum noise levels registered were caused by the neighbouring property's dog barking.
- Traffic is heard as a constant distant hum.
- Background noise environment was generally quiet with seldom insect, bird noises and distant dog barks
- A train pass-by was recorded during the night-time attended measurement causing maximum noise levels of 52dB

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	28	30	30
L_{Aeq}	44	43	42

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	45	43
Weekend L_{Aeq}	43	41
Weekly L_{Aeq}	45	42

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	11:00AM	15 minutes	29	39	66
22/06/2016	10:15PM	15 minutes	36	41	52

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 13		
Noise Monitoring Address:	15 Jenson Close, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780E8		
Noise Monitoring Period:	21/06/2016	To	28/06/2016

Map of Noise Monitoring Location

- Background noise is characterized by birds chirping and distant dog barks.
- A bus driving alongside the rail tracks caused a maximum noise level of 56 dB(A)
- Freight train caused peaks of 73 dB(A).
- The landowner reported an average of 3 passenger trains and 5 freight trains during the day.

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	31	31	29
L_{Aeq}	48	45	48

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	48	48
Weekend L_{Aeq}	46	47
Weekly L_{Aeq}	48	48

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	3:16PM	15 minutes	34	42	60
22/06/2016	1:30AM	15 minutes	35	52	71

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 14		
Noise Monitoring Address:	675 Pacific Highway, Korora NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780E6		
Noise Monitoring Period:	28/11/2016	To	12/12/2016

- Truck pass-by 74 dB.
- Main noise source - traffic on pacific highway.
- Cicadas in background
- Truck passby 80 dBA
- Truck passbys coasting down hill
- High number of truck pass-bys

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	55	51	42
L_{Aeq}	65	65	62

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	66	64
Weekend L_{Aeq}	65	59
Weekly L_{Aeq}	65	63

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
28/11/2016	4:00PM	15 minutes	60	67	80
29/11/2016	11:30PM	15 minutes	45	63	79

Photo of Noise Monitoring Location

Noise Monitoring Location:	Validation 15		
Noise Monitoring Address:	3 Korora School Road, Korora NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780D0		
Noise Monitoring Period:	29/11/2016	To	12/12/2016

- Constant traffic noise from Pacific Highway over noise barrier.
- Insects in background - constant
- Heavy vehical pass-bys - frequent.
- Car pass-by on school access road.
- Kids playing in distance.
- Seldom compression brake burst.
- Mechanical noise for building intermitant (pulsating), audible only when not masked by traffic noise from Pacific Highway.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	52	46	37
L_{Aeq}	59	59	55

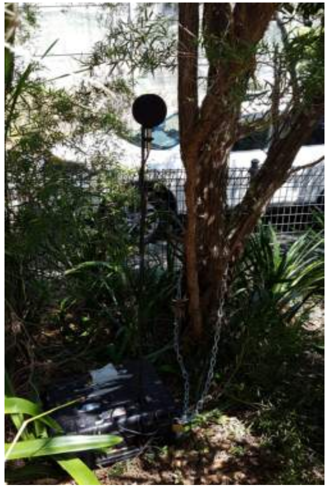
Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	60	57
Weekend L_{Aeq}	57	52
Weekly L_{Aeq}	59	56

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
29/11/2016	10:00AM	15 minutes	53	57	69
30/11/2016	12:00AM	15 minutes	36	55	73

Photo of Noise Monitoring Location



Noise Monitoring Location:	Baseline 16		
Noise Monitoring Address:	19 Rigoni Cresent, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780D1		
Noise Monitoring Period:	21/06/2016	To	27/06/2016

- Background noise is characterised by local fauna and residential occupancy.
- Presumably the main noise source are trains passing at the back of the property.
- There is direct line of sight to the rail tracks east of the property.
- Hardly any road traffic noise was heard.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	27	27	25
L_{Aeq}	51	51	53

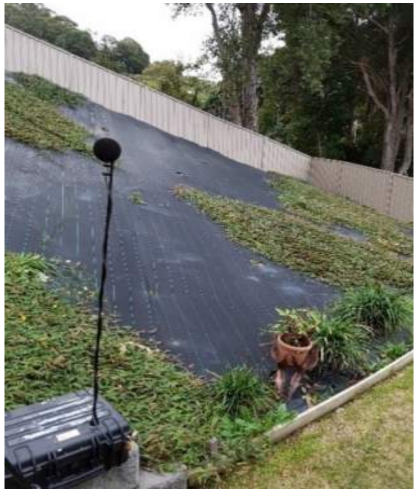
Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	52	53
Weekend L_{Aeq}	49	53
Weekly L_{Aeq}	52	53

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	4:15PM	15 minutes	30	50	71
22/06/2016	1:00AM	15 minutes	31	34	47

Photo of Noise Monitoring Location



Noise Monitoring Location:	Baseline 17		
Noise Monitoring Address:	170 West Korora Road, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	878042		
Noise Monitoring Period:	22/06/2016	To	27/06/2016

- Background noise typical of rural areas
- Background noise levels ranging from 52 – 56 dB(A)
- Traffic noise is not significant. Car pass by on Korora Road peaks at 38-40 dB

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	30	37	30
L_{Aeq}	55	45	42

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	51	44
Weekend L_{Aeq}	41	35
Weekly L_{Aeq}	49	42

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
23/06/2016	12:15AM	15 minutes	32	36	56
27/06/2016	5:15PM	15 minutes	42	49	57

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 18		
Noise Monitoring Address:	111 Bruxner Park Rd (FROM GOOGLE EARTH)		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	878000		
Noise Monitoring Period:	21/06/2016	To	28/06/2016

Map of Noise Monitoring Location

- The main noise source is traffic from the Pacific Highway to the north east and south east.
- Light vehicle tyre noise was audible however heavy vehicle engine noise contributed most to typical peak noise levels, 52-53 dB (A) and peak level of 57 dB (A).
- Peak levels of 62 and 64 dB (A) were recorded from light vehicles travelling along Bruxner Park road.
- Attended measurements at this location observed maximum levels of 52-54 dB from heavy vehicles travelling along northbound lanes on the Pacific Highway.

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	43	38	34
L_{Aeq}	51	47	46

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	50	46
Weekend L_{Aeq}	49	44
Weekly L_{Aeq}	50	45

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
21/06/2016	7:30PM	15 minutes	43	48	65
22/06/2016	1:15AM	15 minutes	37	44	56

Photo of Noise Monitoring Location

Photograph not available

Noise Monitoring Location:	Baseline 19		
Noise Monitoring Address:	133B Mackays Road, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	878061		
Noise Monitoring Period:	22/06/2016	To	30/06/2016

- Noise sources include heavy vehicles (servicing a banana plantation) on unsealed roads 600m to the west 40-44 dB(A).
- Generally the ambient noise is consistent with rural areas and occasional traffic noise.
- Peak noise levels from heavy vehicle using compression brakes – 49-53 dB(A) ~600m from the west.
- Occaisional peak noise levels from traffic to the south ranged from 40-44 dB(A).
- A freight train travelling west along the railway was observed for 3 minutes, with constant levels ranging 47-50 dB(A) and a peak level of 59 dB(A). The low and mid frequencies were dominant on approach, with increasing high frequency content over time due to wheel screech as the track bends to the south east and south west of the location. After the locomotive has passed, frequent transients of carriage wheels on the tracks are occasionally heard.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	26	29	28
L_{Aeq}	56	37	45

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	55	46
Weekend L_{Aeq}	44	37
Weekly L_{Aeq}	54	45

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	4:46PM	15 minutes	36	41	53
22/06/2016	10:45PM	15 minutes	31	42	59

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 20		
Noise Monitoring Address:	18 Anniversary Place, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	87809F		
Noise Monitoring Period:	22/06/2016	To	28/06/2016

- The background noise is consistent of rural areas.
- Tolling bells were heard in the distance causing noise levels of 41 dB.
- Occasional vehicle driving on Anniversary Plaza caused noise levels up to 59 dB.
- Distant traffic noise from heavy vechicles cause noise levels between 40-45 dB.

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	31	30	30
L_{Aeq}	44	38	39

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	45	40
Weekend L_{Aeq}	42	36
Weekly L_{Aeq}	45	39

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
22/06/2016	12:00PM	15 minutes	32	39	59
22/06/2016	11:00PM	15 minutes	36	39	49

Photo of Noise Monitoring Location

Noise Monitoring Location:	Baseline 21		
Noise Monitoring Address:	18 Anniversary Place, Coffs Harbour NSW 2450		
Noise Logger Type:	ARL Ngara Type 1		
Noise Logger Serial Number:	8780D1		
Noise Monitoring Period:	28/11/2016	To	11/12/2016

- Cicadas in the background peak
- Traffic noise is rarely heard (masked by the wind), nearest road is North Boambee.
- Truck passby - 60 dB
- Only about 3-5 vehicles passed by during measurement.
- Distant truck noises

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	41	38	35
L_{Aeq}	58	62	52

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	60	57
Weekend L_{Aeq}	58	51
Weekly L_{Aeq}	60	56

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
28/11/2016	1:00PM	15 minutes	51	59	74
29/11/2016	10:00PM	15 minutes	37	43	66

Photo of Noise Monitoring Location

Noise Monitoring Location:	Attended 1		
Noise Monitoring Address:	77 Spagnolos Road, Coffs Harbour NSW 2450		
Noise Logger Type:	B&K Sound Level Meter 2270		
Noise Logger Serial Number:			
Noise Monitoring Period:	-	To	-

Map of Noise Monitoring Location

- Background noise typical of rural areas
- No influence of traffic noise

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	-	-	-
L_{Aeq}	-	-	-

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	-	-
Weekend L_{Aeq}	-	-
Weekly L_{Aeq}	-	-

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
24/06/2016	9:45AM	15 minutes	35	39	58
28/06/2016	10:00PM	15 minutes	33	35	59

Photo of Noise Monitoring Location

Noise Monitoring Location:	Attended 2		
Noise Monitoring Address:	111 Spagnolos Road, Coffs Harbour NSW 2450		
Noise Logger Type:	B&K Sound Level Meter 2270		
Noise Logger Serial Number:			
Noise Monitoring Period:	-	To	-

- Background noise typical of rural areas
- No influence of traffic noise

Map of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	-	-	-
L_{Aeq}	-	-	-

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	-	-
Weekend L_{Aeq}	-	-
Weekly L_{Aeq}	-	-

Attended Noise Measurement Results

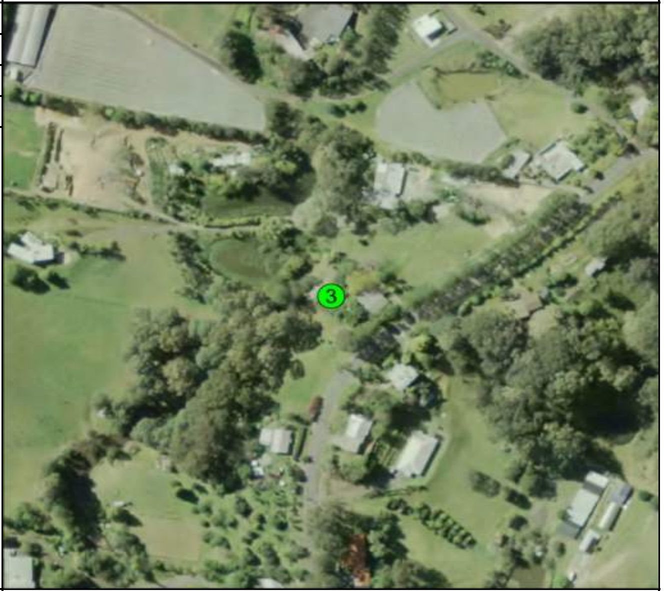
Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
24/06/2016	10:45AM	15 minutes	30	38	69
28/06/2016	10:30PM	15 minutes	35	36	61

Photo of Noise Monitoring Location

Noise Monitoring Location:	Attended 3		
Noise Monitoring Address:	83 Old Coast Road, Korora NSW 2450		
Noise Logger Type:	B&K Sound Level Meter 2270		
Noise Logger Serial Number:			
Noise Monitoring Period:	-	To	-

- Distant traffic noise can be heard at measurement location
- Background noise is generally calm

Map of Noise Monitoring Location



Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	-	-	-
L_{Aeq}	-	-	-

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	-	-
Weekend L_{Aeq}	-	-
Weekly L_{Aeq}	-	-

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
24/06/2016	11:30AM	15 minutes	40	55	80
27/06/2016	10:30PM	15 minutes	39	43	57

Photo of Noise Monitoring Location

Noise Monitoring Location:	Attended 4		
Noise Monitoring Address:	38 Korora Basin Road, Korora NSW 2450		
Noise Logger Type:	B&K Sound Level Meter 2270		
Noise Logger Serial Number:			
Noise Monitoring Period:	-	To	-

- Distant traffic noise can be heard at measurement location
- Background noise is generally calm

Map of Noise Monitoring Location

Photo of Noise Monitoring Location

Ambient Noise Logging Results – CNVG Defined Time Periods

Noise Level (dBA)	Time Period		
	Daytime (0700 - 1800)	Evening (1800 - 2200)	Night-Time (2200 - 0700)
RBL	-	-	-
L_{Aeq}	-	-	-

Ambient Noise Logging Results – RNP Defined Time Periods

Noise Level (dBA)	Time Period	
	Daytime (0700 - 2200)	Night-Time (2200 - 0700)
Weekday L_{Aeq}	-	-
Weekend L_{Aeq}	-	-
Weekly L_{Aeq}	-	-

Attended Noise Measurement Results

Date	Start Time	Duration	Noise Level (dBA)		
			L_{A90}	L_{Aeq}	L_{Amax}
24/06/2016	12:20PM	15 minutes	38	49	68
25/06/2016	00:05PM	15 minutes	39	46	55

Sub-appendix D

Noise monitoring graphs

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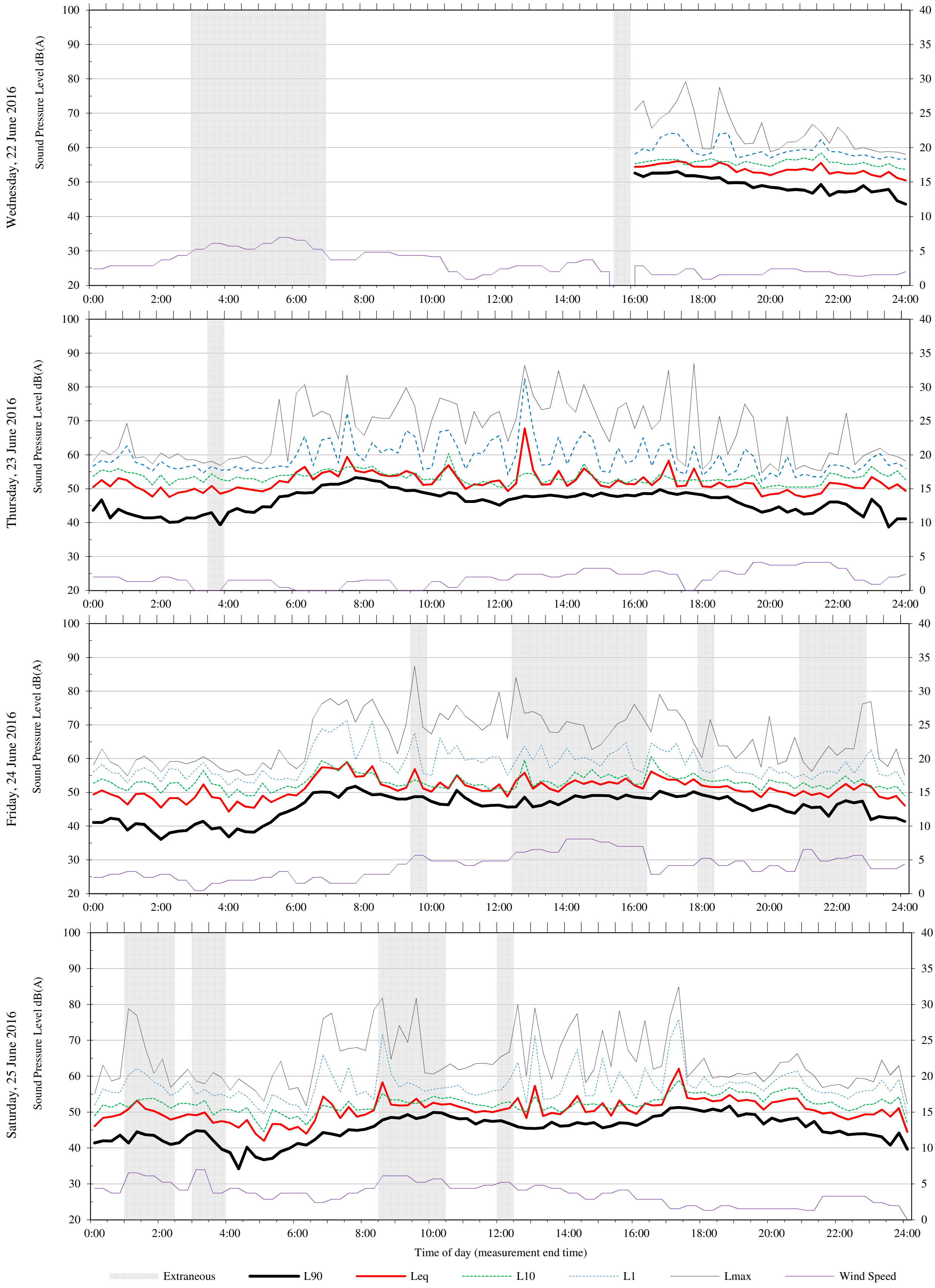
Appendix D

Noise monitoring graphs

Unattended monitoring: 1 - Validation (Free Field)



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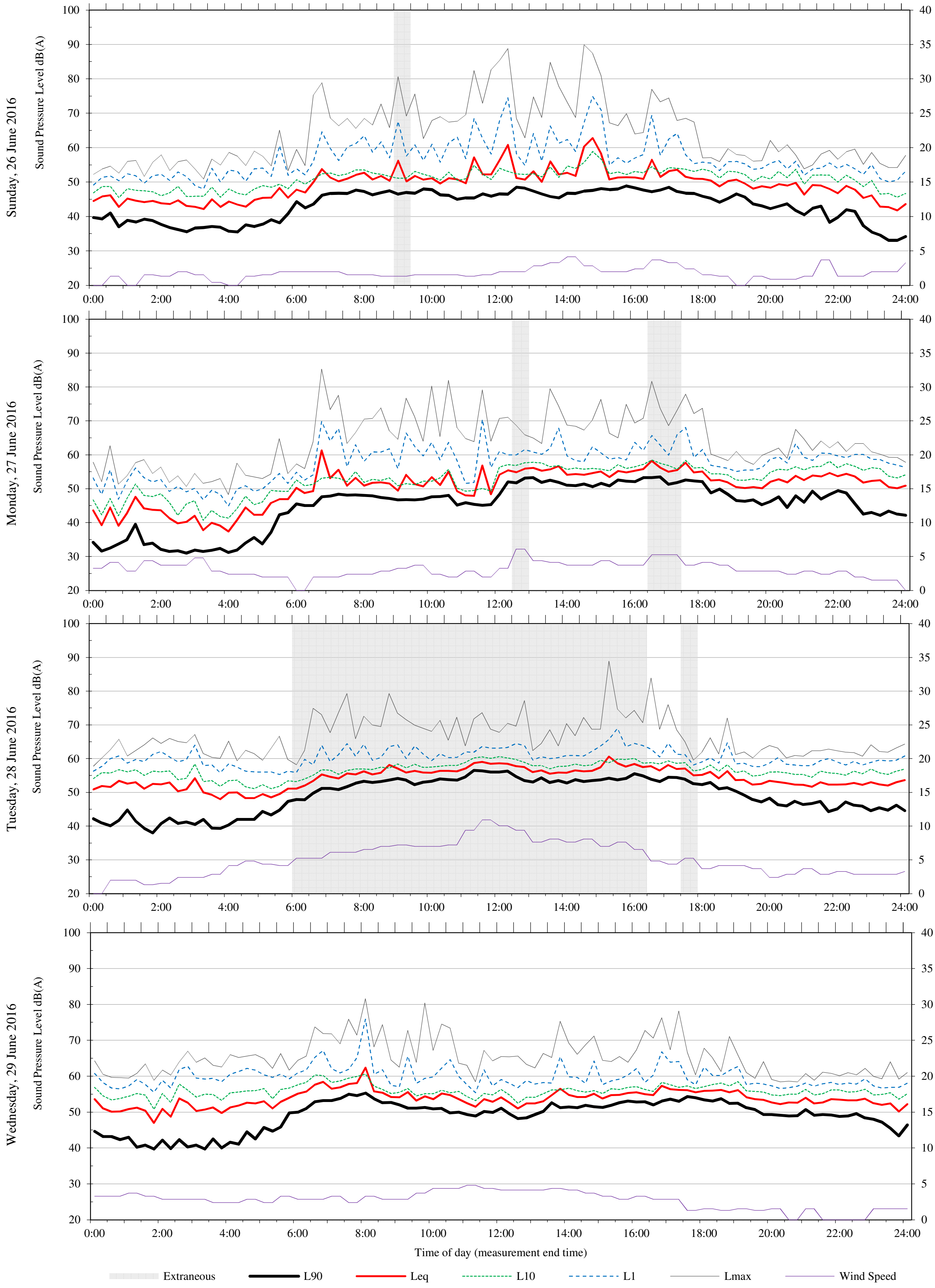
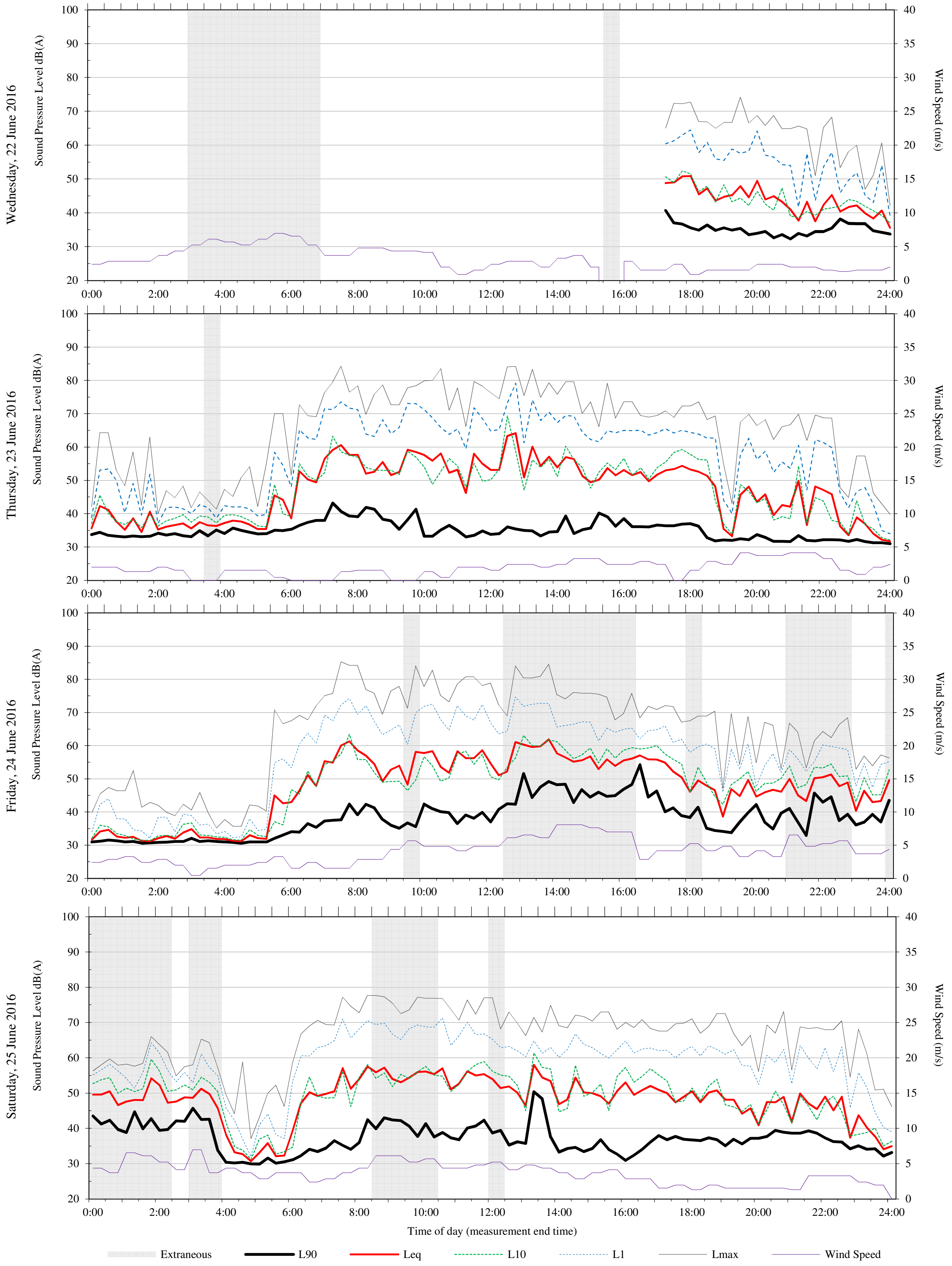
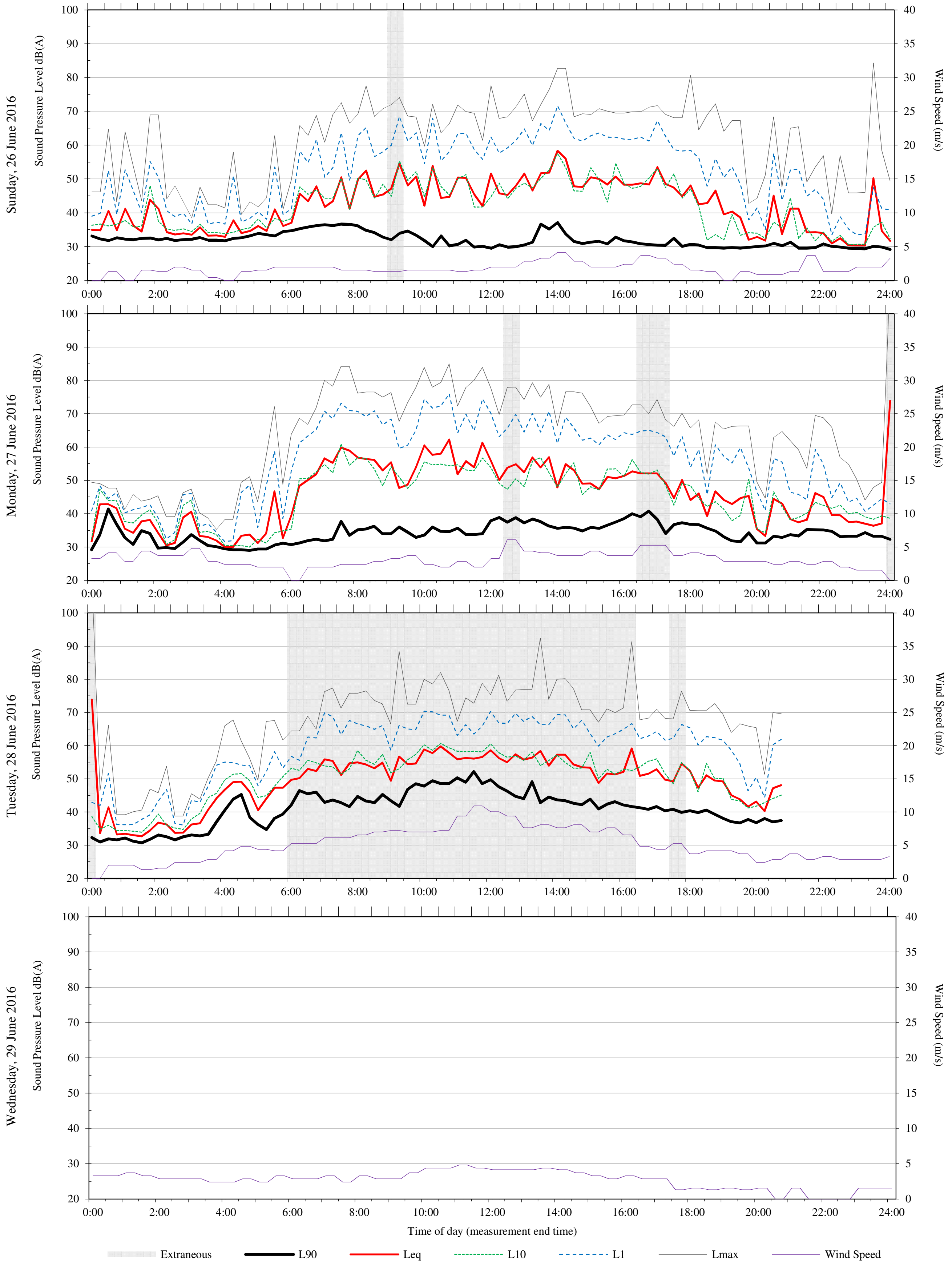


Unattended monitoring: 2 - Validation (Free Field)

ARUP



Unattended monitoring: 2 - Validation (Free Field)



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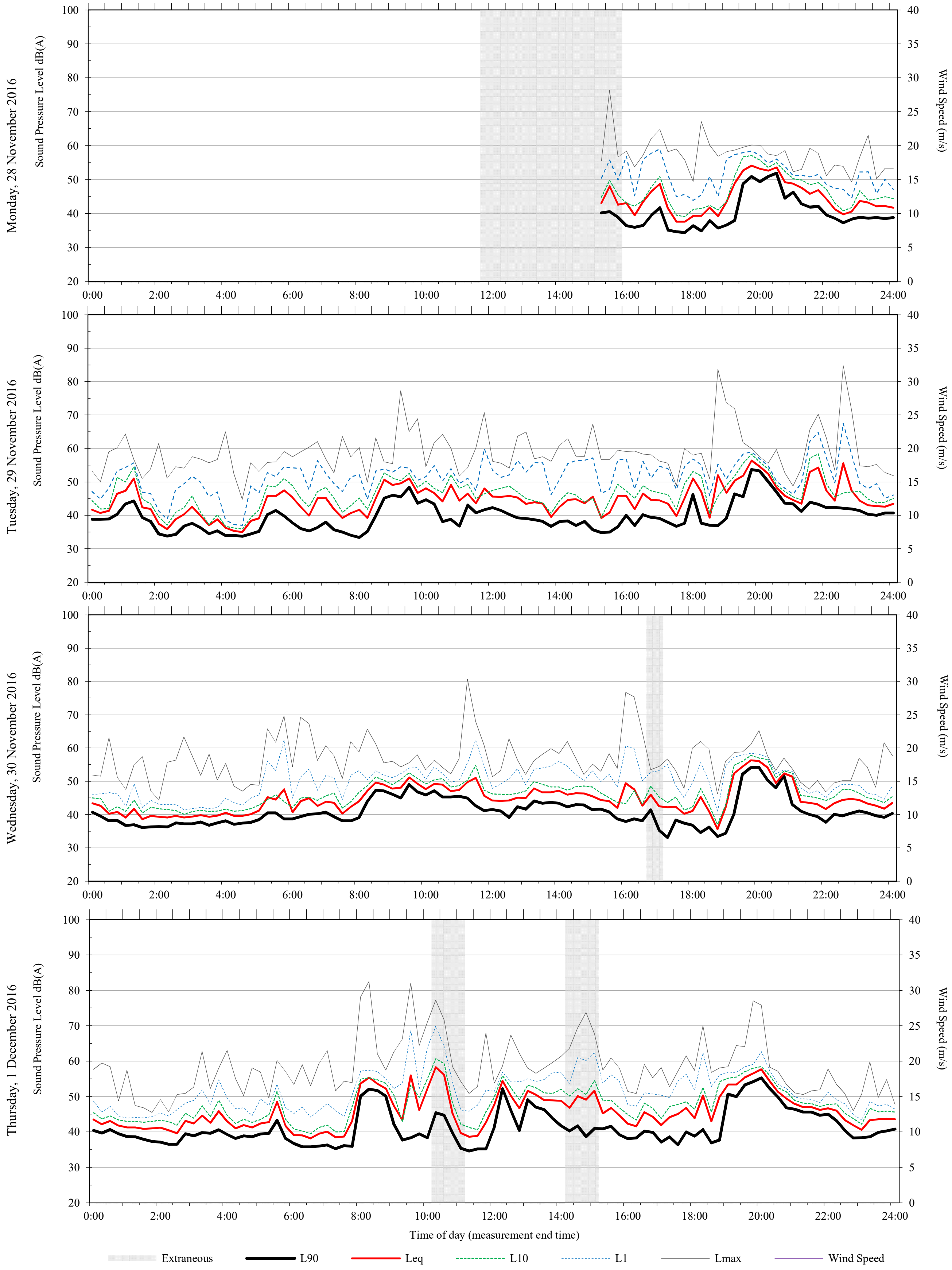

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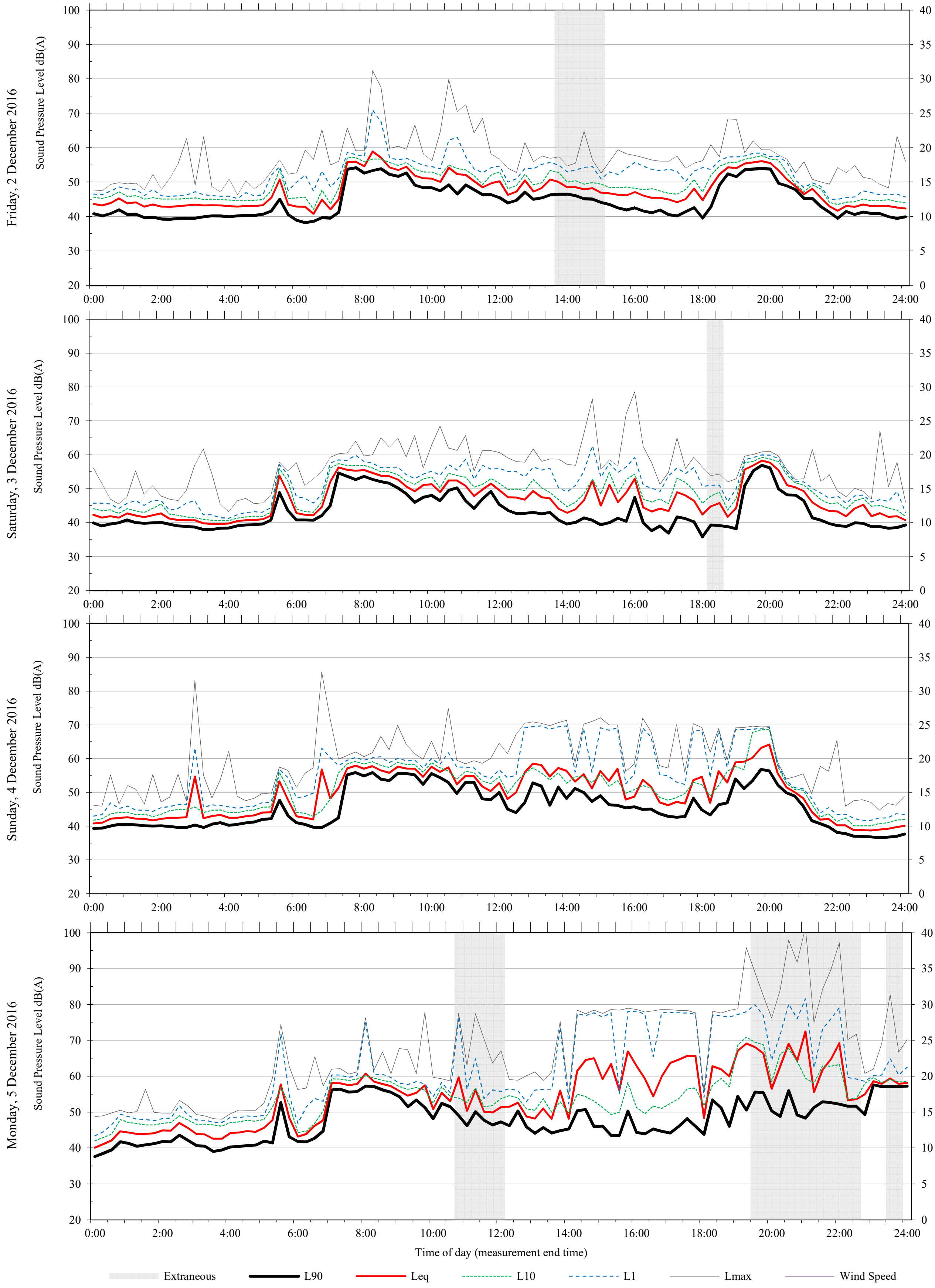

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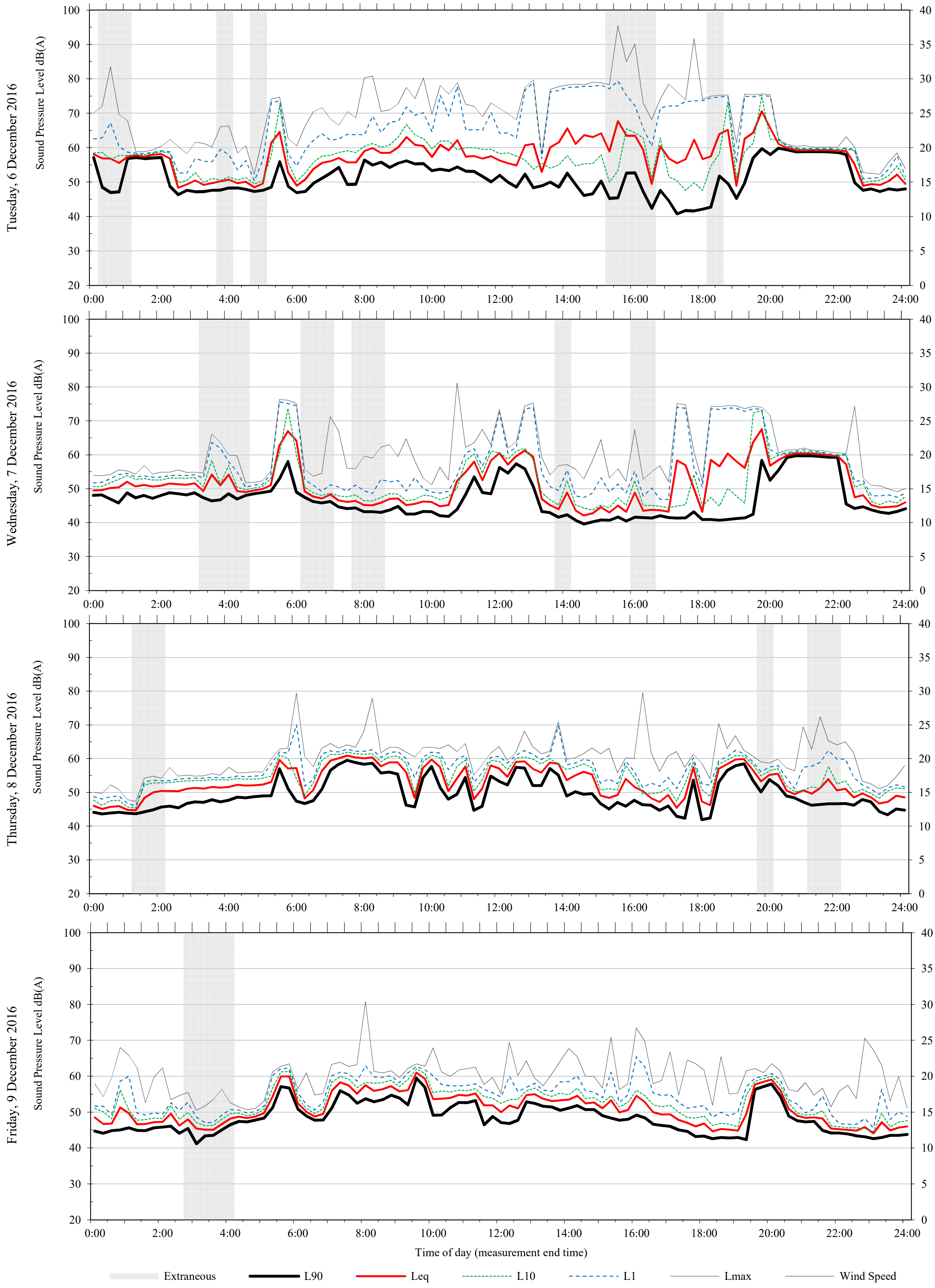
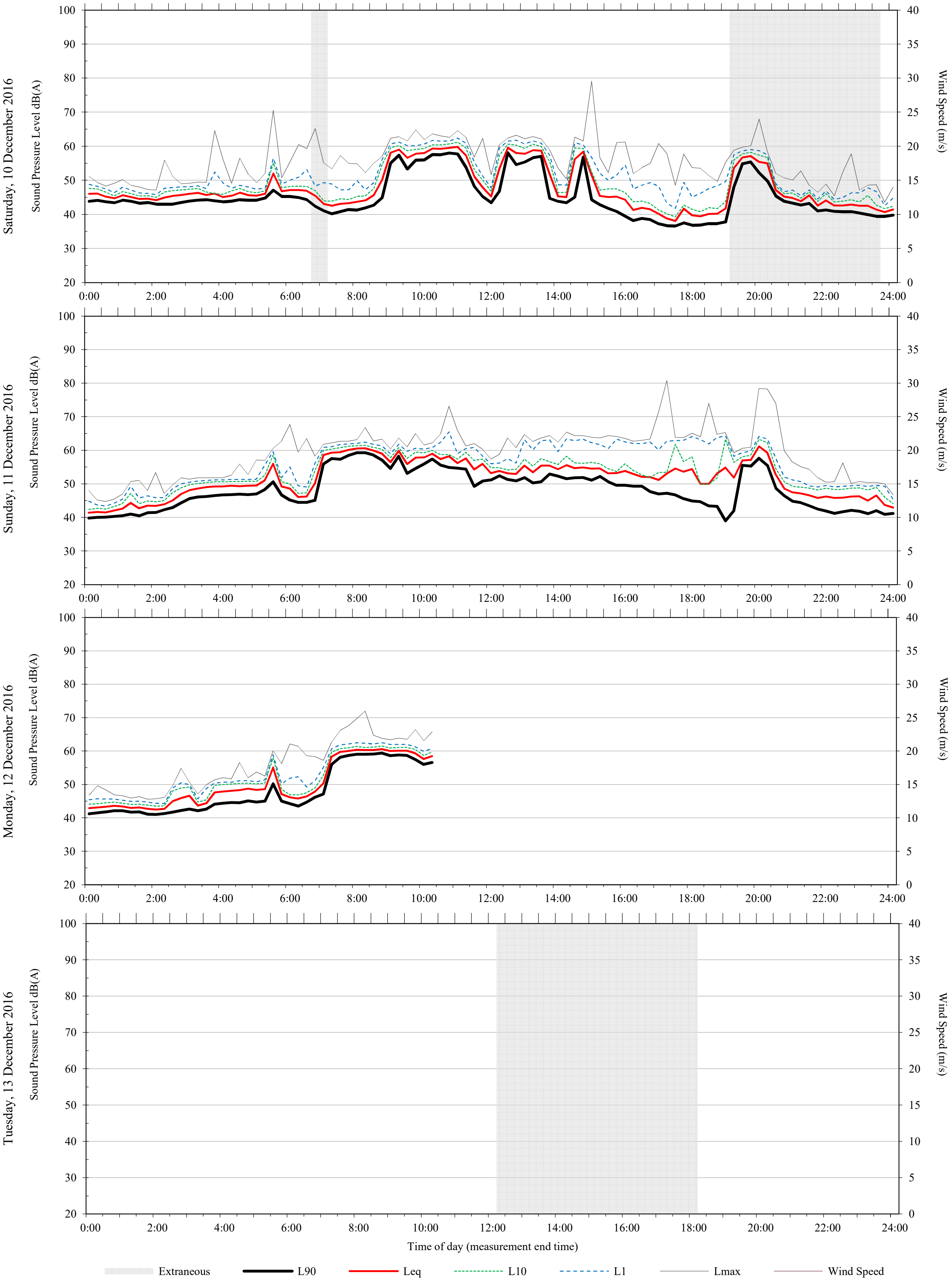
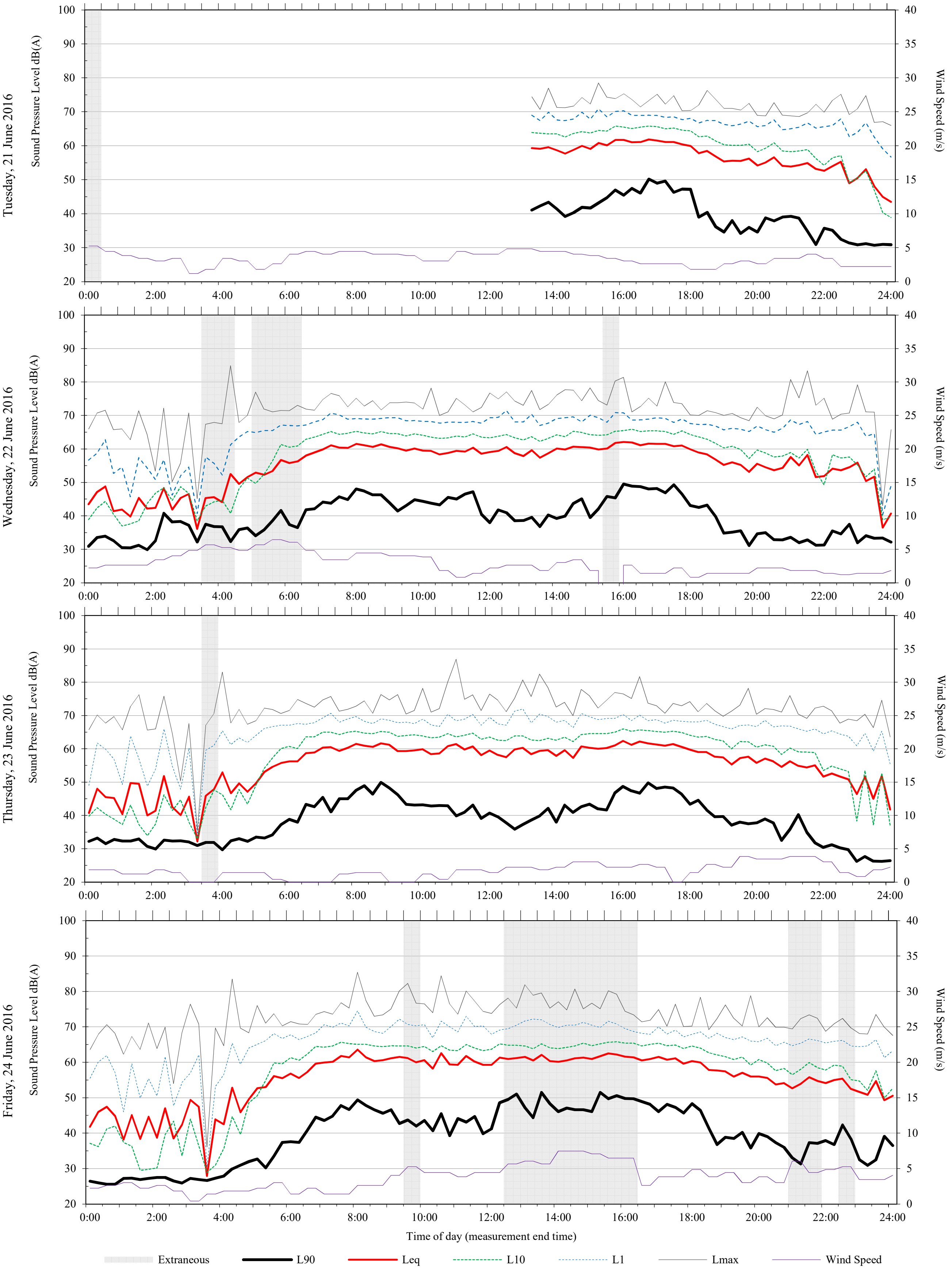


Unattended monitoring: 3 - Baseline (Free Field)



Unattended monitoring: 4 - Validation (Free Field)

ARUP



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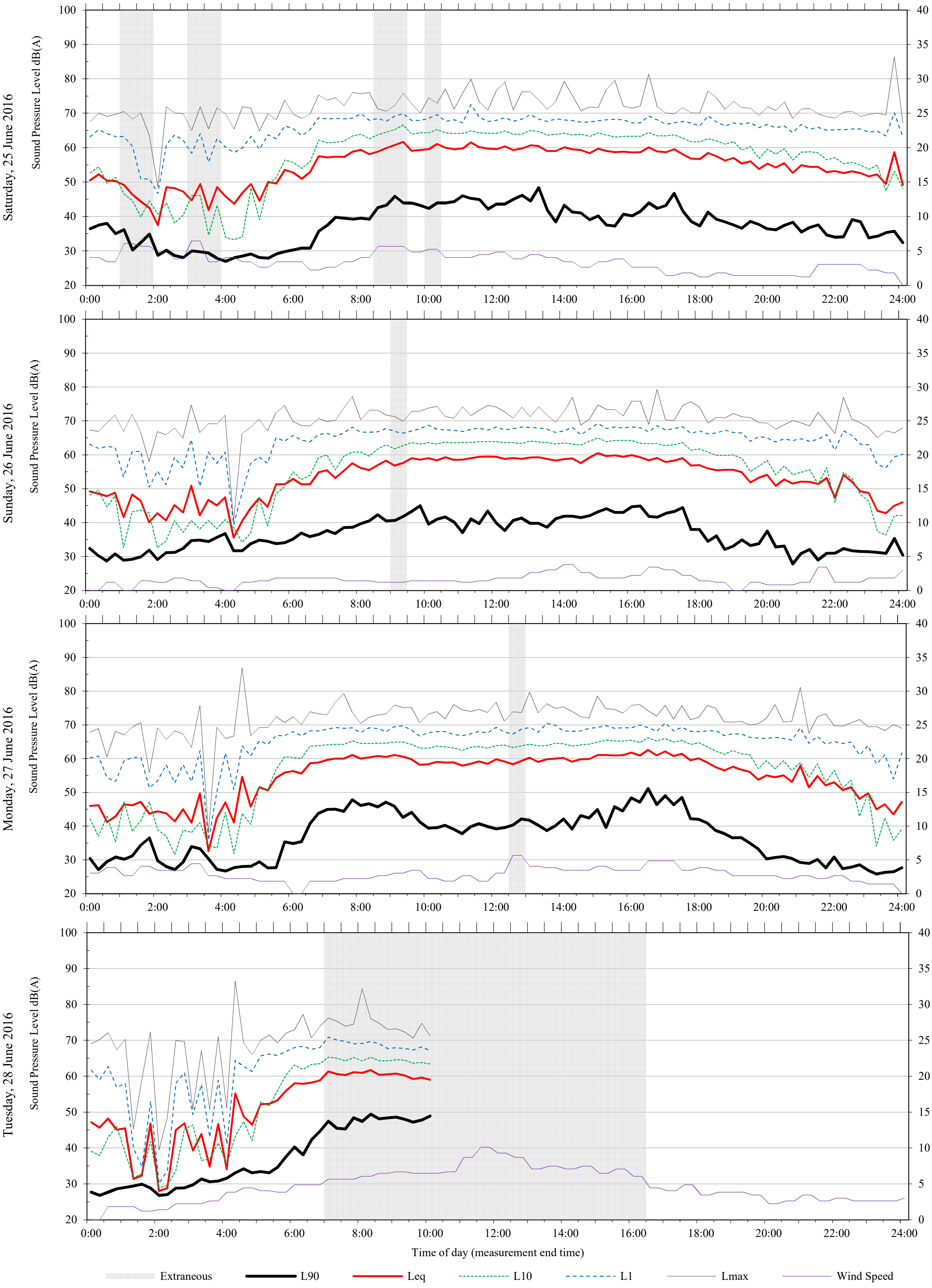

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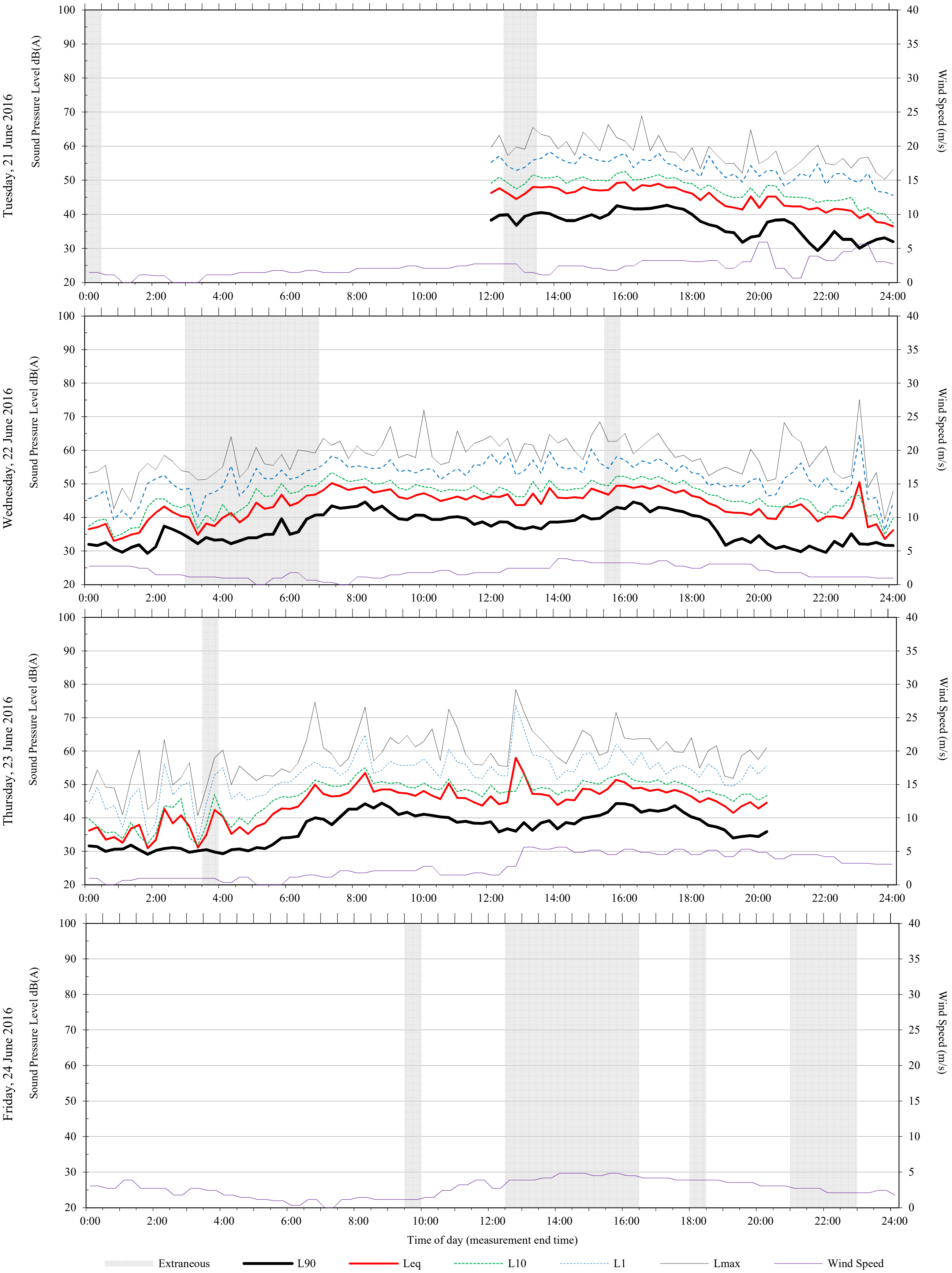

Unattended monitoring: 6 - Baseline (Free Field)

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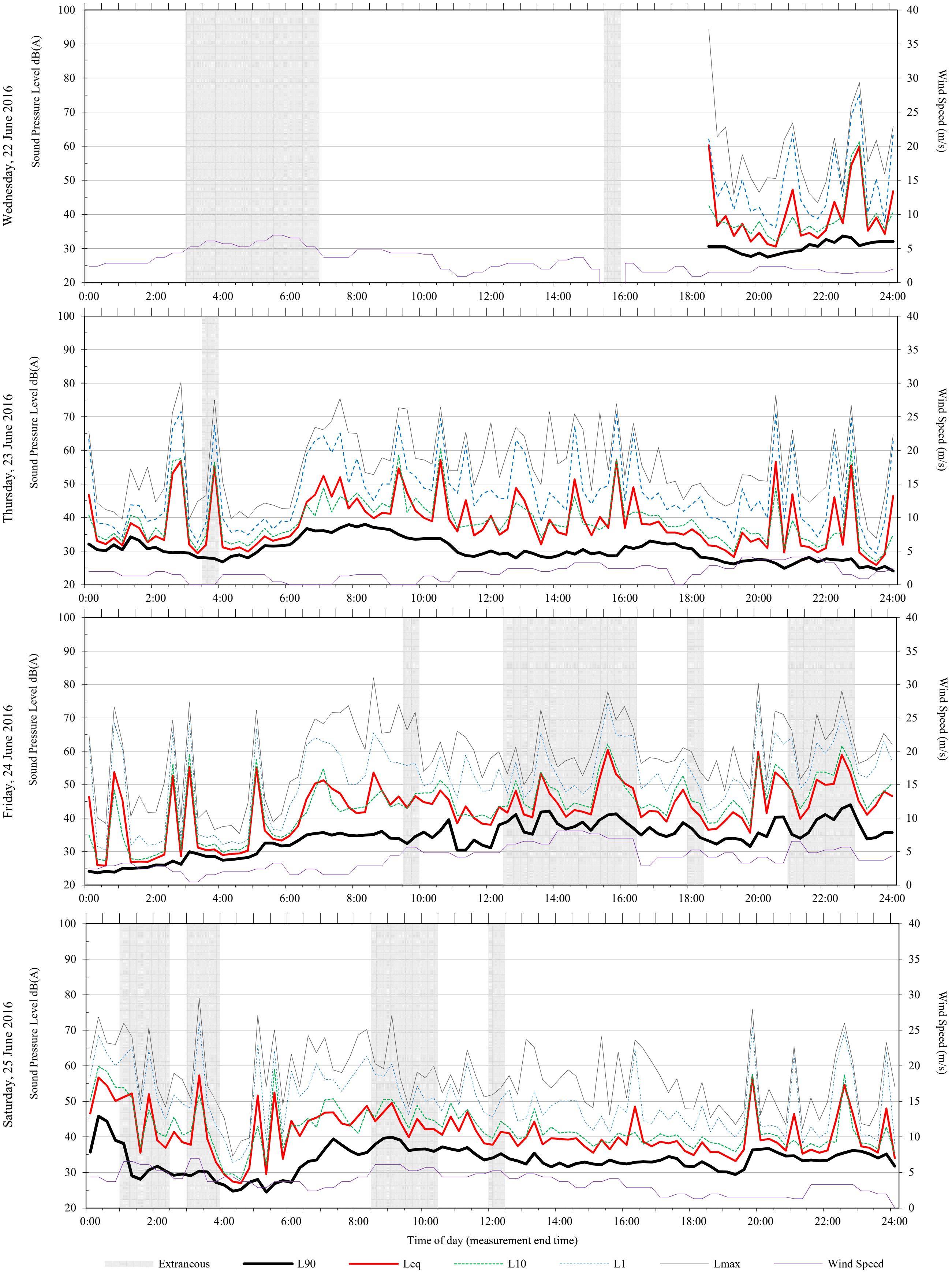
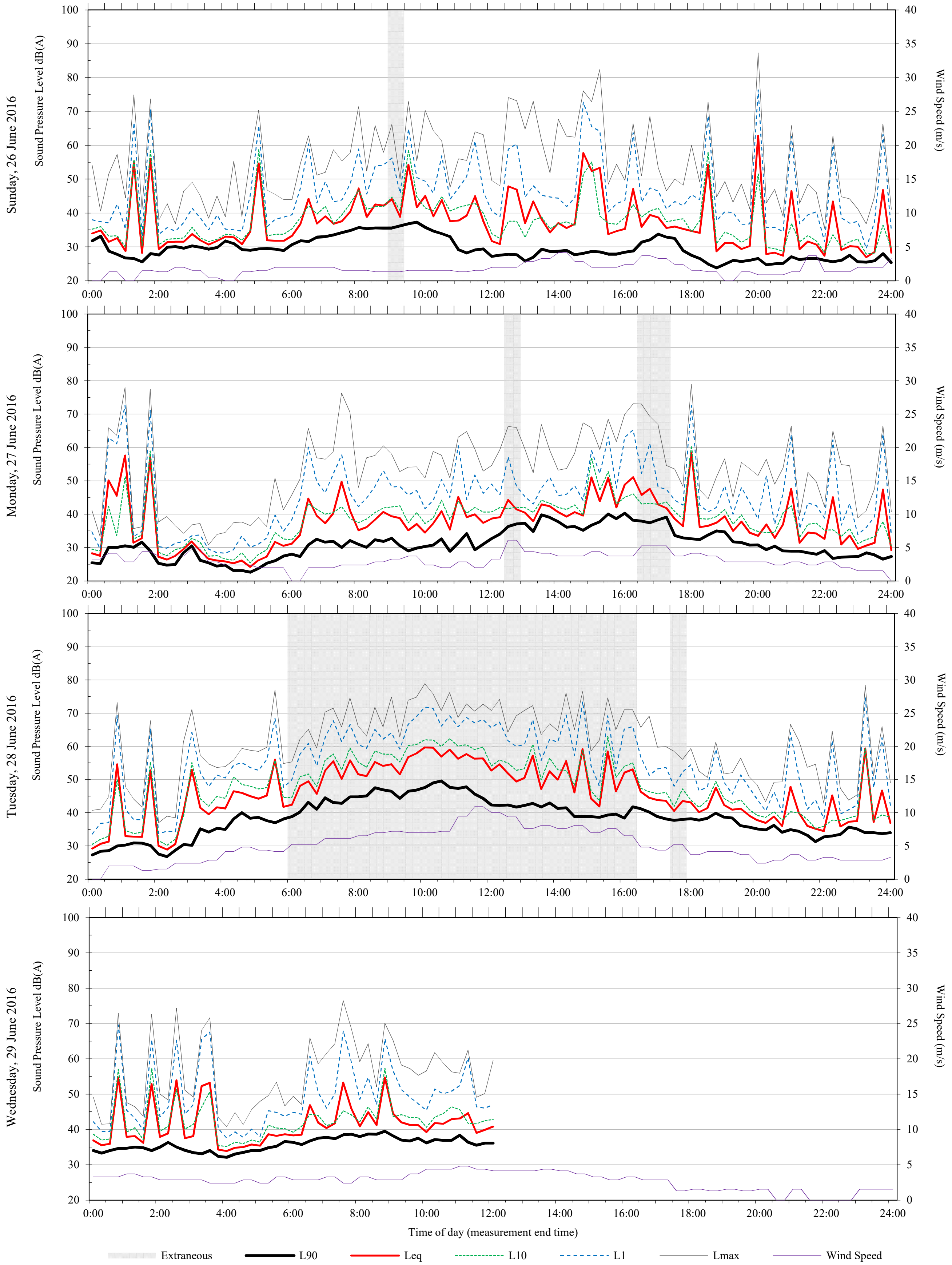


Unattended monitoring: 6 - Baseline (Free Field)

ARUP



Unattended monitoring: 7 - Baseline (Free Field)

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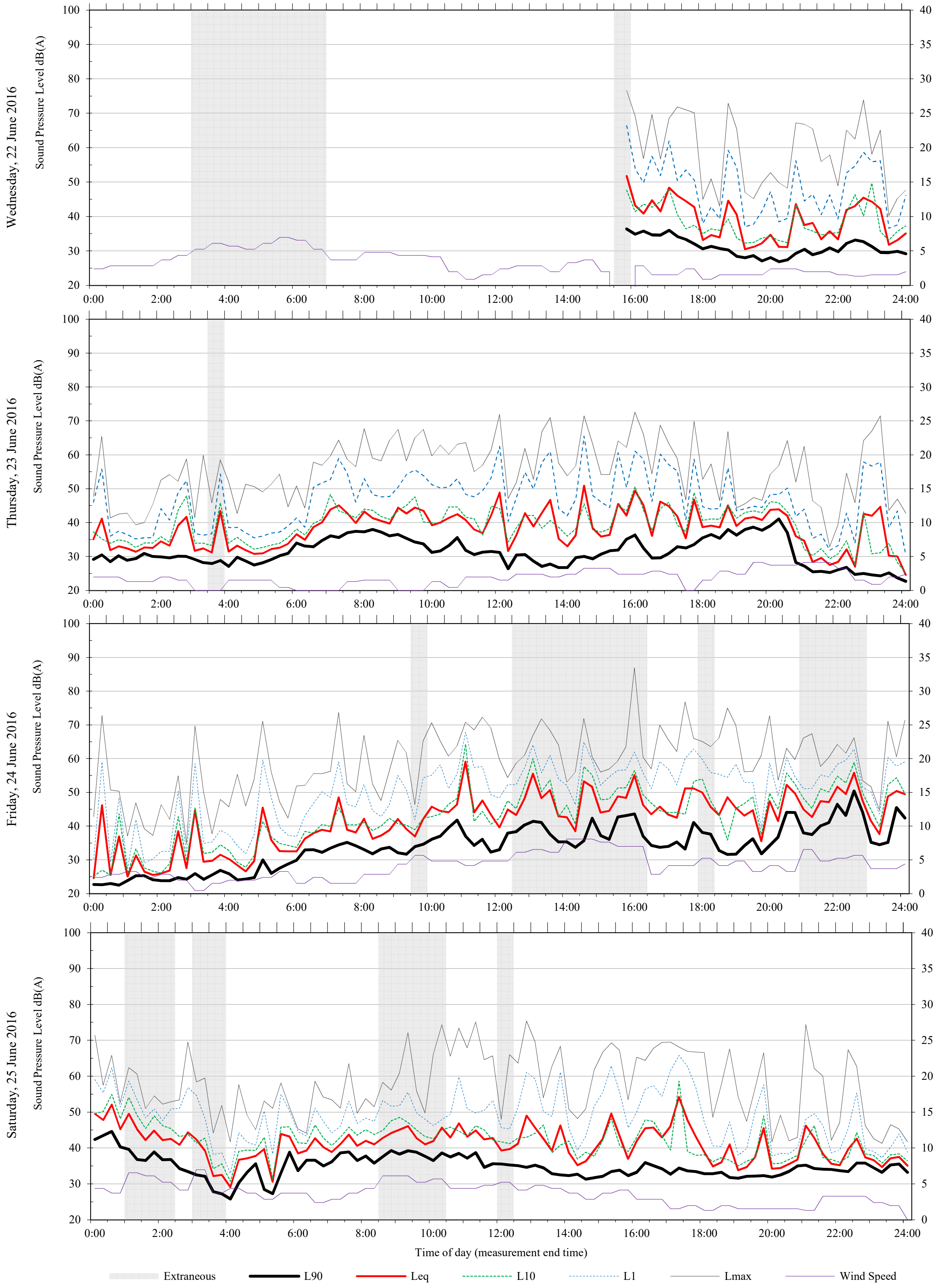

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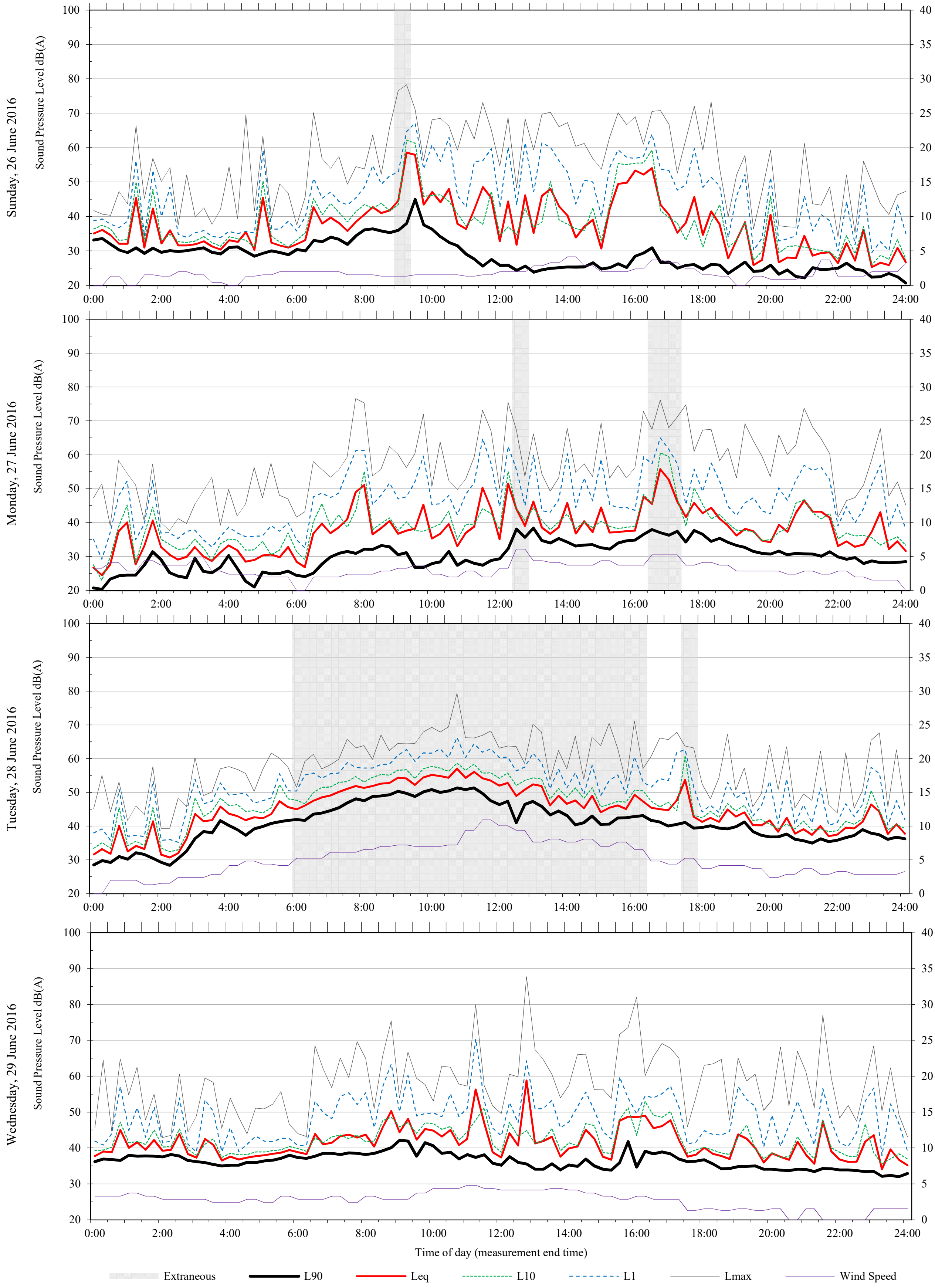

Unattended monitoring: 8 - Validation (Free Field)

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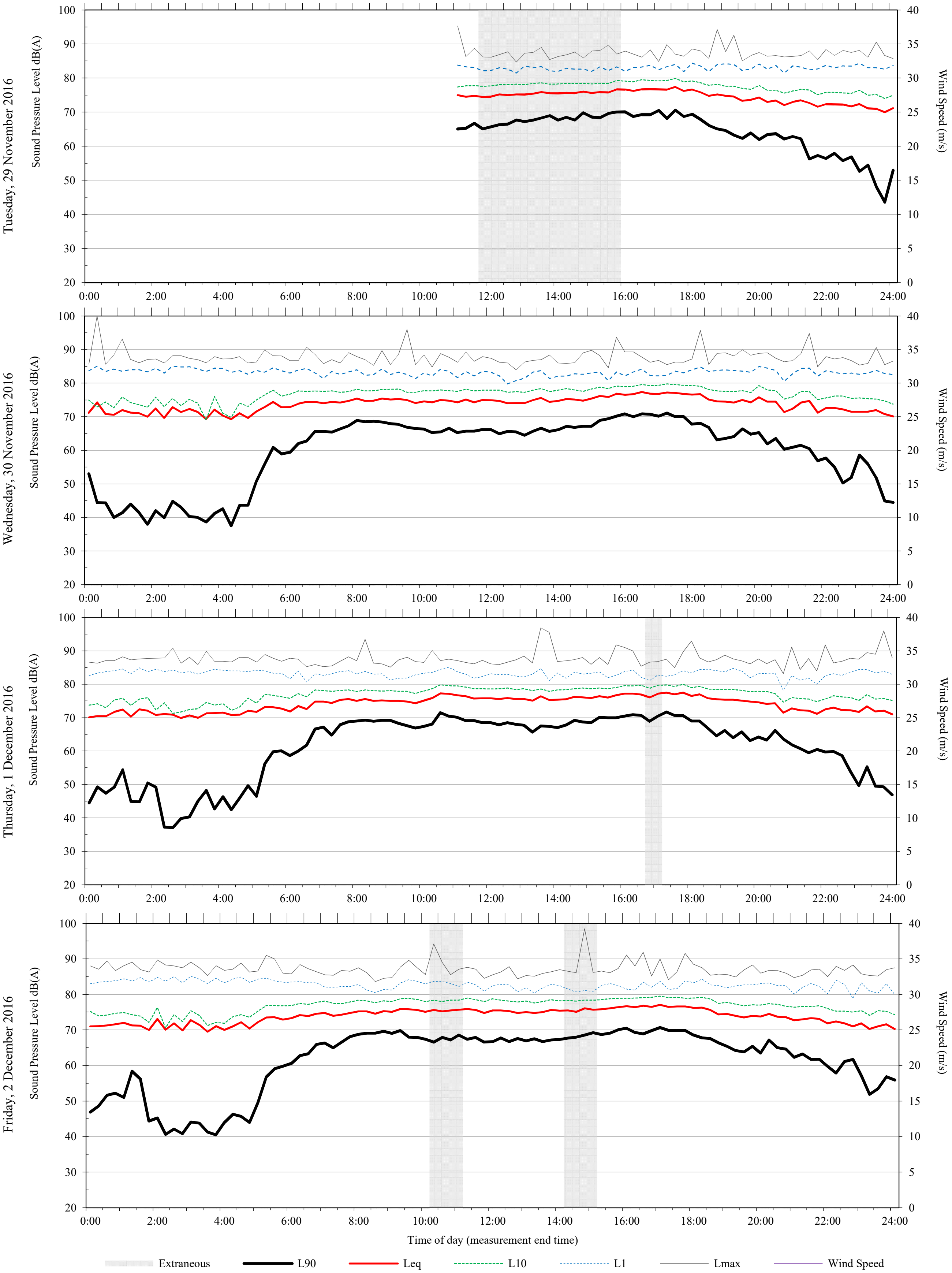

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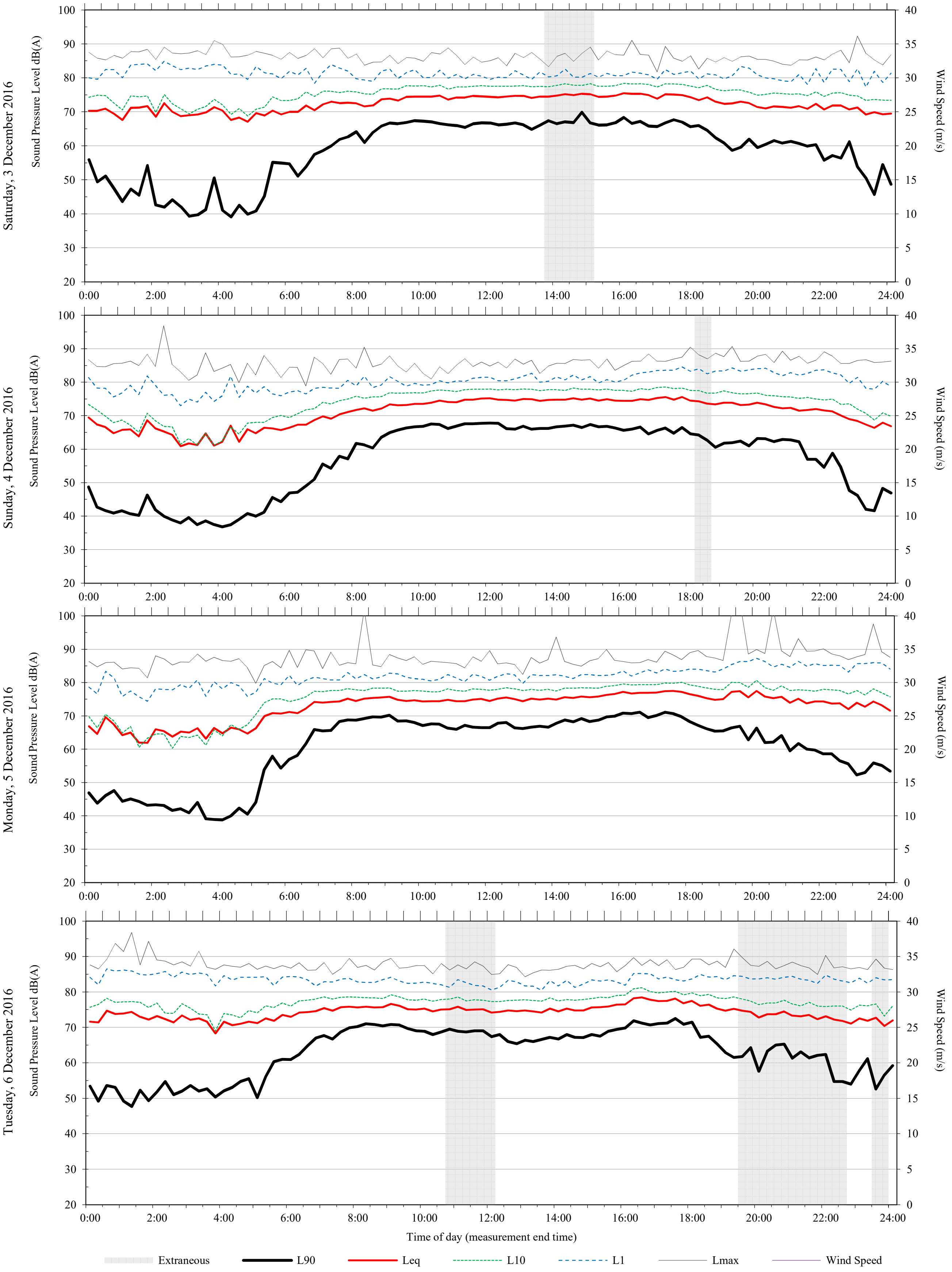

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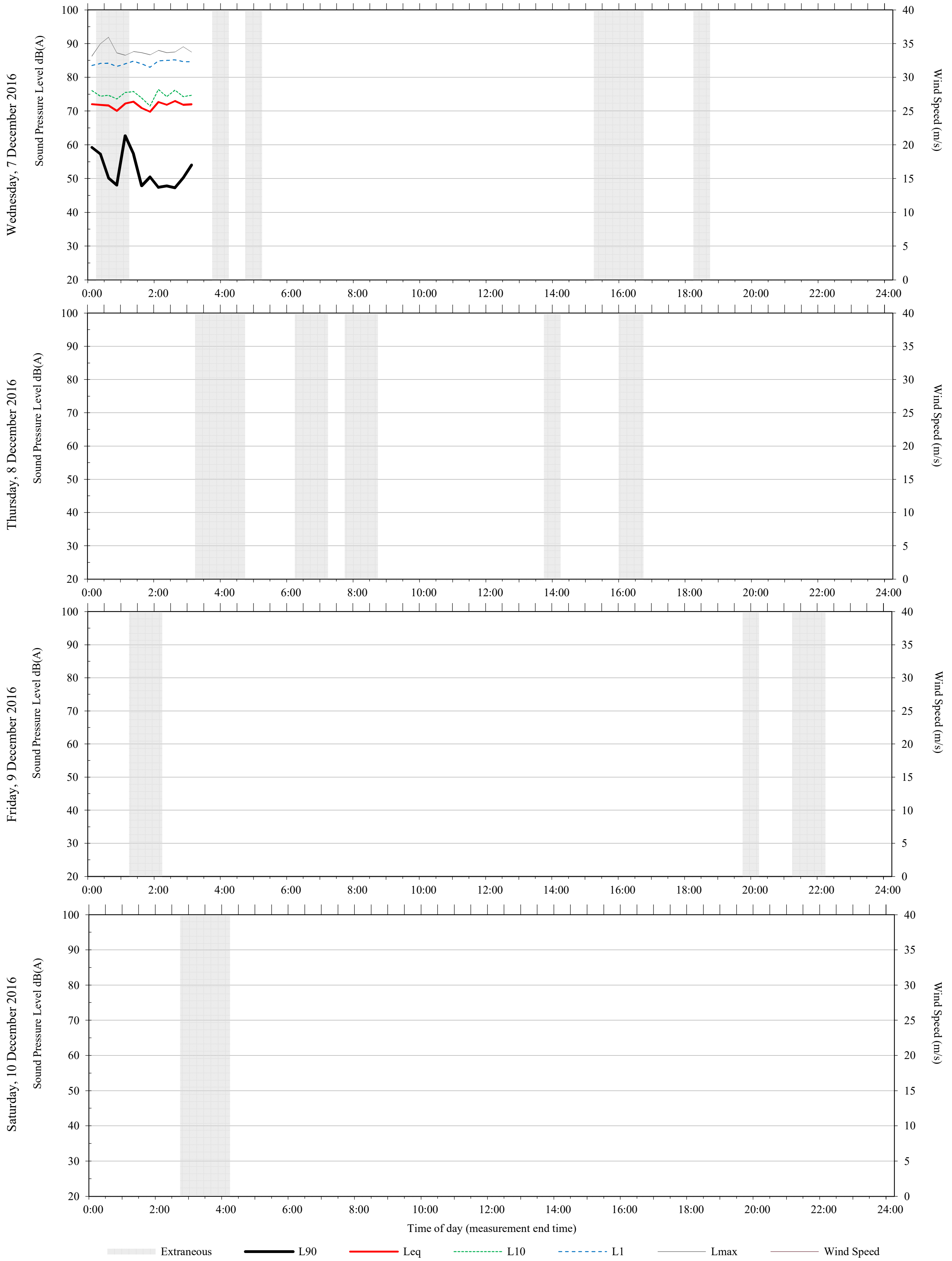

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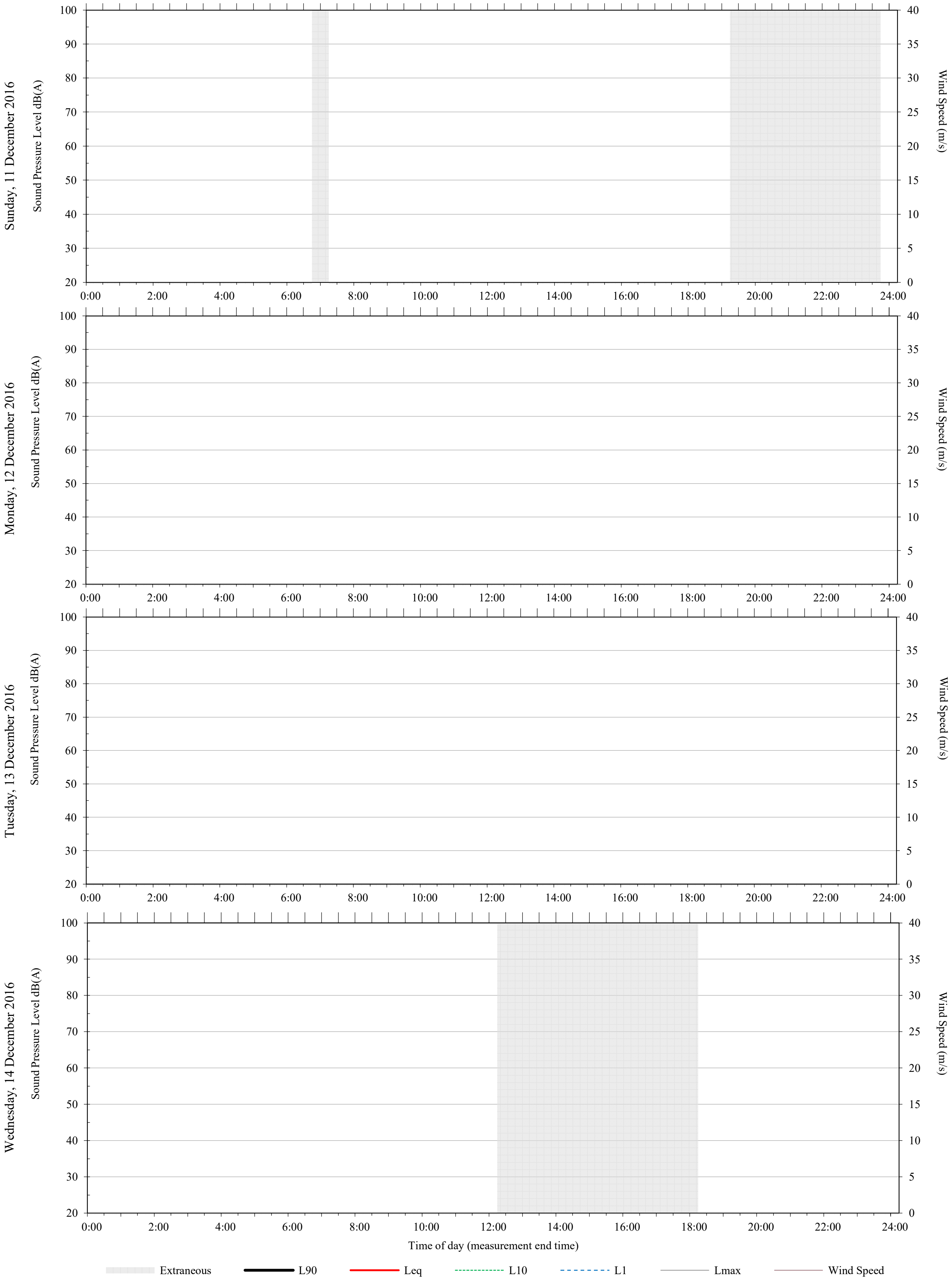

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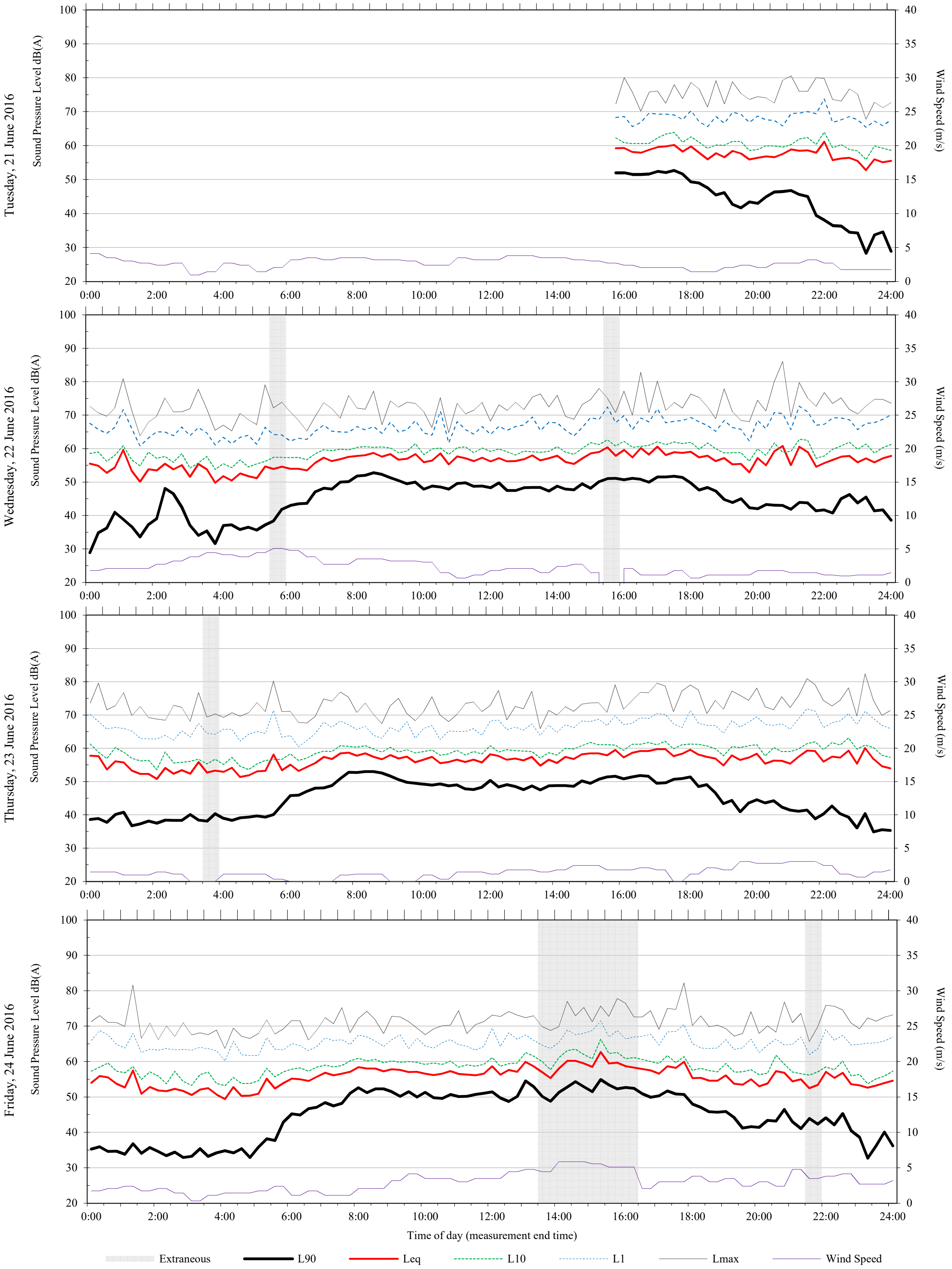

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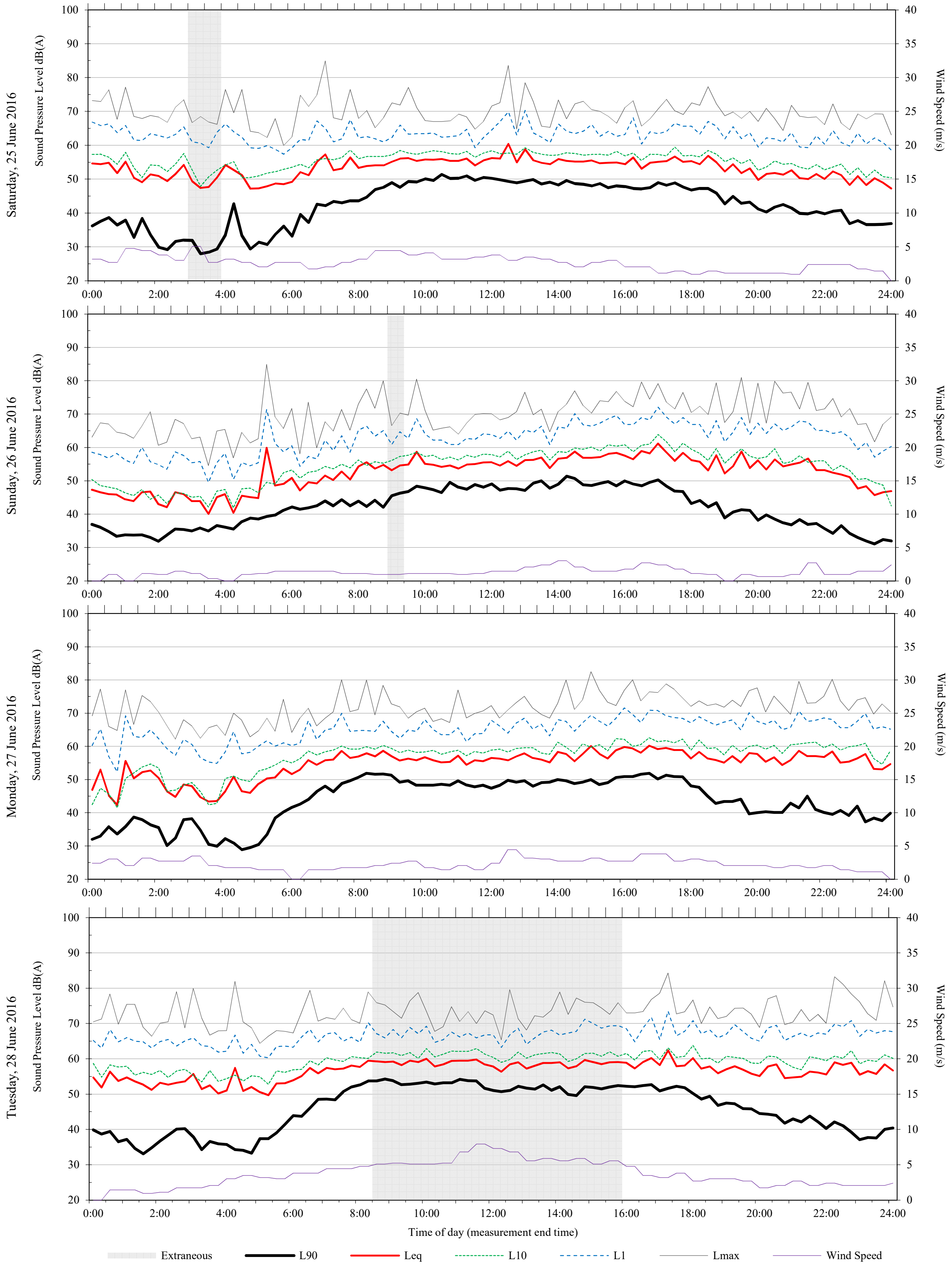
ARUP



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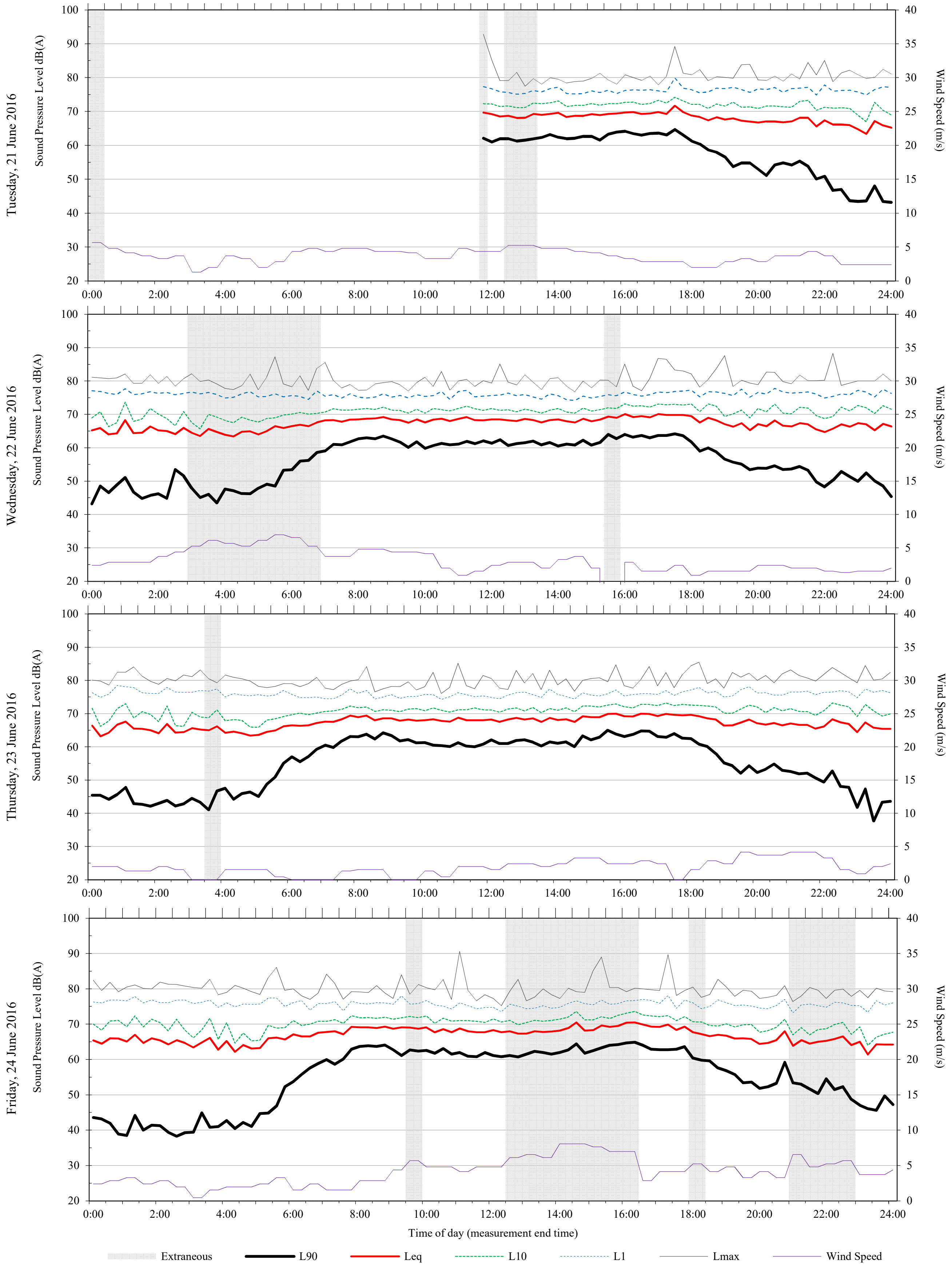

Unattended monitoring: 10 Validation (Free Field)

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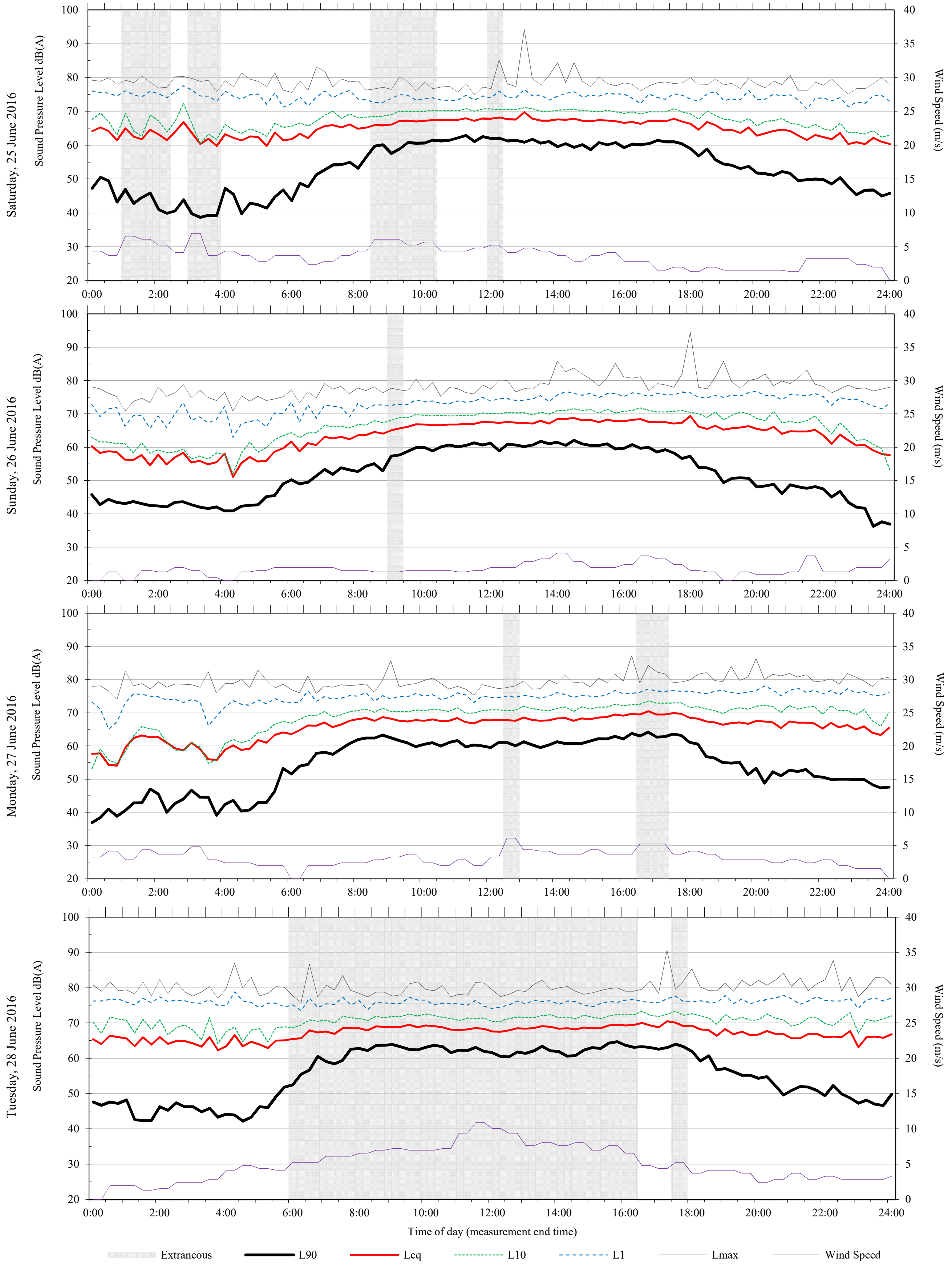

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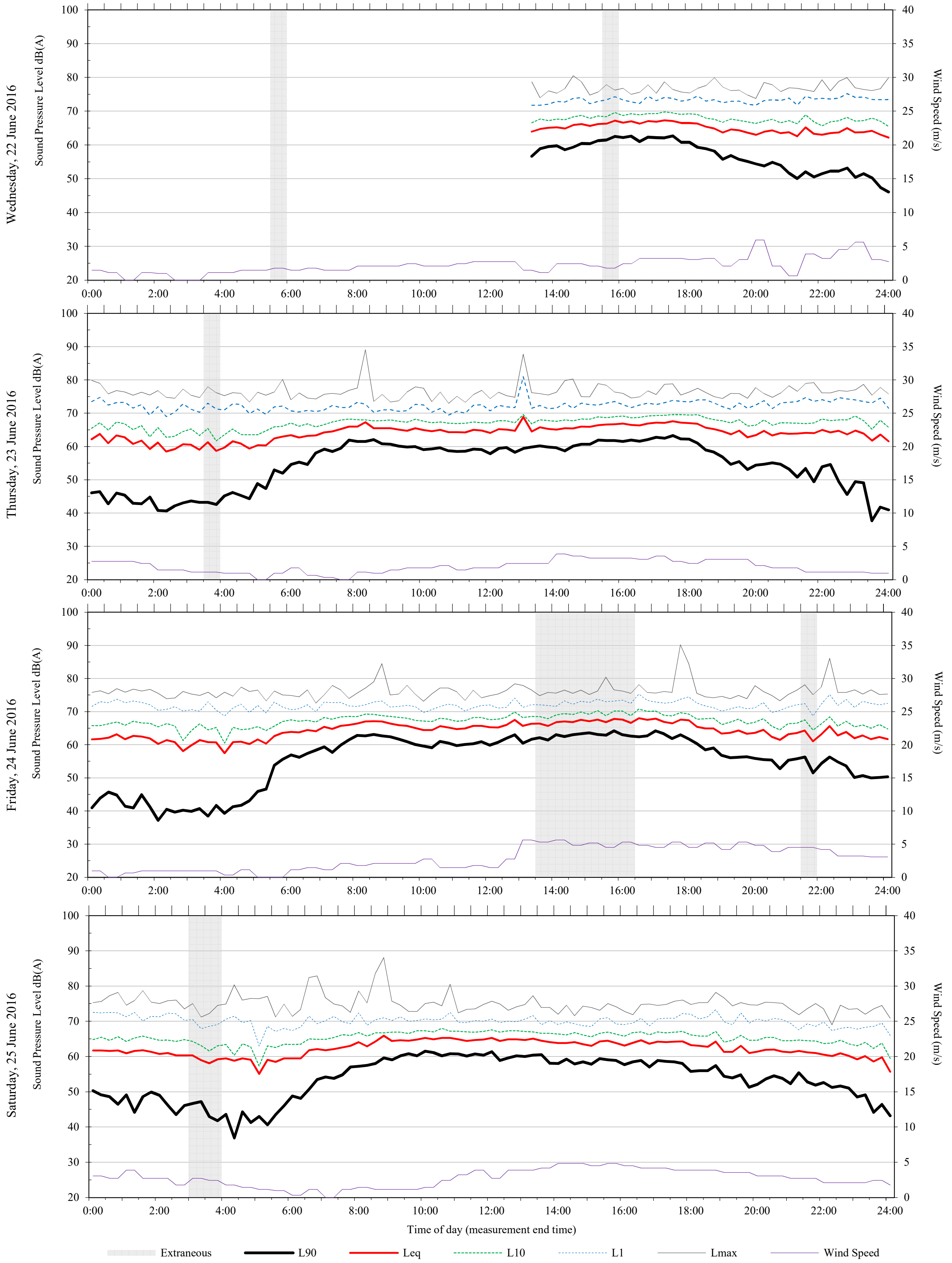

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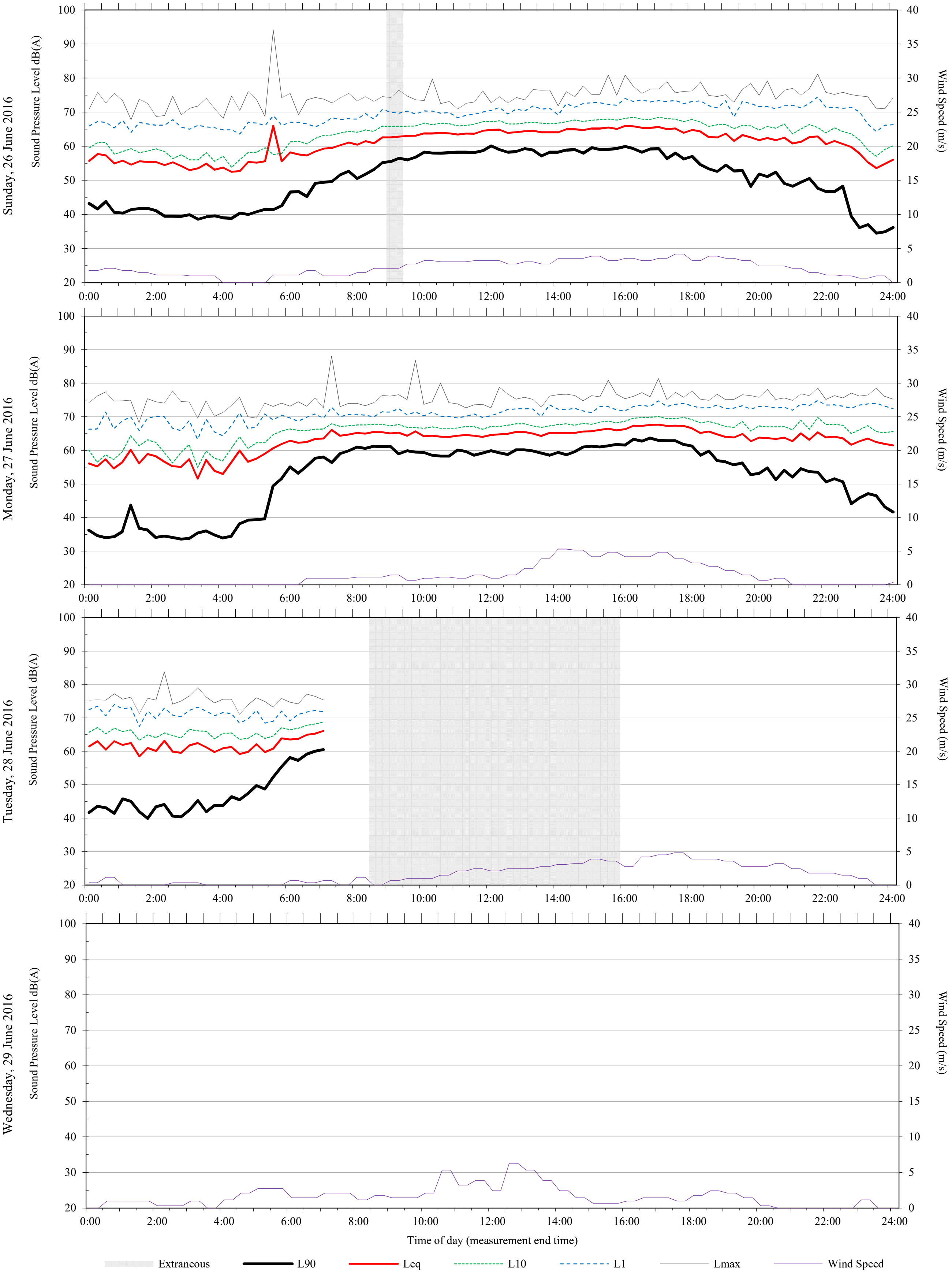

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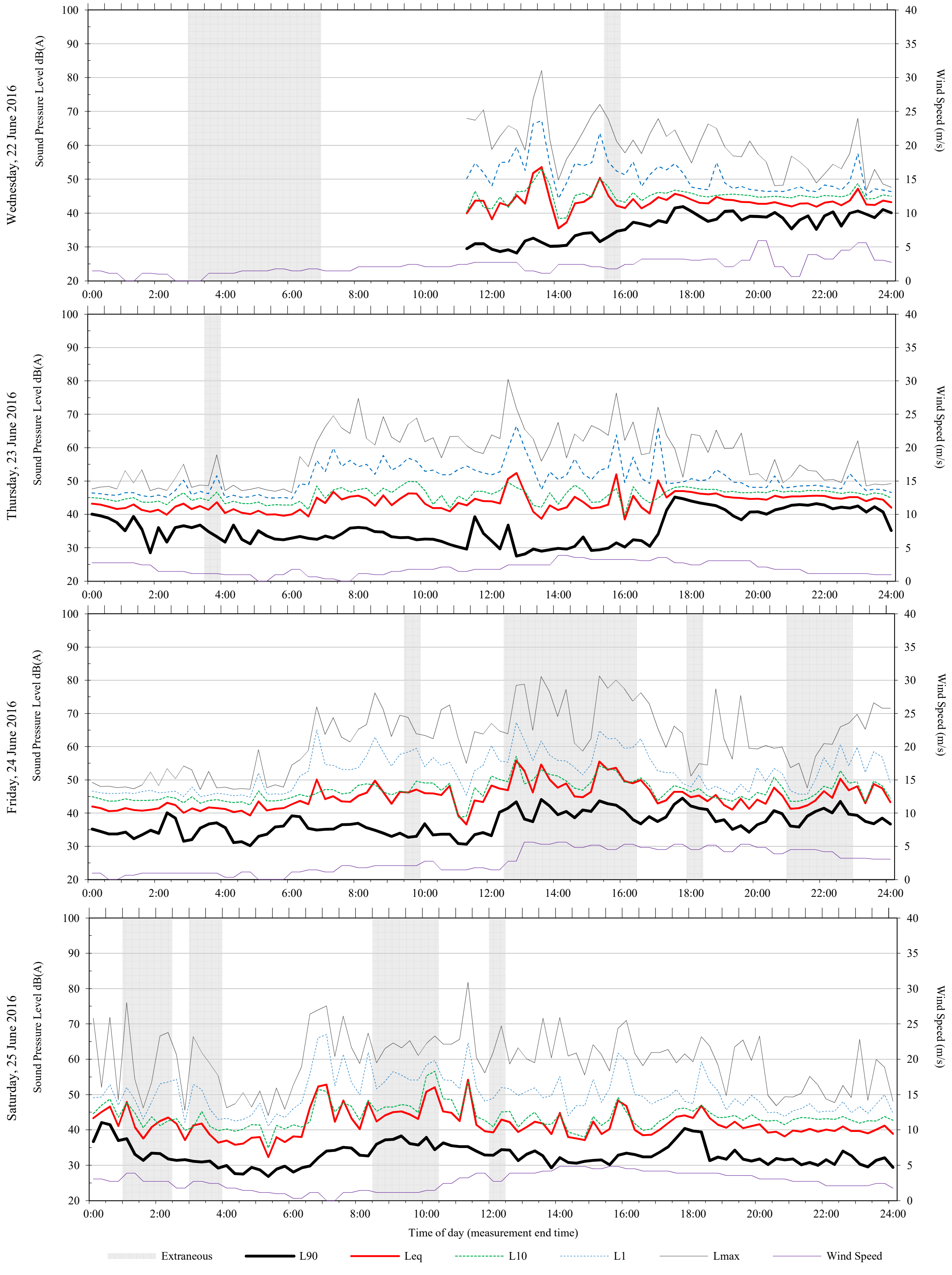

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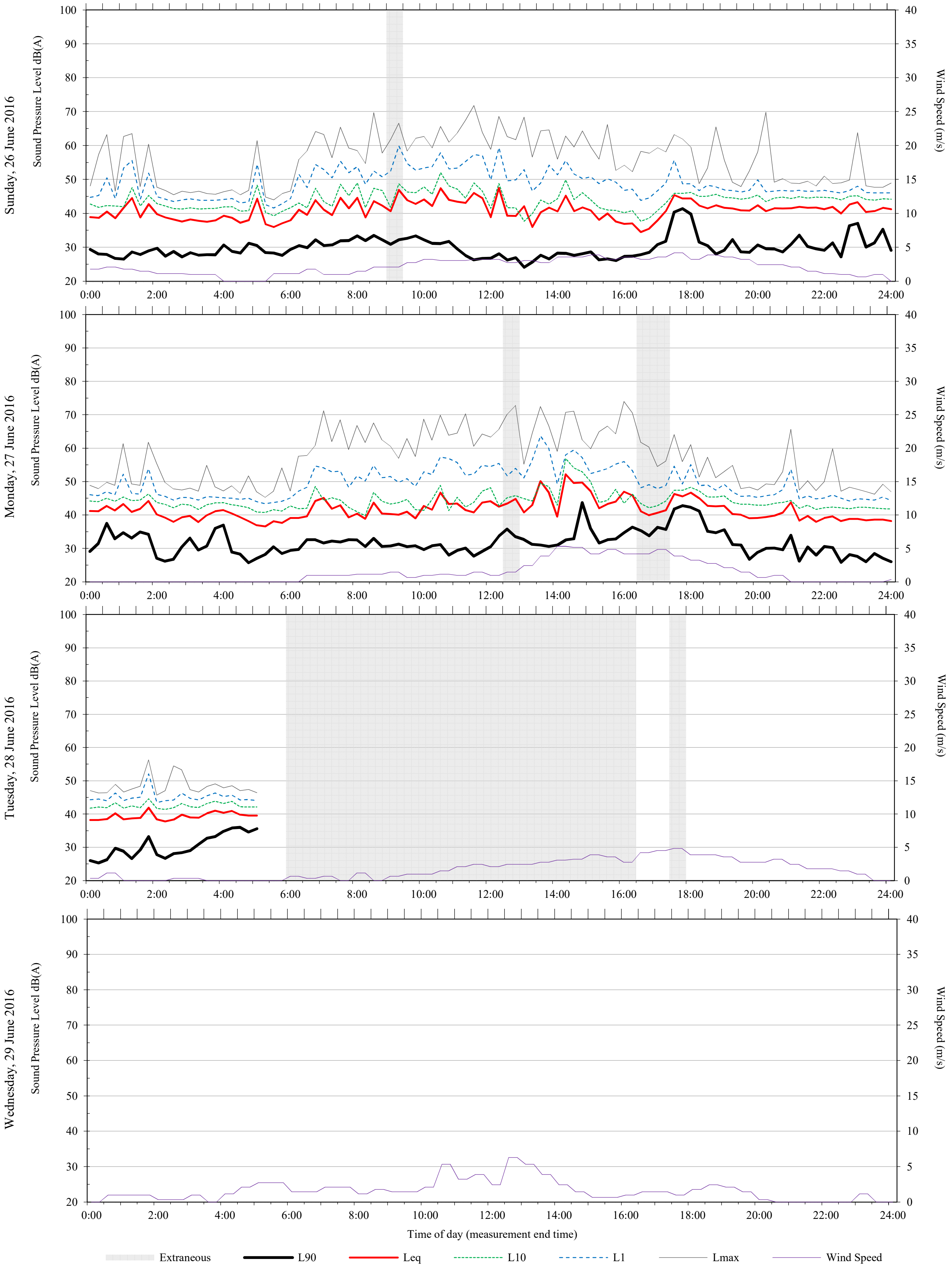

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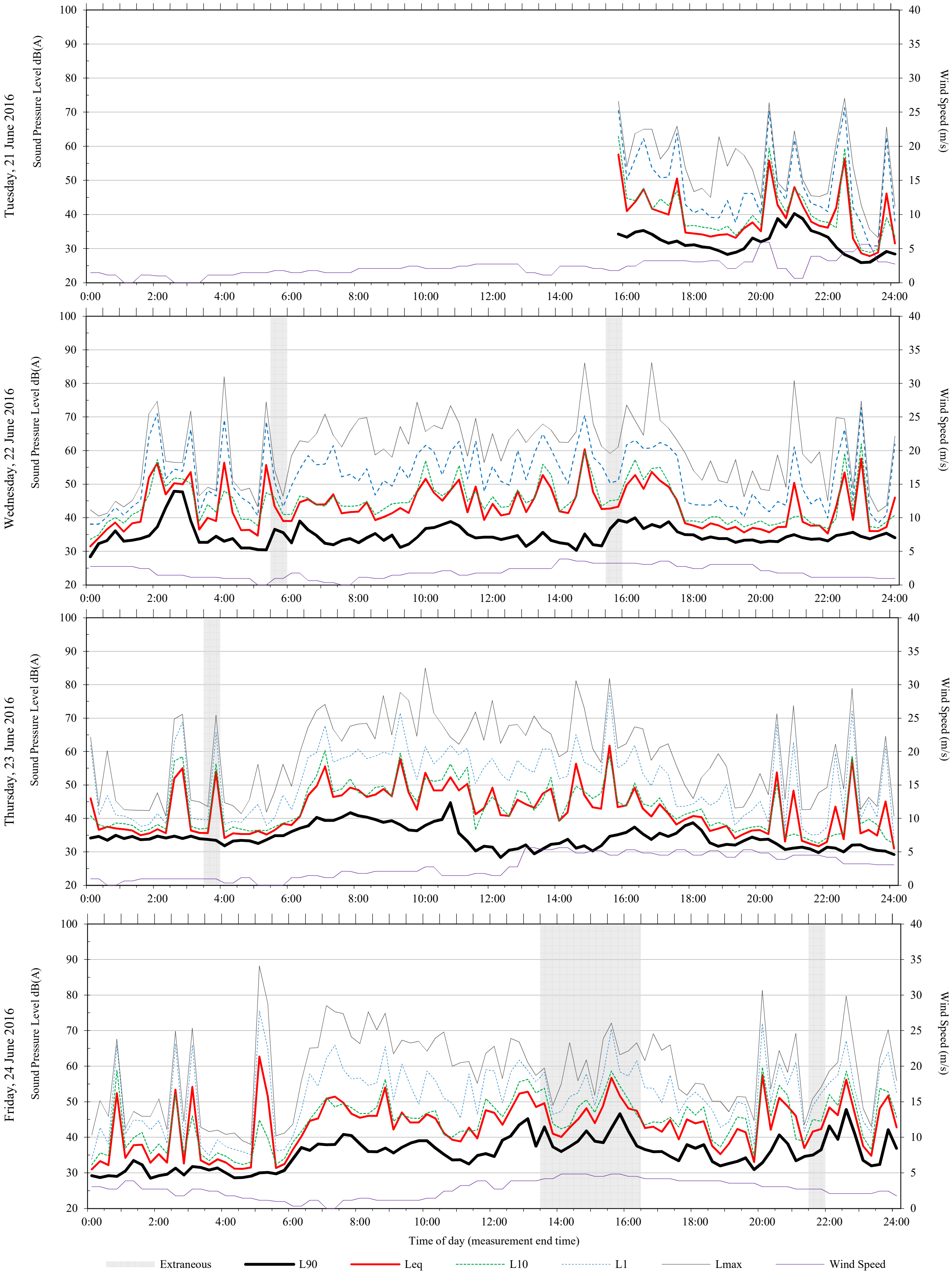

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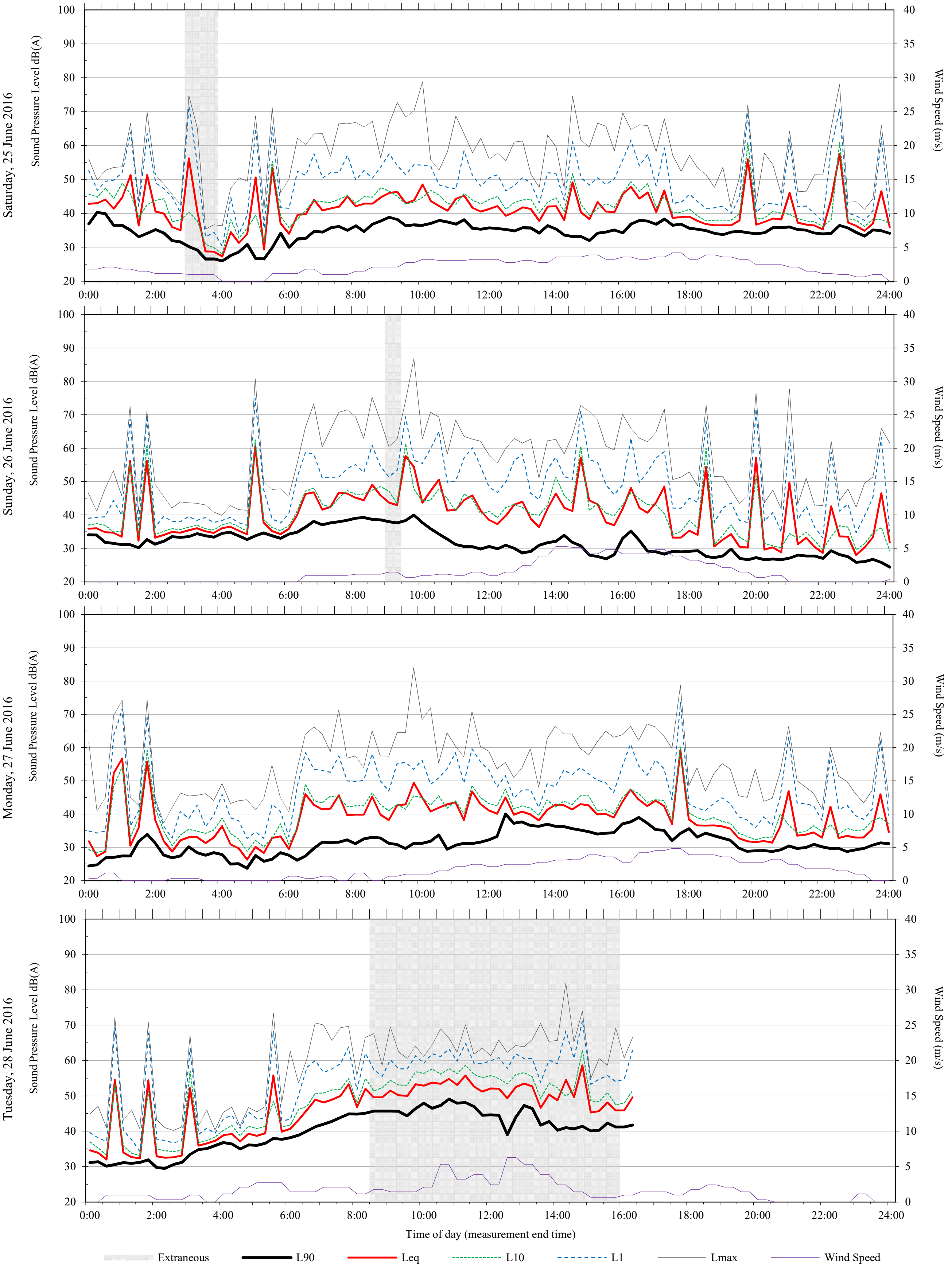

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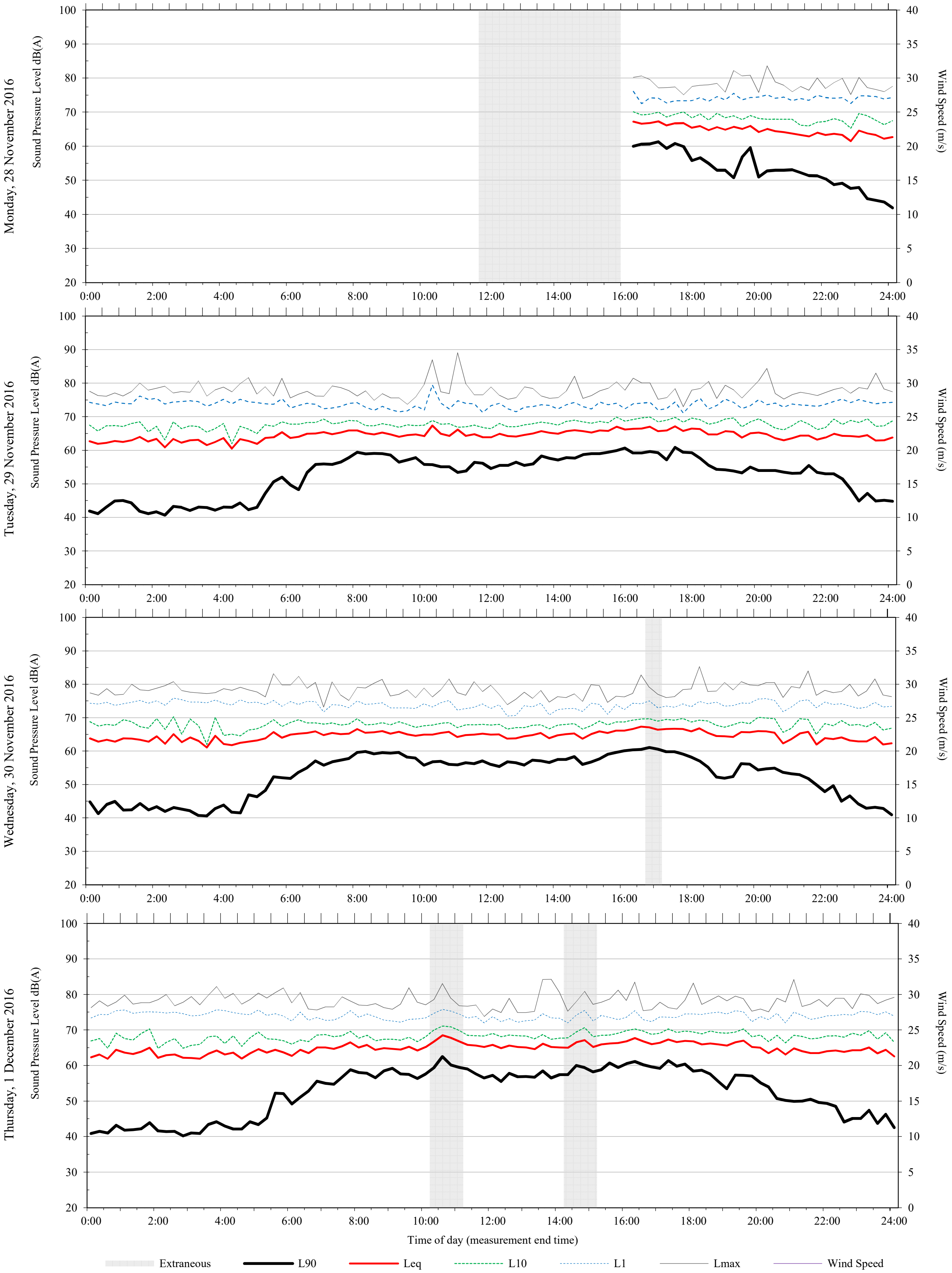

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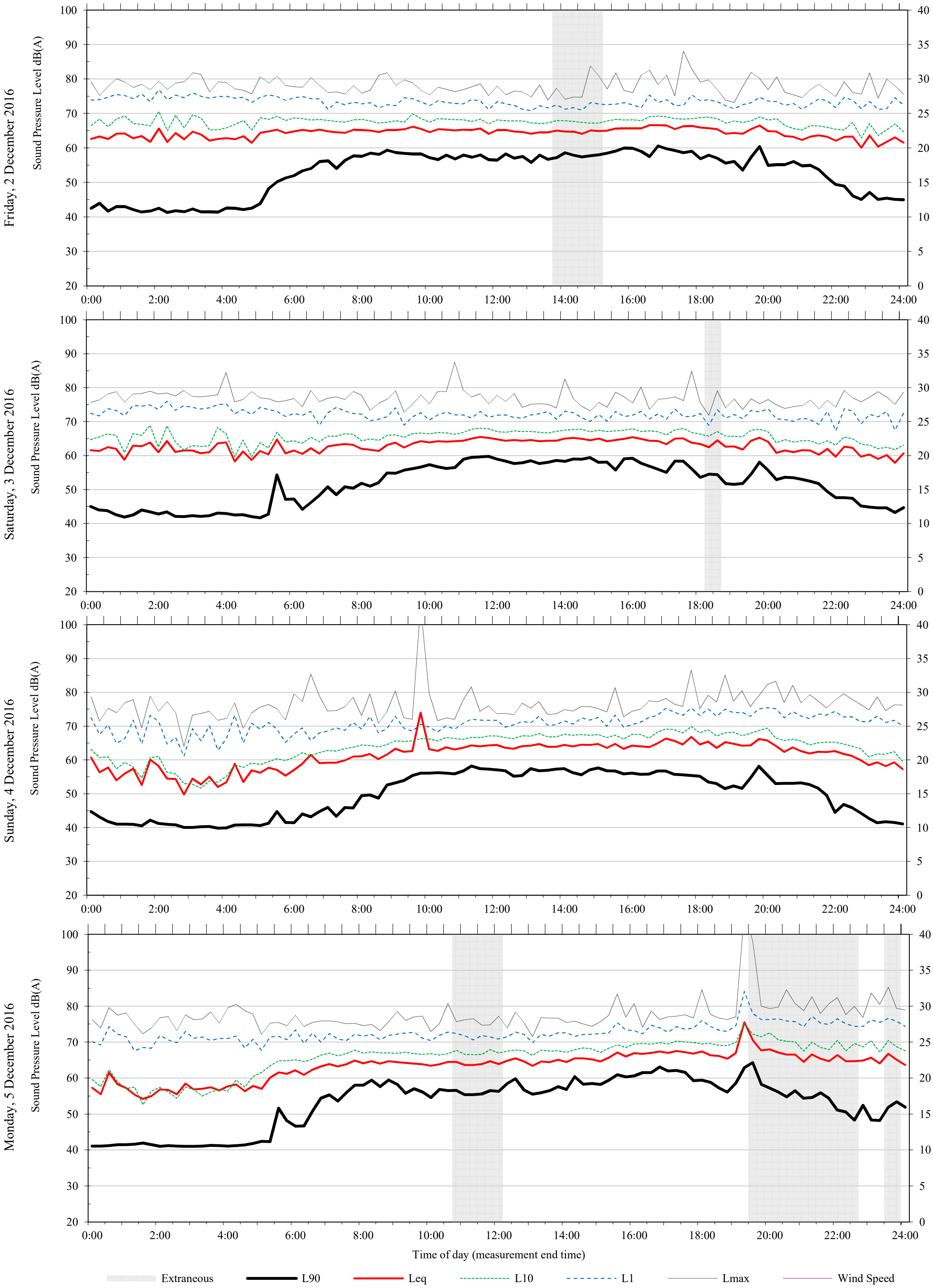

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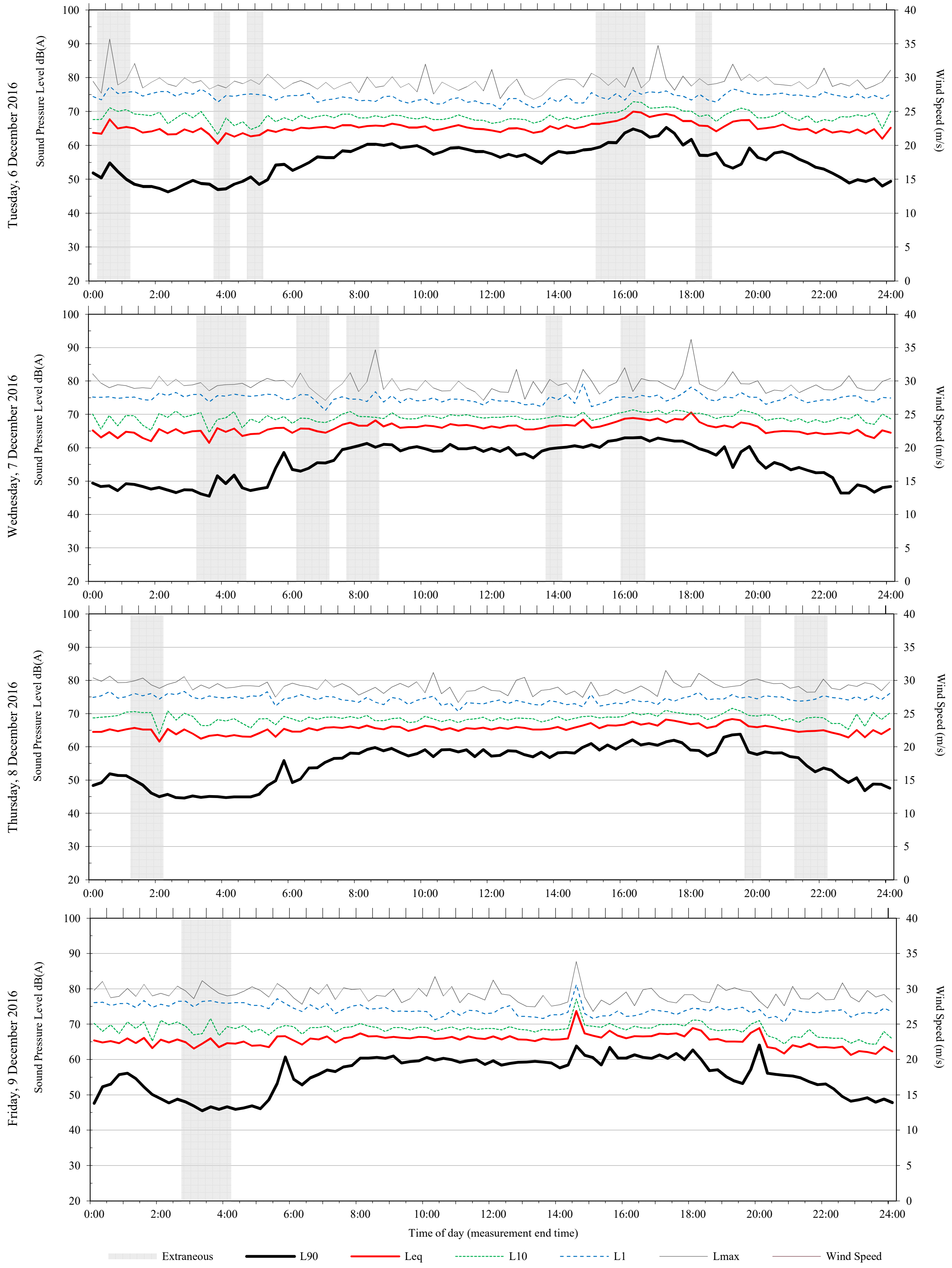

Unattended monitoring: 14 - Validation (Free Field)

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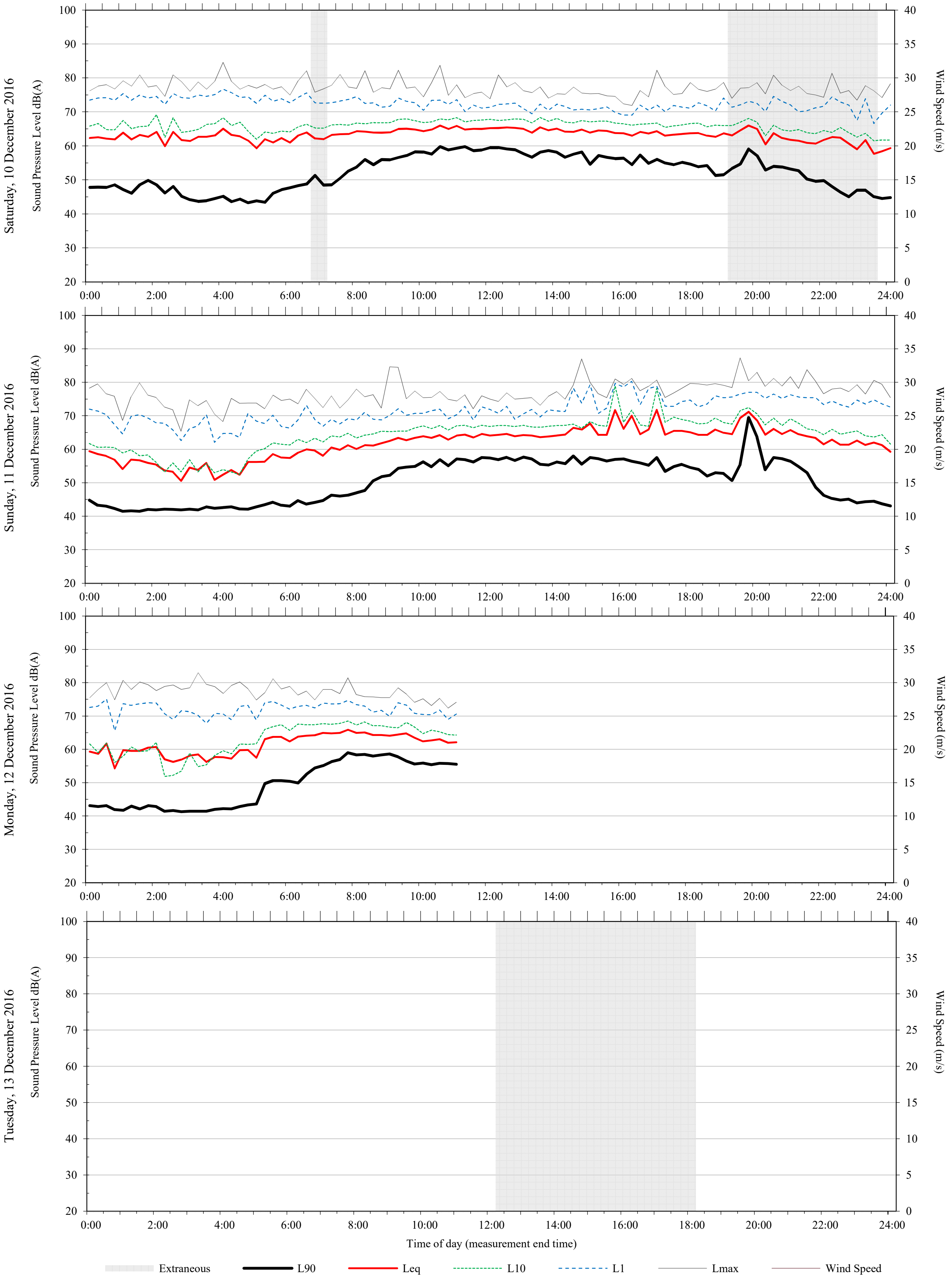

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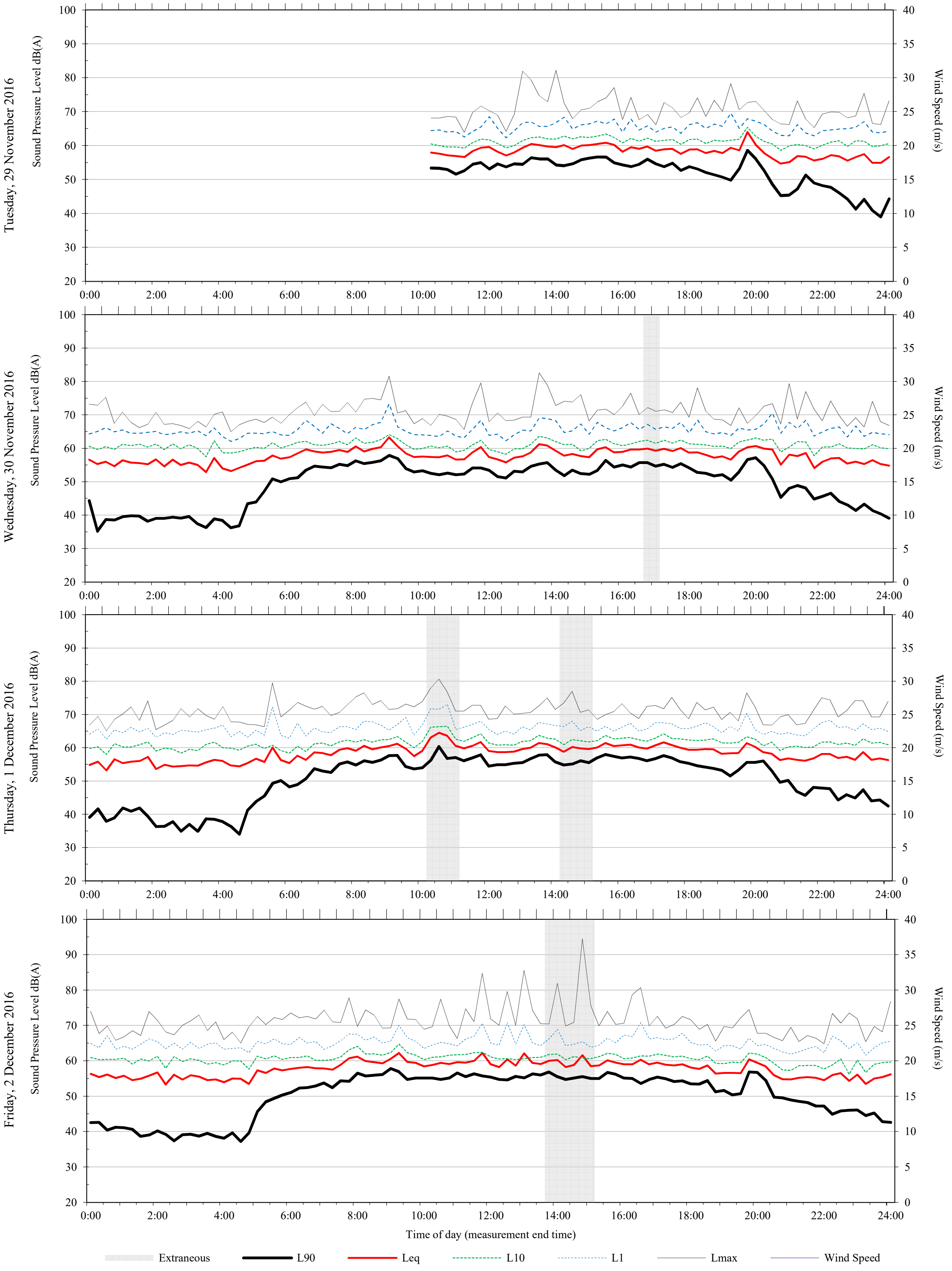

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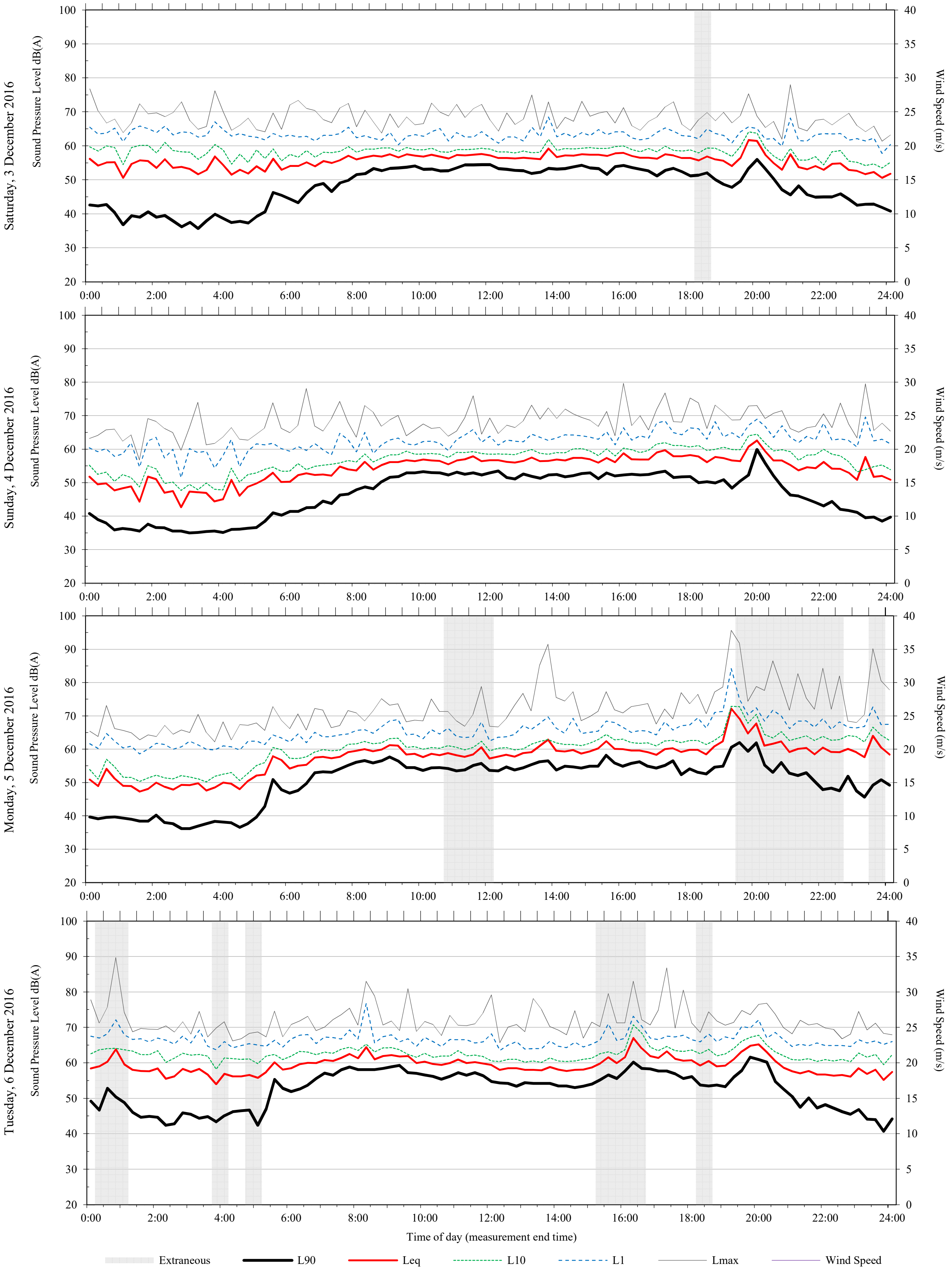

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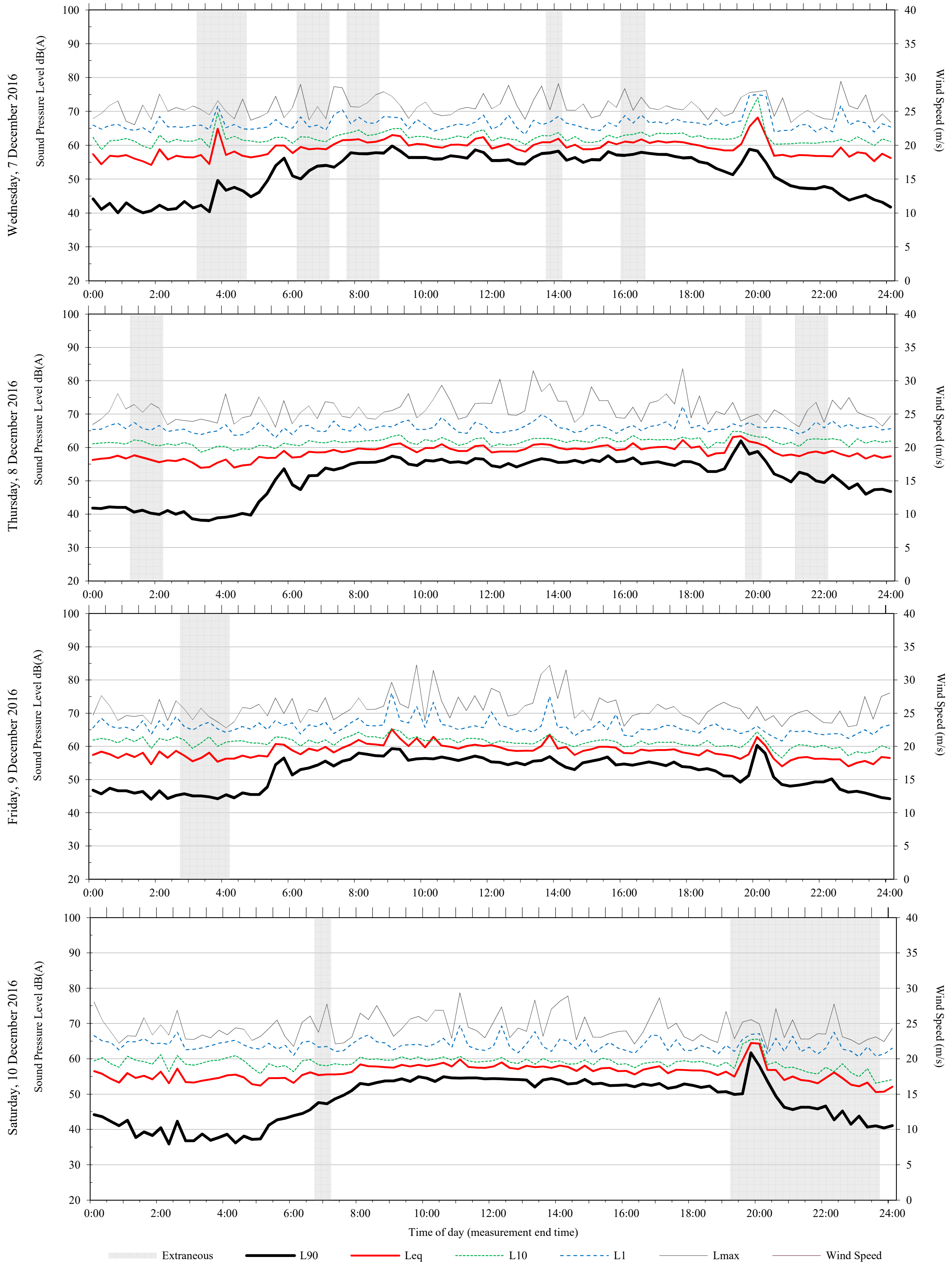

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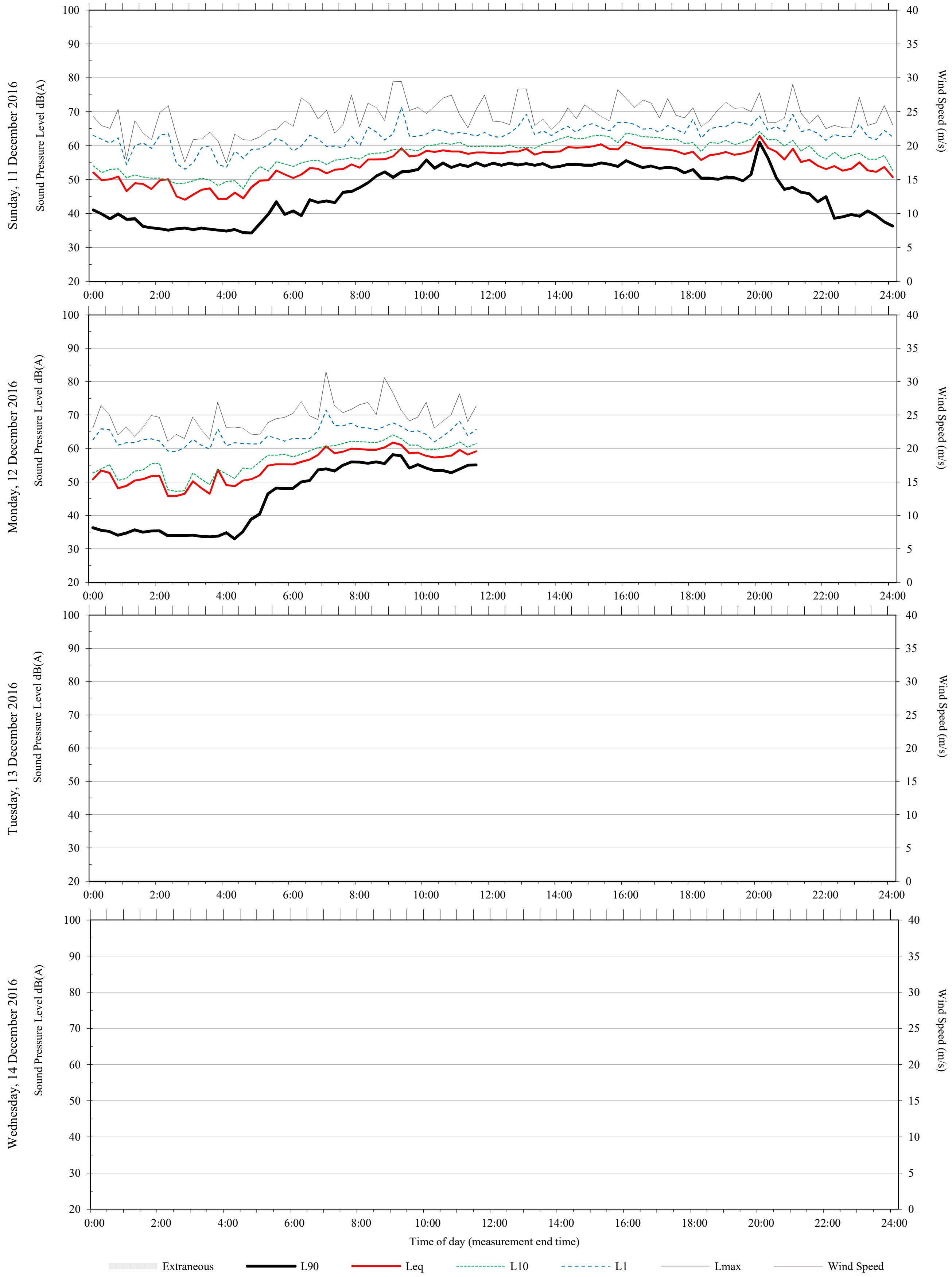

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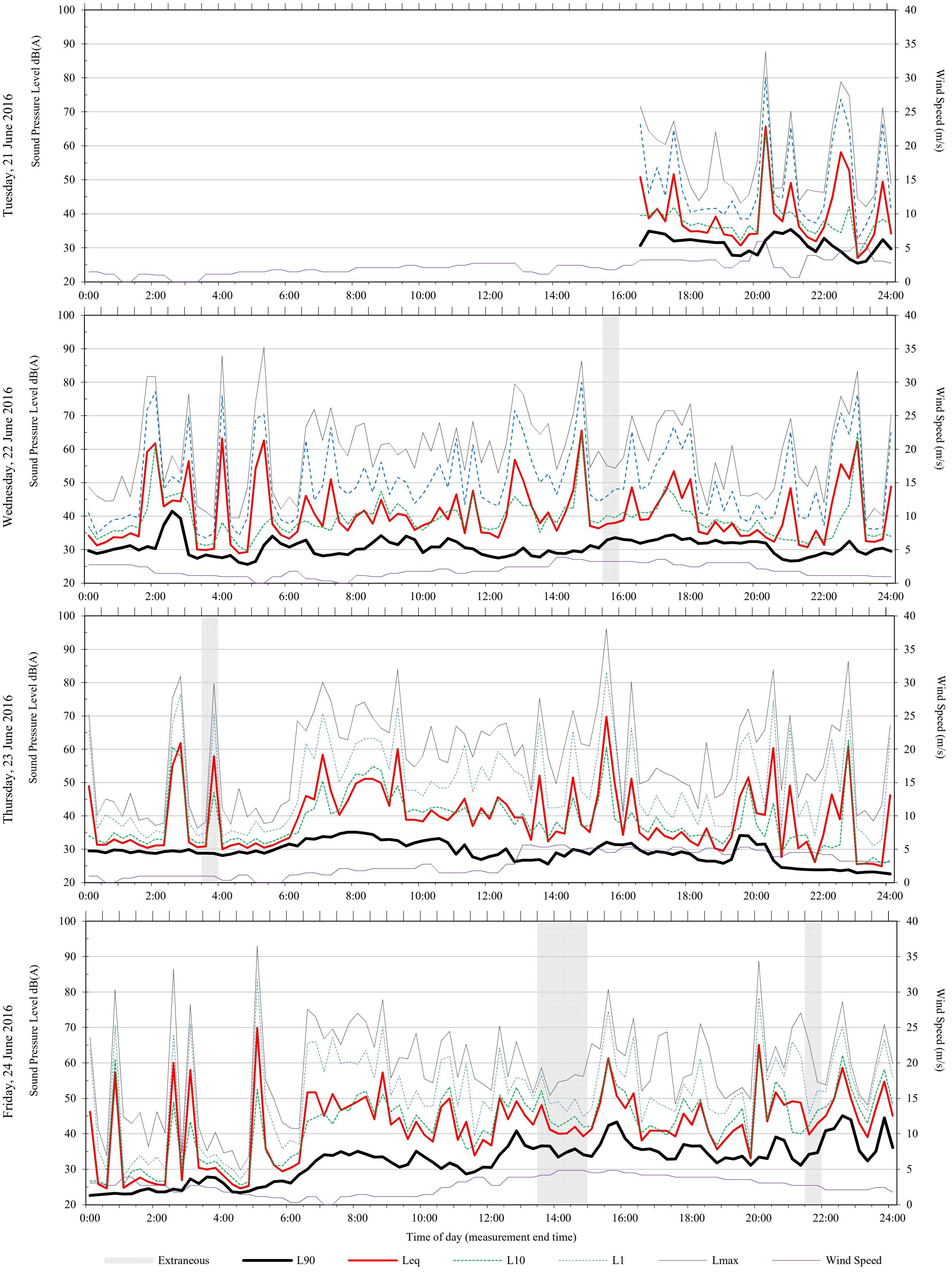
ARUP



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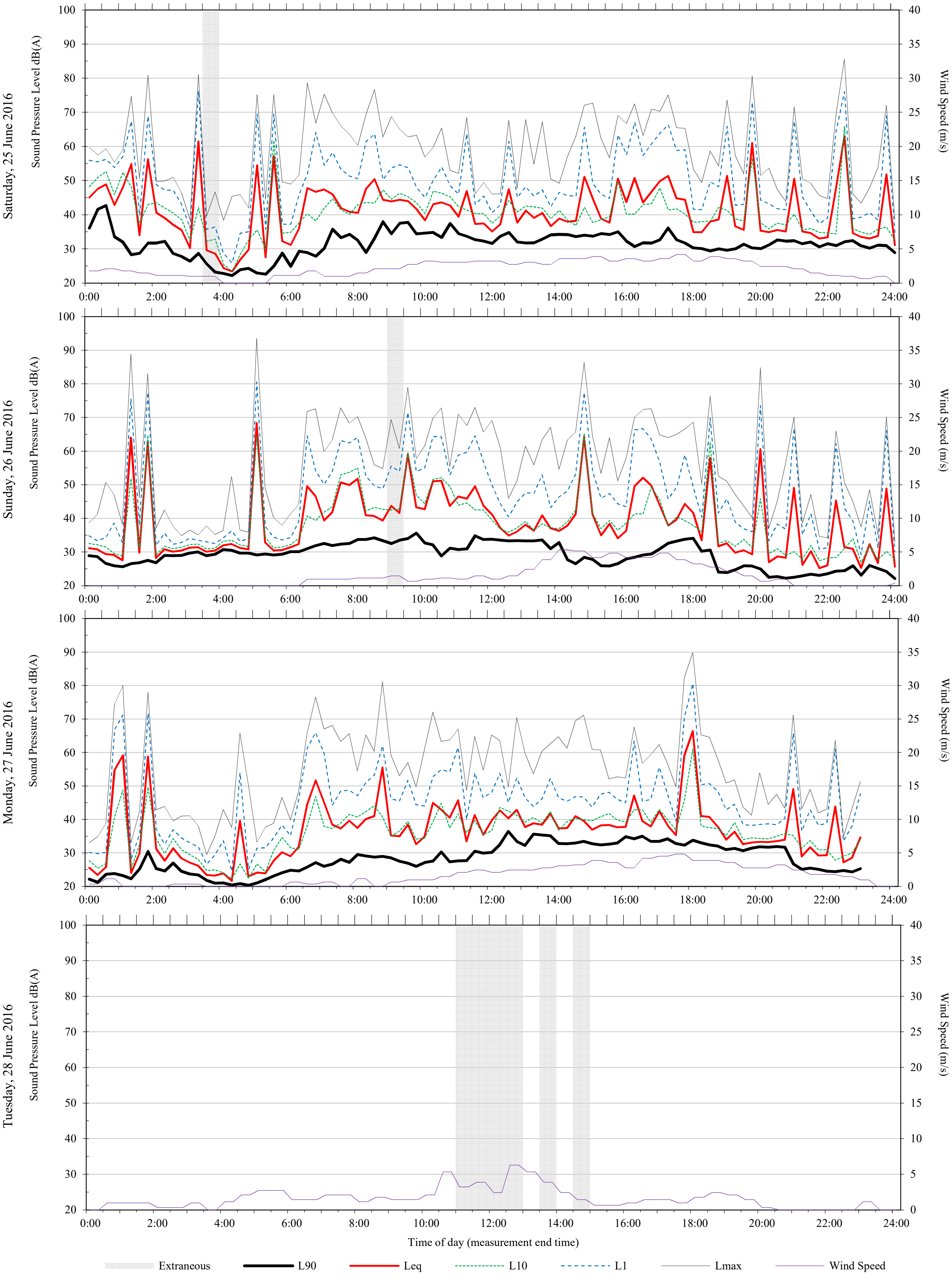

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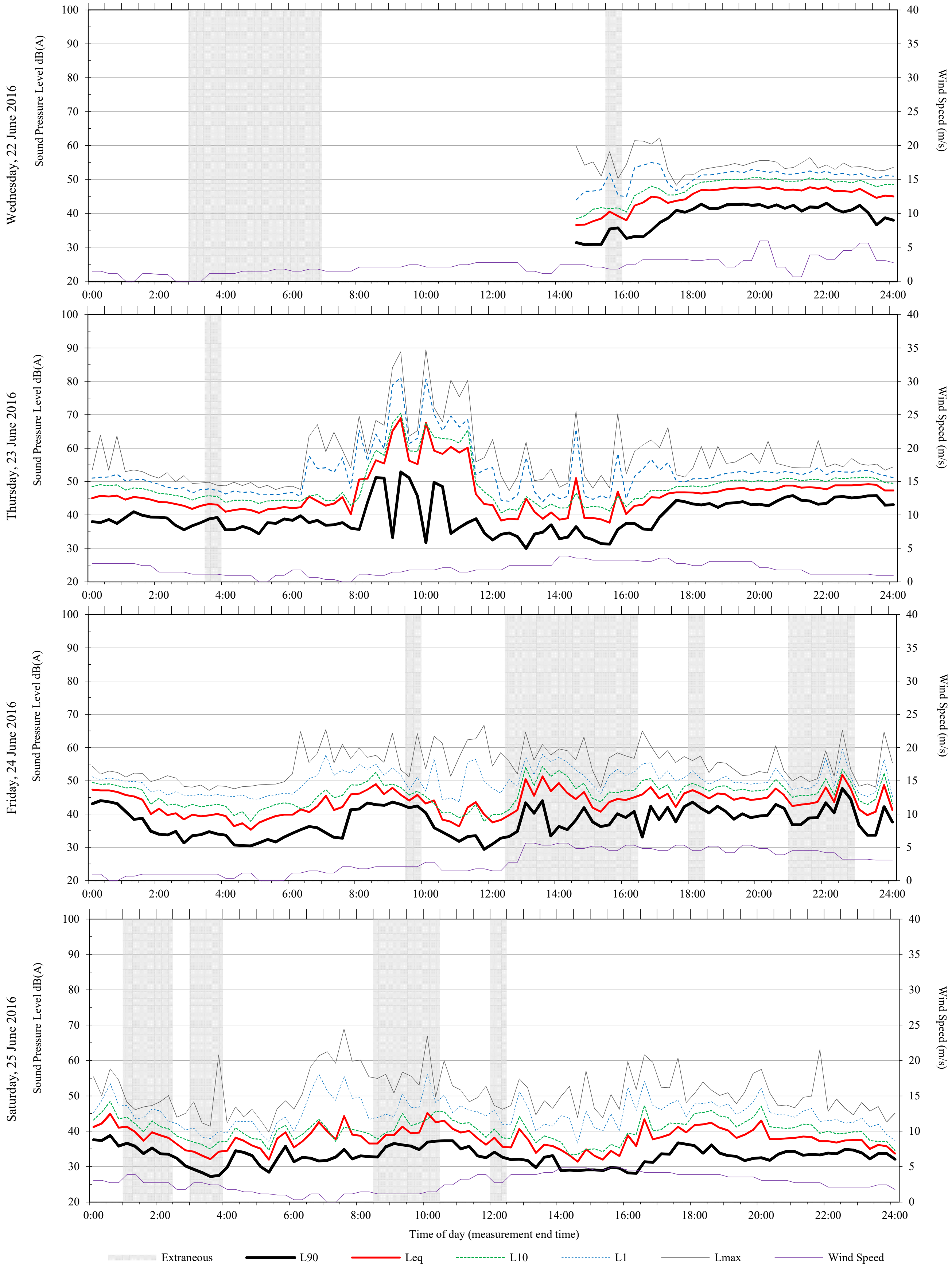

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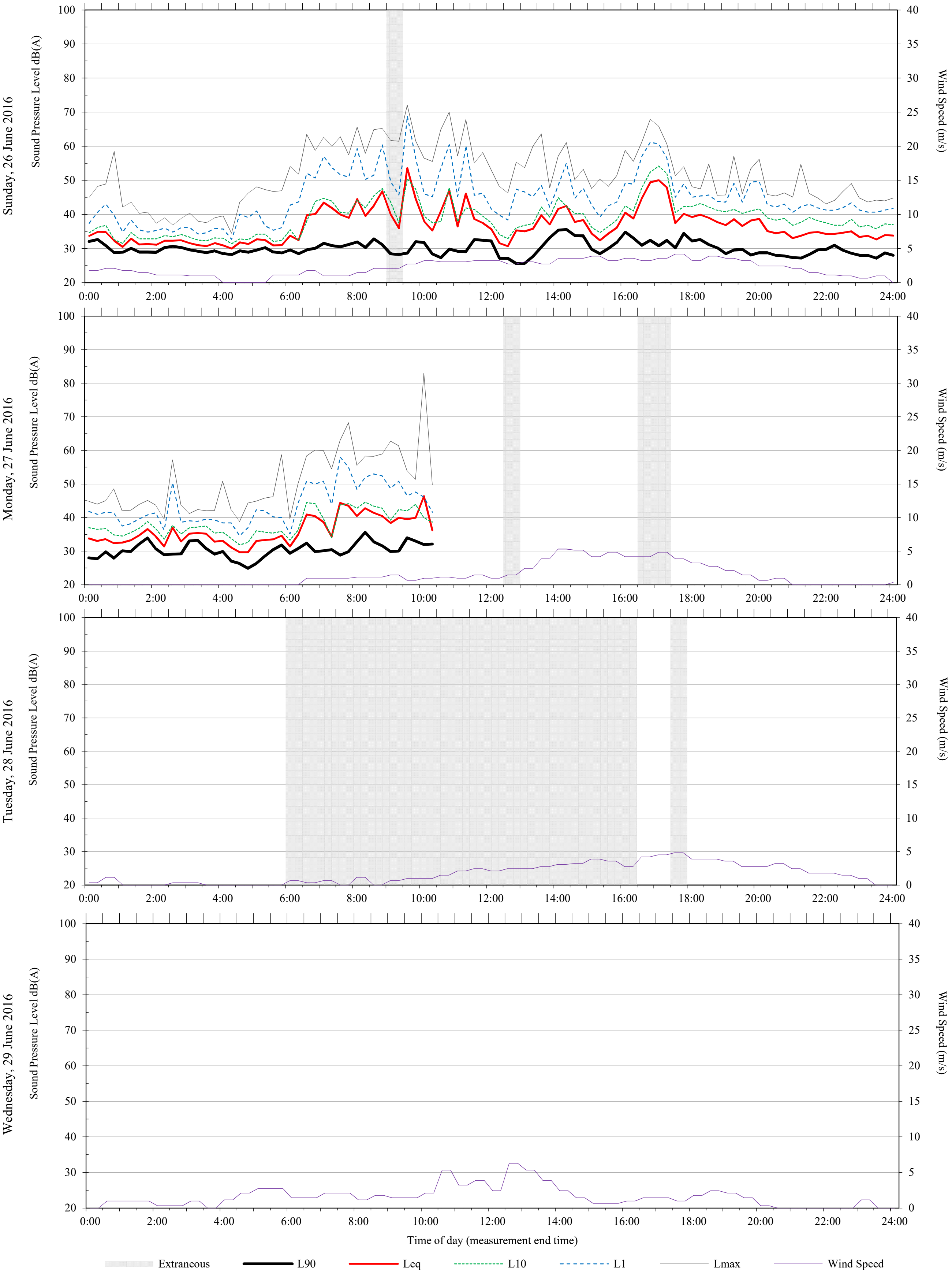

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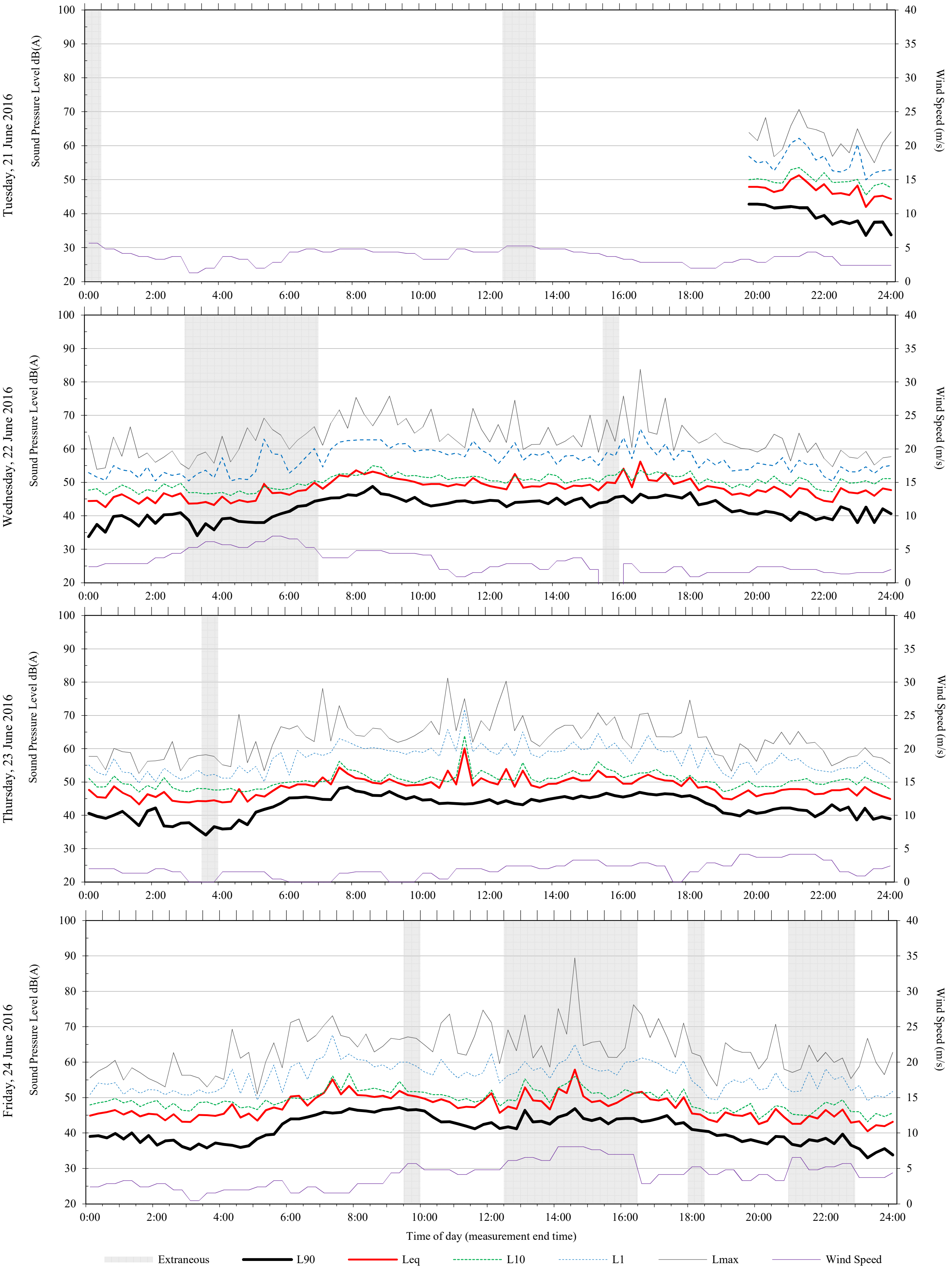

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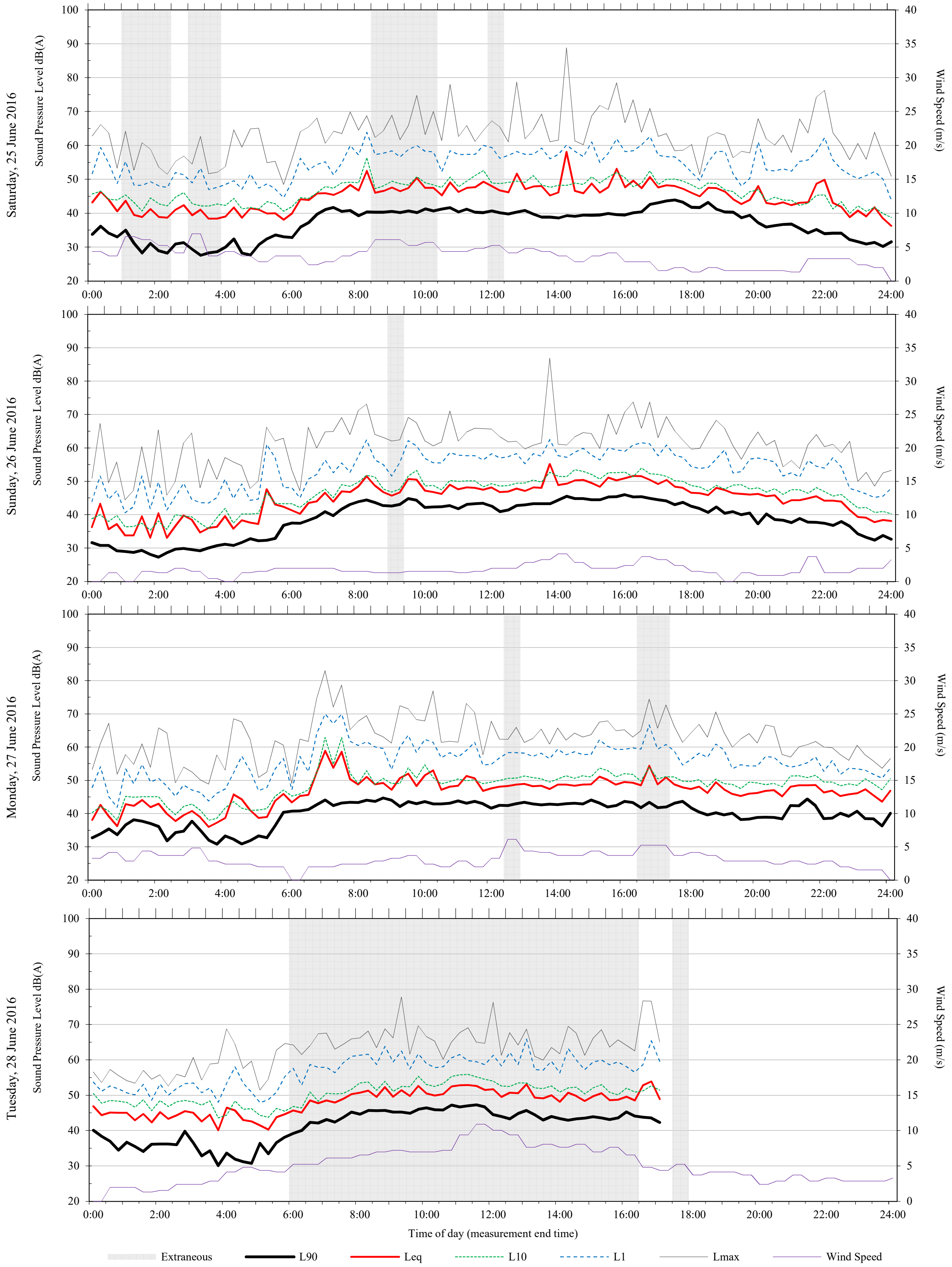

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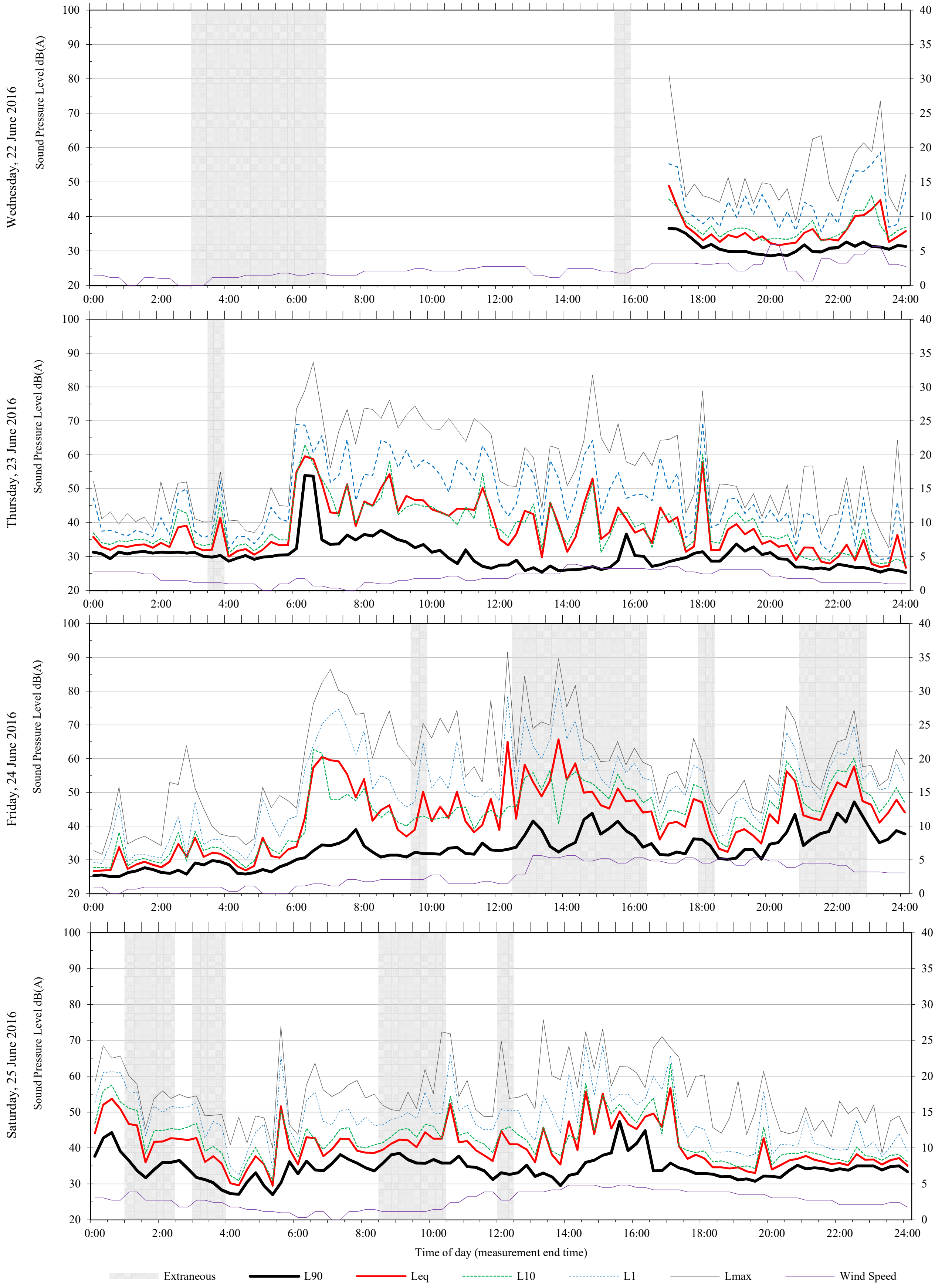

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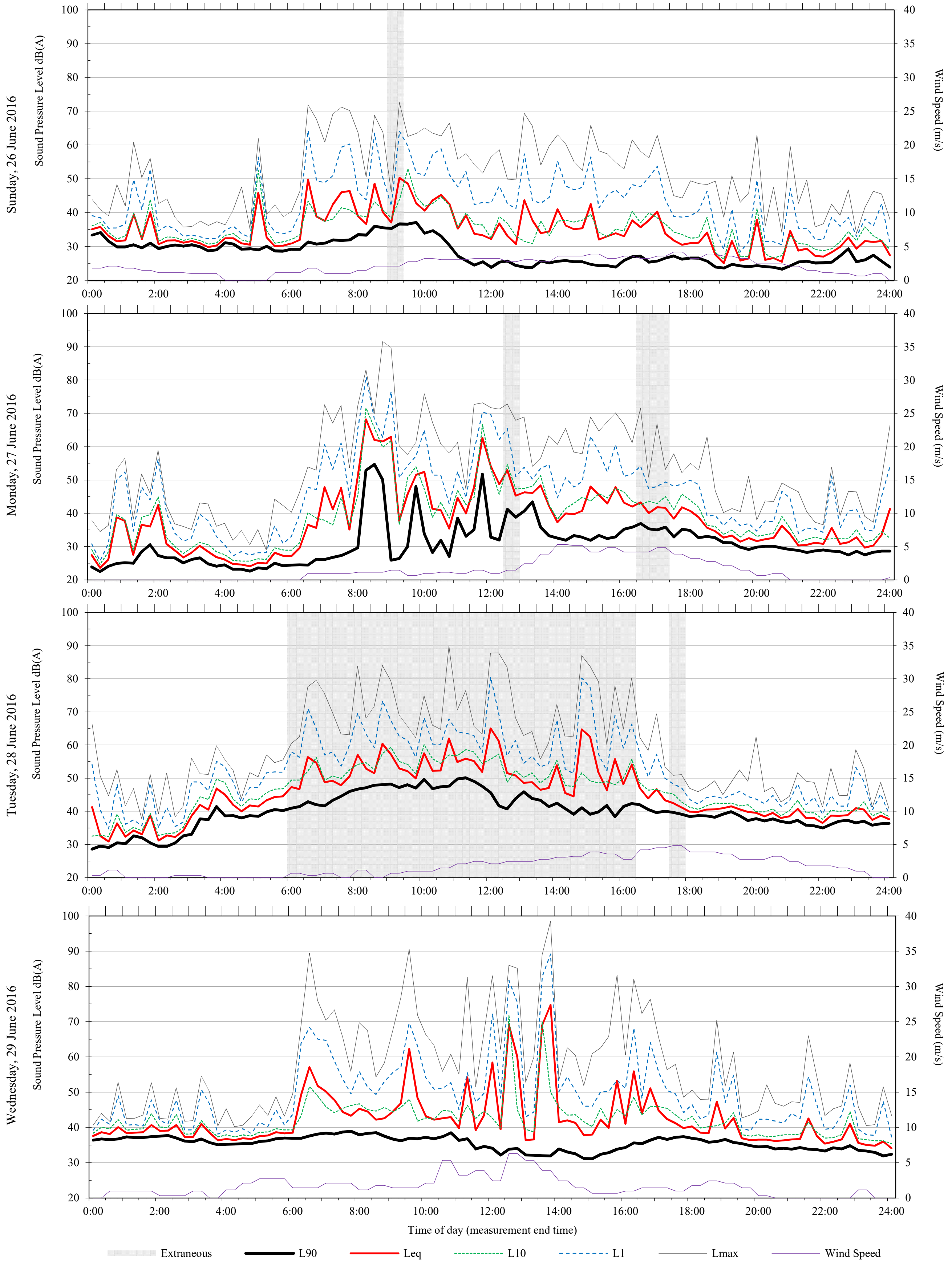

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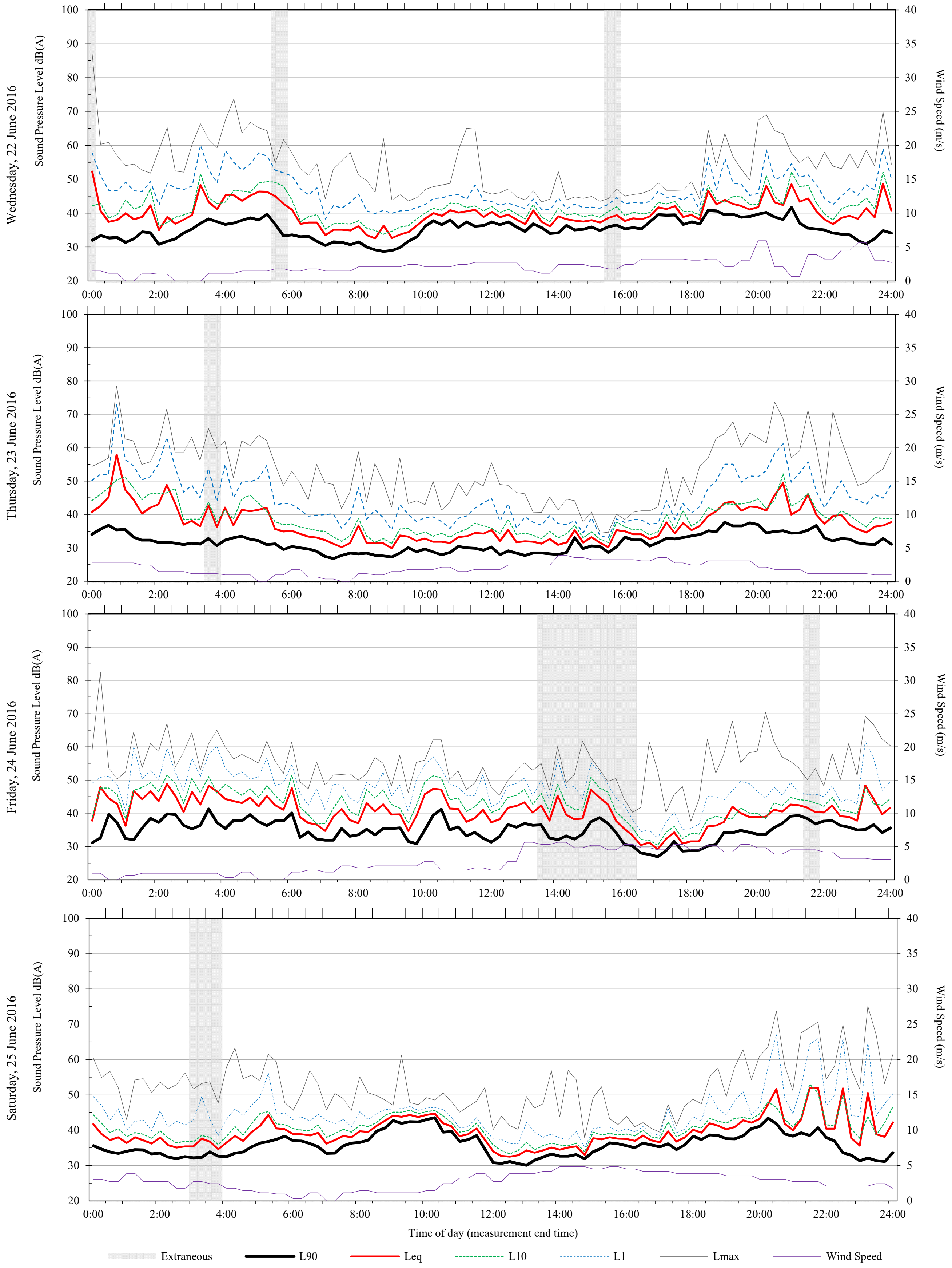

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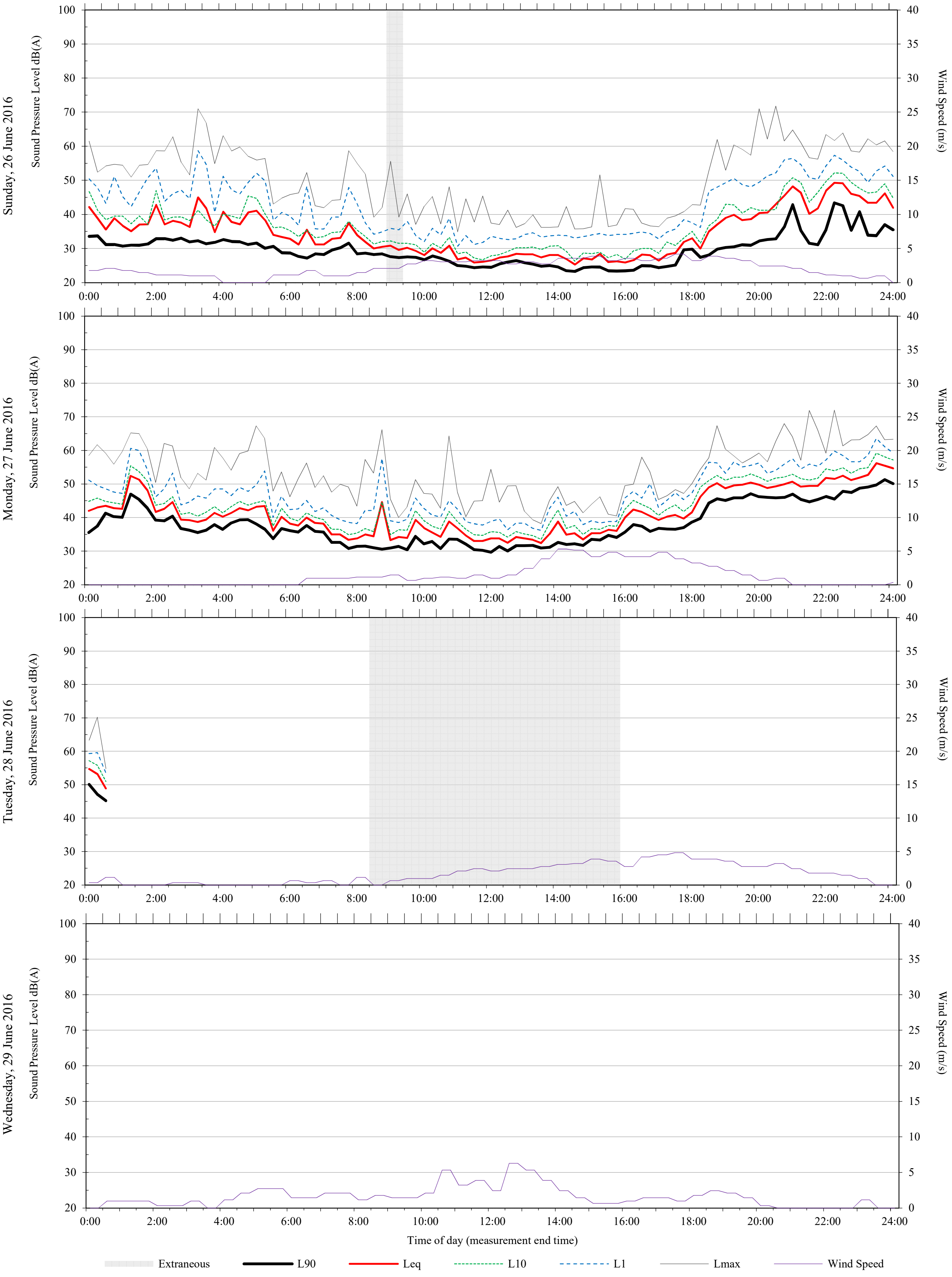

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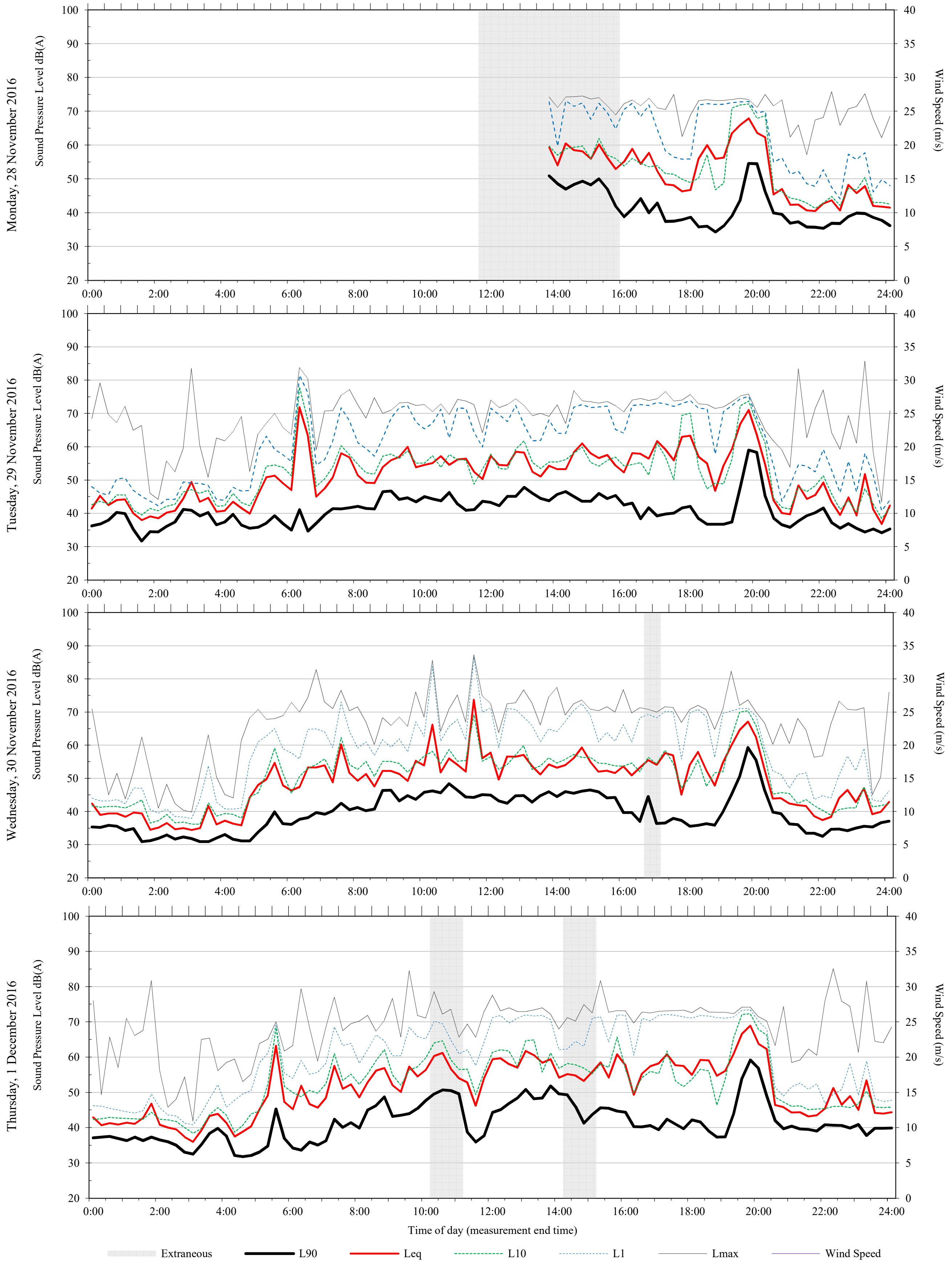

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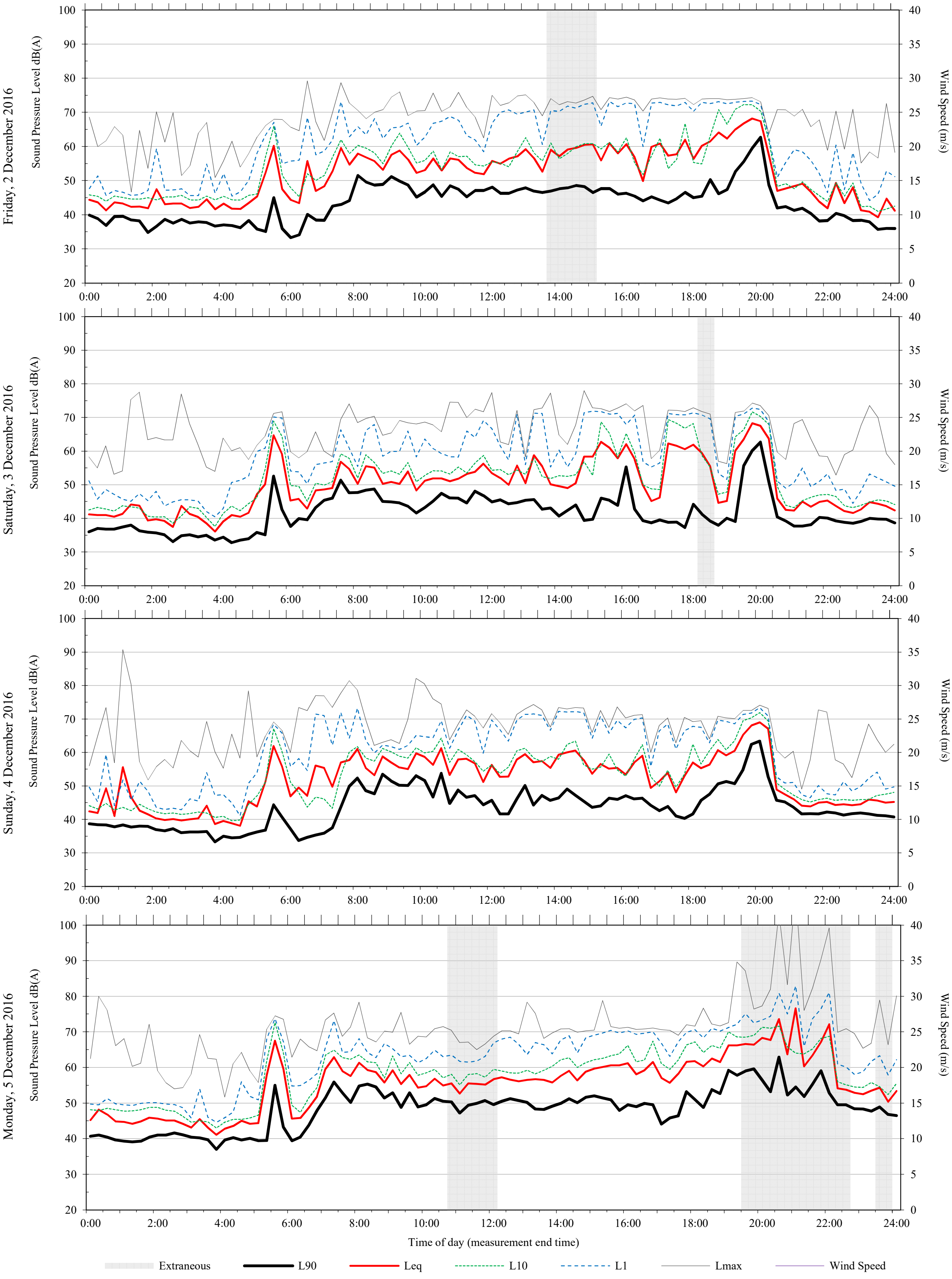

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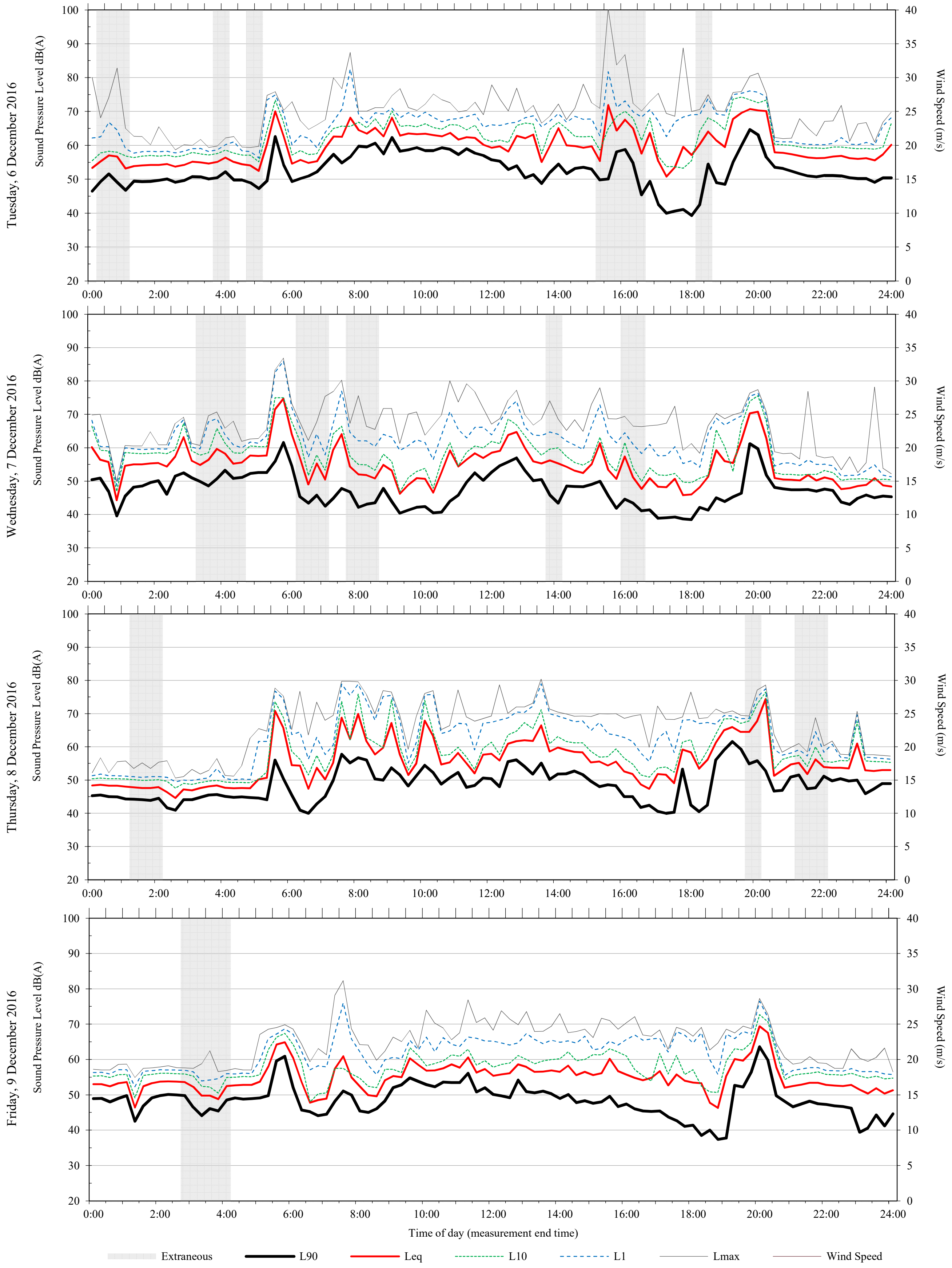

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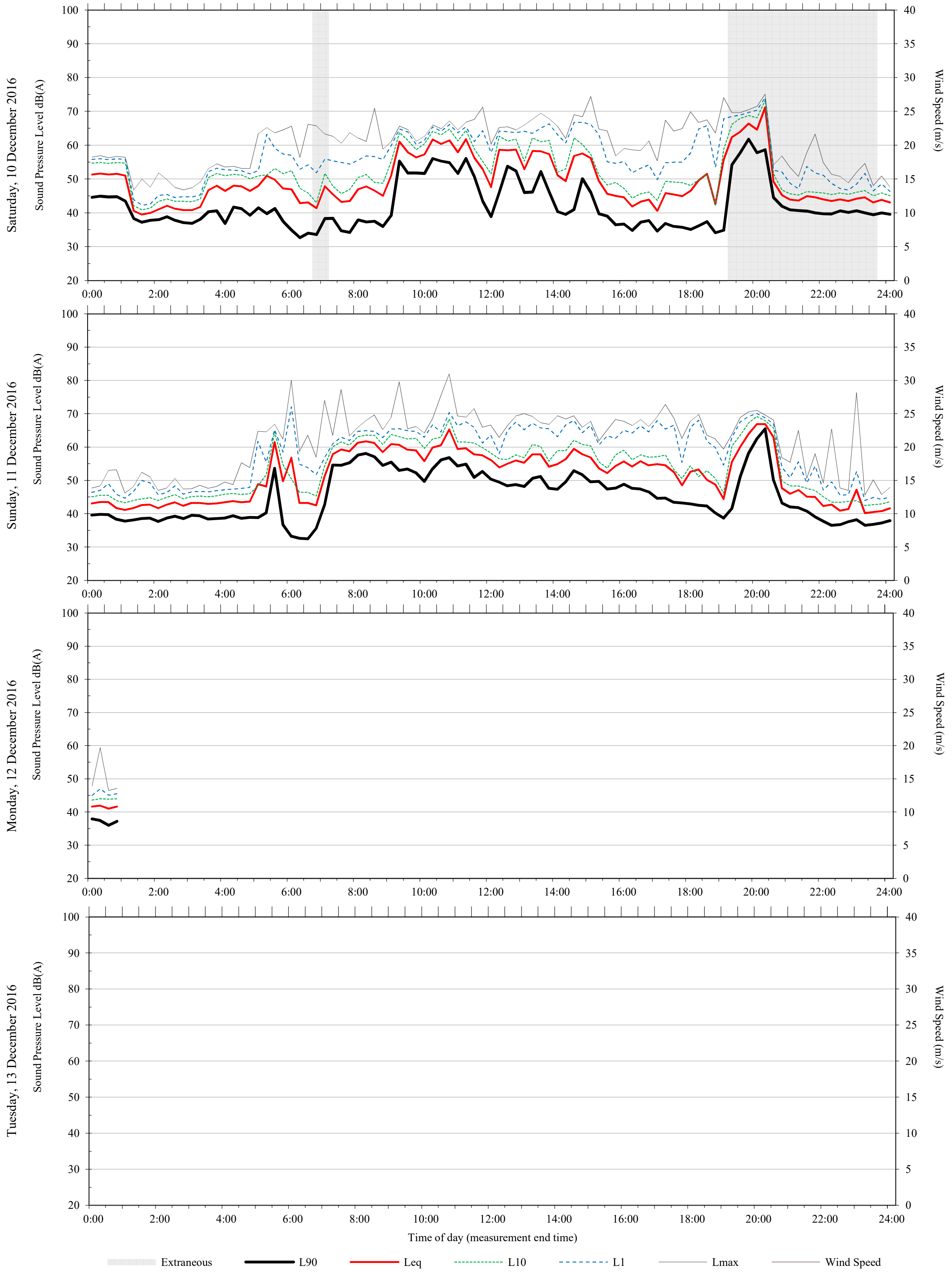

SUB-APPENDIX

E

Sub-appendix E

Transition zone noise contours

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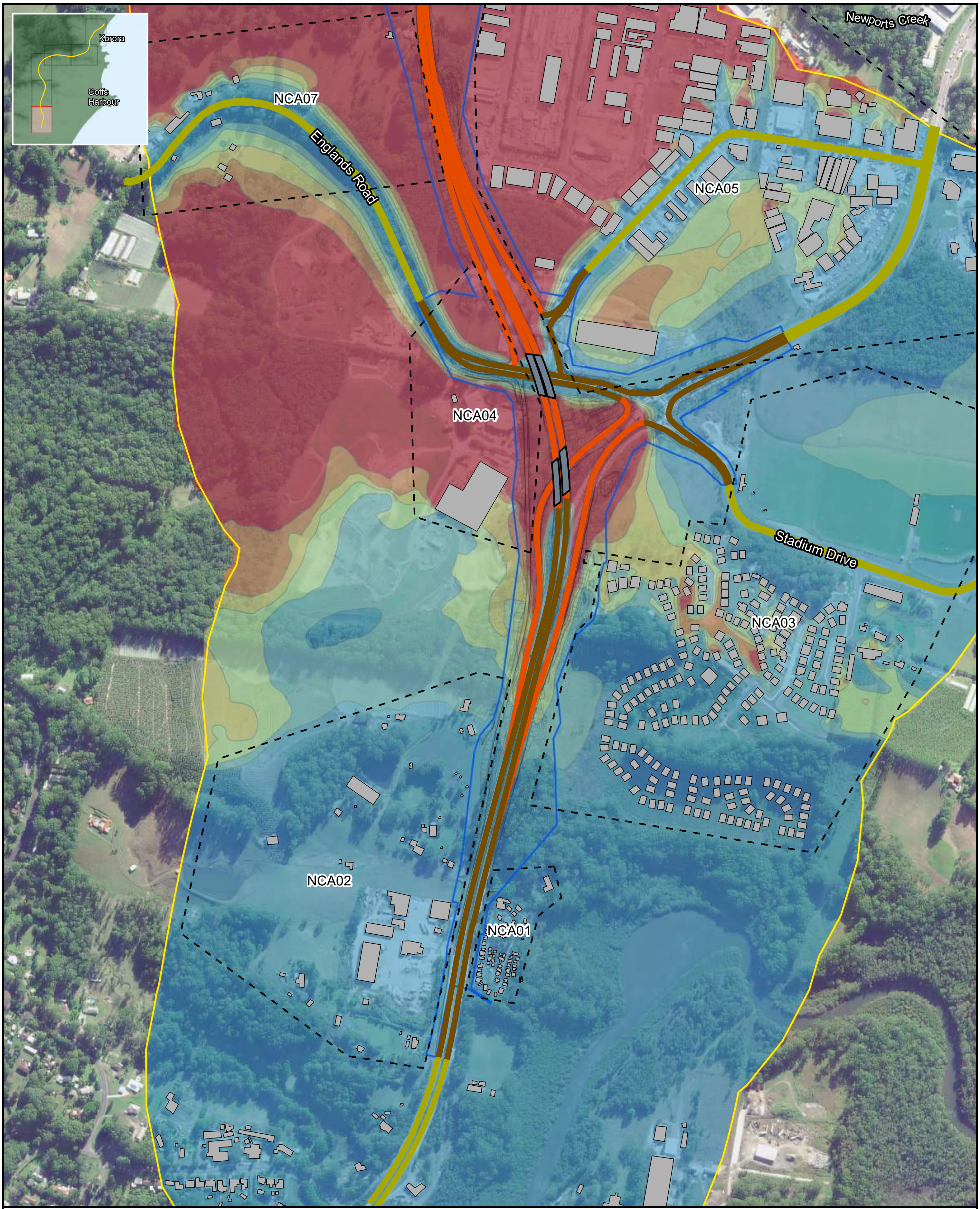
Appendix E

Transition Zone Noise Contours



Legend

☐ Construction footprint
▬ Bridge
▬ Tunnel
▭ NCA
☐ Study Area
▬ New roads
▬ Redeveloped roads
▬ Existing Roads

2034 Daytime transition zone criteria

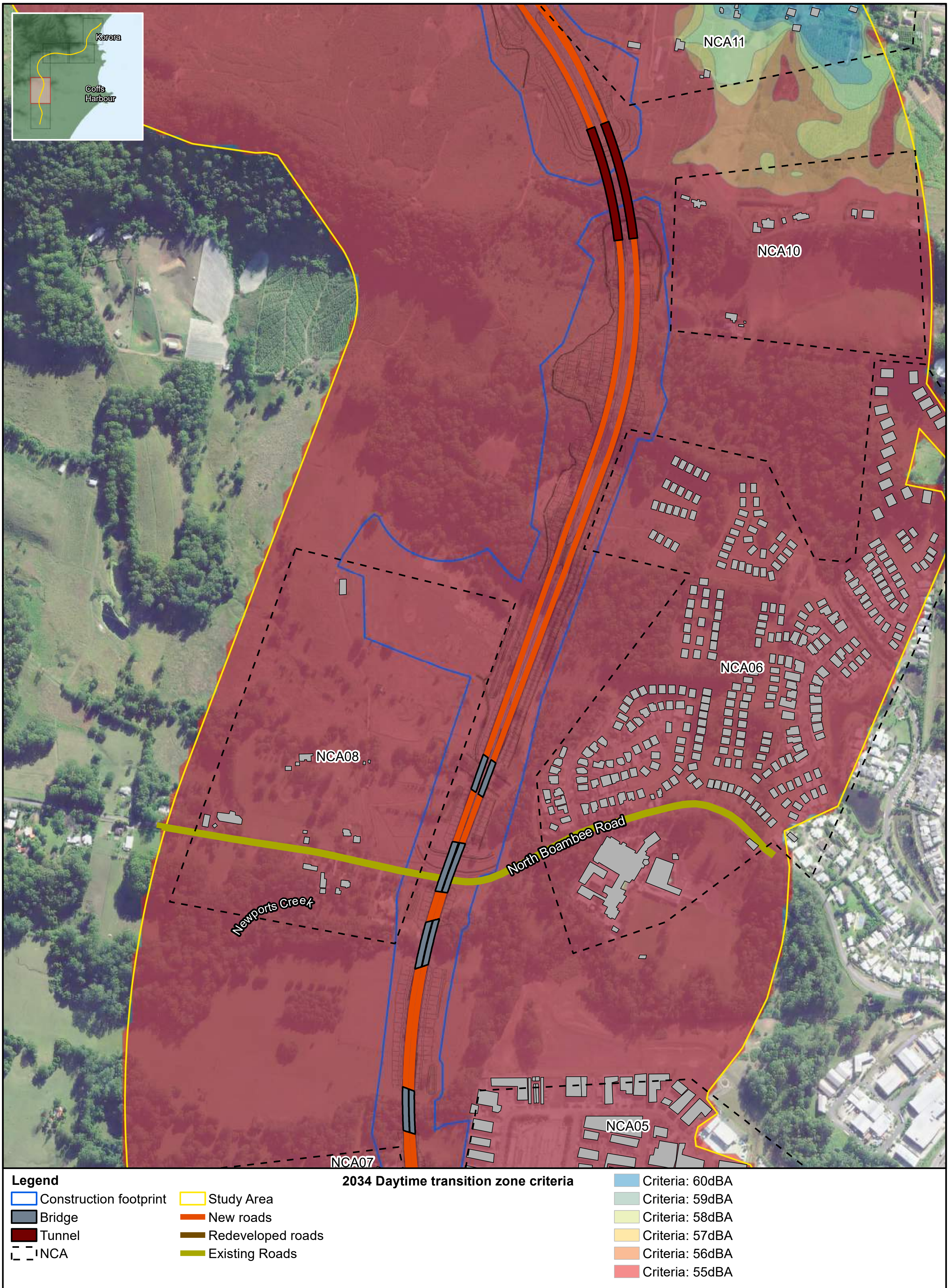
🟦 Criteria: 60dBA
🟩 Criteria: 59dBA
🟩 Criteria: 58dBA
🟨 Criteria: 57dBA
🟧 Criteria: 56dBA
🟥 Criteria: 55dBA

Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 01

0 0.1 0.2 0.3 km
N
Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

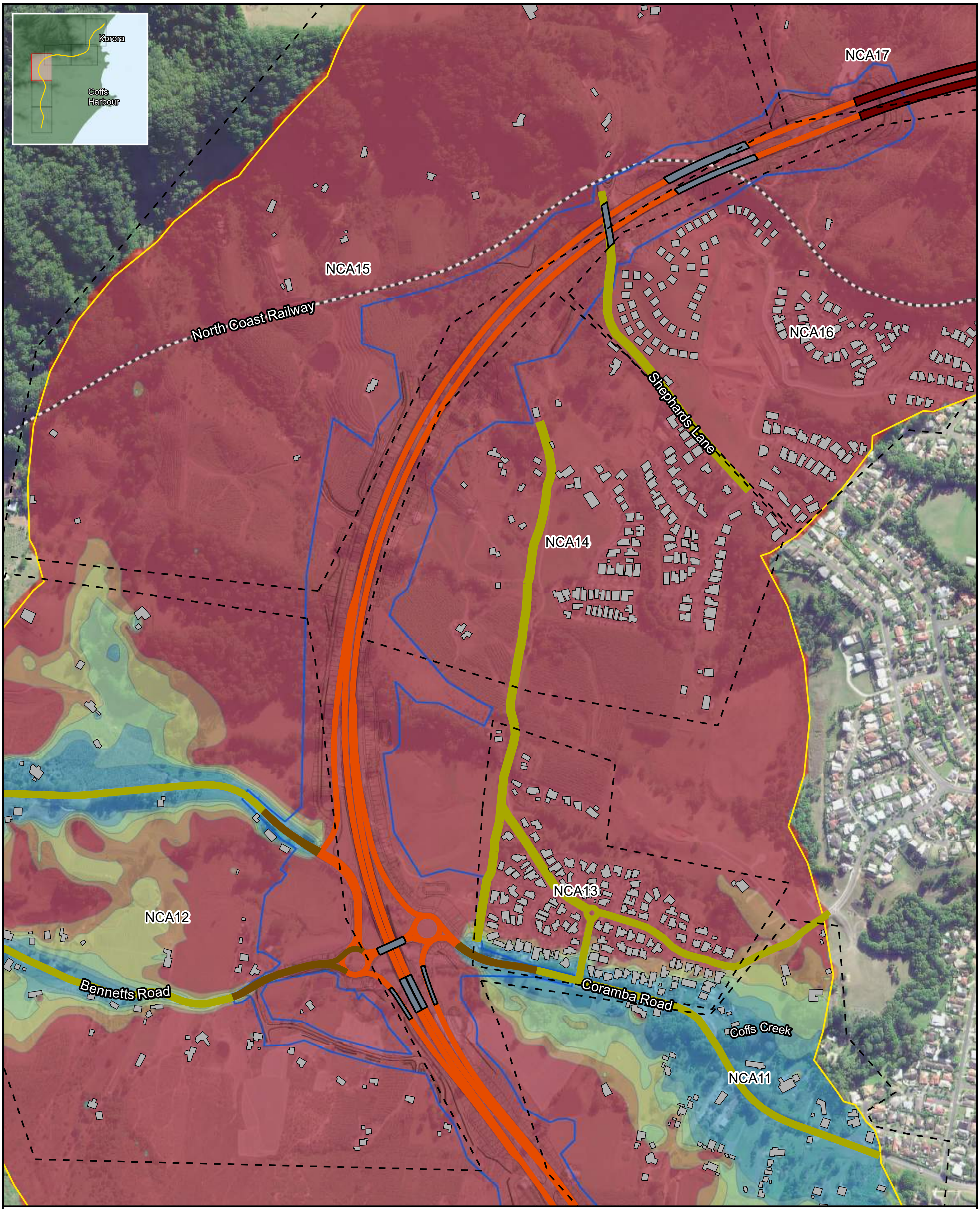


Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 02

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Legend

- Construction footprint
- Bridge
- Tunnel
- NCA
- Study Area
- New roads
- Redeveloped roads
- Existing Roads

2034 Daytime transition zone criteria

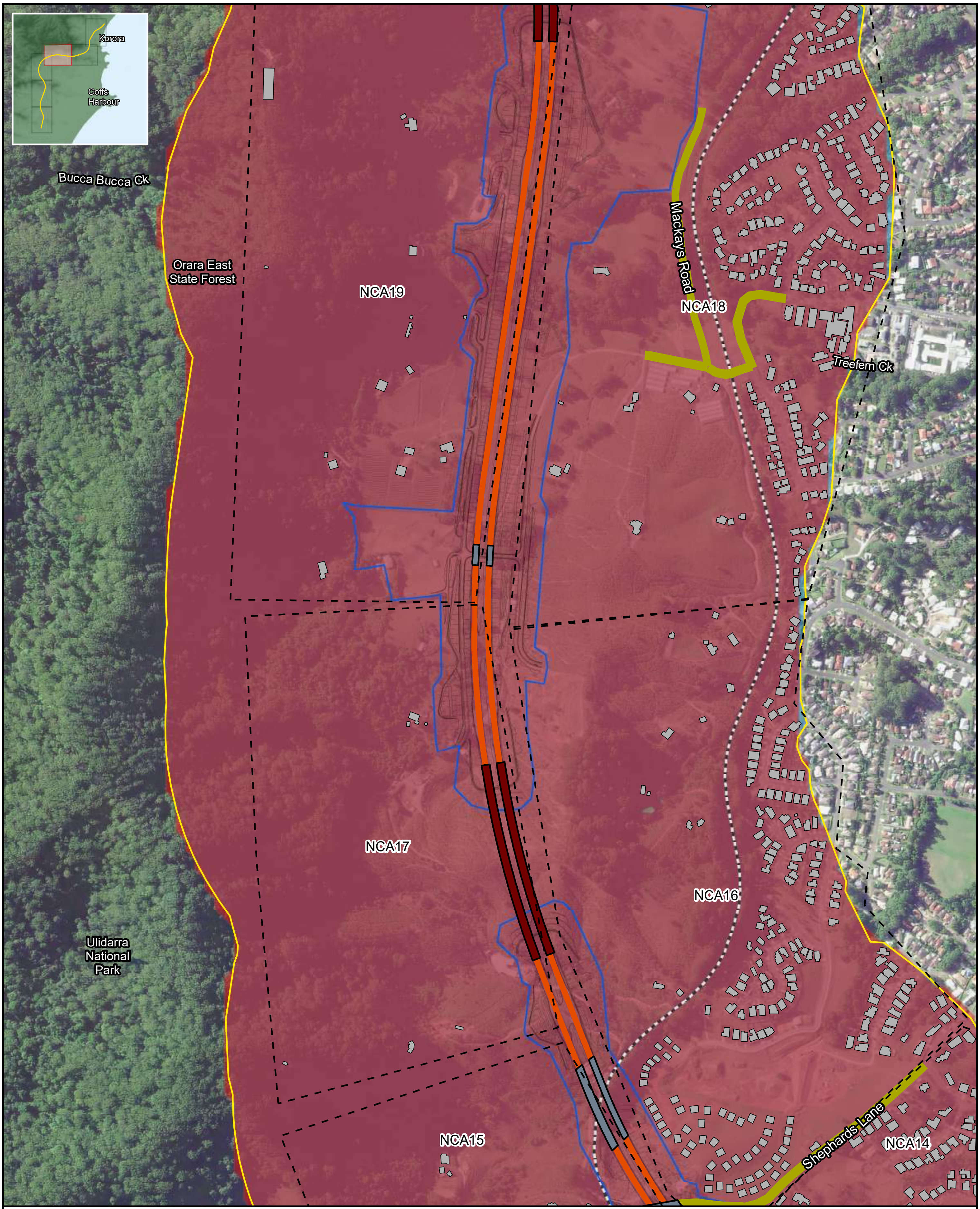
- Criteria: 60dBA
- Criteria: 59dBA
- Criteria: 58dBA
- Criteria: 57dBA
- Criteria: 56dBA
- Criteria: 55dBA

Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 03

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Legend

- ☐ Construction footprint
- ▨ Bridge
- ■ Tunnel
- ⬚ NCA
- ☐ Study Area
- ━ New roads
- ━ Redeveloped roads
- ━ Existing Roads

2034 Daytime transition zone criteria

- ■ Criteria: 60dBA
- ■ Criteria: 59dBA
- ■ Criteria: 58dBA
- ■ Criteria: 57dBA
- ■ Criteria: 56dBA
- ■ Criteria: 55dBA

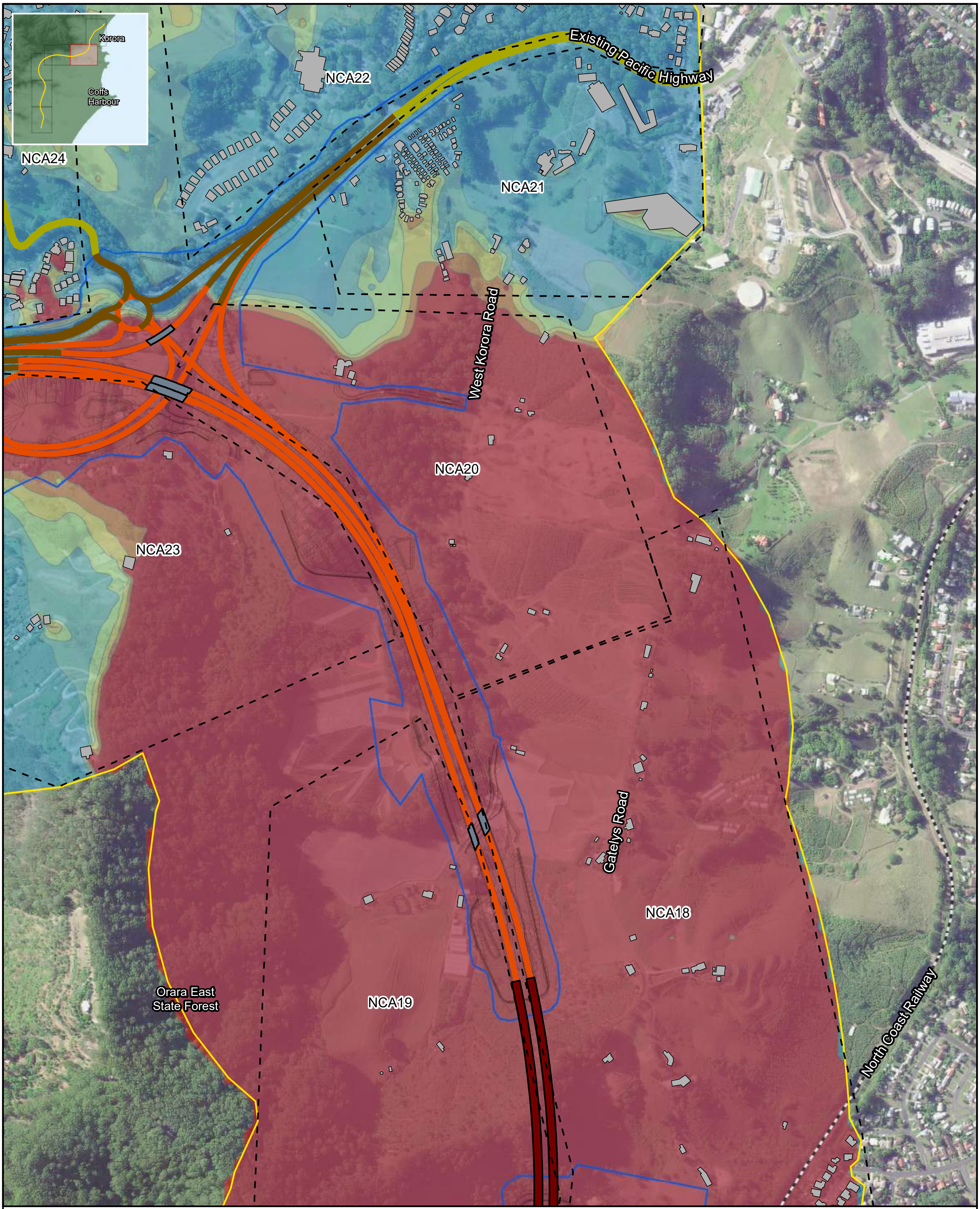
0 0.1 0.2 0.3 km N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 04



Legend

Construction footprint
Bridge
Tunnel
NCA
Study Area
New roads
Redeveloped roads
Existing Roads

2034 Daytime transition zone criteria

Criteria: 60dBA
Criteria: 59dBA
Criteria: 58dBA
Criteria: 57dBA
Criteria: 56dBA
Criteria: 55dBA

Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 05

0 0.1 0.2 0.3 km N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

Legend

- Construction footprint
- Bridge
- Tunnel
- NCA
- Study Area
- New roads
- Redeveloped roads
- Existing Roads

2034 Daytime transition zone criteria

- Criteria: 60dBA
- Criteria: 59dBA
- Criteria: 58dBA
- Criteria: 57dBA
- Criteria: 56dBA
- Criteria: 55dBA

Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 06

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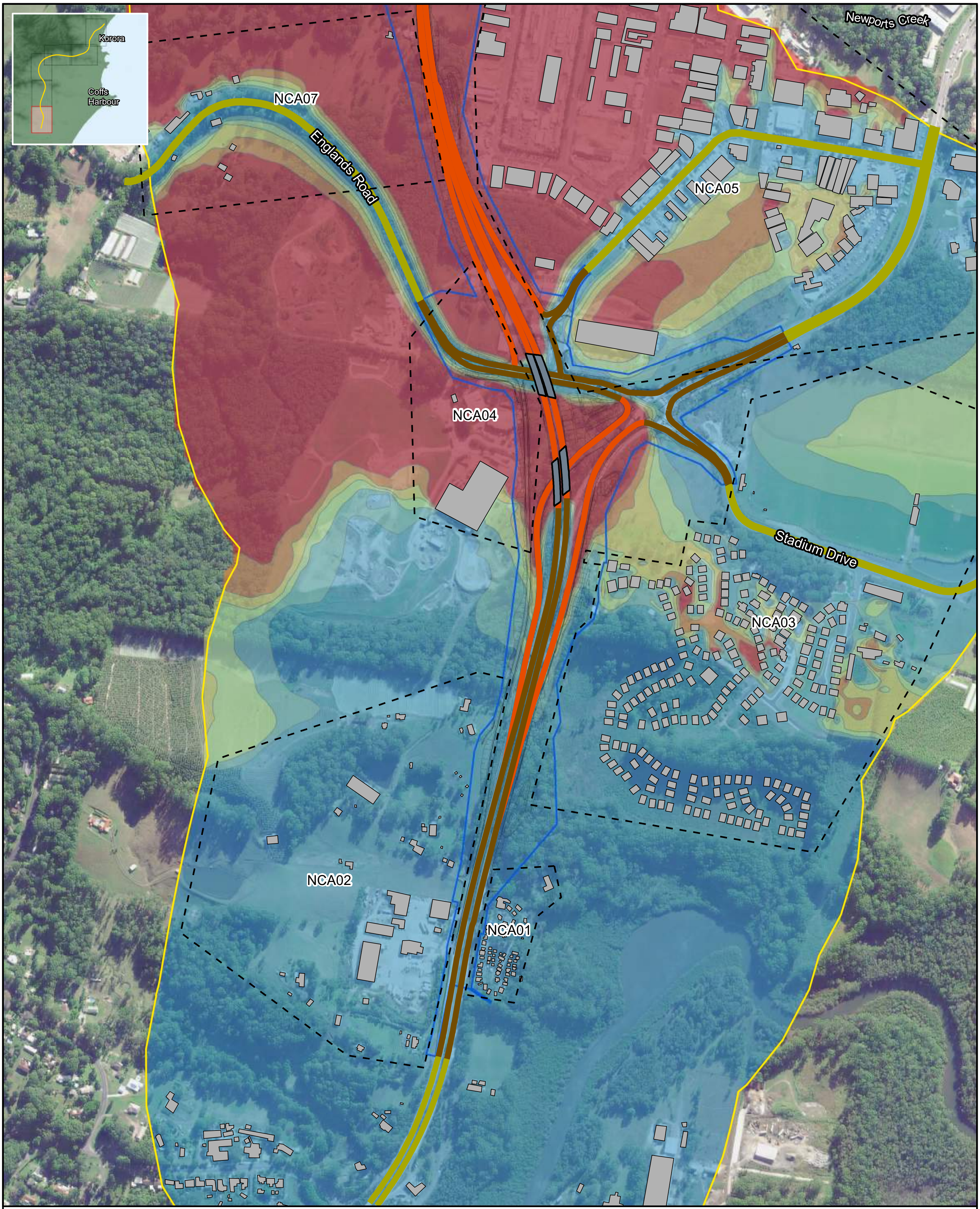
GDA 1994 MGA Zone 56



Legend

- ▭ Construction footprint
- ▬ Bridge
- ▬ Tunnel
- ⬚ NCA
- ▭ Study Area
- ▬ New roads
- ▬ Redeveloped roads
- ▬ Existing Roads

2034 Night-time transition zone criteria

- 🟦 Criteria: 55dBA
- 🟩 Criteria: 54dBA
- 🟨 Criteria: 53dBA
- 🟨 Criteria: 52dBA
- 🟧 Criteria: 51dBA
- 🟥 Criteria: 50dBA

Coffs Harbour Bypass

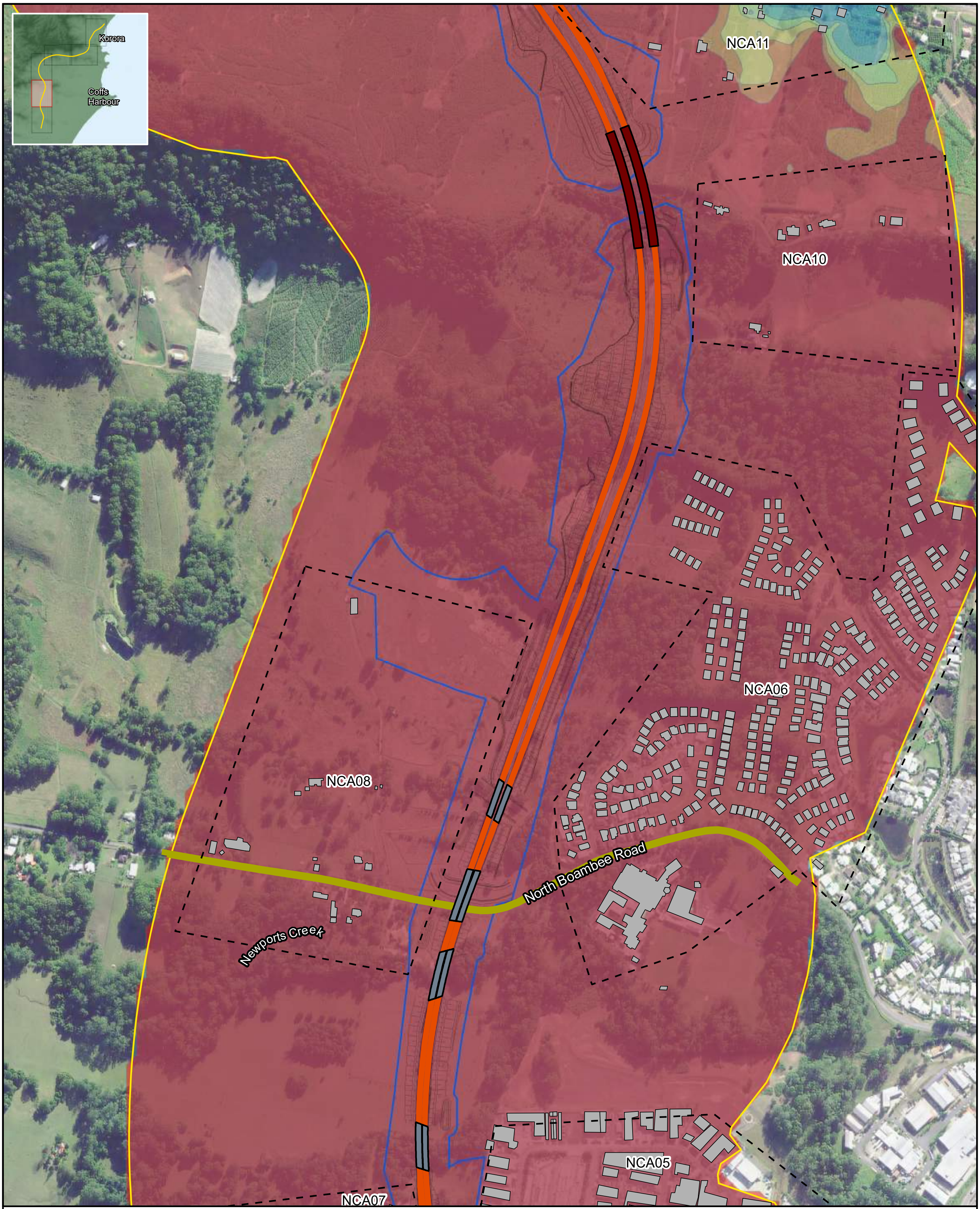
NCG Transition zones

Road classification and transition zone criteria- 01

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Legend

▭ Construction footprint	▭ Study Area	🟦 Criteria: 55dBA
■ Bridge	▬ New roads	🟩 Criteria: 54dBA
■ Tunnel	▬ Redeveloped roads	🟨 Criteria: 53dBA
⬚ NCA	▬ Existing Roads	🟨 Criteria: 52dBA
		🟧 Criteria: 51dBA
		🟥 Criteria: 50dBA

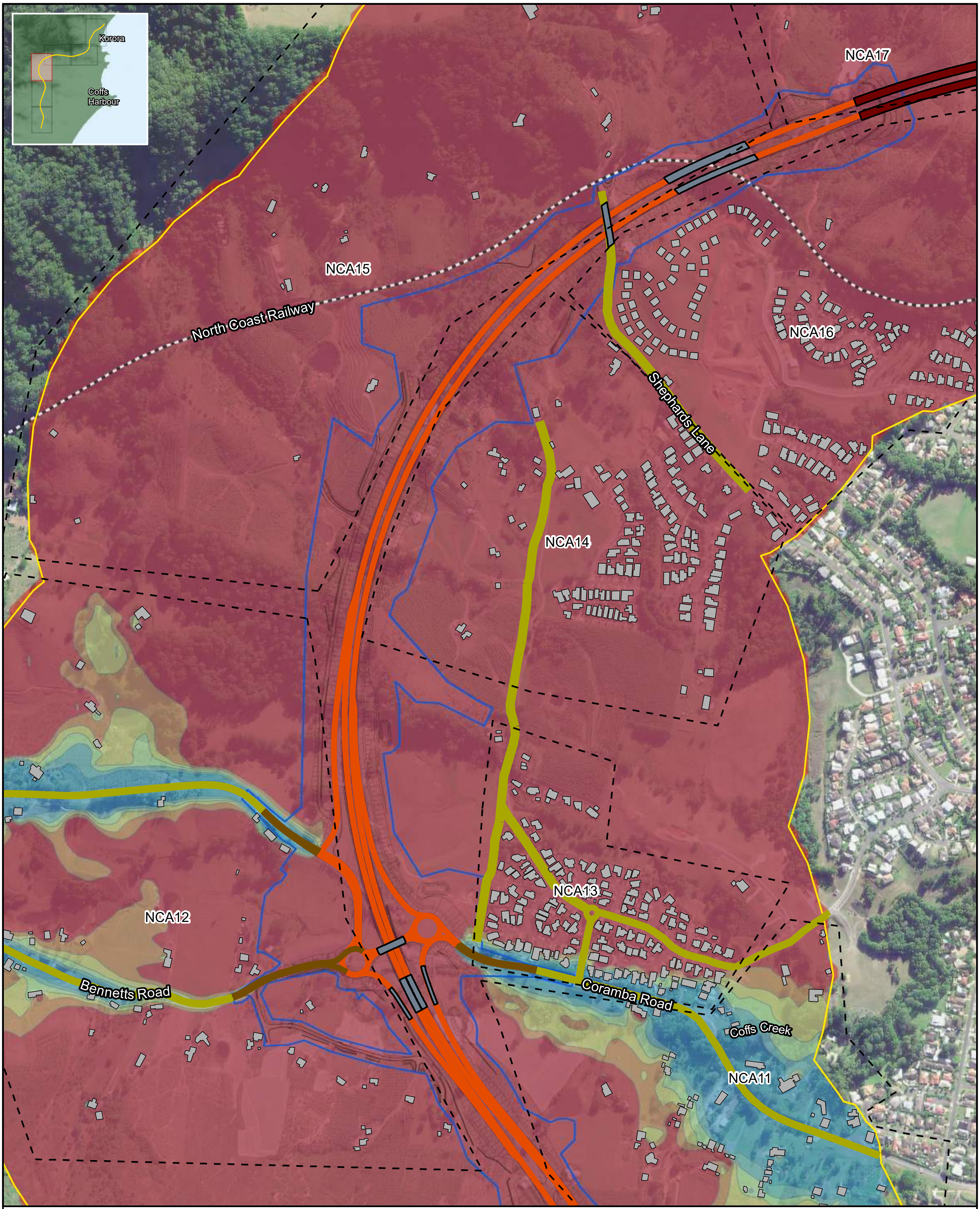
2034 Night-time transition zone criteria

Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 02

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Legend

- 🟦 Construction footprint
- ▨ Bridge
- 🟥 Tunnel
- ┆ NCA
- 🟨 Study Area
- ▬ New roads
- ▬ Redeveloped roads
- ▬ Existing Roads

2034 Night-time transition zone criteria

- 🟦 Criteria: 55dBA
- 🟩 Criteria: 54dBA
- 🟩 Criteria: 53dBA
- 🟨 Criteria: 52dBA
- 🟧 Criteria: 51dBA
- 🟥 Criteria: 50dBA

Coffs Harbour Bypass

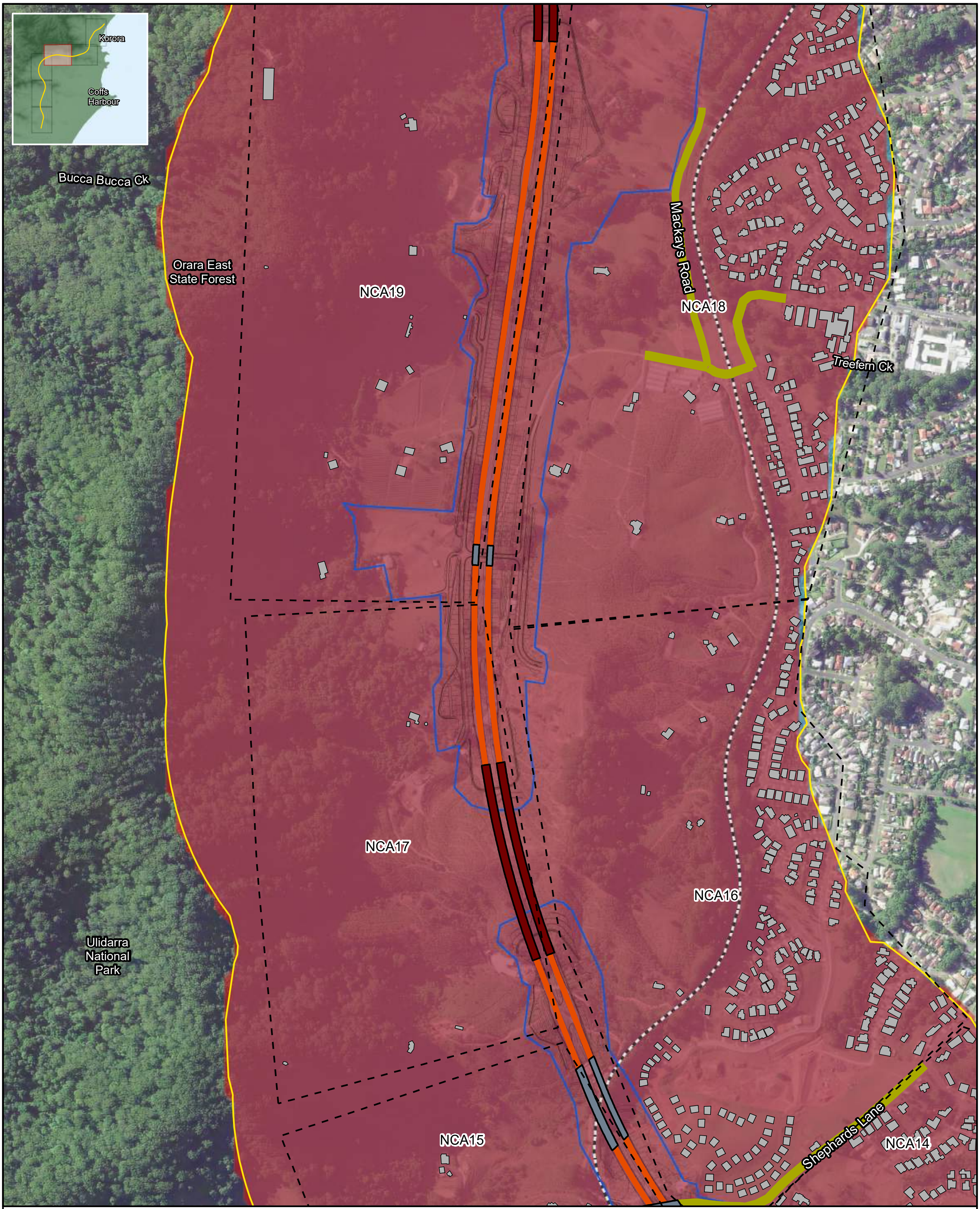
NCG Transition zones

Road classification and transition zone criteria- 03

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Legend

- ☐ Construction footprint
- ▨ Bridge
- ■ Tunnel
- ⬚ NCA
- ☐ Study Area
- ▬ New roads
- ▬ Redeveloped roads
- ▬ Existing Roads

2034 Night-time transition zone criteria

- 🟦 Criteria: 55dBA
- 🟩 Criteria: 54dBA
- 🟨 Criteria: 53dBA
- 🟨 Criteria: 52dBA
- 🟧 Criteria: 51dBA
- 🟥 Criteria: 50dBA

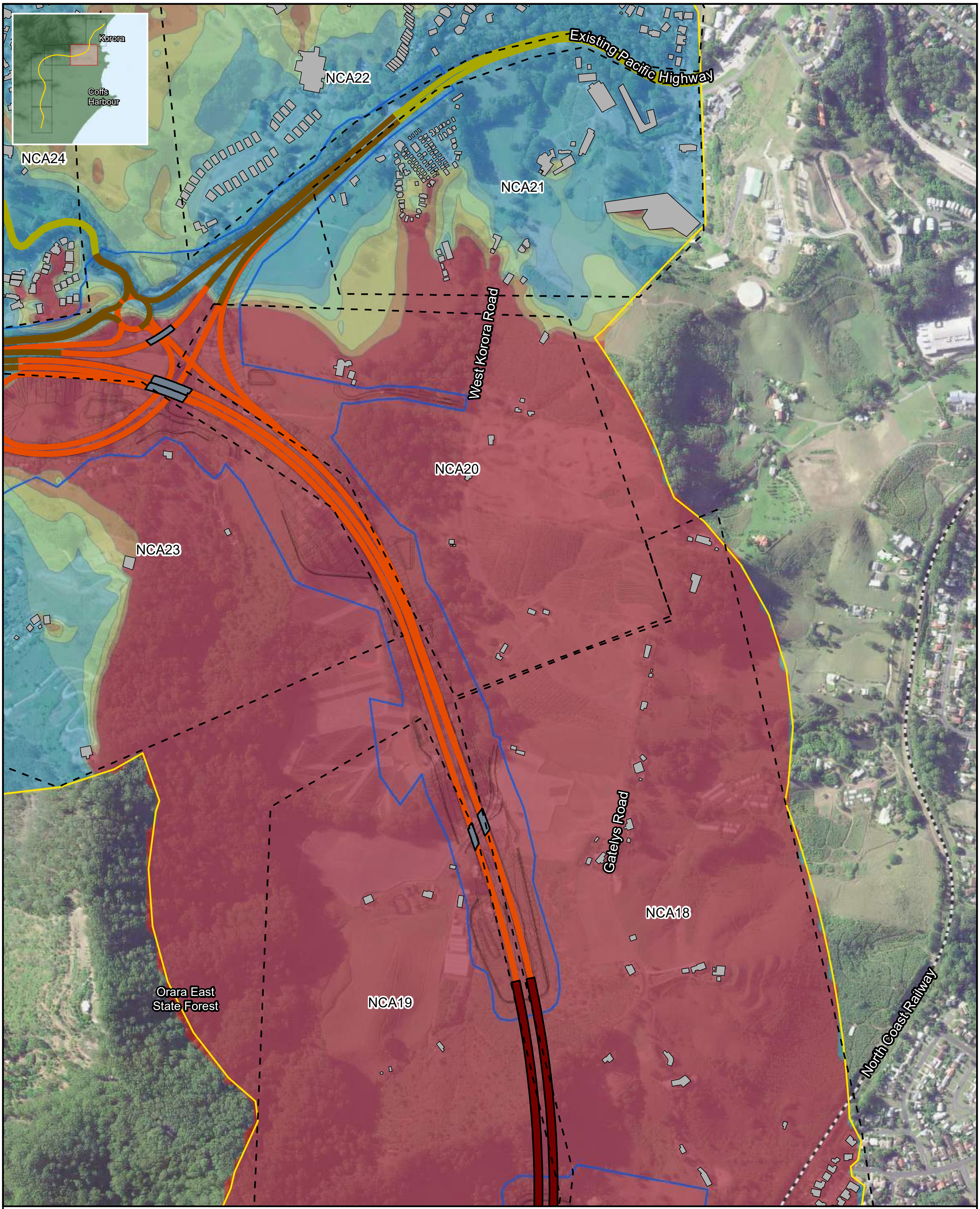
Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 04

0 0.1 0.2 0.3 km N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Legend

▭ Construction footprint
▨ Bridge
■ Tunnel
⌐¬ NCA

▭ Study Area
▬ New roads
▬ Redeveloped roads
▬ Existing Roads

2034 Night-time transition zone criteria

🟦 Criteria: 55dBA
🟩 Criteria: 54dBA
🟨 Criteria: 53dBA
🟨 Criteria: 52dBA
🟧 Criteria: 51dBA
🟥 Criteria: 50dBA

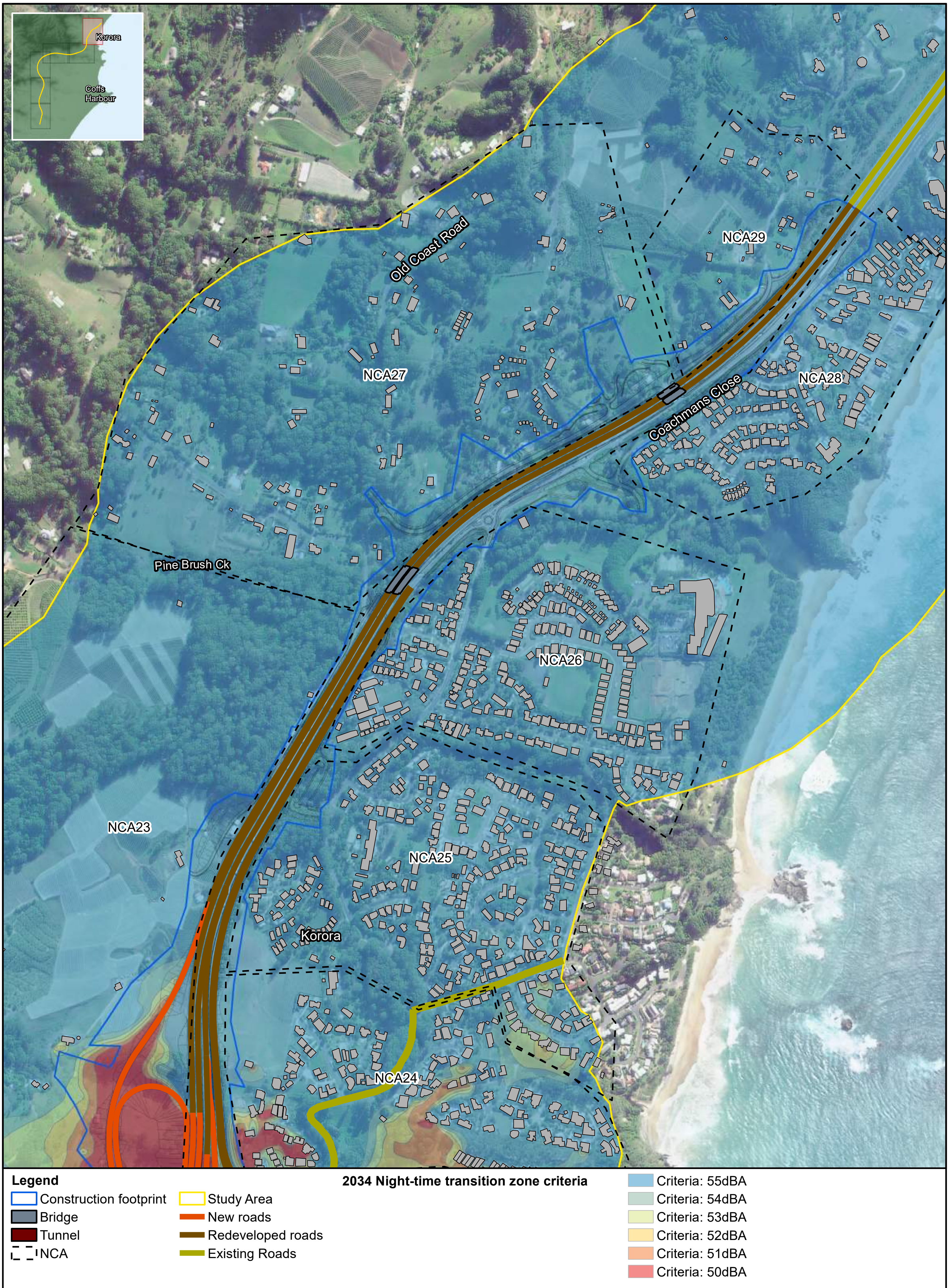
Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 05

0 0.1 0.2 0.3 km N

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Coffs Harbour Bypass

NCG Transition zones

Road classification and transition zone criteria- 06

0 0.1 0.2 0.3 km

N

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

SUB-APPENDIX

F

Sub-appendix F

Traffic modelling parameters

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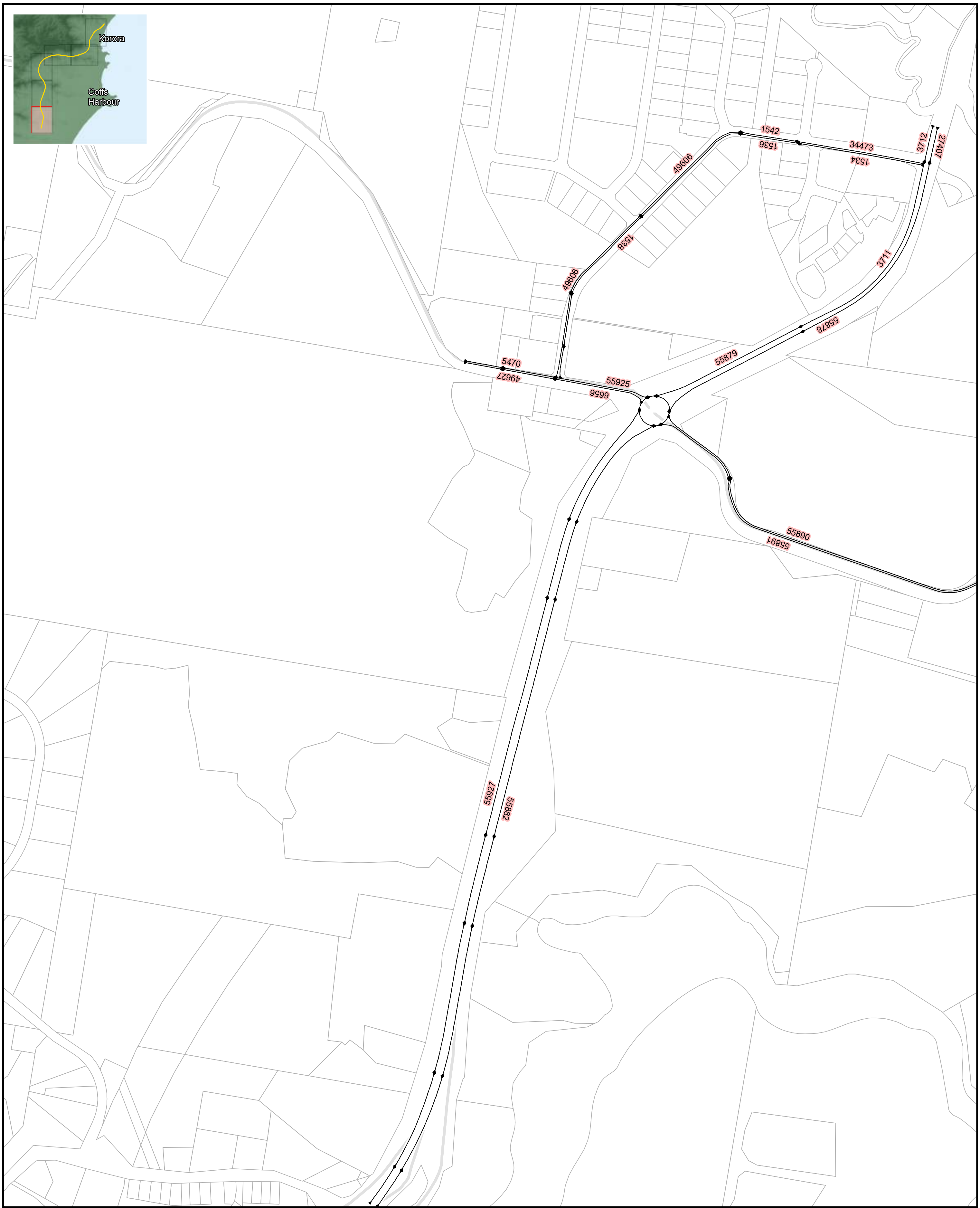
Appendix F

Traffic Modelling Parameters

F1 Road string IDs

F1.1 No Build Scenario



Legend

- North Coast Railway
- River (Major)
- Park / State forest

Coffs Harbour Bypass

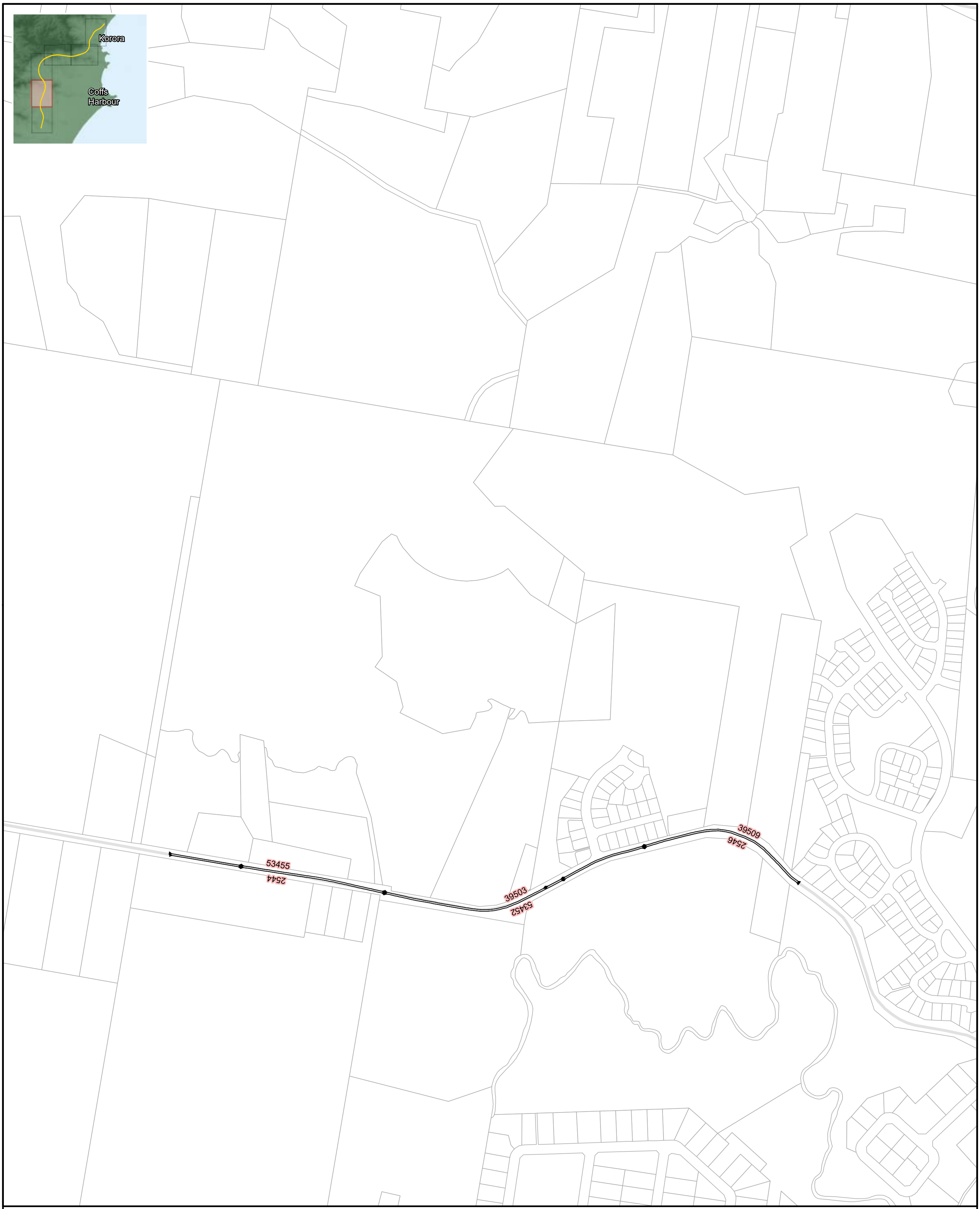
Appendix F

Build scenario road string IDs - 01

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Legend

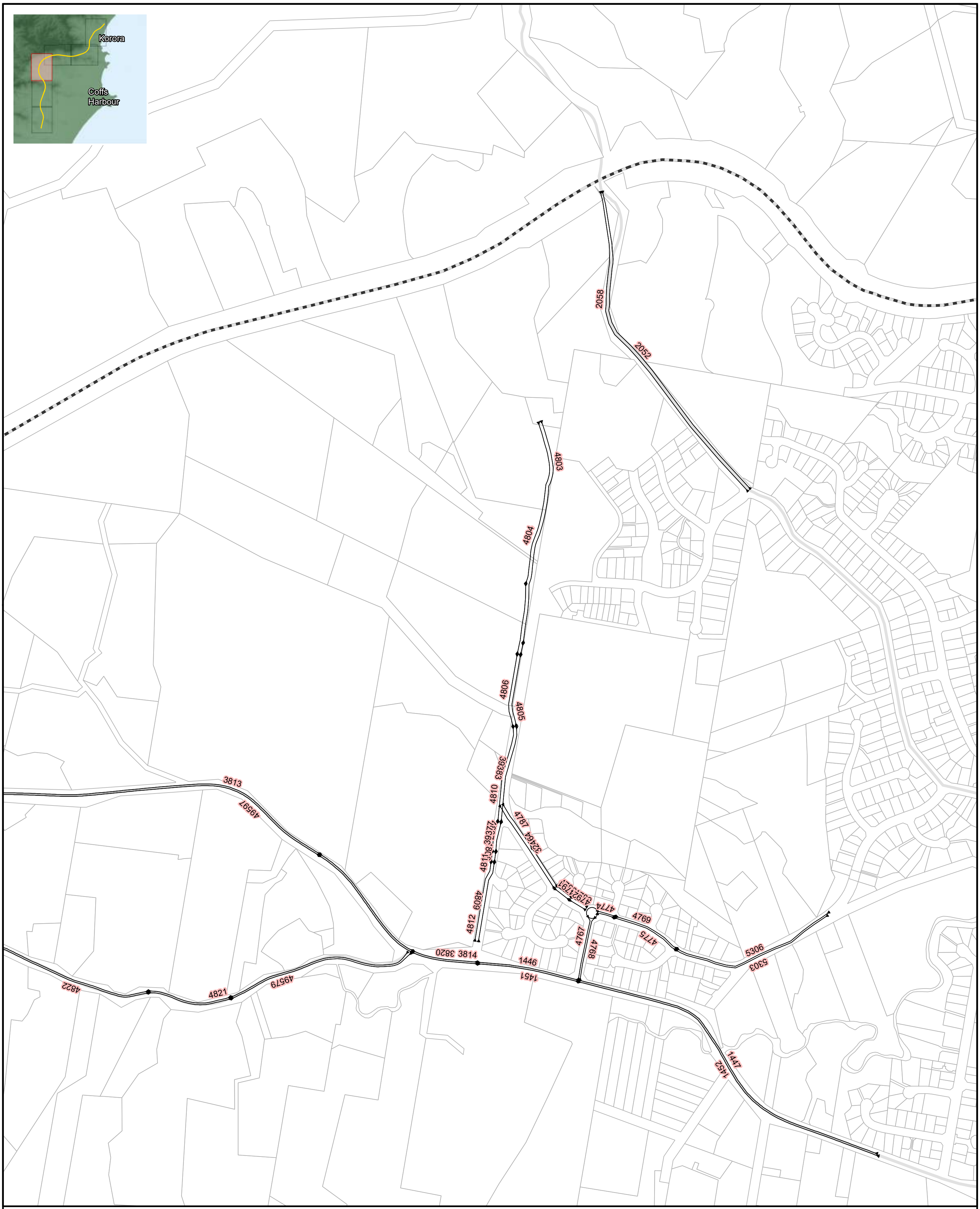
- North Coast Railway
- River (Major)
- Park / State forest

Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 02

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56



Legend

▬ ▬ North Coast Railway

── River (Major)

⬚ Park / State forest

Coffs Harbour Bypass

Appendix F

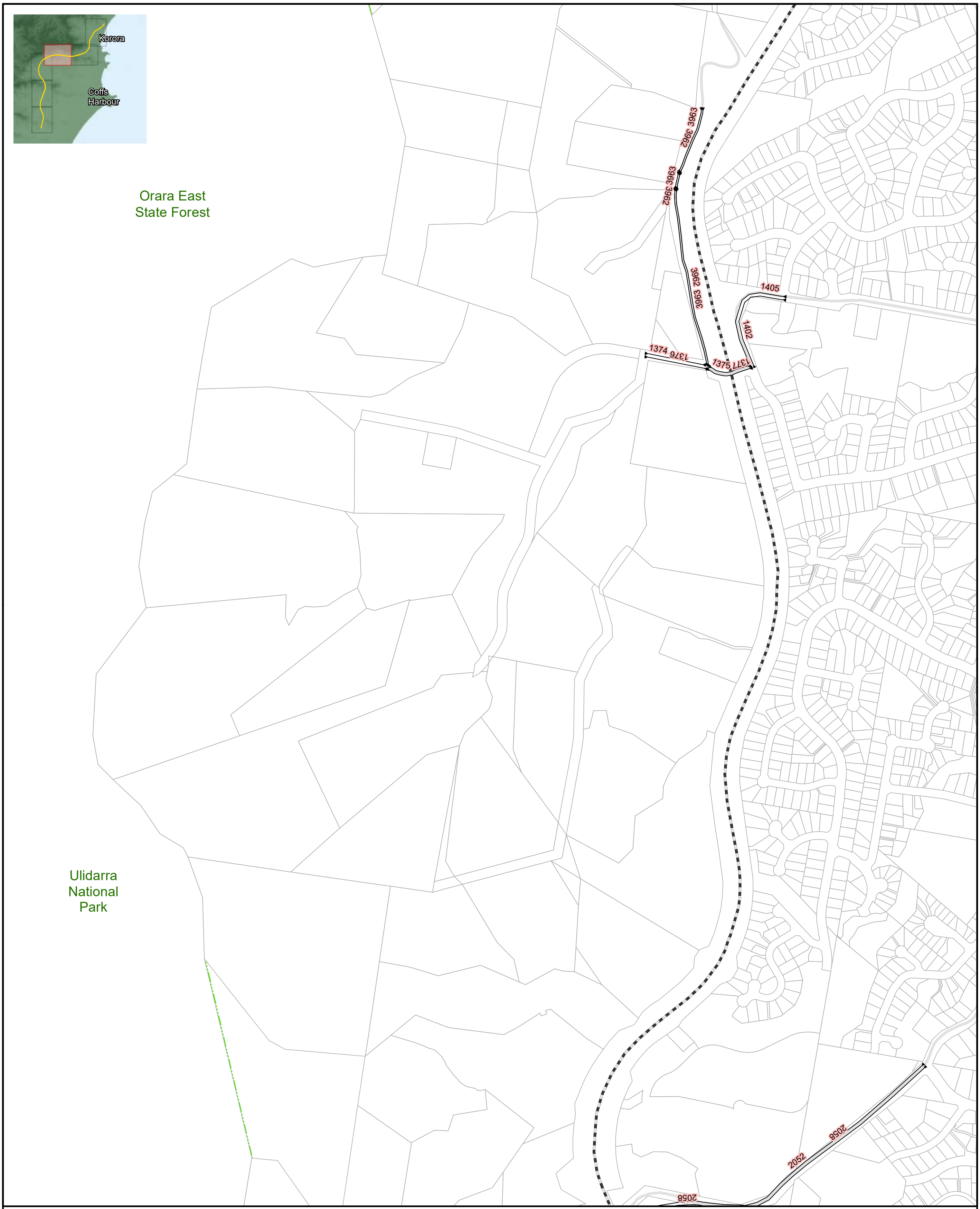
Build scenario road string IDs - 03

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

N



Legend

- North Coast Railway
- River (Major)
- Park / State forest

Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 04

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

Legend

- - - North Coast Railway

— River (Major)

▭ Park / State forest

Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 05

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

N

Legend

North Coast Railway

River (Major)

Park / State forest

Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 06

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

N

F1.2 Build Scenario

Legend

North Coast Railway

River (Major)

Park / State forest

Coffs Harbour Bypass

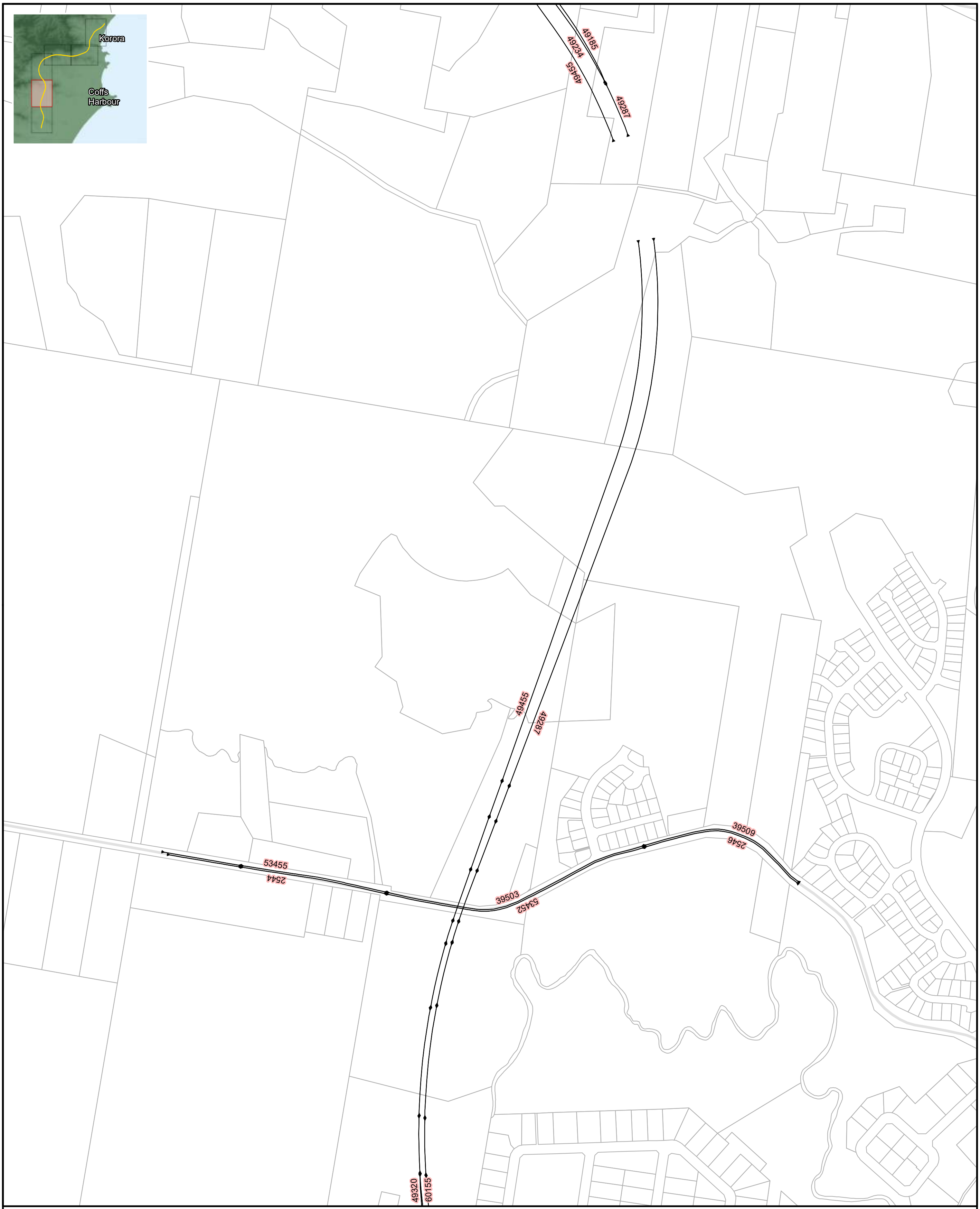
Appendix F

Build scenario road string IDs - 01

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Legend

North Coast Railway

River (Major)

Park / State forest

Coffs Harbour Bypass

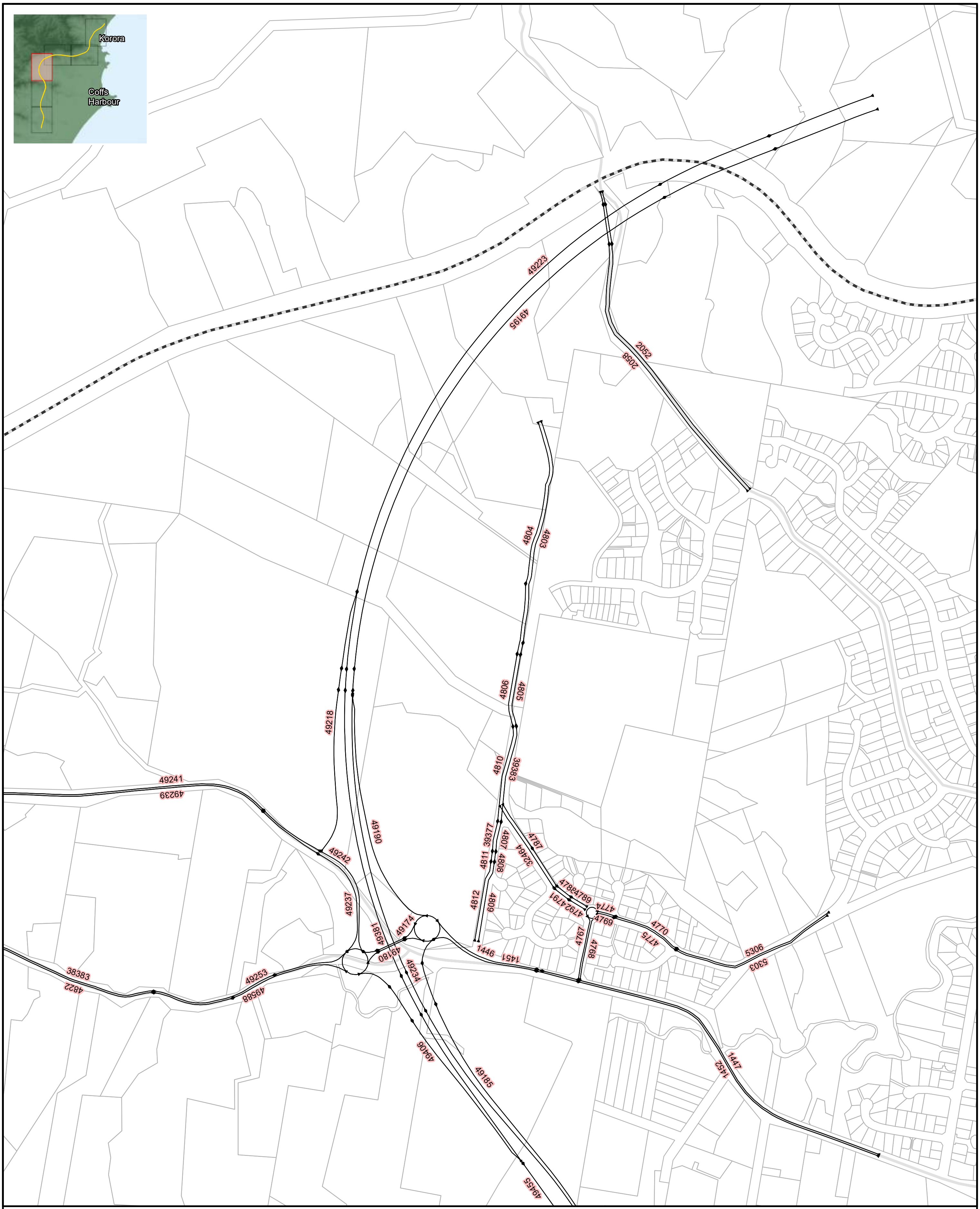
Appendix F

Build scenario road string IDs - 02

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000
GDA 1994 MGA Zone 56

N



Legend

North Coast Railway

River (Major)

Park / State forest

Coffs Harbour Bypass

Appendix F

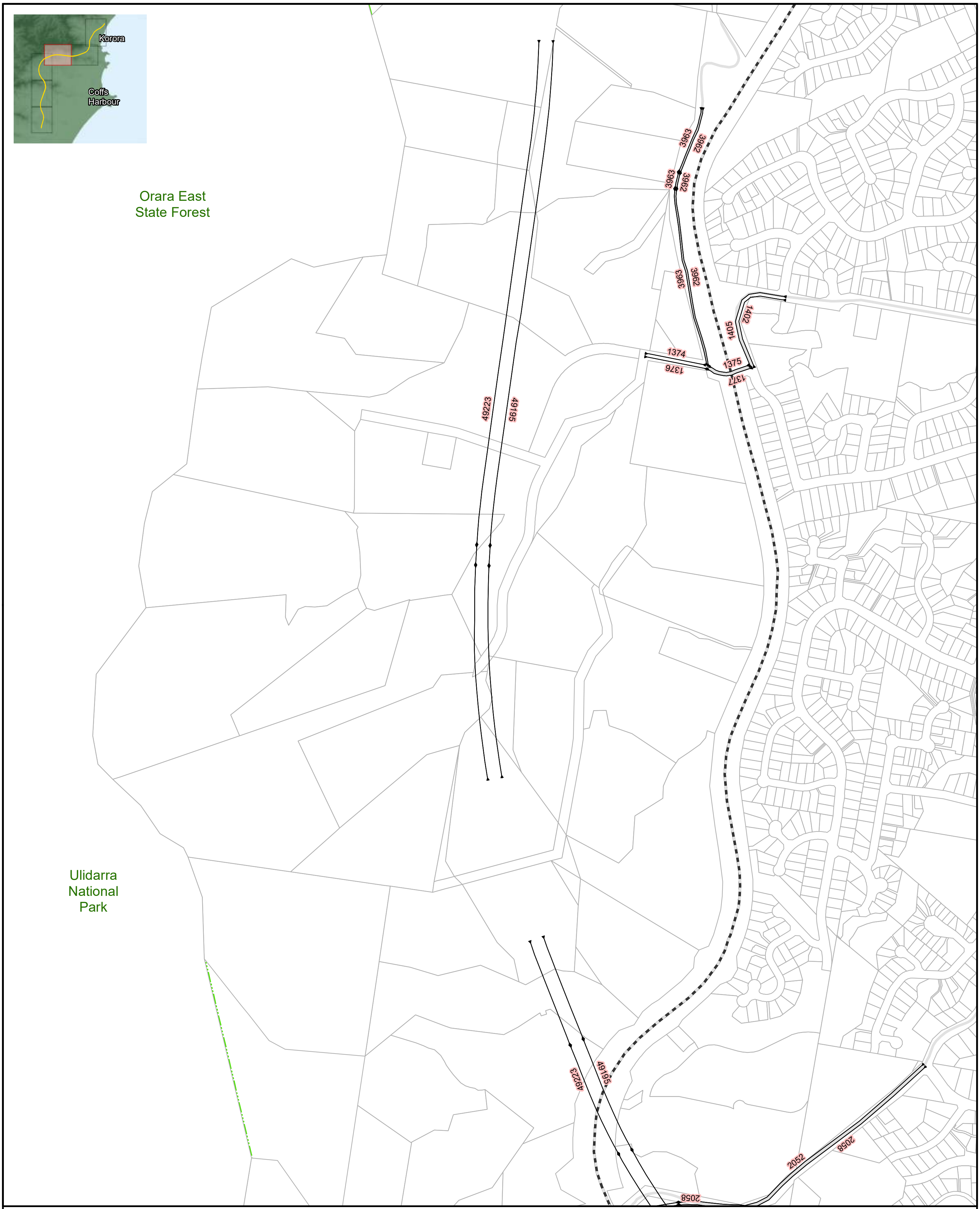
Build scenario road string IDs - 03

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

N



Legend

North Coast Railway

River (Major)

Park / State forest

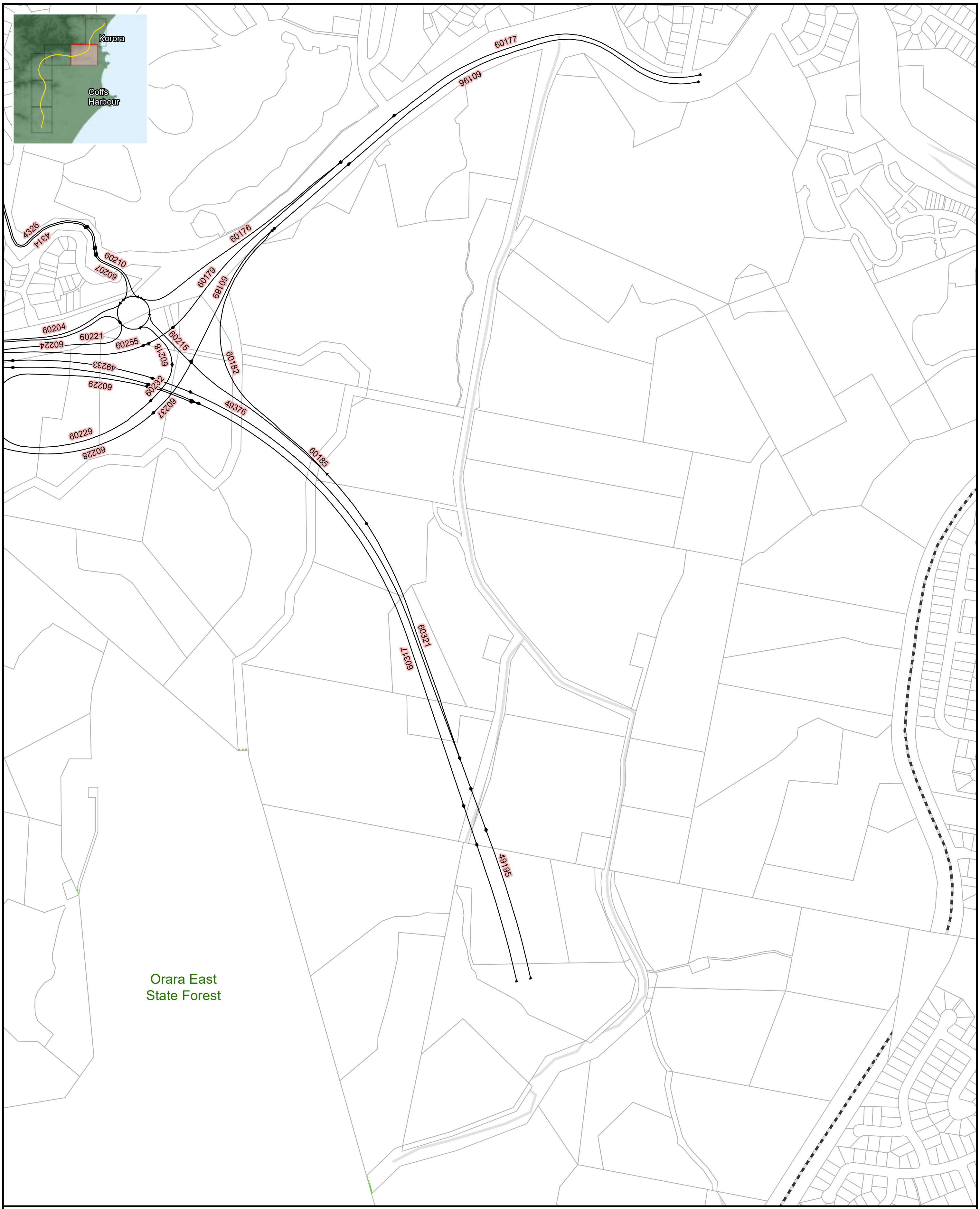
Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 04

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56



Legend

North Coast Railway

River (Major)

Park / State forest

Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 05

0 0.1 0.2 0.3 km

N

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

Legend

North Coast Railway

River (Major)

Park / State forest

Coffs Harbour Bypass

Appendix F

Build scenario road string IDs - 06

0 0.1 0.2 0.3 km

Scale @A4: 1:10,000

GDA 1994 MGA Zone 56

N

F2 Traffic volumes

F2.1 Project Traffic Volumes

ID	No Build													Build													
	Speed km/h	2024 No Build						2034 No Build						Speed km/h	2024 Build						2034 Build					
		Daytime			Night-time			Daytime			Night-time				Daytime			Night-time			Daytime			Night-time		
		Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB		Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB
1374	40	10	2	-6.6	5	1	-6.6	8	1	-6.6	3	0	-6.6	40	10	2	-6.6	5	1	-6.6	8	1	-6.6	3	0	-6.6
1375	40	10	2	-6.6	5	1	-6.6	8	1	-6.6	3	0	-6.6	40	10	2	-6.6	5	1	-6.6	8	1	-6.6	3	0	-6.6
1376	40	6	1	-6.6	3	0	-6.6	9	1	-2.1	4	0	-2.1	40	7	1	-6.6	3	0	-6.6	9	1	-1.6	4	0	-1.9
1377	40	6	1	-6.6	3	0	-6.6	9	1	-2.1	4	0	-2.1	40	7	1	-6.6	3	0	-6.6	9	1	-1.6	4	0	-1.9
1402	50	8	1	-6.6	4	0	-6.6	10	1	-2.1	4	0	-2.1	50	9	1	-6.6	4	0	-6.6	10	1	-1.6	4	0	-1.9
1405	50	11	2	-6.6	5	1	-6.6	8	1	-6.6	4	0	-6.6	50	11	2	-6.6	5	1	-6.6	8	1	-6.6	3	0	-6.6
1446	70	206	13	-3.2	93	5	-3.2	209	15	-2.3	94	5	-2.4	70	251	10	-2.7	108	3	-2.9	273	11	-3.5	115	4	-3.4
1447	70	237	12	-2.8	103	4	-2.7	247	14	-1.7	107	5	-1.6	70	230	9	-2.7	100	3	-2.9	249	10	-3.5	106	4	-3.4
1451	70	162	11	-2.4	70	4	-2.3	168	14	-1.4	72	5	-1.3	70	233	12	-2.8	105	4	-2.5	242	23	-3.6	107	8	-3.3
1452	70	159	11	-2.8	72	4	-2.8	163	13	-2.0	74	5	-2.1	70	212	11	-2.6	94	4	-2.3	221	21	-3.5	96	8	-3.2
1534	40	111	15	-3.0	49	5	-3.2	101	14	-2.0	41	4	-2.4	40	114	20	-2.6	50	9	-1.9	142	20	-2.3	69	11	-1.1
1536	40	137	16	-3.4	60	5	-3.6	131	20	-2.8	54	7	-3.2	40	247	34	-3.5	109	15	-2.7	302	49	-2.9	146	25	-1.6
1538	40	131	10	-3.0	55	3	-3.2	136	21	-3.3	56	7	-3.7	-	-	-	-	-	-	-	-	-	-	-	-	-
1542	40	113	28	-4.2	47	10	-4.1	128	28	-3.9	53	10	-3.7	40	91	18	-4.4	44	6	-4.8	96	17	-3.5	46	6	-4.0
2052	50	0	0	0.0	0	0	0.0	3	0	0.0	1	0	0.0	50	0	0	0.0	0	0	0.0	2	0	0.0	1	0	0.0
2058	50	0	0	0.0	0	0	0.0	0	1	-6.6	0	0	-6.6	50	0	0	0.0	0	0	0.0	0	1	-6.6	0	0	-6.6
2544	50	3	0	-6.6	1	0	-6.6	6	0	0.0	3	0	0.0	50	4	0	-6.6	2	0	-6.6	5	0	0.0	2	0	0.0
2546	50	154	4	-6.6	62	1	-6.6	181	7	-6.6	74	3	-6.6	50	156	3	-6.6	63	1	-6.6	193	7	-6.6	79	2	-6.6
3711	60	641	84	-1.8	218	44	-0.7	708	96	-0.4	236	53	0.7	60	509	41	-3.3	206	12	-3.9	596	42	-2.6	240	12	-3.4
3712	60	791	114	-2.2	275	55	-1.0	876	125	-0.8	303	64	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-
3813	80	185	12	-2.5	83	4	-2.4	188	15	-1.9	84	5	-1.9	-	-	-	-	-	-	-	-	-	-	-	-	-
3814	80	195	12	-2.5	88	4	-2.4	201	15	-1.9	91	5	-1.8	-	-	-	-	-	-	-	-	-	-	-	-	-
3820	80	157	12	-1.9	68	4	-1.6	164	14	-0.7	70	5	-0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
3962	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
3963	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
4314	50	125	2	-6.6	44	1	-6.6	121	2	-6.6	42	1	-6.6	50	183	2	-6.6	62	1	-6.6	178	2	-6.6	62	1	-6.6
4316	50	108	3	-6.6	38	1	-6.6	107	2	-6.6	37	1	-6.6	50	157	2	-6.6	52	1	-6.6	158	2	-6.6	54	1	-6.6
4326	50	89	3	-6.6	32	1	-6.6	108	3	-6.6	39	1	-6.6	50	138	5	-6.0	51	2	-6.0	158	5	-4.5	57	2	-4.2
4328	50	75	2	-6.6	27	1	-6.6	87	1	-6.6	31	0	-6.6	50	120	3	-5.7	43	1	-5.9	135	3	-3.1	48	1	-2.6
4767	30	26	1	-6.6	11	0	-6.6	22	0	-6.6	11	0	-6.6	30	45	1	-6.6	19	0	-6.6	49	1	-6.6	20	0	-6.6
4768	30	20	1	-6.6	10	0	-6.6	21	0	0.0	10	0	0.0	30	46	2	-6.6	22	1	-6.6	50	2	-6.6	24	1	-6.6
4769	40	22	1	-6.6	10	0	-6.6	21	0	0.0	10	0	0.0	40	42	1	-6.6	17	0	-6.6	43	0	-6.6	18	0	-6.6
4770	-	-	-	-	-	-	-	-	-	-	-	-	-	40	37	1	-6.6	16	0	-6.6	37	0	-6.6	16	0	-6.6
4774	40	15	1	-6.6	7	0	-6.6	20	0	0.0	9	0	0.0	40	42	2	-6.6	20	1	-6.6	45	2	-6.6	21	1	-6.6
4775	40	14	0	-6.6	6	0	-6.6	17	0	0.0	8	0	0.0	40	48	1	-6.6	20	0	-6.6	50	2	-6.6	21	1	-6.6
4787	40	2	0	0.0	1	0	0.0	4	0	0.0	2	0	0.0	40	4	0	0.0	2	0	0.0	3	0	0.0	1	0	0.0
4788	40	11	0	0.0	5	0	0.0	12	0	0.0	6	0	0.0	40	9	0	0.0	4	0	0.0	10	0	0.0	5	0	0.0
4789	40	11	0	0.0	5	0	0.0	12	0	0.0	6	0	0.0	40	9	0	0.0	4	0	0.0	10	0	0.0	5	0	0.0
4791	40	9	0	0.0	4	0	0.0	13	0	-6.6	6	0	-6.6	40	8	0	-6.6	3	0	-6.6	11	0	-6.6	4	0	-6.6
4792	40	9	0	0.0	4	0	0.0	13	0	-6.6	6	0	-6.6	40	8	0	-6.6	3	0	-6.6	11	0	-6.6	4	0	-6.6
4803	40	6	0	0.0	3	0	0.0	6	0	0.9	3	0	0.9	40	6	0	0.0	3	0	0.0	6	0	0.9	3	0	0.9
4804	40	5	0	0.0	3	0	0.0	6	0	0.0	3	0	0.0	40	5	0	0.0	2	0	0.0	5	0	0.0	2	0	0.0
4805	40	6	0	0.0	3	0	0.0	6	0	0.9	3	0	0.9	40	6	0	0.0	3	0	0.0	6	0	0.9	3	0	0.9
4806	40	5	0	0.0	3	0	0.0	6	0	0.0	3	0	0.0	40	5	0	0.0	2	0	0.0	5	0	0.0	2	0	0.0
4807	40	11	1	-6.6	5	0	-6.6	13	0	0.9	6	0	0.9	40	11	1	-6.6	5	0	-6.6	13	0	0.9	6	0	0.9
4808	40	9	1	-6.6	5	0	-6.6	8	0	0.9	4	0	0.9	40	12	1	-6.6	6	0	-6.6	11	0	0.9	5	0	0.9
4809	40	9	1	-6.6	5	0	-6.6	8	0	0.9	4	0	0.9	40	12	1	-6.6	6	0	-6.6	11	0	0.9	5	0	0.9
4810	40	5	0	0.0	3	0	0.0	6	0	0.0	3	0	0.0	40	5	0	0.0	2	0	0.0	5	0	0.0	2	0	0.0
4811	40	6	0	0.0	3	0	0.0	5	0	0.0	2	0	0.0	40	7	0	0.0	3	0	0.0	6	0	0.0	3	0	0.0
4812	40	6	0	0.0	3	0	0.0	5	0	0.0	2	0	0.0	40	7	0	0.0	3	0	0.0	6	0	0.0	3	0	0.0
4821	40	11	0	0.0	5	0	0.0	14	0	0.0	6	0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
4822	40	1	3	-6.6	0	1	-6.6	2	2	-6.6	1	1	-6.6	40	1	2	-6.6	1	1	-6.6	2	4	-6.6	1	2	-6.6
5303	40	9	0	0.0	4	0	0.0	11	0	0.0	5	0	0.0	40	34	1	-6.6	16	0	-6.6	33	2	-6.6	15	1	-6.6
5306	40	17	1	-6.6	7	0	-6.6	14	0	-6.6	7	0	-6.6	40	34	1	-6.6	14	0	-6.6	34	1	-6.6	14	0	-6.6
5335	50	18	1	-6.6	6	0	-6.6	22	0	0.0	7	0	0.0	50	24	1	-6.6	8	0	-6.6	23	0	0.0	7	0	0.0
5336	50	41	2	-6.6	14	1	-6.6	46	0	0.0	15	0	0.0	50	48	2	-6.6	17	1	-6.6	50	0	0.0	17	0	0.0
5337	50	15	0	0.0	5	0	0.0	17	0	0.0	5	0	0.0	50	16	0	0.0	5	0	0.0	20	0	0.0	6	0	0.0
5338	50	37	0	0.0	12	0	0.0	39	0	0.0	12	0	0.0	50	42	0	0.0	14	0	0.0	45	0	0.0	15	0	0.0
5340	50	15	0	0.0	5	0	0.0	17	0	0.0	5	0	0.0	50	16	0	0.0	5	0	0.0	20	0	0.0	6	0	0.0
5345	50	18	1	-6.6	6	0	-6.6	22	0	0.0	7	0	0.0	50	24	1	-6.6	8	0	-6.6	23	0	0.0	7	0	0.0

ID	No Build													Build													
	Speed km/h	2024 No Build						2034 No Build						Speed km/h	2024 Build						2034 Build					
		Daytime			Night-time			Daytime			Night-time				Daytime			Night-time			Daytime			Night-time		
		Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB		Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB
5470	50	132	24	-4.7	56	9	-4.6	204	31	-2.7	87	11	-2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
6656	50	173	29	-4.5	71	9	-5.2	242	39	-3.3	104	12	-4.3	-	-	-	-	-	-	-	-	-	-	-	-	-
8346	80	741	89	-0.3	273	50	0.9	875	96	0.9	322	55	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-
8897	80	836	96	-0.6	328	48	0.5	906	98	0.6	355	50	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-
9601	60	962	102	-2.1	371	50	-1.0	1070	107	-0.9	412	54	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
9743	110	647	86	1.1	238	49	2.4	771	92	2.5	283	53	3.8	110	637	84	0.6	237	47	1.9	748	92	2.0	279	53	3.3
27407	60	672	112	-1.8	262	57	-0.8	683	118	-0.7	260	62	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-
32464	40	2	0	0.0	1	0	0.0	4	0	0.0	2	0	0.0	40	5	0	0.0	2	0	0.0	3	0	0.0	1	0	0.0
34473	40	160	31	-4.3	67	11	-4.2	180	31	-3.0	75	11	-2.8	40	114	21	-4.3	54	7	-4.6	126	16	-3.1	60	5	-3.6
38383	-	-	-	-	-	-	-	-	-	-	-	-	-	40	3	0	0.0	2	0	0.0	7	0	0.0	3	0	0.0
39377	40	8	0	0.0	4	0	0.0	9	0	0.0	4	0	0.0	40	8	0	0.0	3	0	0.0	8	0	0.0	3	0	0.0
39383	40	6	0	0.0	3	0	0.0	6	0	0.9	3	0	0.9	40	6	0	0.0	3	0	0.0	6	0	0.9	3	0	0.9
39503	50	48	0	-6.6	23	0	-6.6	93	1	-6.6	43	0	-6.6	50	46	0	-6.6	22	0	-6.6	92	1	-6.6	44	0	-6.6
39509	50	175	1	-6.6	73	0	-6.6	218	2	-3.3	93	1	-3.4	50	175	1	-6.6	73	0	-6.6	218	2	-3.3	93	1	-3.4
49174	-	-	-	-	-	-	-	-	-	-	-	-	-	70	257	14	-3.1	114	5	-3.1	272	16	-2.6	119	5	-2.6
49180	-	-	-	-	-	-	-	-	-	-	-	-	-	70	125	8	-2.9	55	2	-2.8	136	11	-3.5	58	4	-3.5
49185	-	-	-	-	-	-	-	-	-	-	-	-	-	60	233	13	-3.0	106	6	-1.7	245	21	-2.6	111	9	-1.2
49190	-	-	-	-	-	-	-	-	-	-	-	-	-	60	69	4	-2.9	28	1	-2.9	83	5	-4.6	33	2	-4.6
49195	-	-	-	-	-	-	-	-	-	-	-	-	-	110	456	77	0.3	205	41	1.7	527	83	2.1	235	47	3.4
49196	-	-	-	-	-	-	-	-	-	-	-	-	-	100	959	94	0.2	390	45	1.4	1039	107	1.6	420	53	2.9
49208	-	-	-	-	-	-	-	-	-	-	-	-	-	100	897	115	-0.1	384	48	0.9	1020	144	1.3	444	62	2.4
49218	-	-	-	-	-	-	-	-	-	-	-	-	-	60	65	5	-4.9	27	1	-4.9	69	6	-4.2	29	2	-4.1
49223	-	-	-	-	-	-	-	-	-	-	-	-	-	110	408	67	0.4	170	40	1.8	478	77	2.0	198	48	3.4
49233	-	-	-	-	-	-	-	-	-	-	-	-	-	110	173	50	0.8	72	32	2.0	208	60	2.5	88	40	3.7
49234	-	-	-	-	-	-	-	-	-	-	-	-	-	110	381	73	0.4	174	39	1.7	442	79	2.3	201	46	3.6
49237	-	-	-	-	-	-	-	-	-	-	-	-	-	70	170	12	-2.4	74	4	-2.3	186	16	-1.3	79	5	-1.2
49239	-	-	-	-	-	-	-	-	-	-	-	-	-	70	148	10	-2.1	65	3	-1.9	157	12	-0.7	67	4	-0.6
49241	-	-	-	-	-	-	-	-	-	-	-	-	-	70	181	12	-3.1	82	4	-3.1	187	15	-2.5	85	5	-2.6
49242	-	-	-	-	-	-	-	-	-	-	-	-	-	70	140	9	-2.9	65	3	-3.0	146	11	-2.4	67	4	-2.6
49253	-	-	-	-	-	-	-	-	-	-	-	-	-	40	11	0	0.0	5	0	0.0	14	0	0.0	6	0	0.0
49257	-	-	-	-	-	-	-	-	-	-	-	-	-	110	638	88	0.6	267	55	1.8	751	100	1.9	316	63	3.3
49286	-	-	-	-	-	-	-	-	-	-	-	-	-	110	755	88	0.4	301	45	1.6	820	92	1.8	327	47	3.1
49287	-	-	-	-	-	-	-	-	-	-	-	-	-	110	561	89	0.2	258	45	1.5	627	103	1.8	287	56	3.2
49313	-	-	-	-	-	-	-	-	-	-	-	-	-	110	370	68	0.6	158	40	1.9	400	78	2.4	170	50	3.7
49320	-	-	-	-	-	-	-	-	-	-	-	-	-	110	313	50	1.1	127	34	2.2	348	54	2.8	139	39	3.8
49376	-	-	-	-	-	-	-	-	-	-	-	-	-	110	252	63	0.7	117	35	1.9	292	63	2.6	134	38	3.8
49381	-	-	-	-	-	-	-	-	-	-	-	-	-	110	345	63	0.7	144	40	1.9	411	71	2.3	171	47	3.5
49406	-	-	-	-	-	-	-	-	-	-	-	-	-	60	157	10	-3.5	67	3	-3.3	169	12	-1.4	71	4	-1.2
49455	-	-	-	-	-	-	-	-	-	-	-	-	-	110	496	75	0.4	209	43	1.7	573	83	2.2	239	51	3.5
49579	40	7	2	-6.6	4	1	-6.6	9	3	-6.6	4	1	-6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
49588	-	-	-	-	-	-	-	-	-	-	-	-	-	40	8	2	-6.6	4	1	-6.6	7	3	-6.6	3	2	-6.6
49597	80	150	10	-1.5	65	3	-1.3	156	11	-0.4	67	4	-0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
49606	40	87	13	-5.0	36	5	-5.2	114	19	-2.3	47	6	-2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
49627	50	115	22	-4.0	49	7	-4.5	171	29	-3.8	74	10	-4.4	-	-	-	-	-	-	-	-	-	-	-	-	-
53452	50	46	2	-6.6	19	1	-6.6	95	3	-6.6	40	1	-6.6	50	44	2	-6.6	19	1	-6.6	97	4	-6.6	41	1	-6.6
53455	50	2	0	-6.6	1	0	-6.6	5	0	0.0	3	0	0.0	50	2	0	-6.6	1	0	-6.6	5	0	0.0	3	0	0.0
55878	60	552	98	-1.7	198	53	-0.6	584	113	-0.5	207	64	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-
55879	60	692	89	-1.9	236	46	-0.7	765	100	-0.7	255	54	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-
55882	100	758	108	0.2	323	55	1.6	802	133	1.7	340	71	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-
55890	60	295	14	-3.9	166	5	-4.1	299	13	-4.0	168	5	-4.4	-	-	-	-	-	-	-	-	-	-	-	-	-
55891	60	244	22	-5.3	144	8	-5.0	295	24	-4.2	180	9	-3.2	-	-	-	-	-	-	-	-	-	-	-	-	-
55925	50	234	28	-4.3	98	10	-4.3	294	43	-3.2	124	15	-3.4	-	-	-	-	-	-	-	-	-	-	-	-	-
55927	60	891	94	-1.9	357	46	-0.9	945	107	-0.8	375	54	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
56244	80	901	88	-0.4	327	48	0.8	1024	98	0.8	371	55	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-
56250	50	87	2	-6.6	32	1	-6.6	108	3	-6.6	39	1	-6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
56251	50	125	2	-6.6	44	1	-6.6	121	2	-6.6	42	1	-6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
60065	-	-	-	-	-	-	-	-	-	-	-	-	-	80	647	45	-1.9	263	13	-2.2	695	53	-1.0	282	15	-1.6
60068	-	-	-	-	-	-	-	-	-	-	-	-	-	80	509	45	-1.8	218	18	-0.8	577	66	-0.7	251	27	0.5
60081	-	-	-	-	-	-	-	-	-	-	-	-	-	60	228	15	-5.0	99	5	-4.5	294	18	-3.7	129	7	-2.7
60107	-	-	-	-	-	-	-	-	-	-	-	-	-	50	159	17	-4.2	64	5	-4.7	216	20	-2.8	84	5	-3.8

	No Build													Build												
		2024 No Build						2034 No Build							2024 Build						2034 Build					
		Daytime			Night-time			Daytime			Night-time				Daytime			Night-time			Daytime			Night-time		
ID	Speed km/h	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Speed km/h	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB
60114	-	-	-	-	-	-	-	-	-	-	-	-	-	60	628	54	-3.4	254	16	-4.0	737	63	-2.5	297	18	-3.4
60135	-	-	-	-	-	-	-	-	-	-	-	-	-	60	344	33	-3.2	147	12	-2.8	414	50	-2.1	177	17	-1.9
60139	-	-	-	-	-	-	-	-	-	-	-	-	-	60	400	38	-3.2	171	14	-2.5	427	41	-2.1	181	14	-1.6
60142	-	-	-	-	-	-	-	-	-	-	-	-	-	60	368	43	-2.9	164	17	-2.1	427	61	-2.7	198	25	-1.6
60144	-	-	-	-	-	-	-	-	-	-	-	-	-	50	279	42	-3.9	120	16	-3.3	378	51	-3.4	165	19	-2.8
60146	-	-	-	-	-	-	-	-	-	-	-	-	-	60	110	16	-3.6	45	5	-3.6	172	21	-1.9	72	7	-2.1
60154	-	-	-	-	-	-	-	-	-	-	-	-	-	50	131	24	-4.7	56	9	-4.6	204	31	-2.7	87	11	-2.5
60155	-	-	-	-	-	-	-	-	-	-	-	-	-	60	182	28	-3.2	81	11	-2.0	229	29	-2.0	101	12	-0.6
60169	-	-	-	-	-	-	-	-	-	-	-	-	-	60	200	21	-3.8	101	7	-3.5	232	25	-2.9	116	8	-2.6
60170	-	-	-	-	-	-	-	-	-	-	-	-	-	60	62	7	-5.0	29	2	-4.9	79	11	-2.8	36	4	-3.1
60173	-	-	-	-	-	-	-	-	-	-	-	-	-	60	210	26	-2.6	91	11	-1.8	256	46	-2.5	117	19	-1.5
60176	-	-	-	-	-	-	-	-	-	-	-	-	-	60	388	19	-4.1	136	6	-4.3	441	22	-3.3	150	8	-3.4
60177	-	-	-	-	-	-	-	-	-	-	-	-	-	60	837	47	-3.1	298	17	-2.8	916	50	-3.3	322	18	-3.1
60179	-	-	-	-	-	-	-	-	-	-	-	-	-	60	450	28	-2.5	163	11	-2.1	476	28	-3.3	174	11	-2.9
60182	-	-	-	-	-	-	-	-	-	-	-	-	-	60	153	8	-4.3	63	3	-3.8	170	11	-3.5	70	5	-2.9
60185	-	-	-	-	-	-	-	-	-	-	-	-	-	60	51	5	-3.3	23	2	-2.0	65	8	-1.5	29	4	-0.2
60189	-	-	-	-	-	-	-	-	-	-	-	-	-	60	679	33	-2.6	235	13	-1.8	763	39	-2.3	263	15	-1.3
60196	-	-	-	-	-	-	-	-	-	-	-	-	-	60	859	42	-2.9	297	16	-2.1	966	51	-2.6	333	19	-1.6
60207	-	-	-	-	-	-	-	-	-	-	-	-	-	50	184	2	-6.6	62	1	-6.6	179	2	-6.6	62	1	-6.6
60210	-	-	-	-	-	-	-	-	-	-	-	-	-	50	136	5	-6.0	50	2	-6.0	158	5	-4.5	57	2	-4.2
60215	-	-	-	-	-	-	-	-	-	-	-	-	-	50	57	6	-5.1	21	2	-5.2	73	6	-3.2	27	3	-2.8
60218	-	-	-	-	-	-	-	-	-	-	-	-	-	50	461	21	-5.2	158	7	-5.6	505	23	-4.5	174	8	-4.9
60221	-	-	-	-	-	-	-	-	-	-	-	-	-	60	55	0	0.0	19	0	0.0	53	0	0.0	18	0	0.0
60228	-	-	-	-	-	-	-	-	-	-	-	-	-	60	465	32	-2.3	162	13	-1.5	544	33	-2.0	189	13	-0.9
60229	-	-	-	-	-	-	-	-	-	-	-	-	-	60	215	16	-3.3	89	6	-1.9	247	17	-2.2	98	8	-0.7
60232	-	-	-	-	-	-	-	-	-	-	-	-	-	60	245	18	-3.6	101	7	-2.2	280	21	-2.3	111	10	-0.8
60237	-	-	-	-	-	-	-	-	-	-	-	-	-	60	494	31	-2.4	172	13	-1.5	578	34	-2.1	201	13	-1.0
60252	-	-	-	-	-	-	-	-	-	-	-	-	-	60	504	28	-2.5	183	11	-2.1	528	29	-3.3	192	11	-2.9
60278	-	-	-	-	-	-	-	-	-	-	-	-	-	60	307	13	-3.8	133	4	-3.5	306	15	-3.8	133	5	-3.6
60293	-	-	-	-	-	-	-	-	-	-	-	-	-	50	119	22	-4.1	51	7	-4.7	184	30	-3.6	80	10	-4.2
60321	-	-	-	-	-	-	-	-	-	-	-	-	-	60	201	12	-4.0	82	5	-3.5	233	17	-3.0	96	7	-2.4

ID	No Build													Build												
	Speed km/h	2024 No Build						2034 No Build						Speed km/h	2024 Build						2034 Build					
		Daytime			Night-time			Daytime			Night-time				Daytime			Night-time			Daytime			Night-time		
		Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB		Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB
1374	40	27	3	-6.6	15	3	-6.6	19	2	-6.6	12	0	0.0	40	27	3	-6.6	15	3	-6.6	19	2	-6.6	12	0	0.0
1375	40	27	3	-6.6	15	3	-6.6	19	2	-6.6	12	0	0.0	40	27	3	-6.6	15	3	-6.6	19	2	-6.6	12	0	0.0
1376	40	2	2	-6.6	19	0	0.0	14	5	-0.9	18	0	0.0	40	3	2	-6.6	20	0	0.0	13	5	-0.9	17	0	0.0
1377	40	2	2	-6.6	19	0	0.0	14	5	-0.9	17	0	0.0	40	3	2	-6.6	21	0	0.0	13	5	-0.9	17	0	0.0
1402	50	2	2	-6.6	25	0	0.0	14	5	-0.9	18	0	0.0	50	3	2	-6.6	27	0	0.0	13	5	-0.9	18	0	0.0
1405	50	27	3	-6.6	16	3	-6.6	20	2	-6.6	12	0	0.0	50	27	3	-6.6	16	3	-6.6	19	2	-6.6	12	0	0.0
1446	70	553	19	-2.2	212	23	-3.0	548	31	-0.9	233	16	-3.4	70	538	15	-2.7	363	15	-1.4	577	17	-2.3	432	17	-4.4
1447	70	583	18	-2.1	225	22	-2.9	599	30	-0.9	238	16	-3.4	70	544	12	-3.0	295	15	-1.4	591	15	-2.0	347	17	-4.4
1451	70	153	20	-2.7	403	16	-1.6	192	25	-1.6	382	19	-0.7	70	440	24	-2.6	457	15	-1.9	484	54	-3.5	483	18	-2.7
1452	70	153	21	-2.8	447	15	-1.4	198	25	-1.6	419	19	-0.7	70	331	20	-2.3	454	14	-1.8	367	48	-3.4	481	18	-2.7
1534	40	192	27	-2.8	171	21	-2.7	197	24	-2.3	147	22	-1.2	40	142	23	-3.5	189	25	-2.0	175	31	-2.0	222	22	-0.9
1536	40	212	29	-2.4	237	22	-4.5	219	34	-2.9	230	33	-2.1	40	363	38	-3.1	357	43	-4.1	387	70	-2.3	458	55	-1.7
1538	40	128	21	-2.7	286	12	-2.8	143	30	-4.2	293	37	-2.3	-	-	-	-	-	-	-	-	-	-	-	-	-
1542	40	162	65	-4.5	209	23	-2.9	156	60	-3.8	268	26	-3.5	40	198	41	-4.9	136	18	-3.3	201	44	-3.8	140	9	-2.6
2052	50	0	0	0.0	0	0	0.0	0	0	0.0	7	0	0.0	50	0	0	0.0	0	0	0.0	0	0	0.0	7	0	0.0
2058	50	1	0	0.0	0	0	0.0	1	2	-6.6	0	0	0.0	50	1	0	0.0	0	0	0.0	1	2	-6.6	0	0	0.0
2544	50	7	0	0.0	3	1	-6.6	8	0	0.0	11	0	0.0	50	9	0	0.0	3	1	-6.6	10	0	0.0	10	0	0.0
2546	50	452	7	-6.6	230	5	-6.6	425	10	-6.6	342	11	-6.6	50	470	7	-6.6	227	5	-6.6	477	10	-6.6	345	11	-6.6
3711	60	1243	135	-2.6	929	119	-1.3	1315	152	-1.2	1057	133	0.1	60	1103	80	-3.3	663	53	-2.9	1198	81	-2.5	835	59	-1.9
3712	60	1322	201	-3.0	1315	141	-1.3	1386	218	-1.5	1520	154	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
3813	80	490	19	-1.6	193	20	-2.1	479	31	-0.6	218	16	-2.7	-	-	-	-	-	-	-	-	-	-	-	-	-
3814	80	522	19	-1.6	203	20	-2.1	524	31	-0.6	226	16	-2.7	-	-	-	-	-	-	-	-	-	-	-	-	-
3820	80	155	21	-2.2	383	16	-0.9	189	25	-1.0	373	19	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
3962	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
3963	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	40	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
4314	50	180	3	-6.6	244	3	-6.6	196	2	-6.6	215	3	-6.6	50	292	3	-6.6	273	3	-6.6	300	2	-6.6	256	3	-6.6
4316	50	179	5	-6.6	201	3	-6.6	196	3	-6.6	178	3	-6.6	50	284	3	-6.6	220	3	-6.6	299	2	-6.6	208	3	-6.6
4326	50	205	5	-6.6	102	3	-6.6	262	3	-6.6	108	5	-6.6	50	318	7	-6.6	157	8	-5.1	381	4	-6.6	161	11	-4.0
4328	50	163	3	-6.6	92	3	-6.6	197	0	0.0	96	2	-6.6	50	267	3	-6.6	141	8	-5.1	316	0	0.0	141	8	-3.3
4767	30	40	3	-6.6	50	0	0.0	33	1	-6.6	47	0	0.0	30	44	3	-6.6	111	0	0.0	49	2	-6.6	119	0	0.0
4768	30	70	2	-6.6	19	1	-6.6	78	0	0.0	14	0	0.0	30	160	4	-6.6	43	1	-6.6	179	5	-6.6	41	0	0.0
4769	40	45	3	-6.6	35	0	0.0	40	0	0.0	37	0	0.0	40	49	2	-6.6	96	0	0.0	50	1	-6.6	103	0	0.0
4770	-	-	-	-	-	-	-	-	-	-	-	-	-	40	47	2	-6.6	84	0	0.0	45	1	-6.6	88	0	0.0
4774	40	47	2	-6.6	17	1	-6.6	57	0	0.0	23	0	0.0	40	146	4	-6.6	39	1	-6.6	158	5	-6.6	39	0	0.0
4775	40	34	0	0.0	17	1	-6.6	43	0	0.0	22	0	0.0	40	132	2	-6.6	37	1	-6.6	141	5	-6.6	36	0	0.0
4787	40	8	0	0.0	1	0	0.0	14	0	0.0	2	0	0.0	40	9	0	0.0	2	0	0.0	9	0	0.0	6	0	0.0
4788	40	37	0	0.0	11	0	0.0	40	0	0.0	12	0	0.0	40	27	0	0.0	9	0	0.0	31	0	0.0	12	0	0.0
4789	40	37	0	0.0	11	0	0.0	40	0	0.0	12	0	0.0	40	27	0	0.0	9	0	0.0	31	0	0.0	12	0	0.0
4791	40	9	0	0.0	24	0	0.0	11	1	-6.6	31	0	0.0	40	7	1	-6.6	21	0	0.0	9	1	-6.6	25	0	0.0
4792	40	9	0	0.0	24	0	0.0	11	1	-6.6	31	0	0.0	40	7	1	-6.6	21	0	0.0	9	1	-6.6	25	0	0.0
4803	40	23	0	0.0	4	0	0.0	18	1	0.9	9	0	0.0	40	23	0	0.0	4	0	0.0	18	1	0.9	9	0	0.0
4804	40	1	0	0.0	15	0	0.0	6	0	0.0	13	0	0.0	40	1	0	0.0	15	0	0.0	6	0	0.0	12	0	0.0
4805	40	23	0	0.0	4	0	0.0	18	1	0.9	9	0	0.0	40	23	0	0.0	4	0	0.0	18	1	0.9	9	0	0.0
4806	40	1	0	0.0	15	0	0.0	6	0	0.0	13	0	0.0	40	1	0	0.0	15	0	0.0	6	0	0.0	12	0	0.0
4807	40	37	0	0.0	9	3	-6.6	42	1	0.9	10	0	0.0	40	37	0	0.0	9	3	-6.6	42	1	0.9	10	0	0.0
4808	40	31	0	0.0	8	3	-6.6	27	1	0.9	8	0	0.0	40	41	0	0.0	10	3	-6.6	36	1	0.9	8	0	0.0
4809	40	32	0	0.0	8	3	-6.6	27	1	0.9	8	0	0.0	40	42	0	0.0	10	3	-6.6	36	1	0.9	8	0	0.0
4810	40	1	0	0.0	15	0	0.0	6	0	0.0	13	0	0.0	40	1	0	0.0	15	0	0.0	6	0	0.0	12	0	0.0
4811	40	0	0	0.0	20	0	0.0	7	0	0.0	9	0	0.0	40	3	0	0.0	21	0	0.0	9	0	0.0	14	0	0.0
4812	40	0	0	0.0	20	0	0.0	7	0	0.0	9	0	0.0	40	3	0	0.0	21	0	0.0	9	0	0.0	14	0	0.0
4821	40	33	0	0.0	11	0	0.0	48	0	0.0	8	0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
4822	40	1	3	-6.6	1	3	-6.6	0	5	-6.6	6	3	-6.6	40	1	3	-6.6	2	3	-6.6	0	5	-6.6	6	3	-6.6
5303	40	18	0	0.0	20	0	0.0	16	0	0.0	27	0	0.0	40	110	2	-6.6	37	0	0.0	111	5	-6.6	34	0	0.0
5306	40	54	3	-6.6	10	0	0.0	38	0	0.0	17	1	-6.6	40	51	2	-6.6	68	0	0.0	42	1	-6.6	80	1	-6.6
5335	50	52	2	-6.6	12	0	0.0	55	0	0.0	20	0	0.0	50	68	2	-6.6	14	0	0.0	57	0	0.0	22	0	0.0
5336	50	116	3	-6.6	32	3	-6.6	127	0	0.0	37	0	0.0	50	138	3	-6.6	36	4	-6.6	137	0	0.0	41	0	0.0
5337	50	14	0	0.0	32	0	0.0	22	0	0.0	30	0	0.0	50	13	0	0.0	36	0	0.0	19	0	0.0	41	0	0.0
5338	50	31	0	0.0	87	0	0.0	35	0	0.0	84	0	0.0	50	32	0	0.0	98	0	0.0	41	0	0.0	99	0	0.0
5340	50	14	0	0.0	32	0	0.0	22	0	0.0	30	0	0.0	50	13	0	0.0	36	0	0.0	19	0	0.0	41	0	0.0
5345	50	52	2	-6.6	12	0	0.0	55	0	0.0	20	0	0.0	50	68	2	-6.6	14	0	0.0	57	0	0.0	22	0	0.0

ID	No Build													Build													
	Speed km/h	2024 No Build						2034 No Build						Speed km/h	2024 Build						2034 Build					
		Daytime			Night-time			Daytime			Night-time				Daytime			Night-time			Daytime			Night-time		
		Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB		Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB
5470	50	180	49	-4.3	243	25	-4.7	290	52	-2.2	370	45	-2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
6656	50	365	46	-4.6	179	44	-4.1	435	70	-3.0	314	48	-3.3	-	-	-	-	-	-	-	-	-	-	-	-	-
8346	80	658	161	-0.8	1544	115	0.5	803	170	0.2	1792	128	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-
8897	80	1918	144	-1.3	869	137	-0.1	2056	130	-0.7	970	157	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-
9601	60	2237	147	-2.7	987	154	-1.7	2468	132	-1.9	1122	180	-0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
9743	110	578	156	0.7	1346	110	1.9	715	160	1.8	1572	124	3.5	110	524	157	0.1	1374	106	1.4	645	155	1.2	1585	131	3.0
27407	60	1121	134	-2.6	1258	196	-1.3	1146	148	-1.7	1318	202	-0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
32464	40	2	0	0.0	5	0	0.0	3	0	0.0	8	0	0.0	40	10	0	0.0	6	0	0.0	5	0	0.0	6	0	0.0
34473	40	207	72	-4.9	317	27	-2.4	227	73	-3.2	371	26	-1.9	40	209	45	-5.0	206	23	-2.9	242	42	-3.2	205	7	-3.0
38383	-	-	-	-	-	-	-	-	-	-	-	-	-	40	11	0	0.0	3	0	0.0	27	0	0.0	3	0	0.0
39377	40	2	0	0.0	25	0	0.0	10	0	0.0	18	0	0.0	40	2	0	0.0	24	0	0.0	10	0	0.0	17	0	0.0
39383	40	23	0	0.0	4	0	0.0	18	1	0.9	9	0	0.0	40	23	0	0.0	4	0	0.0	18	1	0.9	9	0	0.0
39503	50	145	1	-6.6	52	0	0.0	290	0	0.0	103	2	-6.6	50	145	1	-6.6	52	0	0.0	290	0	0.0	103	2	-6.6
39509	50	362	2	-6.6	271	1	-6.6	476	1	-6.6	323	6	-2.6	50	362	2	-6.6	271	1	-6.6	476	1	-6.6	323	6	-2.6
49174	-	-	-	-	-	-	-	-	-	-	-	-	-	70	560	18	-2.1	372	24	-2.7	591	29	-1.0	418	21	-3.6
49180	-	-	-	-	-	-	-	-	-	-	-	-	-	70	154	11	-1.6	294	13	-3.5	205	25	-3.4	281	10	-2.8
49185	-	-	-	-	-	-	-	-	-	-	-	-	-	60	472	21	-3.1	310	20	-3.2	464	48	-2.7	370	18	-3.6
49190	-	-	-	-	-	-	-	-	-	-	-	-	-	60	119	7	-1.9	149	6	-3.5	147	7	-3.4	182	7	-5.3
49195	-	-	-	-	-	-	-	-	-	-	-	-	-	110	909	94	-0.4	657	134	0.7	1069	99	1.3	759	144	2.5
49196	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1923	151	-0.4	1242	134	0.9	1945	181	1.0	1460	143	2.3
49208	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1260	143	-0.7	1661	184	0.8	1453	189	0.7	1819	224	2.4
49218	-	-	-	-	-	-	-	-	-	-	-	-	-	60	151	12	-4.5	79	5	-5.3	152	20	-3.9	90	1	-5.3
49223	-	-	-	-	-	-	-	-	-	-	-	-	-	110	593	116	-0.3	678	81	1.4	645	124	0.9	846	98	3.3
49233	-	-	-	-	-	-	-	-	-	-	-	-	-	110	166	80	0.0	349	66	1.8	200	90	1.3	421	82	3.7
49234	-	-	-	-	-	-	-	-	-	-	-	-	-	110	786	85	-0.7	496	132	0.9	925	86	1.4	576	144	2.8
49237	-	-	-	-	-	-	-	-	-	-	-	-	-	70	198	22	-2.8	394	15	-1.4	250	33	-1.6	392	18	-0.1
49239	-	-	-	-	-	-	-	-	-	-	-	-	-	70	154	18	-2.5	363	13	-1.1	186	23	-0.7	357	17	0.0
49241	-	-	-	-	-	-	-	-	-	-	-	-	-	70	484	19	-2.2	193	20	-2.8	478	32	-1.3	219	16	-3.4
49242	-	-	-	-	-	-	-	-	-	-	-	-	-	70	382	12	-1.7	144	17	-2.6	386	21	-0.9	162	15	-3.3
49253	-	-	-	-	-	-	-	-	-	-	-	-	-	40	33	0	0.0	11	0	0.0	48	0	0.0	8	0	0.0
49257	-	-	-	-	-	-	-	-	-	-	-	-	-	110	533	154	0.2	1369	103	1.3	641	160	1.1	1598	131	2.9
49286	-	-	-	-	-	-	-	-	-	-	-	-	-	110	1776	134	-0.3	741	123	1.0	1875	121	0.4	873	144	2.7
49287	-	-	-	-	-	-	-	-	-	-	-	-	-	110	1241	108	-0.8	806	156	0.7	1382	134	0.8	950	169	2.5
49313	-	-	-	-	-	-	-	-	-	-	-	-	-	110	637	63	-0.1	619	131	1.0	701	83	1.2	709	139	3.0
49320	-	-	-	-	-	-	-	-	-	-	-	-	-	110	479	68	0.3	471	74	1.8	505	80	2.0	569	73	3.6
49376	-	-	-	-	-	-	-	-	-	-	-	-	-	110	566	76	-0.1	285	103	1.1	633	65	1.7	361	112	3.1
49381	-	-	-	-	-	-	-	-	-	-	-	-	-	110	445	104	-0.1	604	79	1.6	490	106	1.3	767	96	3.4
49406	-	-	-	-	-	-	-	-	-	-	-	-	-	60	198	19	-4.9	338	12	-1.7	211	21	-1.3	378	18	-1.4
49455	-	-	-	-	-	-	-	-	-	-	-	-	-	110	648	126	-0.4	938	91	1.5	702	126	1.3	1155	115	3.1
49579	40	7	3	-6.6	18	3	-6.6	8	5	-6.6	19	3	-6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
49588	-	-	-	-	-	-	-	-	-	-	-	-	-	40	8	3	-6.6	19	3	-6.6	6	5	-6.6	19	4	-6.6
49597	80	152	18	-1.9	362	13	-0.4	183	20	-0.5	353	15	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
49606	40	203	24	-3.9	75	17	-6.6	214	33	-1.7	146	25	-2.7	-	-	-	-	-	-	-	-	-	-	-	-	-
49627	50	213	35	-3.9	154	35	-3.7	299	55	-3.8	253	39	-3.0	-	-	-	-	-	-	-	-	-	-	-	-	-
53452	50	66	2	-6.6	89	4	-6.6	119	6	-6.6	212	4	-6.6	50	68	2	-6.6	87	4	-6.6	128	6	-6.6	214	5	-6.6
53455	50	7	1	-6.6	3	0	0.0	14	0	0.0	9	0	0.0	50	7	1	-6.6	3	0	0.0	14	0	0.0	9	0	0.0
55878	60	836	105	-2.6	1118	176	-1.3	870	129	-1.8	1233	190	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
55879	60	1337	143	-2.7	1008	124	-1.4	1424	168	-1.5	1139	130	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
55882	100	988	125	-0.7	1545	184	0.9	1064	155	0.7	1644	219	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
55890	60	575	29	-4.0	363	14	-2.6	553	25	-4.2	421	15	-2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
55891	60	333	34	-5.5	400	30	-4.9	426	43	-4.4	453	22	-3.3	-	-	-	-	-	-	-	-	-	-	-	-	-
55925	50	255	57	-4.3	481	28	-3.4	355	65	-2.9	575	65	-2.7	-	-	-	-	-	-	-	-	-	-	-	-	-
55927	60	1846	148	-2.6	1098	134	-1.4	1840	184	-1.4	1266	138	-0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
56244	80	821	156	-0.9	1909	116	0.4	944	172	0.0	2150	131	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-
56250	50	203	5	-6.6	98	2	-6.6	265	3	-6.6	105	5	-6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
56251	50	181	3	-6.6	244	3	-6.6	195	2	-6.6	216	3	-6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
60065	-	-	-	-	-	-	-	-	-	-	-	-	-	80	1438	83	-2.0	769	63	-1.2	1434	102	-0.9	898	68	-0.6
60068	-	-	-	-	-	-	-	-	-	-	-	-	-	80	624	78	-2.1	1033	50	-0.8	744	102	-0.7	1108	85	0.1
60081	-	-	-	-	-	-	-	-	-	-	-	-	-	60	305	27	-5.5	456	19	-4.1	432	39	-3.9	565	15	-2.6
60107	-	-	-	-	-	-	-	-	-	-	-	-	-	50	246	37	-4.2	308	24	-3.3	338	44	-3.1	407	26	-2.5

ID	No Build													Build												
	Speed km/h	2024 No Build						2034 No Build						Speed km/h	2024 Build						2034 Build					
		Daytime			Night-time			Daytime			Night-time				Daytime			Night-time			Daytime			Night-time		
		Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB		Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB	Hourly peak number of light vehicles	Hourly peak number of heavy vehicles	Heavy vehicle correction dB
60114	-	-	-	-	-	-	-	-	-	-	-	-	-	60	1369	103	-3.2	811	73	-3.3	1491	125	-2.3	1024	83	-2.1
60135	-	-	-	-	-	-	-	-	-	-	-	-	-	60	660	65	-3.0	530	35	-3.0	752	81	-1.8	685	74	-1.5
60139	-	-	-	-	-	-	-	-	-	-	-	-	-	60	554	70	-3.1	818	48	-2.4	629	74	-2.4	850	51	-1.4
60142	-	-	-	-	-	-	-	-	-	-	-	-	-	60	629	77	-3.3	590	42	-2.0	661	91	-2.9	744	80	-1.4
60144	-	-	-	-	-	-	-	-	-	-	-	-	-	50	367	78	-4.3	569	51	-3.1	496	93	-3.8	770	63	-2.5
60146	-	-	-	-	-	-	-	-	-	-	-	-	-	60	150	30	-2.9	199	20	-3.7	247	38	-1.2	299	31	-1.5
60154	-	-	-	-	-	-	-	-	-	-	-	-	-	50	178	48	-4.3	242	25	-4.7	288	51	-2.2	370	45	-2.6
60155	-	-	-	-	-	-	-	-	-	-	-	-	-	60	167	60	-3.7	459	21	-1.4	201	47	-2.7	589	39	-0.9
60169	-	-	-	-	-	-	-	-	-	-	-	-	-	60	614	46	-3.8	186	24	-3.5	680	50	-2.4	243	31	-3.4
60170	-	-	-	-	-	-	-	-	-	-	-	-	-	60	161	14	-4.6	54	7	-5.3	204	23	-2.6	65	11	-2.8
60173	-	-	-	-	-	-	-	-	-	-	-	-	-	60	173	46	-3.1	458	25	-1.4	188	64	-3.3	570	60	-0.8
60176	-	-	-	-	-	-	-	-	-	-	-	-	-	60	849	38	-3.6	463	25	-3.9	926	40	-3.1	546	30	-2.6
60177	-	-	-	-	-	-	-	-	-	-	-	-	-	60	1917	97	-3.1	880	51	-2.8	2036	95	-3.5	1015	62	-2.7
60179	-	-	-	-	-	-	-	-	-	-	-	-	-	60	1069	59	-2.9	418	26	-1.9	1108	55	-3.8	472	32	-2.7
60182	-	-	-	-	-	-	-	-	-	-	-	-	-	60	229	11	-4.4	315	21	-3.7	280	28	-3.0	336	15	-3.3
60185	-	-	-	-	-	-	-	-	-	-	-	-	-	60	121	5	-3.4	53	11	-3.4	161	7	-1.0	66	16	-2.1
60189	-	-	-	-	-	-	-	-	-	-	-	-	-	60	604	77	-2.3	1466	40	-2.5	661	84	-2.1	1676	50	-1.7
60196	-	-	-	-	-	-	-	-	-	-	-	-	-	60	831	86	-2.5	1788	60	-2.8	946	108	-2.3	2011	67	-2.1
60207	-	-	-	-	-	-	-	-	-	-	-	-	-	50	293	3	-6.6	276	3	-6.6	300	2	-6.6	258	3	-6.6
60210	-	-	-	-	-	-	-	-	-	-	-	-	-	50	317	7	-6.6	153	8	-5.1	382	4	-6.6	160	11	-4.0
60215	-	-	-	-	-	-	-	-	-	-	-	-	-	50	126	8	-5.1	69	10	-4.4	179	7	-4.4	72	12	-2.6
60218	-	-	-	-	-	-	-	-	-	-	-	-	-	50	714	40	-4.6	763	27	-5.2	752	49	-4.4	873	24	-3.7
60221	-	-	-	-	-	-	-	-	-	-	-	-	-	60	133	0	0.0	44	0	0.0	130	0	0.0	43	0	0.0
60228	-	-	-	-	-	-	-	-	-	-	-	-	-	60	367	75	-2.0	1019	37	-2.3	441	70	-1.7	1179	47	-1.5
60229	-	-	-	-	-	-	-	-	-	-	-	-	-	60	421	33	-3.3	337	17	-3.4	441	34	-2.7	428	16	-1.6
60232	-	-	-	-	-	-	-	-	-	-	-	-	-	60	502	34	-3.4	363	25	-3.9	544	36	-2.3	444	25	-2.6
60237	-	-	-	-	-	-	-	-	-	-	-	-	-	60	391	74	-2.1	1079	36	-2.3	475	71	-1.8	1249	47	-1.5
60252	-	-	-	-	-	-	-	-	-	-	-	-	-	60	1200	59	-2.9	465	26	-1.9	1236	56	-3.9	515	32	-2.7
60278	-	-	-	-	-	-	-	-	-	-	-	-	-	60	700	24	-3.7	416	18	-3.1	677	28	-4.3	484	17	-2.3
60293	-	-	-	-	-	-	-	-	-	-	-	-	-	50	228	36	-4.2	154	34	-3.6	336	59	-3.4	253	38	-3.0
60321	-	-	-	-	-	-	-	-	-	-	-	-	-	60	347	16	-4.1	366	31	-3.6	441	35	-2.5	402	31	-2.7

F2.2 Validation Traffic Volumes

Associated logger location for validation	Section	Direction	Speed km/h	2016 Validation					
				Daytime			Night-time		
				Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB	Hourly average number of light vehicles	Hourly average number of heavy vehicles	Heavy vehicle correction dB
1, 11	Pacific Highway 700m South of Stadium Dr	NB	93.2	761	99	-0.3	138	41	1.6
	Pacific Highway 700m South of Stadium Dr	SB	103.5	752	117	0.0	123	33	1.4
2	North Boambee Road - 100m West of Highlander Drive	WB	74.7	10	2	-0.5	2	0	0.0
	North Boambee Road - 100m West of Highlander Drive	EB	76.0	10	2	-4.4	2	0	0.0
4, 5	Coramba Road	WB	81.0	166	13	-3.3	16	2	-3.8
	Coramba Road	EB	77.8	160	16	-2.9	28	3	-4.0
	Bennetts Road 200m West of Coramba road	WB	64.3	8	1	-5.1	1	0	0.0
	Bennetts Road 200m West of Coramba road	EB	67.2	7	1	-4.9	1	0	0.0
8, 9, 10, 14, 15, 18	Pacific Highway - 200m north of Charlesworth Bay Rd	NB	84.9	822	108	-0.2	151	38	0.9
	Pacific Highway - 200m north of Charlesworth Bay Rd	SB	84.4	761	145	-1.0	157	39	-0.3
	Pacific Highway - Adjacent to Fern Tree Place	NB	78.0	822	66	-0.7	119	48	0.8
	Pacific Highway - Adjacent to Fern Tree Place	SB	81.0	806	85	-1.0	133	44	-0.3
	Pacific Highway - Adjacent to end of Coachmens Close	NB	90.7	918	126	-0.5	181	43	1.2
	Pacific Highway - Adjacent to end of Coachmens Close	SB	109.3	663	122	0.3	143	24	2.2