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Study of noise level at roundabouts in Maminasata area

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Abstract. The rapid growth of a country affects one of many fields, such as transportation, which is important for development and as public facilities. This research was conducted at the Mandai Roundabout, Riburane Roundabout, and the Samata Roundabout. This study aims to analyze the noise level at 3 observation points, as well as noise prediction by using the CoRTN method (Traffic Noise Calculation) based on Vissim Software in 2019-2023. Data collected for 12 hours from 07.00 until 19.00 by taking samples for 10 minutes per hour using the Sound Level Meter (SLM) type TM-103. While for the prediction results, the number of vehicles and vehicle speed are used. For vehicle speed predictions, the number of vehicles are added by 7% per year then run the program Vissim. The results are divided into 3 locations, the Mandai Roundabout about 76.21 dB; Riburane Roundabout about 75.82 dB; and the Samata Roundabout about 80.09 dB where the noise level is higher than the standard from government, Minister of Environment No.48 on 1996 which stated the standard for noise level in trading and service area is 70 dB. The estimated result based on the CoRTN model on the roundabout in the Maminasata area using the Leq formula is 73.47 dB for the Mandai Roundabout; 70.07 dB for Riburane Roundabout; and 73.40 dB for the Samata Roundabout. There has been a difference in predicted results from 2019-2023. In 2019 there has been a difference of about $\geq$ 3 dB, which is 4.1 dB at the Mandai Roundabout so that improvements need to be made to this region.

1. Introduction

Growth in population each year increases will be followed by growth in vehicle ownership to meet the need for easy transportation in doing every activity. Growth average motorized vehicles in Makassar range 7% every year. Growth rate dominated by two-wheeled vehicles, which, since 2014, reaching one million units. A traffic jam generally occurs in the intersection, either three-intersection, four-intersection, or five-intersection. Rules of intersection in the form of signs, roundabouts, and traffic lights are very necessary as an effort in helping the movement of vehicles at an intersection so as not point of excessive conflict between each vehicle when entering an intersection. Roundabout traffic is an intersection wherein same-way traffic crossing around around road in the middle of the intersection. This roundabout has the same capacity as the intersection that is controlled by the traffic light. Roundabouts in the Maminasata area are one of the protocol roads that became the center of activity public transportation in running their needs. The aggressive nature of the rider is also often the trigger of traffic jams, but this condition does not last long. Based on the background above, the researchers are interested in conducting research with the title : Based on the background above, this

paper aims to: 1) Analyze the level of roundabout traffic noise in the Maminasata region, and 2) Predict the level of roundabout traffic noise in Makassar City using the CoRTN (Calculation of Road Traffic Noise) method with vissim software based traffic simulation.

2. Literature Review

2.1 Noise
Noise or noise pollution is often referred to as an unwanted or interpretable noise or could also be called the wrong voice at the wrong place and time. Noise is one of the main causes of health problems for the workers and the community around the workplace and often causes protests and anger of residents who live nearby the source of the noises. The sources of the noise usually coming from motor vehicles, industrial estates or factories, airplanes, trains, public places, and commerce [1]

2.2 Noise Level of Quality Standards
Noise Level Quality Standards is the maximum noise limit level allowed to be discharged into the environment from businesses or activities so that it does not cause health problems and environmental comfort. Based on the Decree of the State Minister Environmental Number KEP.48 / MENLH / 11/1996, November 25 1996 [2] concerning the allocation of noise level standards Area or Environment Activities can be seen in table 1 below.

Table 1. Noise Level Quality Standards

Area Designation	Noise Level
Housing and settlement	55
Trade and service	70
Office and trade	65
Green open space	50
Industry	70
Airport	75
Government and public facilities	60
Recreation	70
Hospital	55
School	55
Worship place	55

Source: The Decree of the State Minister Environmental, 1996.

2.3 Noise Level Prediction with Models Calculation of Road Traffic Noise (CoRTN)
The CoRTN model is a predictive model and evaluation of noise levels due to traffic that is stated in L10 or Leq. CoRTN model can be used on urban roads and between cities. In its calculations, this model has been considering several influential factors like vehicle volume and composition, speed, gradient, pavement type, ground level type, horizontal and vertical distance, environmental conditions of the road, and the presence of buildings or noise barrier walls.

There is certainty of special assumptions that are developed by Transport and Road Research Laboratory and Department of Transport-Wels Office, HMSO, 1998 for signalized intersections is as follows [3]:

1. Intersections are divided into segments/arms and such that changes/variations noise in each segment becomes small
2. Calculate the basic noise level at a 10 m distance from the closest side of the edge of the segment.
3. Combine the amount of noise level from each -each segment so that will be the level of intersection noise.
4. Each arm at an intersection is a segment and traffic speed is the actual speed of the traffic at an intersection.

3. Methodology

Research conducted is a quantitative research type. Data needed for research analysis can be obtained directly or indirectly. Data obtained directly through measurement, namely condition data Environment condition, geometric intersections, traffic volume, vehicle speed, existing coordinates intersection of the height of trees and buildings around research sites and vehicle noise. This research produces intersection noise data in Makassar City for this time, which was obtained through a noise survey using a sound level meter. (SLM).

3.1 Research Sites

This noise level measurement is done at the roundabout in Makassar City, which is Mandai roundabout, and samata roundabout. The map of research locations can be seen in figure 1.
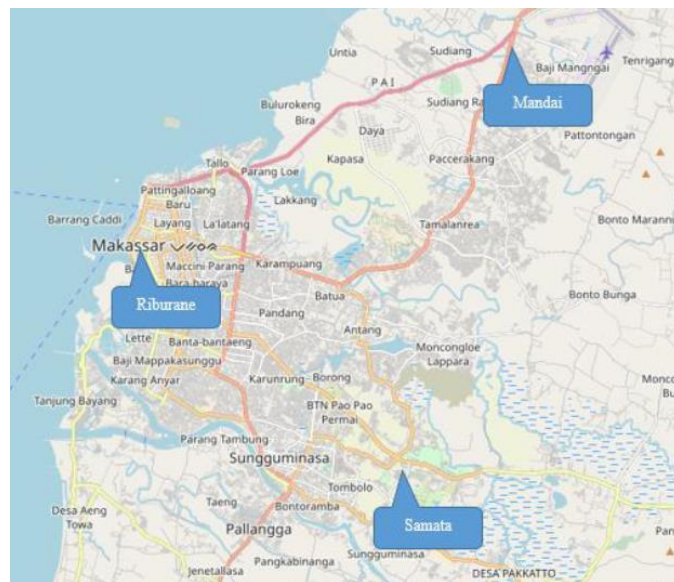
Figure 1. The map of research locations.

3.2 Research time

Research conducted in which there is study literature, preliminary surveys, data collection, and data processing. The data collection process is done on Tuesday, 28 August 2018 at the Samata roundabout; Wednesday, August 29, 2018 at the Tugu Riburane Roundabout; and Thursday 30 August 2018 at the Mandai roundabout at 07.00 - 18.00 WITA.

3.3 Survey Tools

Here are some of the equipment used for surveys in the field, which is shown in picture 2

Figure 2. Noise surveying tools.

3.4 Noise Level Measurement Survey Method

Noise level measurements are made along with vehicle volume measurements, vehicle speed and vehicle horn volume. This measurement is done 10 minutes per hour for 12 hours of observation. The sound Level Meter (SLM) is placed at the tripod pad and set with height 1.2 m from ground level and a minimum distance of 1m from the outermost line of the road. The volume of the counted crossed vehicle is distinguished by the type of vehicles, which is HV, LV, and MC. Whereas for Vehicle speed measurement is used speed point by using a speed gun tool. The number of vehicles observed is a minimum of 20 Vehicle samples for each type of vehicle observation.

4. Results and discussion

The results of the noise measurement level compilation data on the road location are presented in the following sub-sections.

4.1 Noise level

a. Mandai roundabout Noise Level

The noise level graph for Mandai Roundabouts can be seen in figure 3.
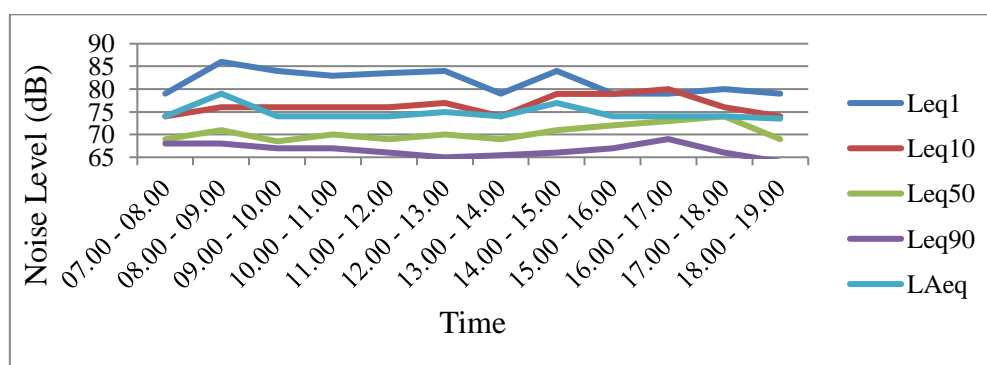
Figure 3. Mandai roundabout noise level chart.

Viewed from Figure 3, L90, which is the background noise, is in the range of 65 - 70 dB and Leq1, which is the estimated level the maximum noise is in the range 75-87 dB. The highest equivalent noise is at 12.00-13.00 WITA, with a value of 78.27 dB. This matter occurs because at that hour is the top hour the large vehicle operates through these roundabouts. The value of the equivalent average noise level (Leqday) alone amounted to 76.21 dB. When compared to the value of Leqday with the noise level quality standards that applies, which is the decision of Minister of Environment No. 48, those value exceeds the maximum quality standard of 70 dB.
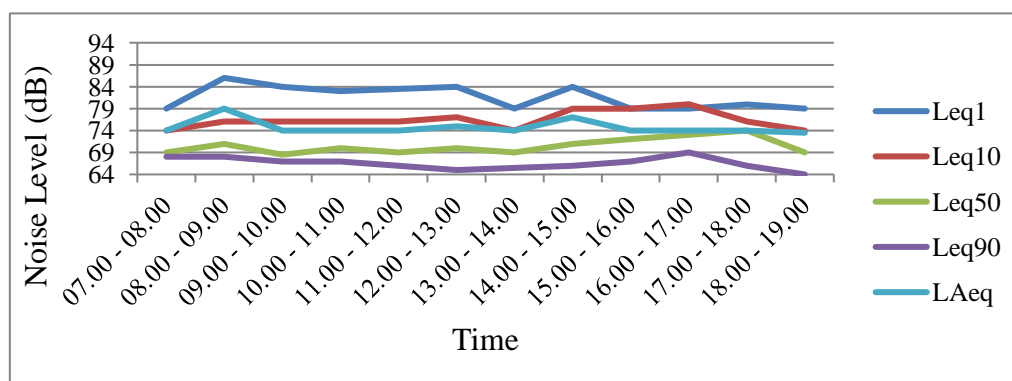
Figure 4. Riburane roundabout noise level chart.

Viewed from figure 4, L90, which is the background noise, is in the range of 64 - 69 dB and Leq1, which is the estimated level the maximum noise is in the range 74-89 dB. The highest equivalent noise value is at 08.00 WITA, with a value of 77.90 dB. This happened because at that hour is the working hour. The value of the equivalent average noise level (Leqday) alone amounted to 75,82 dB. When compared to the value of Leqday with the noise level quality standards that applies, which is the decision of Minister of Environment No. 48, those value exceeds the maximum quality standard of 70 dB.
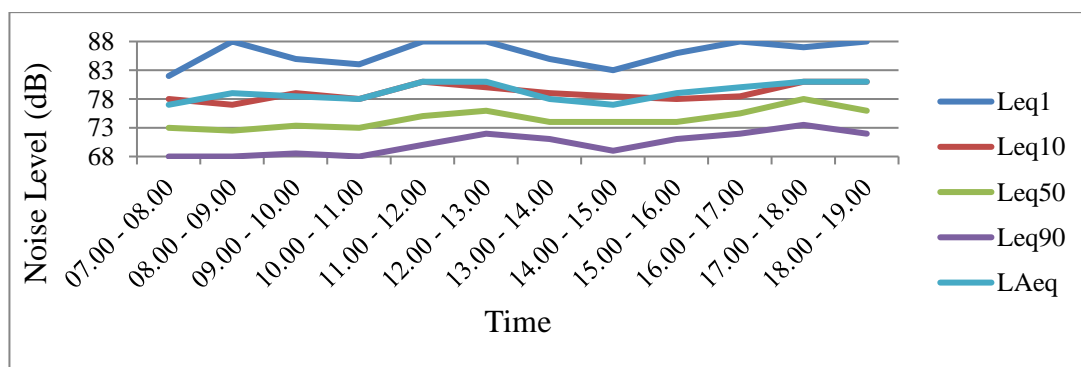
Figure 5. Samata roundabout noise level chart.

Viewed from picture 5, L90, which is the background noise is in the range of 68 - 73 dB and Leq1, which is the estimated level the maximum noise is in the range 73 - 90 dB. The highest equivalent noise value is at 18 WITA, with a value of 88.57 dB. This happened because at that hour is the hour Large vehicle operate through roundabouts and this is an after work hour. The value of the equivalent average noise level (Leqday) alone amounted to 80.09 dB. When compared to the value of Leqday with the noise level quality standards that applies, which is the decision of Minister of Environment No. 48, those value exceeds the maximum quality standard of 70 dB.

4.2 Vehicle Volume

In picture 6, you can see that MC has the highest presentation at the Riburane Roundabout and Samata Roundabout, and LV has the highest presentation in the Mandai Roundabout. Whereas HV is the vehicle with the lowest composition. The difference in the three compositions is due to the order land used around the three roundabouts, where offices, trade, services, schools are very dominant, as well as all three of these roundabouts connecting residential areas with offices, trade and services, universities, schools, and airports. This volume can contribute to the noise level [3].
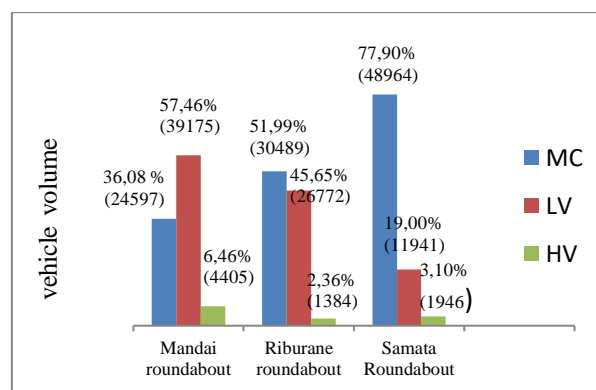
Figure 6. Vehicle composition chart

4.3 Vehicle speed

Table 2. Vehicle speed recapitulation results.

No.	Intersection	Average Vehicle Speed (Km/Hour)		
		MC	LV	HV
1	Mandai roundabout	48.3	38.9	34.6
2	Riburane roundabout	23.7	23.8	21.4
3	Samata roundabout	23.4	22.5	21.7

Mandai roundabout is a roundabout that has the highest speed for all three types of vehicles. This is due to the dimensions differences of the intersection and the setting of the traffic light on each arm [5]

4.4 Calculation of the Noise Level Prediction Using the CoRTN Method
The following is a recapitulation table of data analysis results on the Mandai Roundabout based on CoRTN method, which can be seen in table 3.

Table 3. Mandai Roundabout Noise Level Prediction Results.

	SEGMENT			
	Airport	Toll	Perintis	Maros
Basic noise level dB (A)	67.0	69.0	67.0	67.5
Propagation correction dB (A)	-5.5	3.5	0.2	-0.5
Layout correction in the field	-0.6	-4.2	2.3	-0.4
Occurred noise	61.0	68.3	69.5	71.5
Combined noise level dB (A)	73.47			

Viewed from table 3, the segment that is producing the biggest noise is the Toll segment with a noise level of 69.0 dB, and the Airport segment and points segment produce the smallest noise level, which is 67.0 dB. Level noise that occurs in each segment later used in 2.15 equation and produce 73.47db Lgab

The following is a recapitulation table of data analysis results on the Mandai Roundabout based on CoRTN method which can be seen in table 4

Table 4. Riburane roundabout noise level prediction results.

	SEGMENT		
	Nusantara	Rotterdam	A. Yani
Basic noise level dB (A)	67.6	67.9	67.1
Propagation correction dB (A)	4.6	4.6	-0.1
Layout correction in the field	-3.5	-0.4	-0.8
Occured noise	68.8	72.2	66.3
Combined noise level dB (A)	73.8		

Table 5. Samata roundabout noise level prediction results.

	SEGMENT			
	Hertasning	UIN	Mustafa	Antang
Basic noise level dB (A)	70.3	66.1	64.0	67.6
Propagation correction dB (A)	2.0	3.7	-0.4	2.0
Layout correction in the field	-3.5	3.1	3.3	-2.0
Occured noise	68.8	72.9	66.9	70.4
Combined noise level dB (A)	75.78			

Viewed from table 5, the segments that produces the biggest noise is the hertasning segment with a noise level of 70.3 dB and Mustafa segments produce the smallest noise levels which is 64.0 dB. Level noise that occurs in each segment later used in 19 equation and produce 75.8 Lgab.

4.5 Comparison of noise level analysis results and noise level prediction CoRTN method
To see combined noise levels and applicable noise level quality standards, combined noise levels prediction and measurement results that obtained has exceeded the quality standard.

Table 6. The T Test of direct measurement results and CoRTN prediction results.

	CoRTN Prediction (dB)	Measurement (dB)	Difference (dB)	t Stat	t Critical
Airport roundabout	73.47	76.21	2.74		
Riburane roundabout	70.07	75.82	5.75	-4.247	2.92
Samata roundabout	73.40	80.09	6.69		

Based on table 6, the difference from Direct measurement results data with CoRTN method predicted results, the test results are obtained -4.247 <2.92 or t-stat value <t-critical. So Ho is accepted which shows the direct measurement result data with the results of predictions with CoRTN methods are statistically the same or there is no significant difference.

4.6 Results of volume and speed prediction analysis Vissim based software micro models calibration – simulation
Calibration results of micro-simulation models presented in 3D Micro-Simulation Visualizationin Vissim Software in figures 7, 8 and 9 as follows

Figure 7. Micro 3D visualization – mandai roundabout vissim simulation.

Figure 8. Micro 3D visualization – mandiri roundabout vissim simulation.

Figure 9. Micro 3D visualization – samata roundabout vissim simulation.

Calibration results using the Geoffrey E. Havers Test shows that at the Samata Roundabout intersection, Tugu Mandiri and Mandai are well calibrated.

4.7 Vehicle Speed Prediction based on Vissim software
To predict the speed of a vehicle using Vissim software, vehicle volume data is requied which will be input into the Vissim Software. The volume of vehicles that will be input is the vehicle volume data from the measurement results plus 7% annually according to rate numbers motor vehicle growth in Makassar City. Volume data inputted on Vissim Software can be seen in Tables 7, 8, and 9.

Table 7. Vehicle Volume in 2018 – 2023 at the Mandai Roundabout.

Time	Street	Vehicle Volume (vehicle/hour)					
		Observation (2018)	2019 (+7%)	2020 (+7%)	2021 (+7%)	2022 (+7%)	2023 (+7%)
	Airport	1223	1309	1394	1480	1565	1651
07.00	Toll	1678	1795	1913	2030	2148	2265
	Perintis	1559	1668	1777	1886	1996	2105
	Maros	1177	1259	1342	1424	1507	1589
	Airport	1636	1751	1865	1980	2094	2209
13.00	Toll	1842	1971	2100	2229	2358	2487
	Perintis	1189	1272	1355	1439	1522	1605
	Maros	965	1033	1100	1168	1235	1303
	Airport	1915	2049	2183	2317	2451	2585
16.00	Toll	1953	2090	2226	2363	2500	2637
	Perintis	1220	1305	1391	1476	1562	1647
	Maros	879	941	1002	1064	1125	1187

Table 8. Vehicle Volume in 2018 – 2023 at the Riburane Roundabout.

Time	Street	Vehicle Volume (vehicle/hour)					
		Observation (2018)	2019 (+7%)	2020 (+7%)	2021 (+7%)	2022 (+7%)	2023 (+7%)
	Nusantara	1119	1274	1358	1441	1524	1608
07.00	Rotterdam	2329	2492	2655	2818	2981	3144
	A.Yani	1408	1507	1605	1704	1802	1901
	Nusantara	1433	1533	1634	1734	1834	1935
13.00	Rotterdam	2083	2229	2375	2520	2666	2812
	A.Yani	1402	1500	1598	1696	1795	1893
	Nusantara	1832	1960	2088	2217	2345	2473
16.00	Rotterdam	1438	1539	1639	1740	1841	1941
	A.Yani	1630	1744	1858	1972	2086	2201

Table 9. Vehicle Volume in 2018 – 2023 at the Samata Roundabout.

Time	Street	Vehicle Volume (vehicle/hour)					
		Observation (2018)	2019 (+7%)	2020 (+7%)	2021 (+7%)	2022 (+7%)	2023 (+7%)
	Hertasning	1223	1309	1394	1480	1565	1651
07.00	UIN	1559	1668	1777	1886	1996	2105
	Mustafa	1676	1793	1911	2028	2145	2263
	Antang	1177	1259	1342	1424	1507	1589
	Hertasning	1636	1751	1865	1980	2094	2209
13.00	UIN	1190	1273	1357	1440	1523	1607
	Mustafa	1845	1974	2103	2232	2362	2491
	Antang	962	1029	1097	1164	1231	1299

	Hertasning	1915	2049	2183	2317	2451	2585
16.00	UIN	1220	1305	1391	1476	1562	1647
	Mustafa	1956	2093	2230	2367	2504	2641
	Antang	879	941	1002	1064	1125	1187

If the vehicle volume data has been entered, set the Vehicle Travel Time in the Vissim Software the it will be running to get speed data. The resulting vehicle speed data can be seen in table 10.

Table 10. Vehicle Speed at 2018 – 2023.

Roundabout	Street	2019 (km/hour)	2020 (km/hour)	2021 (km/hour)	2022 (km/hour)	2023 (km/hour)
Mandai roundabout	Airport	1.72	1.62	1.75	1.61	1.44
	Toll	4.88	4.71	3.55	2.41	2.60
	Perintis	8.42	8.41	5.93	3.81	3.44
	Maros	2.57	2.61	2.50	2.15	2.55
Riburane roundabout	Nusantara	22.88	19.62	18.90	22.89	18.48
	Rotterdam	24.96	25.28	24.48	25.39	23.76
	A.Yani	16.09	15.74	15.77	16.05	15.36
Samata roundabout	Hertasning	26.77	23.93	18.52	18.14	25.78
	UIN	15.91	9.51	8.94	6.33	5.38
	Mustafa	12.65	5.70	6.00	2.73	8.51
	Antang	15.80	7.59	7.37	8.16	13.17

4.8 Noise Level Prediction for 2019-2023 with the CoRTN method

Prediction method used in predicting noise at the roundabout area in Maminasata is Calculation of Road Traffic Noise (CoRTN). Then, replace the vehicle volume and speed data in the formula that has been used to predict noise levels with original data. From the results of the analysis, the recapitulation of prediction results the noise level can be seen in table 11.

Table 11. Noise Level Prediction Recapitulation Results at Roundabout in Maminasata Area 2019 – 2023.

Location	Prediction (dB)					
	2018	2019 (+7%)	2020 (+7%)	2021 (+7%)	2022 (+7%)	2023 (+7%)
Mandai roundabout	73.47	77.57	78.74	78.97	80.37	80.96
Riburane roundabout	70.07	70.07	70.22	70.34	72.11	73.13
Samata roundabout	73.4	73.46	73.58	73.63	73.65	74.78

Based on table 11, all three roundaboutshas a difference of analysis results of less than 3 dB for 2019-2023 prediction results. While the difference between direct measurements and Predictions results using the CoRTN method occur due to factors that don't covered either during measurement or when predictive analysis stage.

5. Conclusion

Based on the objectives of this study which based on the results of research and data analysis,then the following conclusions are :

1. Noise level at the roundabout in the area Maminasata which is divided into 3 locations which is Mandai Roundabout is 76.21 dB, Riburane Roundabout is 75.82 dB; and Samata Roundabout is 80.09 dB where all three level of the noise exceeds the KepmenLH No. 48 noise level quality standard for the trade and service area which is 70 dB.

2. The results of the CoRTN model based noise level prediction at the roundabout in the Maminasata area have differences with the calculations using the Leq formula which is 73.47 dB for Mandai roundabout; 70.7 dB for Riburane roundabout; dan 73.40 dB for Samata roundabout. in 2019 there was already a difference of ≥ 3 dB namely 4.1 dB at the Mandai Roundabout, so that noise handling needs to be done in this region.

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