Noise Modeling Report from the Construction Activities of the Tangguh LNG Expansion Project

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1. Introduction

1.2 Background and Objective of the Modeling

The Tangguh LNG will expand its operations by constructing the LNG Train 3 as the initial phase of the expansion and proposed further expansion, among others the construction of the LNG Train 4 and other supporting facilities. The activity includes the construction of new units related to the activities.

During the construction phase, the heavy equipment used will become a new source of noise in the Tangguh LNG area. As the noise emissions will be continuously during the Tangguh LNG construction period, The noise modeling is needed with the purpose to predict the spread of noise caused by the Tangguh LNG construction activities.

1.3 Description of the Activities

The construction activities of the Tangguh LNG Expansion Project are proposed to occur from 2014 to 2018. During this period, various types of activities will be performed throughout the Tangguh LNG area, however they will not be performed simultaneously. The construction activities area is divided into seven areas as presented in **Table 1.1** and **Figure 1.1**.

Table 1.1 The Construction Activities at the Tangguh LNG Expansion Area

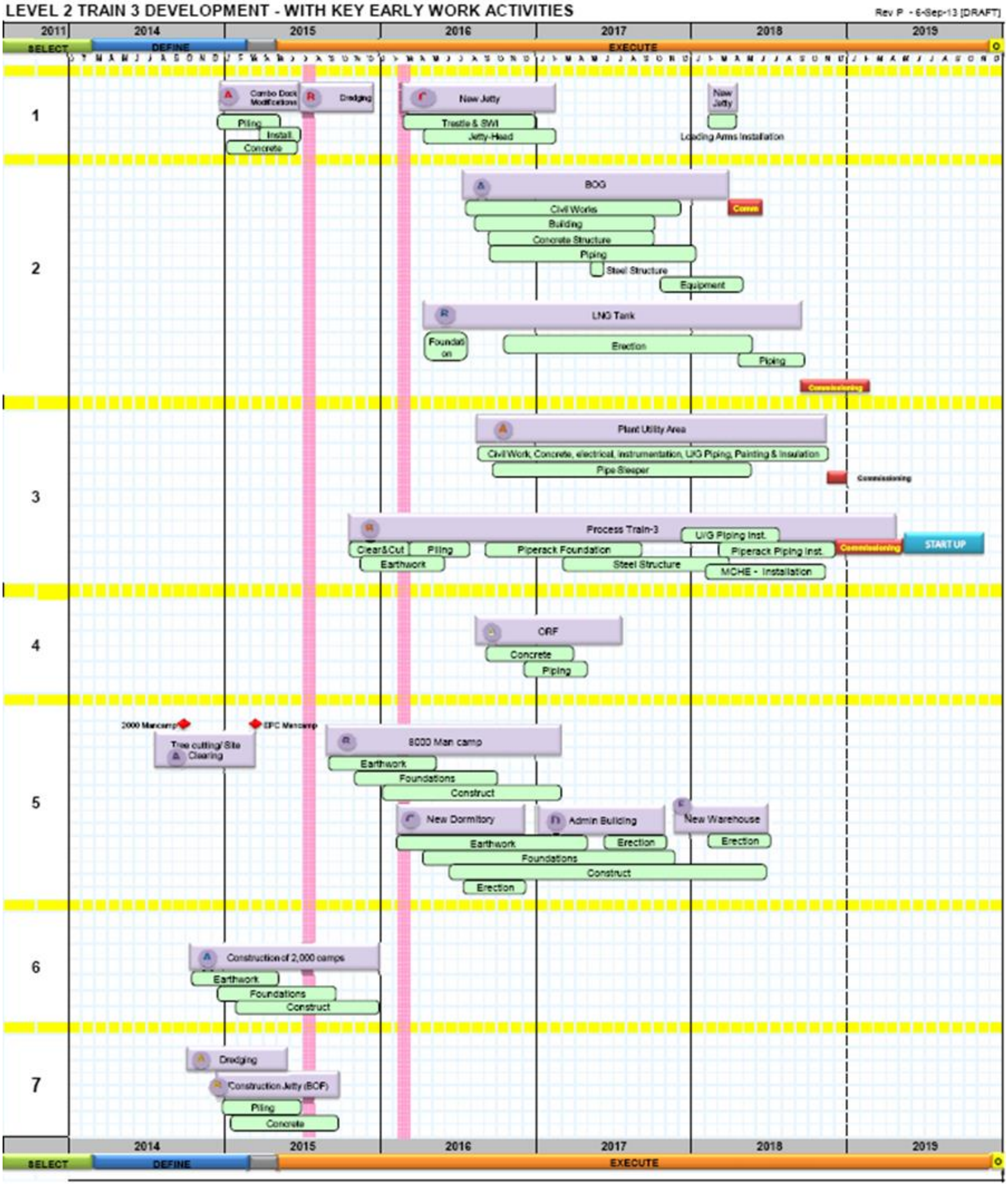
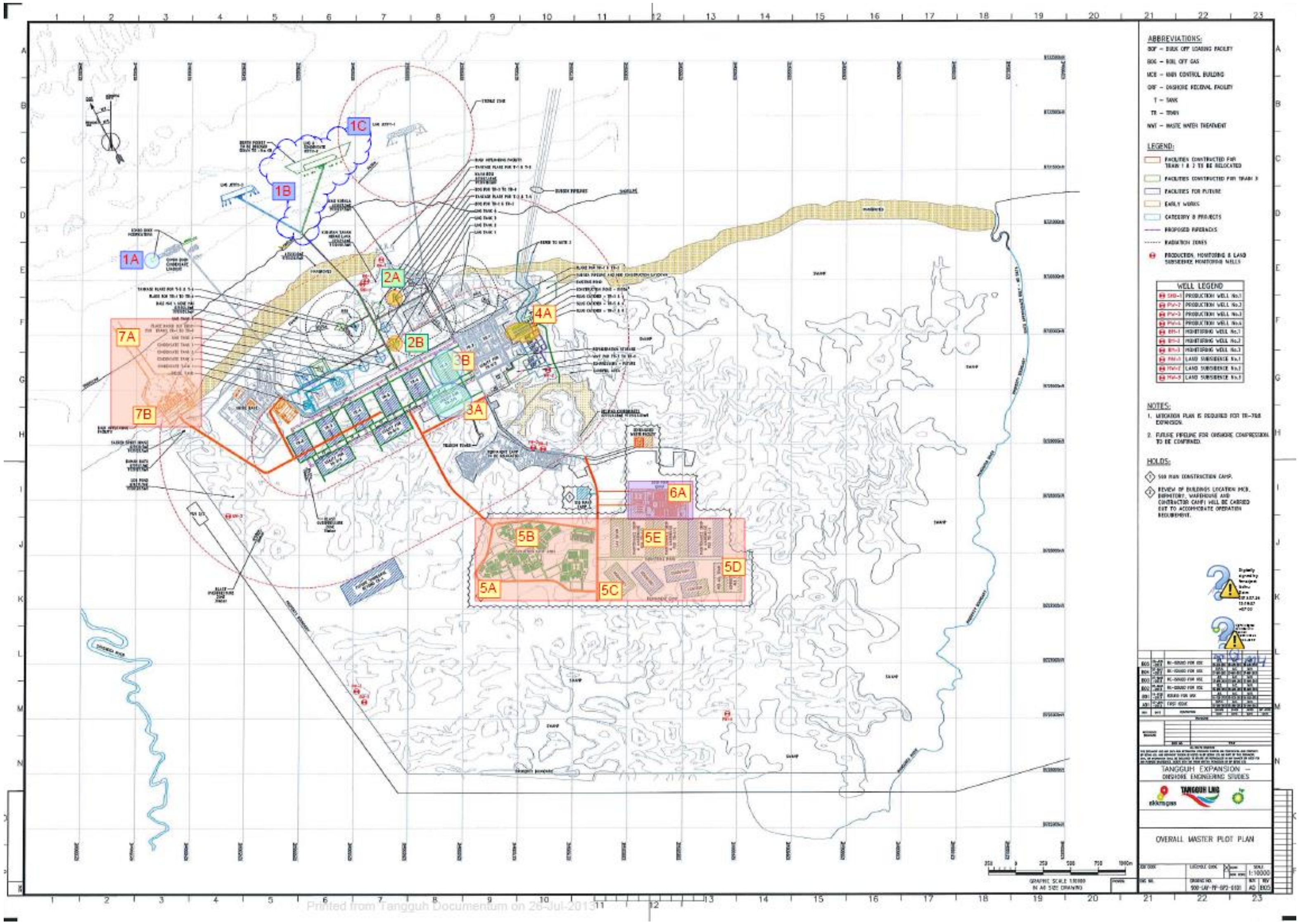


Figure 1.1. Location of the Noise Sources during the Construction Phase of Tangguh LNG Expansion Project



1.4 The Regulation Reference

The reference of noise level standard is based on the Decree of the Minister of the Environment No. 48 Year 1996, as presented in **Table 1.2.** The most restrictive noise level standard is 55 dBA that is applied for housing/settlements areas as well as noise sensitive receptors e.g. hospitals, schools and places of worship.

Table 1.2. Noise Level Standard

Area Use/Activities Environment	Noise level (dBA)
1. Area Use:	
a. Housing and Settlements	55
b. Trade and Services	70
c. Offices and Commerce	65
d. Open Green Spaces	50
e. Industry	70
f. Government and Public Facilities	60
g. Recreation	70
h. Particular Usage:	
- Airport	
- Train Station	60
- Sea port	70
- Cultural Heritage	
2. Activities Environment:	
a. Hospital or similar	55
b. School or similar	55
c. Worship place or similar	55

2. Methodology

In order to obtain a reliable modeling result, a study on the impact of noise propagation was conducted by utilizing a software that is widely applied nationally and internationally, namely MATLAB® by referring to ISO 9613, regarding *Attenuation of Sound during Propagation Outdoors*. Matlab Modeling results are then plotted by using the Surfer software.

2.1. Noise Propagation Modeling with MATLAB®

MATLAB® is a software that is utilized for data analysis, algorithm development as well as modeling and various other applications. MATLAB® is equipped with syntax, tools and various mathematical functions to facilitate analysis and modeling with various approaches, so that the expected results can be faster produced.

This modeling is based on ISO 9613, regarding *Attenuation of Sound during Propagation Outdoors*. The standard contains calculation methods of sound attenuation during propagation outdoors. The purpose is to estimate noise level of environment at a point generated from various noise sources.

Attenuation occurring when noise waves are propagated outdoor may be in the form of attenuation due to distances (divergence) from sound sources to observation points, attenuation due to atmospheric absorption, attenuation due to ground effects, attenuation due to objects blocking the propagation of sounds, etc.

Basic equation of noise pressure on the receiver point is:

$$L_{fT} = L_w + D_c - A$$ **Equation 1**

$$A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$$ **Equation 2**

by:

- L_w : Power level of noise source
- D_c : Directivity factor of noise source
- A : Attenuation (octave band)
- A_{div} : Attenuation due to distance (divergence)
- A_{atm} : Attenuation due to atmospheric absorption
- A_{gr} : Attenuation due to ground effects
- A_{bar} : Attenuation due to barriers
- A_{misc} : Attenuation due to other effects, such as the presence of trees, (forests), the presence of industrial areas or residential areas

Due to limited data (no available octave band data and no available barrier data), this Modeling only calculates attenuation due to distances (divergence), attenuation due to ground effects, and attenuation to the presence of forests.

2.1.1. Attenuation due to distance (Geometrical divergence A_{div})

Attenuation due to distance is calculated by using the following equation:

$$A_{div} = [20 Log(\frac{d}{d_o}) + 11] \ dB$$ **Equation 3**

by: d : the distance from the source to the observation point

d_o : reference distance (in general = 1 meter)

2.1.2. Attenuation due to atmospheric absorption A_{atm}

Attenuation due to atmospheric absorption is calculated by using the following equation:

$$A_{atm} = \frac{\alpha d}{1000}$$ **Equation 4**

α is the coefficient atmospheric attenuation (in dB/km units), for every octave band. Examples o α coefficient is presented in **Table 2.1**.

Table 2.1. Example of atmospheric attenuation coefficient

Temperature	**Relative Humidity**	**Atmospheric attenuation coefficient α, dB/km**							
		Frequency, Hz							
°C	%	63	125	250	500	1000	2000	4000	8000
10	70	0.1	0.4	1.0	1.9	3.7	9.7	32.8	117
20	70	0.1	0.3	101	2.8	5.0	9.0	22.9	76.6
30	70	0.1	0.3	1.0	3.1	7.4	12.7	23.1	59.3
15	20	0.3	0.6	1.2	2.7	8.2	28.2	88.8	202
15	50	0.1	0.5	1.2	2.2	4.2	10.8	36.2	129
15	80	0.1	0.3	1.1	2.4	4.1	8.3	23.7	82.8

2.1.3. Attenuation due to ground effects (A_{gr})

Attenuation due to the largest ground effect is caused by sound reflections from the ground surface experiencing interference with sound directly propagating from the source to the receiver.

To calculate the attenuation, three areas are defined at the sound propagation track, namely:

1. The source area, is the area located between the source to a distance of $30h_s$ with a maximum distance of d_p. h_s is the source height and d_p is the propagation distance from the source to the receiver.

2. The receiver area, is the area located between the receiver to a distance of $30h_r$ with a maximum distance of d_p. h_r is the receiver height and d_p is the propagation distance from the source to the receiver.

3. The middle area, is the area located between the source area and the receiver area. If $d_p < (30h_s + 30h_r)$, the source area and receiver area will overlap, accordingly there is no middle area.

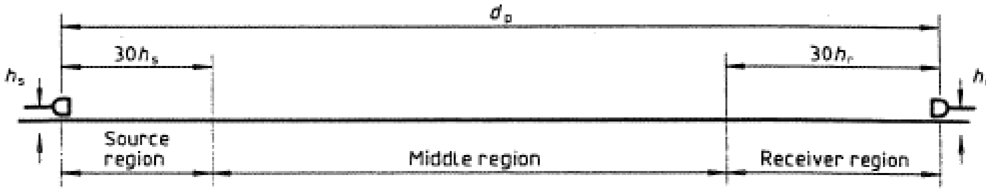


Figure 2.1 Division of areas to determine attenuation due to ground effects

Apart from that, the ground surface of each area is categorized into:

1. **Hard ground,** including cement covered surfaces, tiles, water, ice, concrete and other surfaces with low porosities. For hard surfaces, G=0.

2. ***Porous ground*** or porous surfaces, including grass covered surfaces, trees and other vegetation, and soil surfaces that are usually used for the growth of vegetation, such as rice fields. For porous surfaces, G=1.

3. ***Mixed ground***. If the ground surface is a combination of hard surfaces and porous surfaces, then the G value varies from 0 to 1.

To calculate the surface attenuation, the attenuation in the A_s source should be calculated by calculating the G_s surface factor, the attenuation in the A_p receiver area by calculating the G_p surface factor and the attenuation in the A_m middle area by calculating the G_m surface factor by using **Table 2.2**. Then the attenuation due to the ground effect is calculated by using the following equation:

$$A_{gr} = A_s + A_r + A_m$$ **Equation 5**

Table 2.2. Equation to calculate the ground effect attenuation at the source, receiver and middle areas.

Frequency Hz	A_s or A_r [1)] dB	A_m dB
63	-1,5	$-3q$ [2)]
125	-1.5 + G x *a′(h)*	
250	-1.5 + G x *a′(h)*	
500	-1.5 + G x *a′(h)*	
1000	-1.5 + G x *a′(h)*	$-3q(1-G_m)$
2000	-1.5 + (1-G)	
4000	-1.5 + (1-G)	
8000	-1.5 + (1-G)	

Notes

$a'(h) = 1.5 + 3.0 \times e^{-0.12(h-5)^2}(1-e^{-dpl50}) + 5.7 \times e^{-0.09h^2}(1-e^{-2.8\times10^6 \times dp^2})$

$b'(h) = 1.5 + 8.6 \times e^{-0.09h^2}(1-e^{-dpl50})$

$c'(h) = 1.5 + 14.0 \times e^{-0.46h^2}(1-e^{-dpl50})$

$d'(h) = 1.5 + 5.0 \times e^{-0.9h^2}(1-e^{-dpl50})$

1) To calculate A_s, $G=G_s$ and $h=h_s$ are used. To calculate A_r, $G=G_r$ and $h=h_r$ are used.
2) $q=0$, if d_pO $(30h_s + 30h_r)$
   $q=1-(30*(h_s+h_r)/d_p)$,if $d_p > (30h_s + 30h_r)$

In specific conditions, namely:

1. If only the sound pressure at the receiver position is calculated;
2. If the sound propagation occurs in areas with porous surfaces or mixed ground that are mostly porous surfaces;
3. If propagated sounds are not pure tones.

Then the attenuation is calculated by using the following equation:

$$A_{gr} = 4.8 - (2h_m / d)\left[17 + \left(300 / d\right)\right] \geq 0 \quad dB$$ **Equation 6**

h_m is the average height of the propagation track on the ground surface (meter) and d is the distance between the source and the receiver position (see **Figure 2.2**).

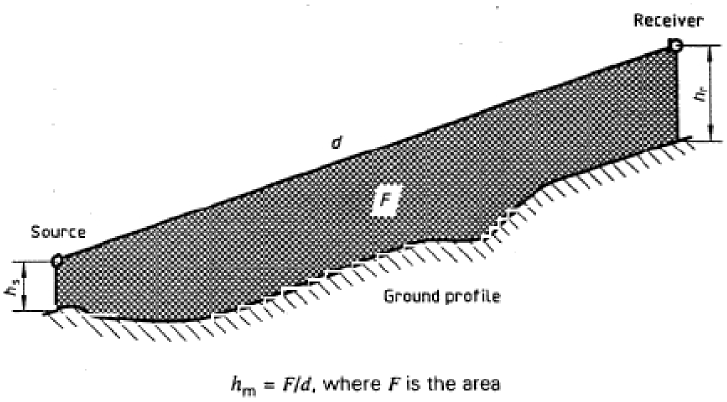


Figure 2.2 Method to evaluate h_m

In the calculation of attenuation due to ground effect, the ground surface in the surroundings of Tangguh LNG is considered to be a porous surface as the ground surface is covered by grass, trees and other vegetation. The impedance effect due to the ground surface is calculated by using the following equation:

$P \sim R^{-b}$ **Equation 7**

R is the propagation distance, while b is the impedance effect factor of the ground surface. For ground surfaces covered with grass, the b=1,2 (Albert, 2004) value is used.

2.1.4 Attenuation due to barriers (A_{bar})

An object is referred to as a barrier if:

4. The surface density is at least 10 kg/m^2;
5. The object surface is covered without any cracks or gaps;
6. The object height from the propagation surface is greater than the octave band (l_l+l_r >λ) wavelength as indicated in **Figure 2.3**.

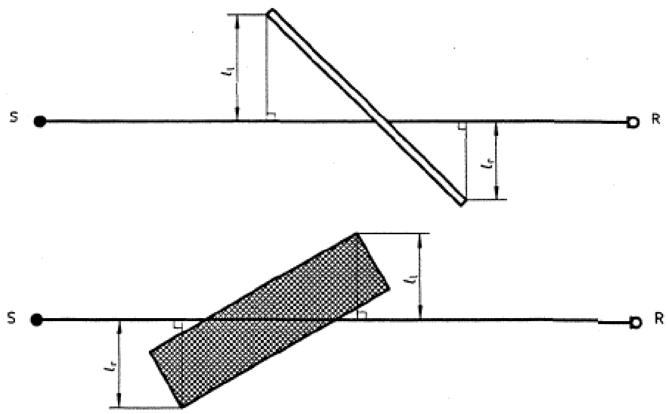


Figure 2.3 Cross-section of two objects/barriers in the propagation track

Diffraction effects occurring at the upper end of the barrier is calculated by using the following equation:

$$A_{bar} = D_z - A_{gr} > 0$$ **Equation 8**

While diffraction effects that occur around the vertical ends are calculated by using the following equation:

$$A_{bar} = D_z > 0$$ **Equation 9**

D_z is the attenuation barrier for each octave band frequency, that is calculated with the following equation:

$$D_z = 10Log\left[3 + \left(C_2 / \lambda\right) C_3 z K_{met}\right] \ dB$$ **Equation 10**

with C2 = 20, inclusive the reflection factor due to the ground effect. If the reflection factor due to the ground effect is calculated separately, C_2 = 40.

C3 = 1 for a single diffraction. For a double diffraction, $C_3 = [1+(5\lambda/e)^2]/[(1/3)+(5\lambda/e)^2]$

λ : wavelength for each octave band

z : difference between the propagation track length of direct sounds and diffracted sounds

K_{met} : correction factor for meteorology effects

e : distance between two diffraction ends when double diffraction occur

2.1.5 Meteorological correction

Meteorological corrections are calculated by using the following equation

$$C_{met} = 0, \ jika \, d_p \leq 10\left(h_s + h_r\right)$$
$$C_{met} = C_0\left[1 - 10\left(h_s + h_r\right)/d_p\right], \ jika \, d_p > 10\left(h_s + h_r\right)$$ **Equation 11**

2.1.6 Other attenuations (A_{misc})

Other attenuations calculated are attenuations due to the presence of trees, attenuations due to industrial areas and attenuations due to housing areas.

Attenuations due to the presence of forests A_{fol}

The presence of trees can cause attenuation if the density of the trees actually blocks the propagation track. The attenuation size due to the trees is indicated in **Table 2.3**.

Attenuation due to the presence of forests can also be calculated by using the following equation:

$$A_{fol} = [8.5 + 0.12d]\ dB$$ **Equation 12**

d is the diameter of the forest/foliage . (Albert, 2004)

Table 2.3. Sound attenuation during propagation at d_f distance, through trees

Propagation distance d_f, meter	Frequency, Hz							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
10 O df O 20	Attenuation , dB:							
	0	0	1	1	1	1	2	3
20 O df O 200	Attenuation , dB/m:							
	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.12

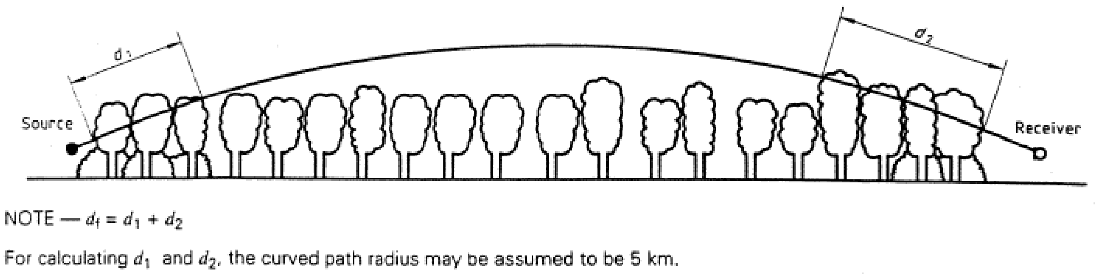


Figure 2.4 Attenuation A_{fol} increases linear towards the d curve length, passing trees/forests

<u>Attenuation due to the presence of industrial areas A_{site}</u>

In industrial areas, attenuation may occur due to the scattering of the installation of equipment and other objects in industrial areas. The attenuation size highly depend on the type of the site and the equipment, therefore accurate attenuation are largely determined by measuring. **Table 2.4** is an estimate of the attenuation size due to the presence of industries. The attenuation size increases linear against the d curve, along the equipment (see **Figure 2.4**), with a maximum attenuation of 10 dB.

Table 2.4. Estimated sound attenuation size due to the presence of industrial areas

Frequency, Hz	63	125	250	500	1000	2000	4000	8000
A_{site}, dB/m	0	0.015	0.025	0.025	0.02	0.02	0.015	0.015

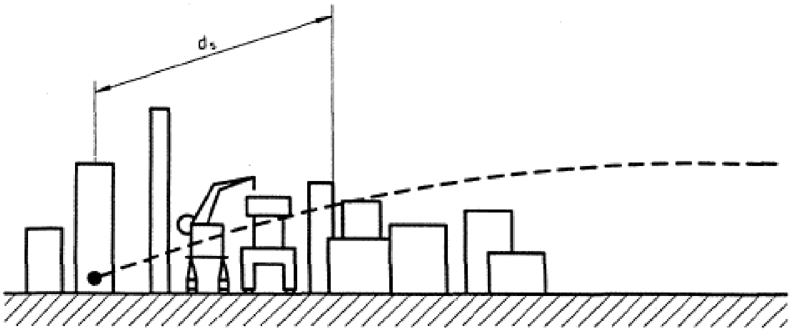


Figure 2.5 Attenuation A_{site} increases linear against the d curve length in industrial areas

Attenuation due to housing areas A_{hous}

The presence of housing areas in the surroundings of the source, receiver and the sound propagation track may contribute to cause attenuation due to the blocked propagation of the sound source. The size of the attenuation A_{hous} is highly dependent on the actual condition, therefore the calculation of A_{hous} is basically an estimated value. Mathematical equations used to calculate A_{hous} are:

$$A_{hous} = A_{hous,1} + A_{hous,2}$$ **Equation 13**

$$A_{hous,1} = 0.1Bd_b \quad dB$$ **Equation 14**

$$A_{hous,2} = -10Log\left[1-\left(p/100\right)\right] \quad dB$$ **Equation 15**

with
- Ahous,2 : is calculated when there are rows of buildings near roads, railways and other corridors
- B : density of buildings or housings along the propagation track, i.e. the area with buildings divided by the total outer area
- d_b : the total length of the propagation track is calculated similarly to the procedure in **Figure 2.4**.
- p : the percentage of the façade length is relative against the total length of the roads or railways

2.2 SURFER

Surfer is a software that can be used to generate Modeling data in the form of 3D visualizations, contours and surface. Basically, Surfer transforms XYZ data into mapping in the form of 3D, contour or surface. The advantages of Surfer are the choices of a number gridding methods and gridding parameters that can be changed according to the requirements.

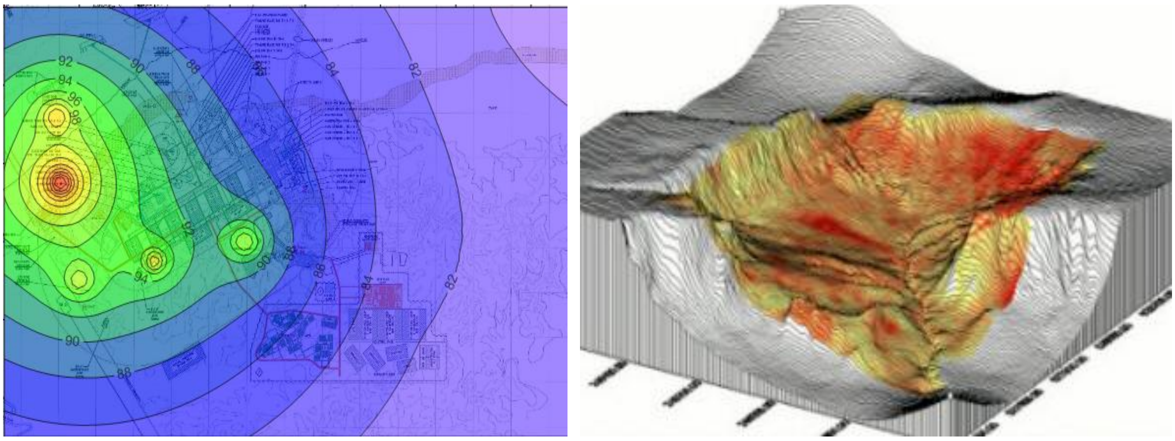


Figure 2.6 Example of SURFER output on data display visualization

2.3 Working Procedure

Briefly, the model working procedure can be described as follows:

1. Collecting all data input required for the model, among others parameters and noise source data (locations of the sound sources and sound power generated by the sources), as well as other supporting data that is useful for the analysis of Modeling results;
2. Checking the collected data quality (quality control and quality assurance);
3. The use of MATLAB® software for Modeling;
4. The use of SURFER software for the presentation of meteorological data statistics;
5. Interpretation and data analysis of Modeling results.

3. Input Parameter and Supporting Data

Modeling of noise exposure involves data that is interrelated among others the characteristics, source of noise and scenario used in the Modeling. Therefore, the availability of complete and reliable data highly determines the accuracy of Modeling results. The followings are the related data as input for the model.

Location of the Noise Sources and Receptors

Noise sources of the Tangguh LNG Expansion Project construction activities are divided into 7 areas, each of which has different activities. Locations and activities are presented in **Figure 1.1** and **Table 1.1**.

Environmental Baseline

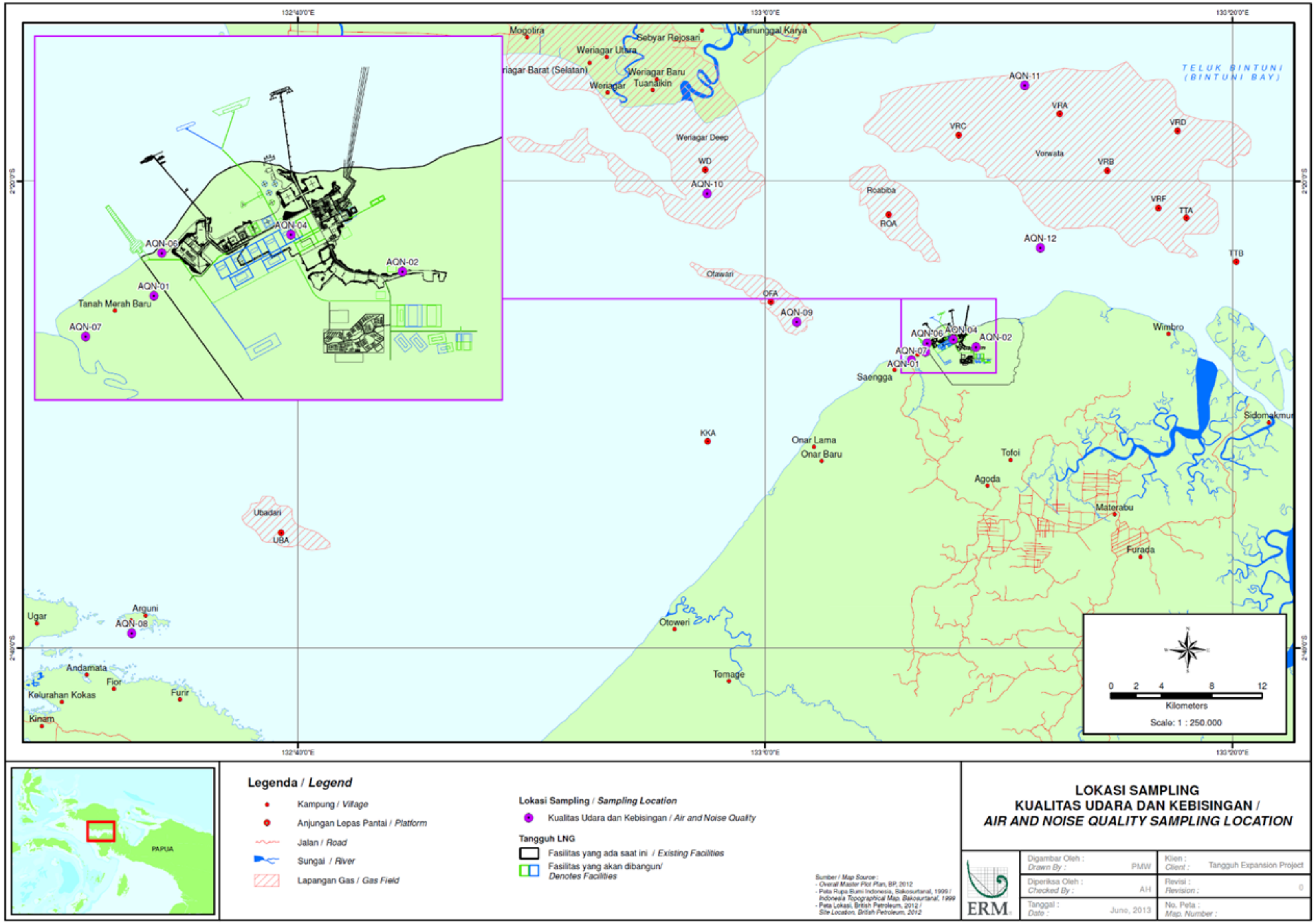
To determine the environmental baseline at Tangguh LNG the Leq value is measured every 5 seconds, with duration of 10 minutes. Basically, noise measurements are conducted to illustrate activities for 24 hours at Tangguh LNG, i.e. by implementing minimal 4-time measurements during the day and 3-time measurements at night. Every measurement of the noise level should represent a 16 hour interval during the day (06:00-22:00) and 8 hours during the night (22:00-06:00).

However, noise level measurements at Tangguh LNG, due to safety reasons are only implemented 3-time measurements during the day at 12 selected points (data obtained from Intertek only states 6 points). Accordingly, the Leq value obtained is equal to Ls (Leq during day time), and the value that is considered to represent a 16-hour interval during the day (06:00-22:00). Data recapitulation of 3-time Lavg measurement results at every point, and the calculation of Leq can be observed in **Table 3.1**.

Table 3.1. Measurement results of L_{avg} and calculation of L_{eq}

Point	Measured L_{avg} (dBA)			L_{eq} per point
	Repeated 1	Repeated 2	Repeated 3	
AQN-01	46.4	43.9	37.5	43.9
AQN-02	47.6	37.2	38.5	43.7
AQN-04	52.7	52	57.8	54.9
AQN-06	41	40.8	40.7	40.8
AQN-07	49	48.9	50.7	49.7
AQN-08	53.2			53.2

Figure 3.1 Location map of noise measurement for the environmental baseline in the Tangguh LNG Expansion Project area



Number, type and size of sound power equipment

The noise exposure size is highly determined by the number of noise sources and sound power radiated. **Table 3.2** contains data of the equipment type and number used in Tangguh LNG construction activities as well as the radiated sounds. The equipment sound power data is taken from the *FHWA Highway Construction Noise Handbook*. Meanwhile, examples of equipment positioning in the scenario of 2014 at area 1A is indicated in **Figure 3.2**.

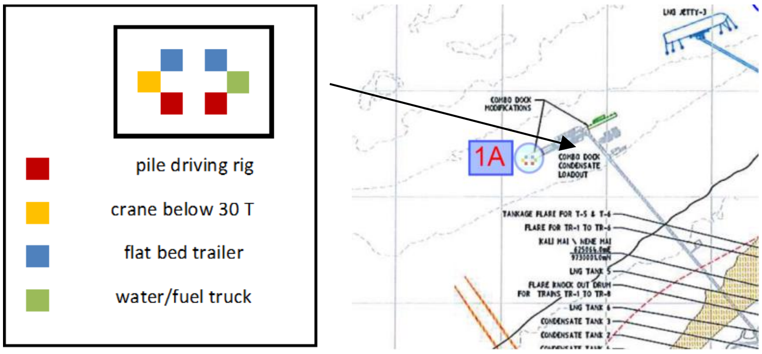


Figure 3.2 Example of instrument positioning for Modeling (scenario of piling activities in area 1A, first semester of 2015)

Modeling Scenario

The construction activities of Tangguh LNG Expansion Project is proposed to be implemented from 2014 to 2018. During this period, activities undertaken are not simultaneously performed and are conducted scattered throughout the entire Tangguh area. The Modeling scenario used is based on the proposed activity (see **Table 1.1**). To obtain more accurate Modeling results, the Modeling scenario is divided into 8 scenario's based on activity groups that are simultaneously implemented, i.e. scenario 2014, scenario semester I of 2015, scenario semester II of 2015, scenario semester I of 2016, scenario semester II of 2016, scenario semester 1 of 2017, scenario semester II of 2017 and scenario 2018.

The scenario used for the noise level Modeling is the worst scenario, i.e. when all equipment in the scenario of the related year is used. The noise value variation actually depends on the variation of activities and the variation and number of equipment used. To identify the variation of noise value, Modeling is also implemented by considering the number of equipment used by 50% and 25% of equipment totality. This Modeling generated a Leq contour that is obtained by combining the value of sound pressure levels during construction work hours (assumed work hours: 08:00 – 16:00), and the ambient noise level when construction activities are not taking place (assumed work hours: 16:00 – 08:00).

Ambient noise values that are used during the day is in accordance with measurements results of the environmental baseline. While the ambient noise value used at night is 40 dB, by referring to the *Environmental Quality Standards for Noise* of Japan. In this Modeling, it is assumed that the distance of the sound source reference is calculated from the midpoint of the sound source. This is because the dimensions of the sound source are unknown. In this Modeling, the attenuation due to the ground effect and the attenuation due to the presence of forests in the surroundings of Tangguh LNG areas are also calculated.

Table 3.2. Equipment Data Used for Noise Exposure Modeling of Tangguh LNG Expansion Project during Construction Activities

	Lmax @ 50 ft (dBA)	Power level (dB re 1 PicoWatt)	Power				1A Combo Dock			1B & 1C New Jetty			2A BOG & Flare Area						2B LNG Tank				
						Batching Plant	Piling	Concrete Works	Installation	Dredging	Piling	Concrete Works	Earthworks	Piling	Concrete Works	Steel Structure	Piping	Equipment Installation	Earthwork	Piling	Concrete Works	Tank Erection & Assembly	Painting &Coating
Dredging Vessel	85	117	0.4618		2					1													
Civil Works																							
Bulldozer , < 20 ton	85	117	0.4618	14	18		-						1	-					1	-			
Bulldozer , > 20 ton	85	117	0.4618	6	12		-						1	-					1	-			
Backhoe	80	112	0.1460	12	21		-						2	-					2	-			
Excavator	85	117	0.4618	18	21		-						2	-					2	-			
Wheel loader	80	112	0.1460	15	18		-						2	-					2	-			
Motor grader	85	117	0.4618	4	15		-						1	-					1	-			
Dump truck	84	116	0.3668	40	43		-						5	-					5	-			
Roller (tandem, tire, vibration)	85	117	0.4618	8	14		-						1	-					1	-			
Compactor (plate, trench, d frog)	80	112	0.1460	13	24		-						3	-					3	-			
Concrete batch plant	83	115	0.2914	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concrete pump	80	112	0.1460	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mixer truck	80	112	0.1460	20	106	-	-	10	-	-	-	10	-	-	10	-	-	-	-	-	20	-	-
Water truck/fuel truck	80	112	0.1460	9	17		1			1			1						2				
Pile driving rig	95	127	4.6178	6	19		2	-	-	-	2	-	-	1	-	-	-	-	-	1	-	-	-
Pekerjaan Mekanikal																							
Ringer crane , 1.200 to 1.500 ton	85	117	0.4618	1	2		-							-						-			
Heavy lift crane , 800 ton	85	117	0.4618	1	2		-							-						-			
Heavy lift crane , 450 atau 500 ton	85	117	0.4618	1	4		-							-						-			
Crane , 150 ton	85	117	0.4618	6	7		-							-						-			
Crane , 100 to 120 ton	85	117	0.4618	5	12		-		1					-		1				-			
Crane , 30 to 50 ton	85	117	0.4618	13	18		-		1					-		2				-			
Crane, below 30 ton	85	117	0.4618	15	70		1	1	1		1	1		1	1	2				1	1	4	1
Prime mover and or self propelled transporter with power pack	85	117	0.4618	7	9		-							-						-			
Low bed trailer, 60 hinga 100 ton	84	116	0.3668	5	11		-							-						-			
Flat bed trailer, 30 hingga 50 ton	84	116	0.3668	10	63		2				2			1		4				1		2	
Boom truck	75	107	0.0462	12	47		-							-		2				-		2	1
Fork lift	85	117	0.4618	4	25		-							-		1	1	1		-		1	1
Welding generators	73	105	0.0291	150	274		-							-		10	15	5		-		30	
Power generators	81	113	0.1995	4	9		-			1			1						1				
							6	11	3	3	5	11	20	3	11	22	16	6	21	3	21	39	3

	3A Plant - Utility Area						3B Plant - Process Train-3							4A ORF					
	Earthwork	Piling	Concrete Works	Steel Structure	Piping Works	Equipment Installation	Earthwork	Piling	Concrete Works	Steel Structure	Piping Works	Equipment Installation	MCHE Installation	Earthwork	Piling	Concrete Works	Steel Structure	Piping Works	Equipment Installation
Dredging Vessel																			
Civil Works																			
Bulldozer , < 20 ton	1	-					1	-							-				
Bulldozer , > 20 ton	1	-					1	-							-				
Backhoe	2	-					3	-							-				
Excavator	2	-					3	-							-				
Wheel loader	2	-					2	-							-				
Motor grader	1	-					2	-							-				
Dump truck	5	-					8	-							-				
Roller (tandem, tire, vibration)	2	-					2	-							-				
Compactor (plate, trench, d frog)	4	-					6	-							-				
Concrete batch plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concrete pump	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mixer truck	-	-	10	-	-	-	-	-	10	-	-	-	-	-	-	6	-	-	-
Water truck/fuel truck	3						3							1					
Pile driving rig	-	3	-	-	-	-	-	3	-	-	-	-	-	-	1	-	-	-	-
Pekerjaan Mekanikal																			
Ringer crane , 1.200 to 1.500 ton		-						-				1	1		-				
Heavy lift crane , 800 ton		-						-				1	1		-				
Heavy lift crane , 450 atau 500 ton		-				1		-				1	1		-				1
Crane , 150 ton		-				2		-			2	2			-				1
Crane , 100 to 120 ton		-		1	1	2		-		1	2	2			-				1
Crane , 30 to 50 ton		-		2	2	2		-		2	3	3			-			1	
Crane, below 30 ton		1	1	4	4	4		1	1	6	5	5			1	1	2	2	
Prime mover and or self propelled transporter with power pack		-				2		-				4	2		-				1
Low bed trailer, 60 hinga 100 ton		-				2		-			2	4			-				1
Flat bed trailer, 30 hingga 50 ton		1		4	4	2		2		4	5	5			1		2	2	2
Boom truck		-		2	5	2		-		2	5	5			-		2	2	2
Fork lift		-		1	1	1		-		1	2	2	2		-		1	1	1
Welding generators		-		15	30	10		-		20	60	10	2		-		10	20	5
Power generators	1						1							1					
	24	5	11	29	47	30	32	6	11	36	86	45	9	2	3	7	17	28	15

	5A - 5E 8,000 Man Contractor Camp							6A 2,000 Man Contractor Camp							7A & 7B B O F		
	Tree Cutting	Earthworks	Piling	Foundation Works	Concrete Works	Building Erection	Finishing & Completion	Tree Cutting	Earthworks	Piling	Foundation Works	Concrete Works	Building Erection	Finishing & Completion	Dredging	Piling	Concrete Works
Dredging Vessel															1		
Civil Works																	
Bulldozer , < 20 ton	8	1	-					4	1	-						-	
Bulldozer , > 20 ton	4	1	-					2	1	-						-	
Backhoe	4	3	-					2	3	-						-	
Excavator	4	3	-					2	3	-						-	
Wheel loader	4	2	-					2	2	-						-	
Motor grader	4	2	-					2	2	-						-	
Dump truck	-	10	-					-	10	-						-	
Roller (tandem, tire, vibration)	-	4	-					-	4	-						-	
Compactor (plate, trench, d frog)	-	4	-					-	4	-						-	
Concrete batch plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Concrete pump	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mixer truck	-	-	-	-	10	-	-	-	-	-	-	10	-	-	-	-	10
Water truck/fuel truck	2							2							1		
Pile driving rig	-	-	2	-	-	-	-	-	-	2	-	-	-	-	-	2	-
Pekerjaan Mekanikal																	
Ringer crane , 1.200 to 1.500 ton			-							-						-	
Heavy lift crane , 800 ton			-							-						-	
Heavy lift crane , 450 atau 500 ton			-							-						-	
Crane , 150 ton			-							-						-	
Crane , 100 to 120 ton			-							-						-	
Crane , 30 to 50 ton			-							-						-	
Crane, below 30 ton	2		1	1	1	2		2		1	1	1	2			1	1
Prime mover and or self propelled transporter with power pack			-							-						-	
Low bed trailer, 60 hinga 100 ton			-			1				-			1			-	
Flat bed trailer, 30 hingga 50 ton	5		2			2	1	2		2			2			1	
Boom truck	4		-			4	1	2		-			4			-	
Fork lift	2		-			2	1	1		-			1			-	
Welding generators			-			20	2			-			10			-	
Power generators	1							1							1		
	44	30	5	1	11	31	5	24	30	5	1	11	20	-	3	4	11

4 Prediction of Noise Exposure Impact at Tangguh LNG

Noise generated by the operations of equipment and construction activities of the related the Tangguh LNG Expansion Project is predicted to impact receptors in the surroundings, either humans as well as wildlife. Although the physical characteristics of noise and hearing can be well understood, however the annoyance and noise concept is still not well understood. [AMDAL BP Tangguh 2002]

For the purpose of predicting the impact, the Noise Level Quality Standard that is based on the Decree of Minister of the Environment No. 48 year 1996 is applied to determine whether the occurring impact is significant or not and is presented in **Table 1.2**.

In general, the noise impact to wildlife can be determined by the extent to which noise interfere with the functioning of the ecosystem. Noise has the potential to affect wildlife in various matters, varying for different types of animals. The wildlife reaction level to noise varies depending on age, gender, season, situation, previous exposure to noise, noise levels, and the spectrum of frequency.

Researches on the affects of noise on wildlife have been frequently performed since tens of years ago. Based on the research of Klein in 1971, noise may cause shocked and fear reactions to animals. This leads to the interruption of wildlife activity. For example, noise of electrical grids may cause declined reproduction activities to deer. If the noise continuously occurs, the wildlife will migrate and further may cause extinction if the new habitat is not suitable. (Dufour, 1980)

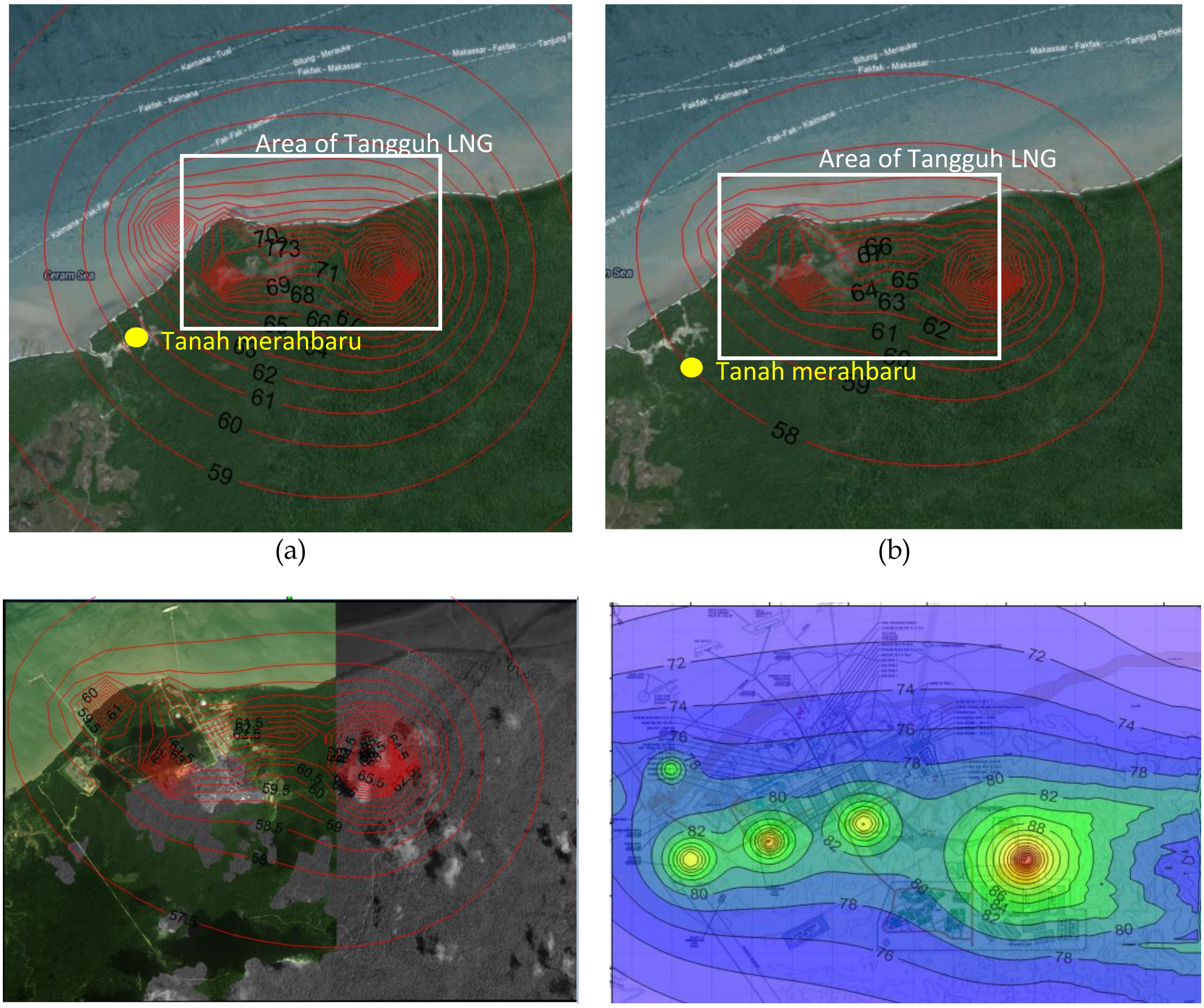
Based on data of the Tangguh LNG, wildlife living in the surroundings of the Tangguh LNG areas consists of 62 species of birds, 31 species of herpetofauna (divided into 11 species of amphibians and 17 species of reptiles) as stated in Sub-chapter 2.2.1.2 regarding the terrestrial fauna baseline at the Tangguh LNG.

As described in Chapter 3, the Modeling scenario used is based on the construction activity plan of the Tangguh LNG Expansion Project (see **Table 1.1**), which further is divided into 8 scenario's based on activities that are simultaneously undertaken, i.e. scenario in 2014, scenario of semester I in 2015, scenario of semester II in 2015, scenario of semester I in 2016, scenario of semester II in 2016, scenario of semester I in 2017, scenario of semester II in 2017, and scenario in 2018.

The scenario used for the Modeling of the noise level is the worst scenario, i.e. when all the equipment in the scenario of that year are used. Variation of the actual noise value will depend on the activity variations, the variations and number of equipments used. To determine the noise level variation, Modeling is also implemented by considering the number of equipment used by 50%, and 25% of the equipment totality. This Modeling generated a Leq contour that is obtained by combining the value level of noise pressure during construction work hours (assumed work hours: 08:00 – 16:00), and the ambient noise level when there are no construction activities (assumed time: 16:00 – 08:00).

The ambient noise values used during day time is in accordance with measurement results of the environmental baseline. While ambient noise values used during nighttime is 40 dB, referring to the *Environmental Quality Standards for Noise* of Japan. In this Modeling it is assumed that the reference distance of the sound source is calculated from the sound source midpoint. This because the dimension of the sound source is unknown. This Modeling also calculated attenuation due to ground effects and the attenuation due to the presence of forests in the surroundings of Tangguh LNG areas.

<u>Modeling Results</u>



(c) (d)

Figure 4.1 Noise Level Modeling Results based on the scenario in year 2014.

(a) Noise contour in Tangguh LNG surrounding areas experiencing noise exposures exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the Tangguh LNG surrounding areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG area.

In the Modeling of the scenario in 2014, the noise level received in the Tanah Merah Baru area is approximately 61 dB. If the equipment used is 50% of the total equipment, the noise level received in the Tanah Merah Baru area is approximately 58 dB. Reduction of equipment to only 25% of the total equipment used cause a decrease in the noise level received in the Tanah Merah Baru area to 57 dB. While in the Tangguh LNG area, the noise level received exceeds 68 dB.

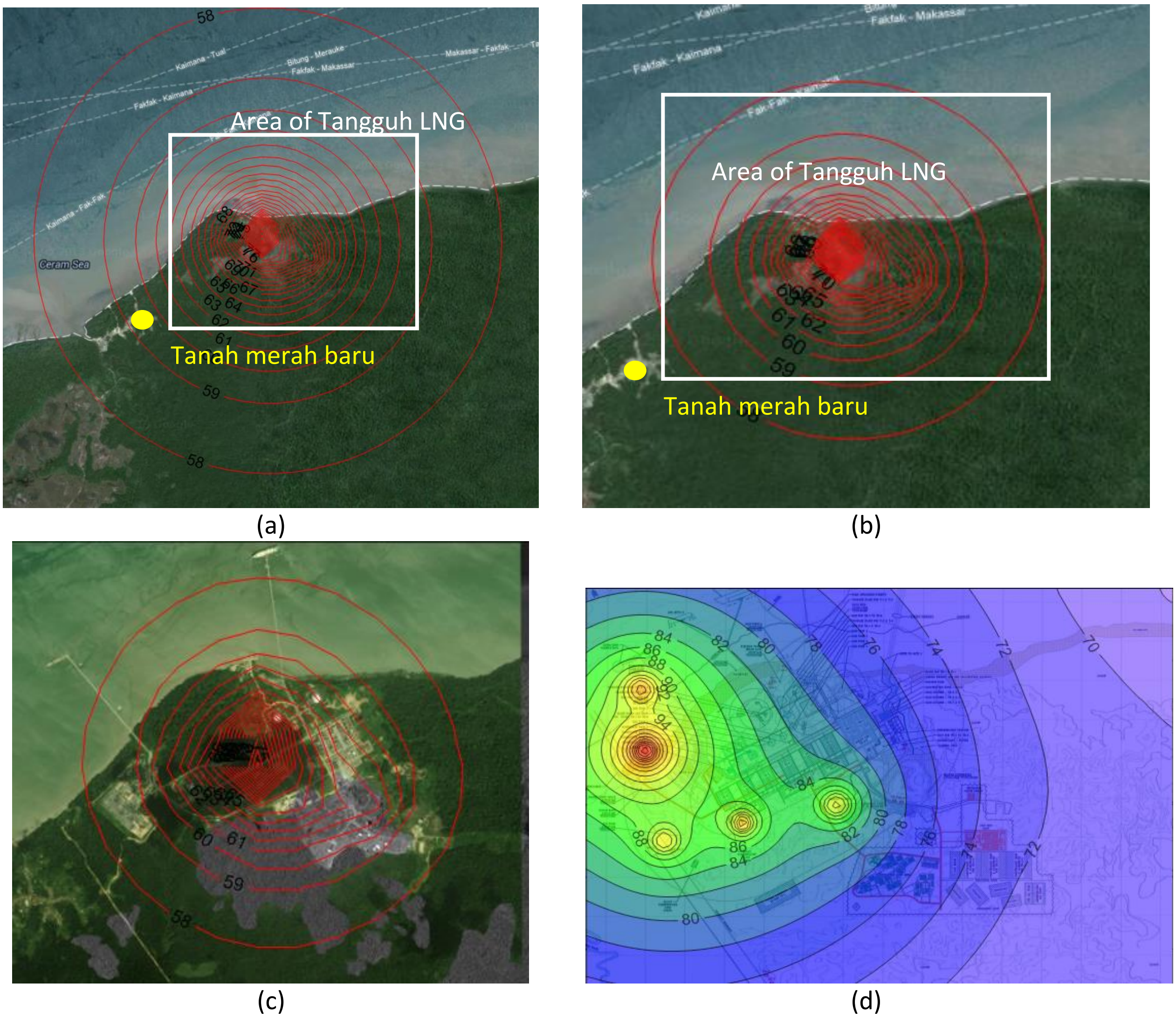
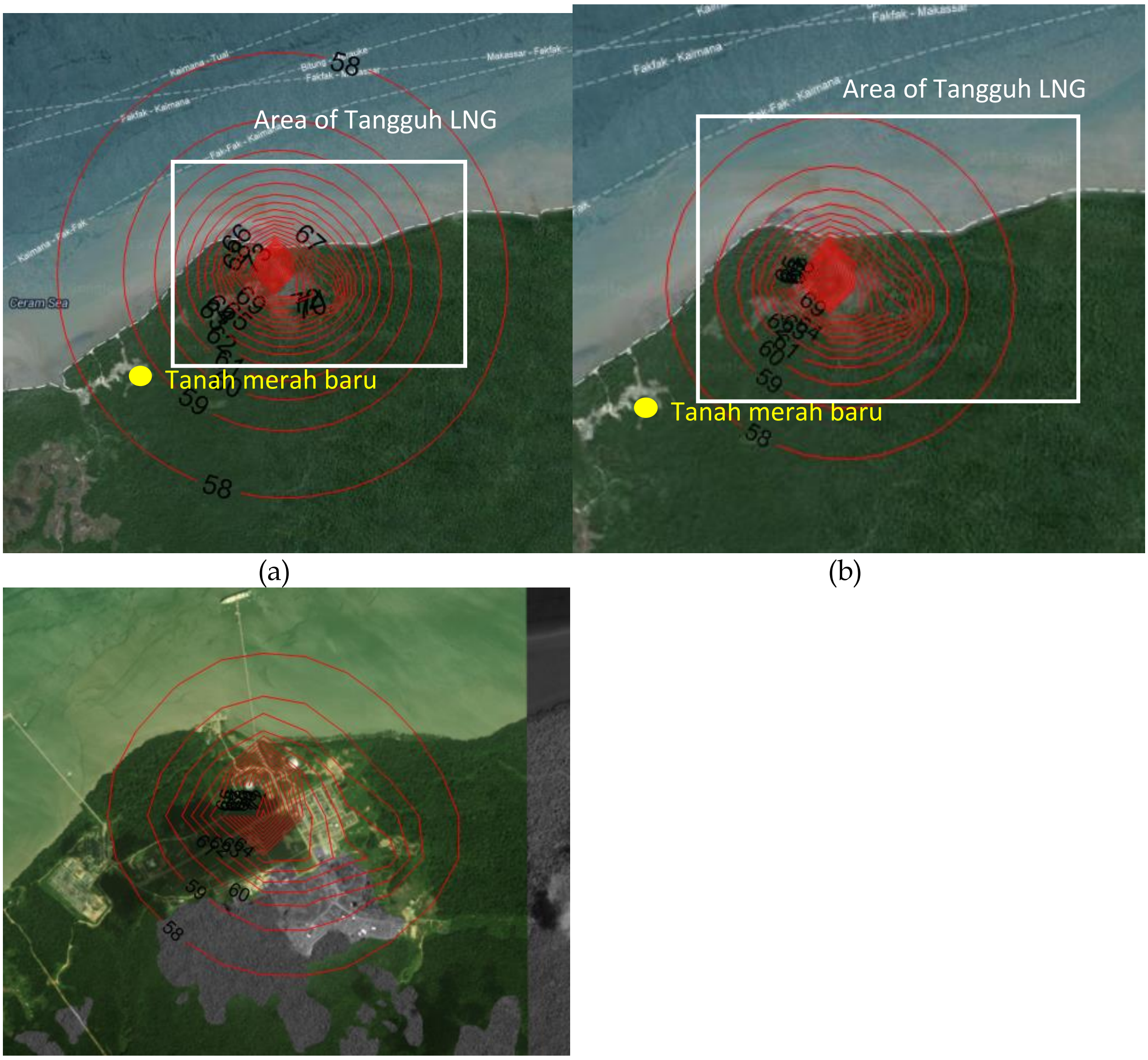


Figure 4.2 Modeling Result of Noise Levels based on the scenario in semester I year 2015 with all activities implemented simultaneously.

(a) Noise contour in the Tangguh LNG surrounding areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the Tangguh LNG surrounding areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the Tangguh LNG surrounding areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG area.

If in the scenario Modeling in semester I of 2015 the entire construction activities in the 1A, 6A, and 7B areas are simultaneously conducted (Area 1A: piling, concrete, installation; Area 6A: earthwork, foundation, and construction; Area 7B: piling and concrete), the noise level received in the Tanah Merah Baru area is approximately 60 dB. The use of 50% of the total equipment, reduces the noise level in the Tanah Merah Baru area up till approximately 58 dB. If the equipment used is only 25% of the total equipment, the noise level received in the Tanah Merah Baru area is less than 58 dB. While in the Tangguh LNG area, the noise level received exceeds 68 dB.



(a) (b) (c)

Figure 4.3 Results of Noise Level Modeling based on the scenario of semester I year 2015: piling activities at area 1A, earthwork at area 6A, piling at area 7B.

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality.

Modeling of the scenario in semester I of 2015 with activities undertaken to be piling in area 1A, earthwork in area 6A, piling in area 7B, noise levels received in the Tanah Merah Baru area will be approximately 58 dB. The use of equipment is 50% of the equipment totality and the noise level reduction in the Tanah Merah Baru area will be less than 58 dB. When the use of equipment is only 25% of the equipment totality, then the noise level of 58 dB will be reached in the construction area of the Tangguh LNG Expansion Project .

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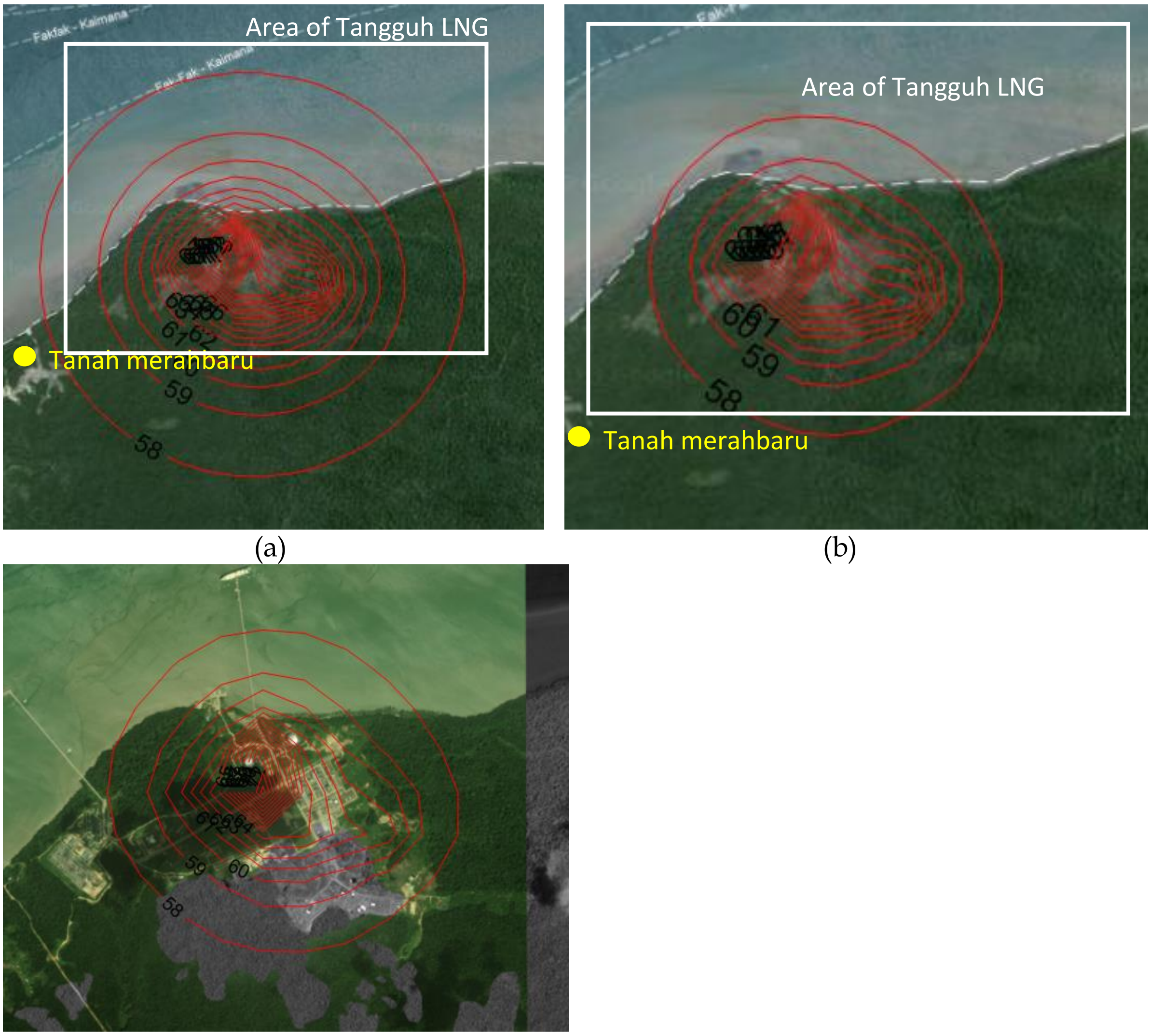


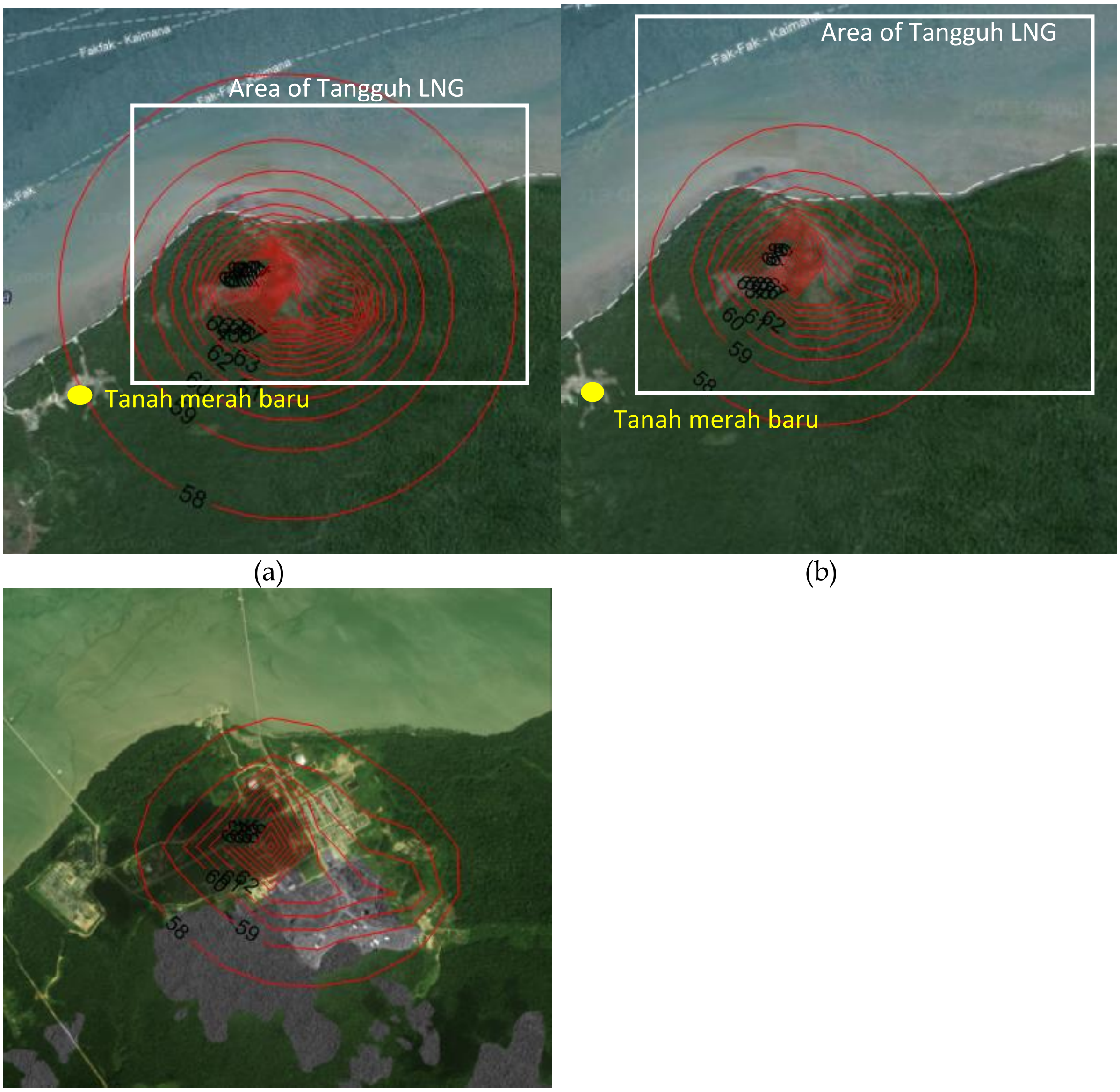
(a) (b)

(c)

Figure 4.4 Noise Level Modeling Results based on the scenario in semester I year 2015: concrete activities at area 1A, foundation at area 6A, concrete at area 7B

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality.

Modeling scenario of semester I year 2015 with activities undertaken in area 1A, foundation at area 6A, and concrete at area 7B, the noise level received in the Tanah Merah Baru area is approximately 58 dB. The use of equipment of 50% of the equipment totality, will reduce the noise level in the Tanah Merah Baru area to less than 58 dB. If the equipment used is only 25% of the equipment totality, then the noise level of 58 dB will be achieved in the construction area of the Tangguh LNG Expansion Project .



(c)

Figure 4.5 Noise level Modeling results based on the scenario in semester I year 2015: installation activities at area 1A, construction at area 6A, concrete at area 7B

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality.

If during the Modeling scenario in semester I year 2015 the activity undertaken is piling in area 1A, earthwork in area 6A, piling in area 7B, the noise level received in the Tanah Merah Baru area is approximately 58 dB. If the equipment used is 50% and 25% of the equipment totality, the noise level of 58 dB will be achieved in the construction area of the Tangguh LNG Expansion Project .

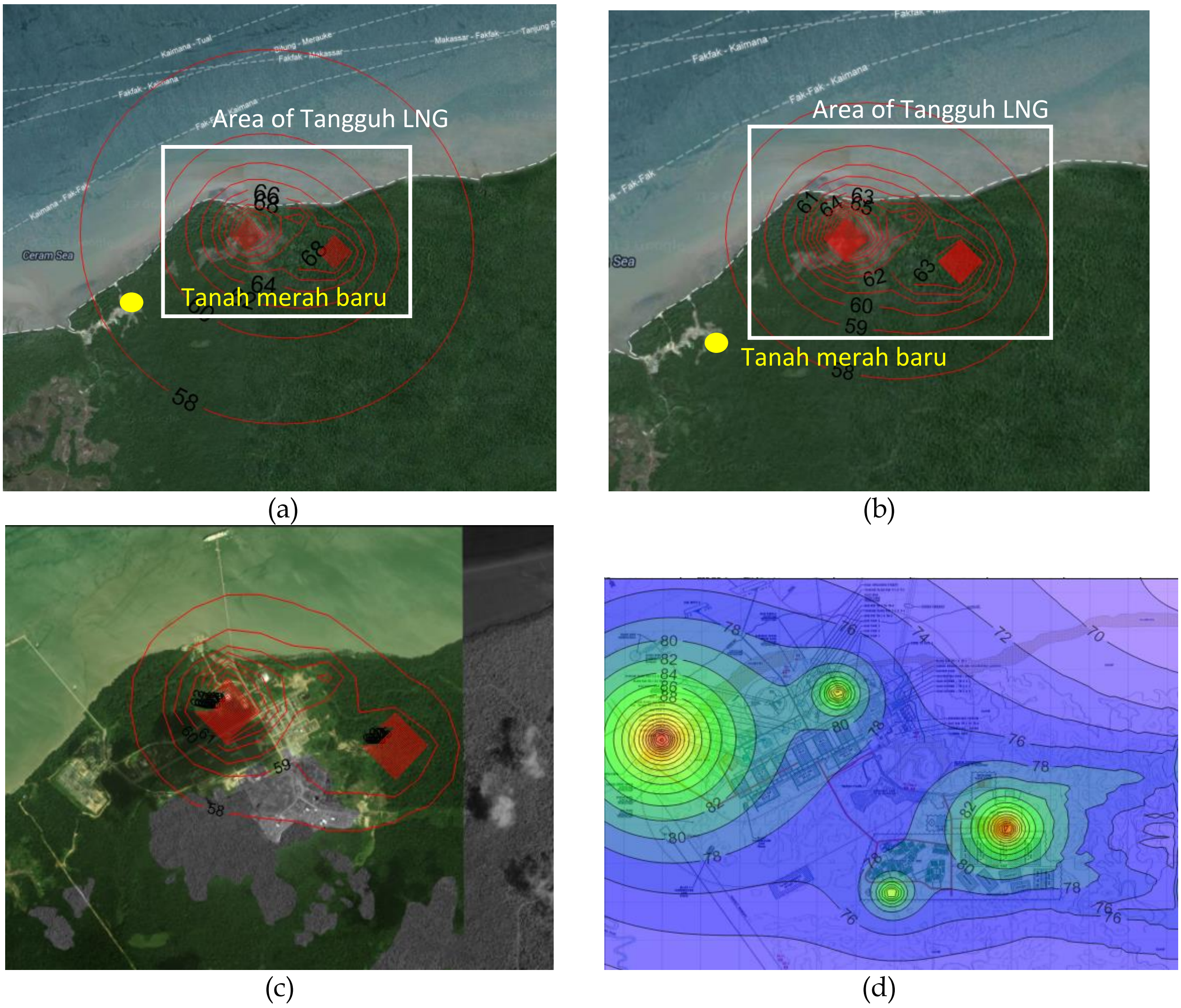


Figure 4.6 Noise level Modeling results based on the scenario of semester II year 2015.

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG areas.

At the Modeling scenario of semester II year 2015, the noise level received in the Tanah Merah Baru area is approximately 59 dB. If the equipment used is 50% and 25% of the equipment totality, the noise level of 58 dB will be achieved the construction area of the Tangguh LNG Expansion Project. While in the Tangguh LNG area, the noise level received will exceed 68 dB.

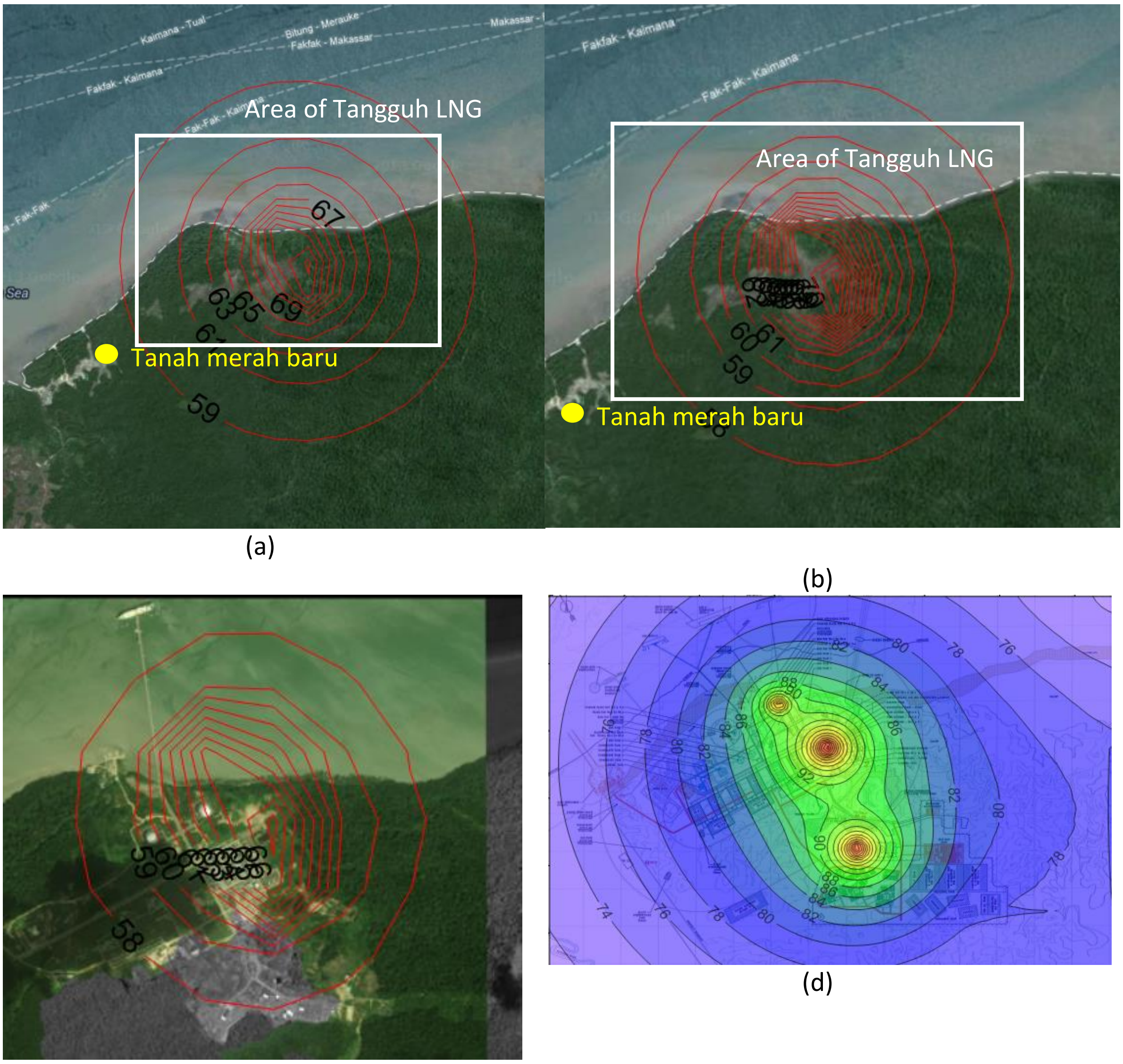


Figure 4.7 Noise level Modeling results based on the scenario in semester I year 2016.

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG area.

At the Modeling scenario of semester I year 2016, the noise level received in the Tanah Merah Baru area is approximately 59 dB. The use of 50% of the equipment totality will reduce the noise level in the Tanah Merah Baru area to less than 58 dB. If the equipment used is only 25% of the equipment totality, the noise level of 58 dB will be reached in the construction area of the Tangguh LNG Expansion Project. While in the Tangguh LNG area, the noise level received exceeds 70 dB.

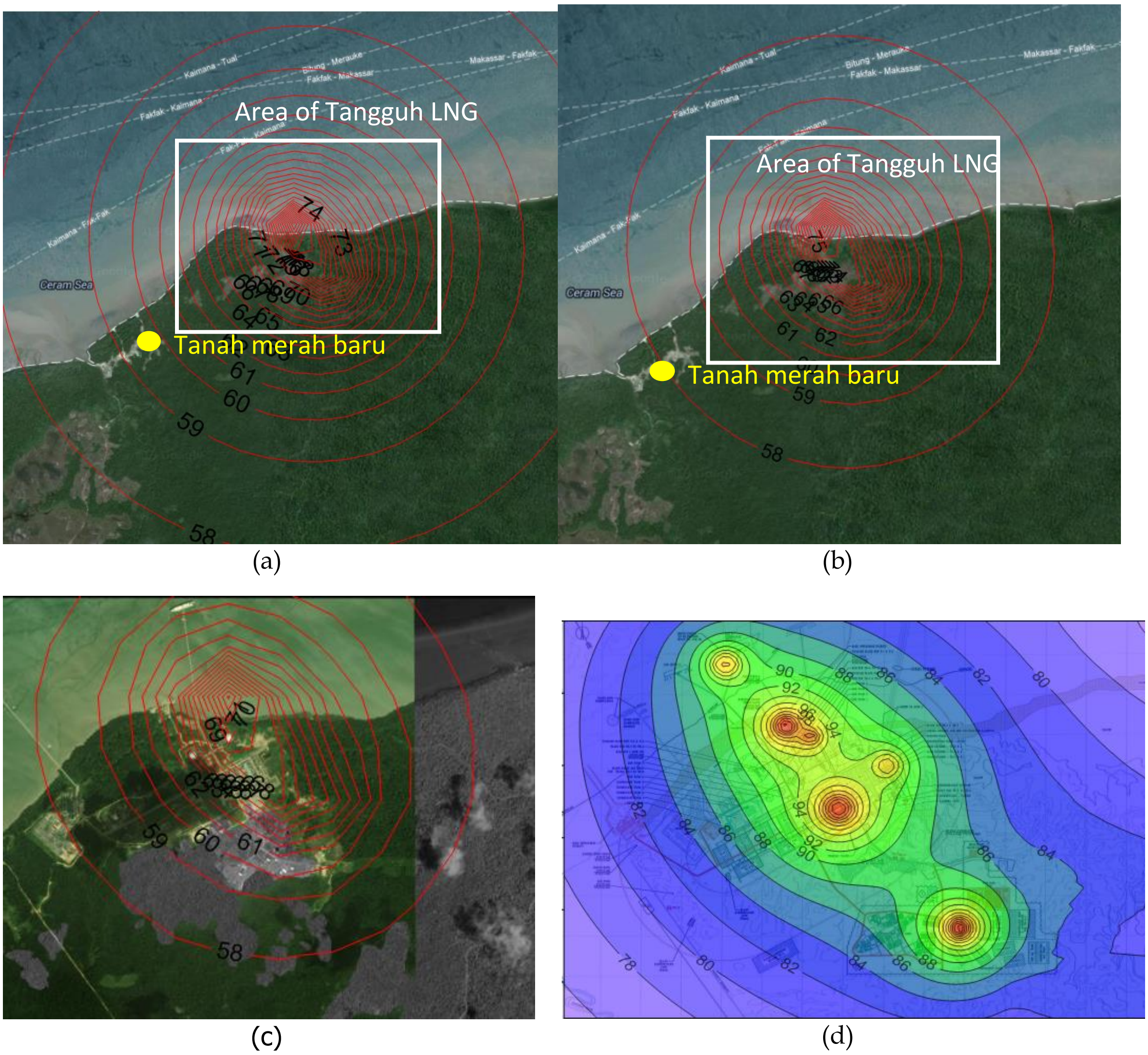
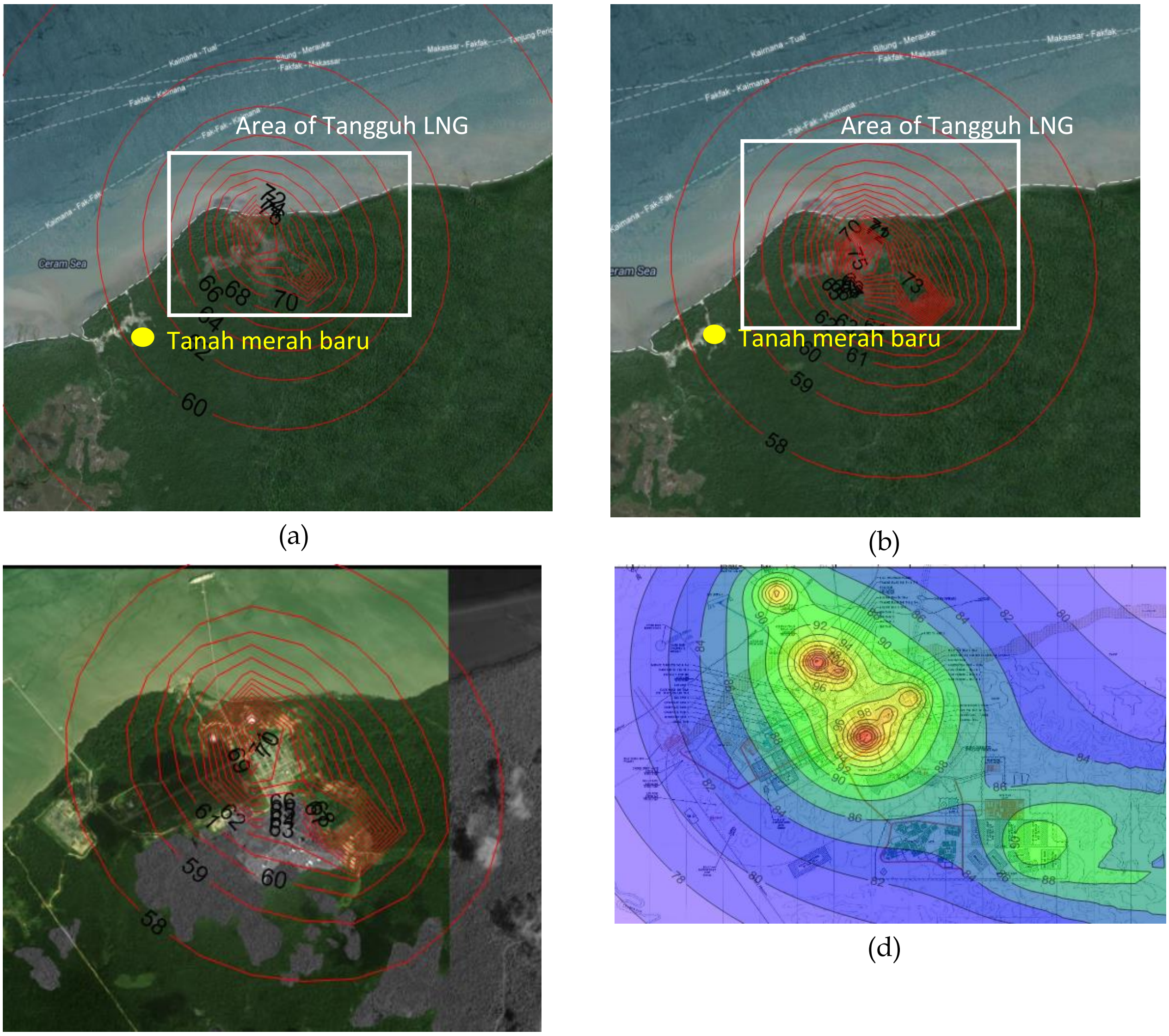


Figure 4.8 Noise level Modeling results based on the scenario of semester II year 2016.

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG area.

At the Modeling scenario of semester II year 2016, the noise level received in the Tanah Merah Baru area is approximately 61 dB. The equipment used is 60% of the equipment totality and will reduce the noise level in the Tanah Merah Baru area to approximately 58 dB. If the equipment used is only 25% of the equipment totality, the noise level of 58 dB will be reached in the Tangguh LNG Expansion Project. While in the Tangguh LNG area, the noise level received exceeds 76 dB.



(a) (b) (c) (d)

Figure 4.9 Noise level Modeling results based on the scenario in semester I year 2017.

(a) Noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG area.

At the Modeling scenario of semester I year 2017, the noise level received in the Tanah Merah Baru area is approximately 60 dB. The use of 50% of the equipment totality will reduce the noise level in the Tanah Merah Baru area to less than 59 dB. If the equipment used is only 25% of the equipment totality, then the noise level in the Tanah Merah Baru area is less than 58 dB. While in the Tangguh LNG area, the noise level received exceeds 76 dB.

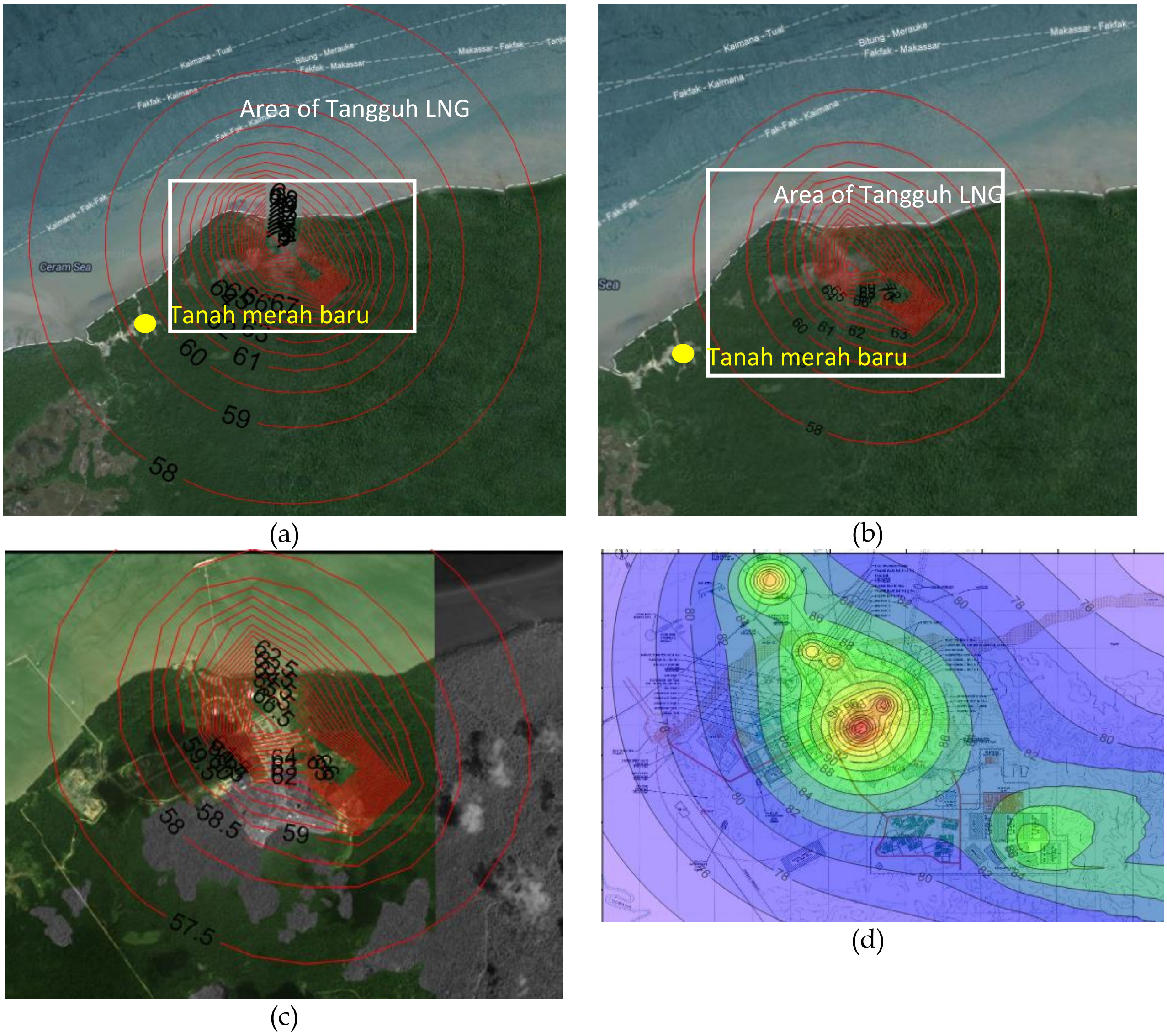


Figure 4.10 Noise level Modeling results based on the scenario of semester II year 2017.

(a) Noise contour in the surroundings of Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG area.

At the Modeling scenario of semester II year 2017, the noise level received in the Tanah Merah Baru area is approximately 59 dB. The use of 50% of the equipment totality reduced the noise level in the Tanah Merah Baru areas up till approximately 58 dB. If the equipment used is only 25% of the equipment totality, the noise level in the Tanah Merah Baru area is less than 58 dB. While in the Tangguh LNG area, the noise level received exceeds 74 dB.

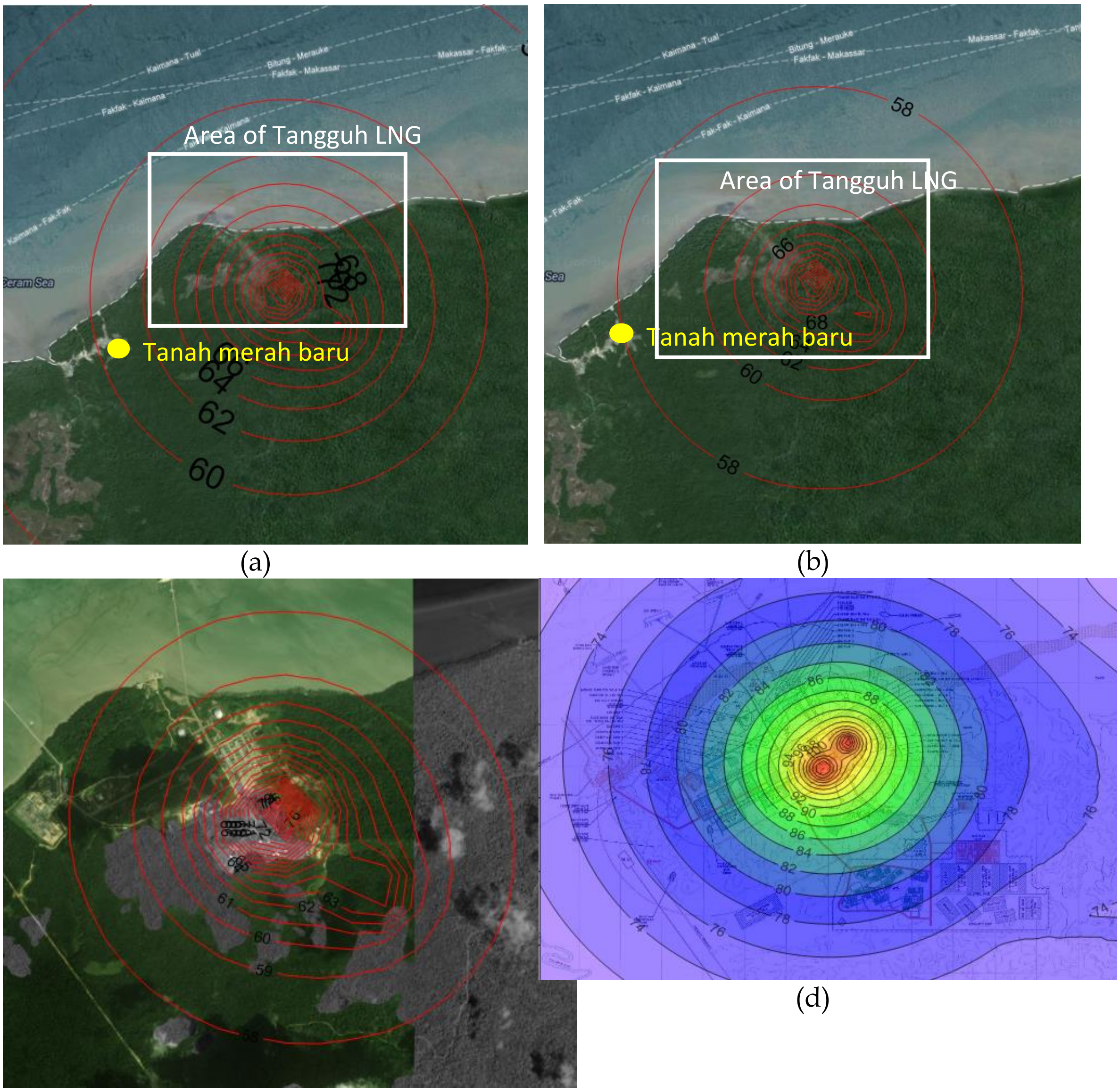


Figure 4.11 Noise level Modeling results based on the scenario in year 2018.

(a)The noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 100% of the equipment totality, (b) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 50% of the equipment totality, (c) noise contour in the surroundings of the Tangguh LNG areas experiencing noise exposure exceeding 55 dBA with 25% of the equipment totality, (d) noise exposure in the Tangguh LNG areas.

At the Modeling scenario of year 2018, the noise level received in the Tanah Merah Baru area is approximately 60 dB. The equipment use of 50% of the equipment totality will reduce the noise level in the Tanah Merah Baru area up till approximately 58 dB. If the equipment use is only 25% of the equipment totality, the noise level in the Tanah Merah Baru area will be less than 58 dB. While in the Tangguh LNG area, the noise level received exceeds 72 dB.

Decrease in sound pressure levels against the distance from the noise source

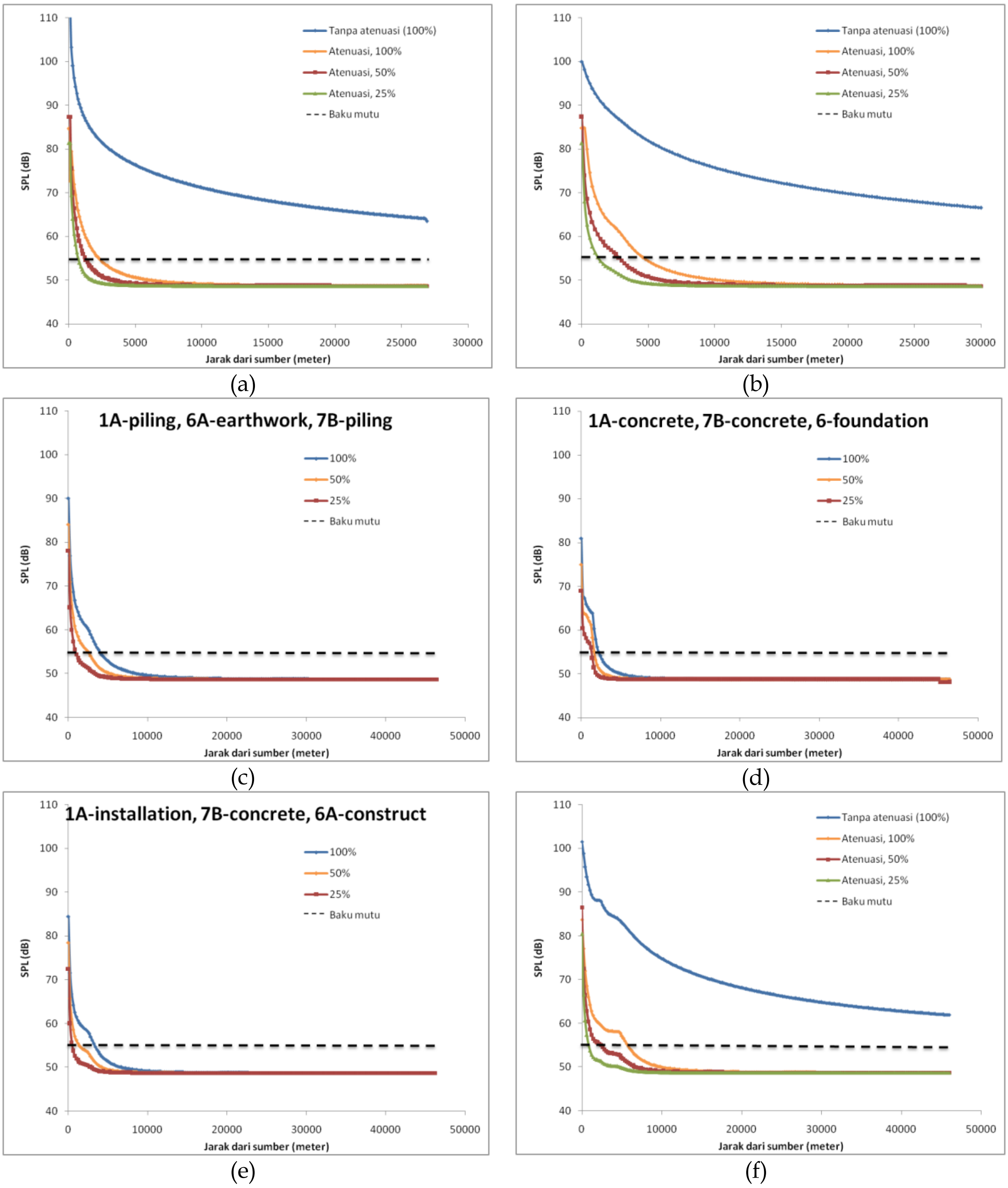
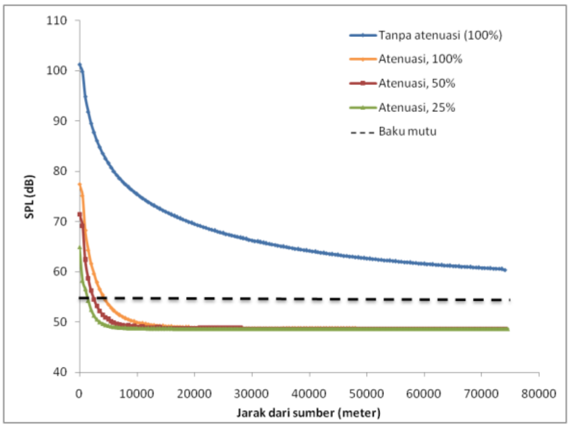
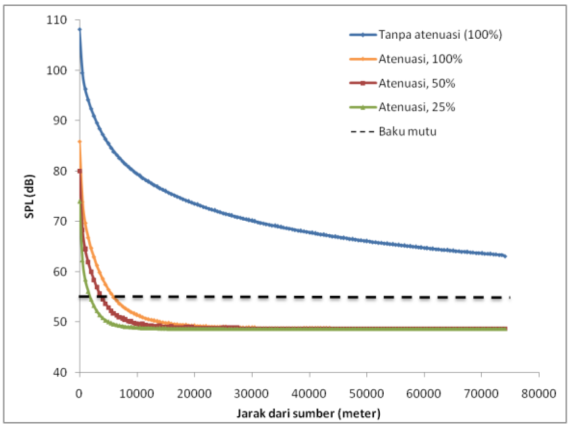


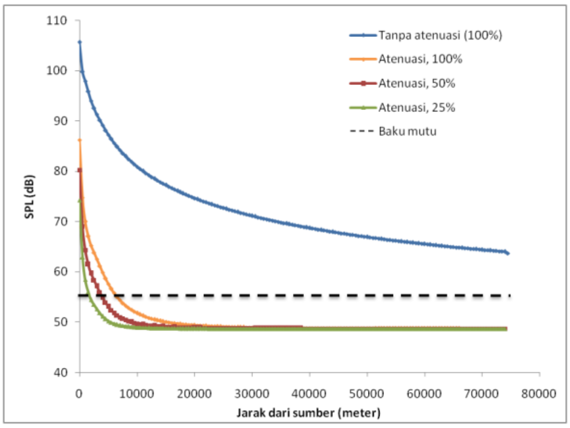
Figure 4.12 Graphic of reduction in the sound pressure level against the distance from the noise source for:
(a)scenario 2014, (b) scenario of semester I year 2015 all activities simultaneously, (c) scenario of semester I year 2015 piling activities in area 1A, earthwork in area 6A, piling in area 7B, (d) scenario of semester I year 2015 concrete activities in area 1A, foundation in area 6A, concrete in area 7B, (e) scenario of semester I year 2015 installation activities in area 1A, construction in area 6A, concrete in area 7B, (f)) scenario of semester II year 2015, (g) scenario of semester I year 2016, (h) scenario of semester II year 2016, (i) scenario of semester I year 2017, (j) scenario of semester II year 2017, and (k) scenario of semester I year 2018.



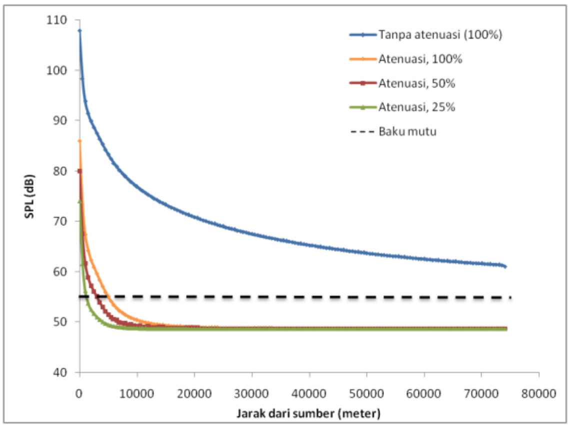
(g)



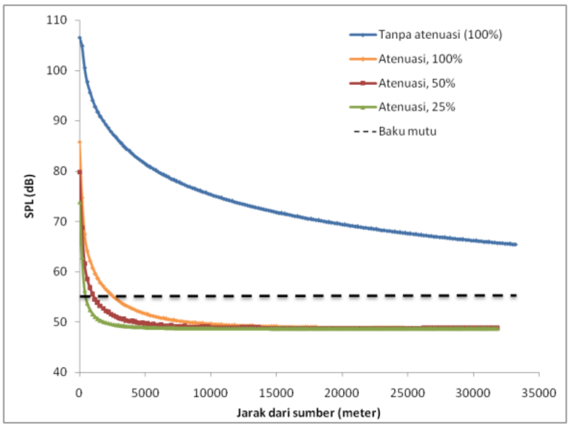
(h)



(i)



(j)



(k)

Figure 4.12 Graphic of reduction in the sound pressure level against the distance from the noise source for:
(a)scenario 2014, (b) scenario of semester I year 2015 all activities simultaneously, (c) scenario of semester I year 2015 piling activities in area 1A, earthwork in area 6A, piling in area 7B, (d) scenario of semester I year 2015 concrete activities in area 1A, foundation in area 6A, concrete in area 7B, (e) scenario of semester I year 2015 installation activities in area 1A, construction in area 6A, concrete in area 7B, (f)) scenario of semester II year 2015, (g) scenario of semester I year 2016, (h) scenario of semester II year 2016, (i) scenario of semester I year 2017, (j) scenario of semester II year 2017, and (k) scenario of semester I year 2018. (continued)

At the scenario of year 2014, with the use of 100% equipment, the noise quality standard is reached at a distance of approximately 3,000 meter (3 km) from the source. The scenario of semester I year 2015, with the use of 100% equipment and when all activities are conducted simultaneously it will cause that the noise quality standard is reached at a distance of approximately 5,000 meter (5 km) from the source. If the activities conducted are only piling in area 1A, earthwork in area 6A, and piling in area 7B, the quality standard is reached at a distance of approximately 4,000 meter (4 km). If activities conducted are only concrete in area 1A, foundation in area 6A, concrete in area 7B, the quality standard is reached at a distance of approximately 2,200 meter (2.2 km). While if the activities conducted is only installation in area 1A, construction in area 6A, concrete in area 7B, the quality standard is reached at a distance of approximately 3,400 meter (3.4 km).

While the scenario of semester I year 2016, with the use of 100% quality standard equipment, noise is reached at a distance of approximately 4,500 meter (4.5 km) from the source. The scenario of semester II year 2016 with activities that involve more heavy equipment, the use of 100% equipment results in noise quality standard that is reached at a distance of approximately 6,000 meter (6 km) from the source.

At the scenario of semester I year 2017, the use of 100% equipment cause that the noise quality standard is reached at a distance of approximately 7,800 meter (7.8 km) from the source. While the simulation of the scenario of semester II year 2017, with the use of 100% equipment caused that the noise quality standard is achieved at a distance of approximately 5,000 meter (5 km) from the source.

In the scenario of year 2018, construction activities will be reduced, accordingly with the use of 100% equipment, the noise quality standard can be achieved at a distance of approximately 2,600 meter (2.6 km) from the source.

Based on Modeling results of impact prediction, it can be observed that impacts on land clearing activities and the construction of the Tangguh LNG Plant are less significant against the increased noise level in the surrounding areas of the Tangguh LNG, including forest areas.

Noise has significant impacts on wildlife, that heavily rely on auditory signals in order to survive. Increased ambient sound pressure levels may disturb or mask communication signals used in mating or for survival, which will affect the mating activities, population distributions and detection of predators or preys.

On insects such as beetles, dragonflies and ladybugs, the frequency spectrum that may disturb is the inaudible frequency spectrum, i.e. the frequency exceeding 20 MHz.

Therefore, the impact of construction noise will less affect the insects. The most affected wildlife are the birds, due to the relatively high bird sensitivity to increased noise levels.

Potential impacts of noise on wildlife consist of hearing damage, physiological changes, and changes in behavior. This impact is further divided into primary and secondary impacts. The primary impacts are direct physical impacts to animals. Secondary impacts are indirect changes occurring between animals and the environment. The noise impact on wildlife can be observed in Table 4.5.

The impact of hearing is related to very high levels of noise. This impact will cause hearing disturbances or threshold shifts of hearing, i.e. decreased ear sensitivity such as partial hearing disturbances. Hearing threshold shifts have the potential to disturb communication and reduce the ability of animals.

Physiological impacts, such as metabolic and hormonal changes that are frequently associated with stress. In general, the stress level of wildlife is difficult to measure. For wildlife, stress reactions are part of survival and routine events.

Changes in the behavior patterns are the most significant noise impact on wildlife. When noise becomes intrusive on the wildlife habitat, the impact occurring can be in the form of changes in habitat locations and migration patterns, as well as abnormal behaviors that may lead to difficulties in mating and survivals.

Table 4.1 Noise impacts on wildlife (Ref: Air and Noise Compliance, 2012. Effects of Noise on Animals)

Type of Impact	Primary Impact	Secondary Impact
Auditory (hearing)	Hearing disturbances	Changes in relations between predator and bait
	Shift of hearing threshold	Interference in mating
		Decrease in various functions
Physiologic	Stress	Decreased reproduction capacity
	Changes in metabolism	Decreased immunity
	Hormonal changes	Decrease in various function
Behavior	Signal masking	Changes in relations between predator and bait
	Avoidance Behavior	Decreased number of population
		Migration and loss of habitat
		Interference in mating

2 Conclusion

The Tangguh LNG plans to expand its operations by constructing the LNG Train 3 as the initial development and the future development among others the construction of the LNG Train 4 and its other supporting facilities. These activities include the construction of related new units. During the construction phase, the heavy equipment used will be a new source of noise in the Tangguh LNG area. As the noise emissions will occur continuously during the construction period of the Tangguh LNG Expansion Project, Modeling of noise distribution is conducted with the purpose to predict the distribution of noise due to the construction activities of the Tangguh LNG Expansion Project. Modeling is performed by using the MATLAB® software based on ISO 9613 on Attenuation of Sound during Propagation Outdoors.

Noise Modeling distribution results indicate, that for the scenario of year 2014, by using 100% quality standard equipment noise is achieved at a distance of approximately 3,000 meter (3 km) from the source. For the scenario of semester I year 2015, by using 100% equipment and when all activities are conducted simultaneously it results in a quality standard of noise that is achieved at a distance of approximately 5,000 meter (5 km) from the source. If activities conducted are only piling in area 1A, earthwork in area 6A, and piling in area 7B, the quality standard is achieved at a distance of approximately 4,000 meter (4 km). If the activities implemented are only concrete in area 1A, foundation in area 6A, concrete in area 7B, the quality standard is achieved at a distance of approximately 2,200 meter (2.2 km). While when the activities undertaken are only installation in area 1A, construction in area 6A, concrete in area 7B, the quality standard is achieved at a distance of approximately 3,400 meter (3.4 km).

As for the scenario in semester I year 2016, with the use of 100% equipment the quality standard of noise is achieved at a distance of approximately 4,500 meter (4.5 km) from the source. For the scenario of semester II year 2016 with activities that involve more heavy equipment, the use of 100% equipment results in the quality standard of noise that is achieved at a distance of approximately 6,000 meter (6 km) from the source. In the scenario of semester I year 2017, the use of 100% equipment will cause that the quality standard of noise is reached at a distance of approximately 7,800 meter (7.8 km) from the source. While the simulation of the scenario of semester II year 2017, the use of 100% equipment results in quality standard of noise that is achieved at a distance of approximately 5,000 meter (5 km) from the source. In the scenario in year 2018, by using 100% equipment the quality standard of noise can be achieved at a distance of approximately 2,600 meter (2.6 km) from the source.

In the overall, Modeling results of impact prediction indicate that the activities of land clearing and construction of the Tangguh LNG train have a less significant impacts on the increase of the noise level in the areas surrounding the Tangguh LNG, including the forest areas. Although at a number of Modeling scenario's, the noise level in the Tanah Merah Baru settlement areas are slightly above the noise quality standards.

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