4 RESULTS

4.1 Existing Sound Levels

Measures of existing sound levels at the selected receptors, 1 through 5, are presented in **Table 4-1**. The graphical interpretation of the data is illustrated in **Figure 4-1** to **Figure 4-3**.

Appendix C contains tables with the sound level data measured during the survey.

Table 4-1. Existing Sound Levels

Period	Receptor	L_{eq} dB(A)	L_{10} dB(A)	L_{min} dB(A)	L_{max} dB(A)
Daytime	1	66.2	68.1	52.6	82.2
	2	66.8	68.8	56.6	86.5
	3	74.1	78.3	57.7	91.9
	4	71.1	74.9	56.6	81.1
	5	61.1	64.0	53.8	69.7
Nighttime	1	63.1	66.0	52.9	78.7
	2	66.7	68.8	56.6	86.5
	3	68.9	73.9	51.0	83.5
	4	66.8	70.3	49.1	85.8
	5	60.1	63.5	52.3	68.4

Table 4-2 presents the results of the existing sound measures collected along the residential areas adjacent or near the PR-2 for the evaluation of existing noise impact levels in the area due to the traffic of trucks.

Table 4-2. Existing Sound Levels for Receptors 6 to 8

Period	Receptor	L_{eq} dB(A)	L_{10} dB(A)	L_{min} dB(A)	L_{max} dB(A)
Daytime	6	61.0	66.9	50.7	78.4
	7	56.6	62.10	48.2	71.4
	8	70.7	72.0	54.0	96.3

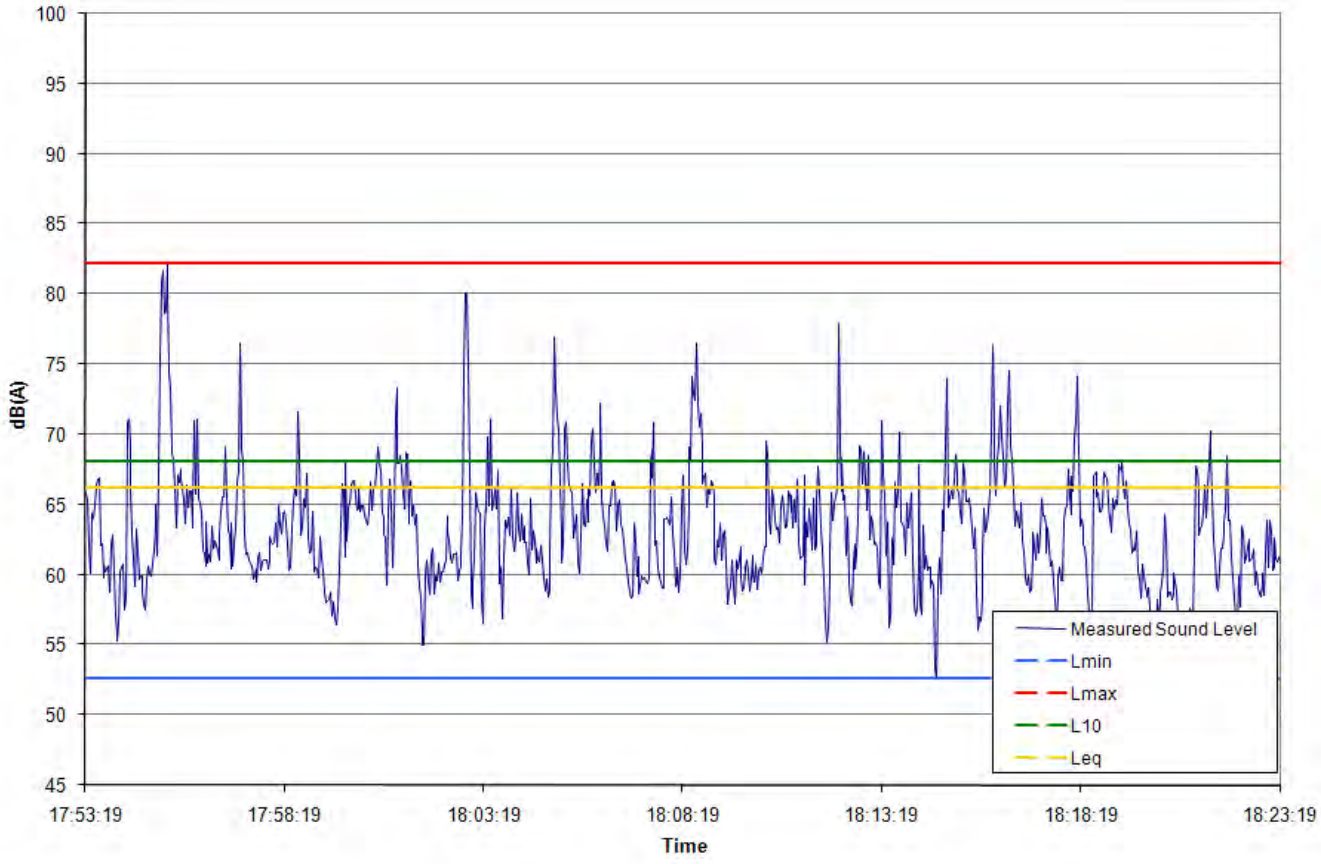


Figure 4-1. Measured Sound Levels – Receptor 1 Daytime

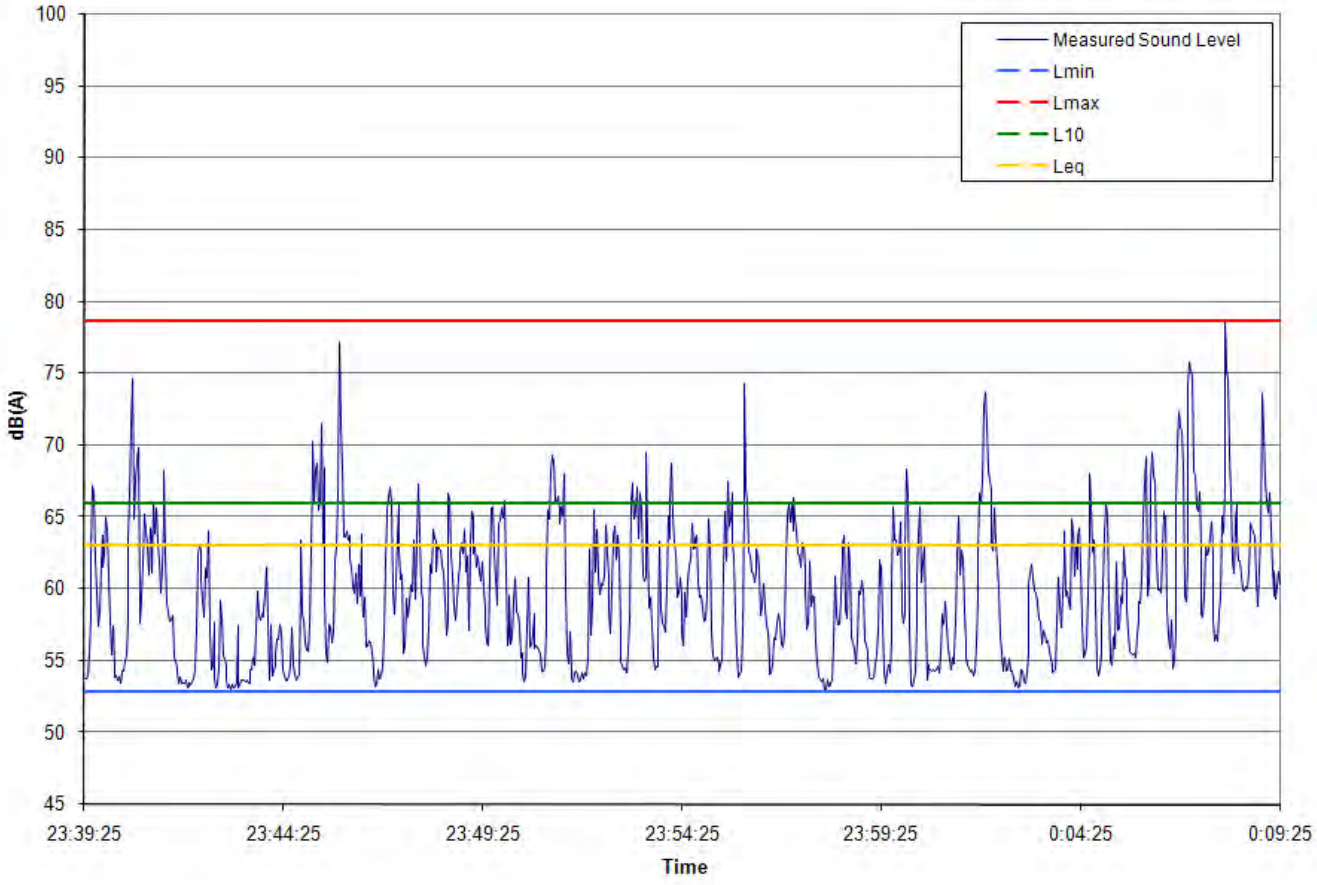


Figure 4-2. Measured Sound Levels – Receptor 1 Nighttime

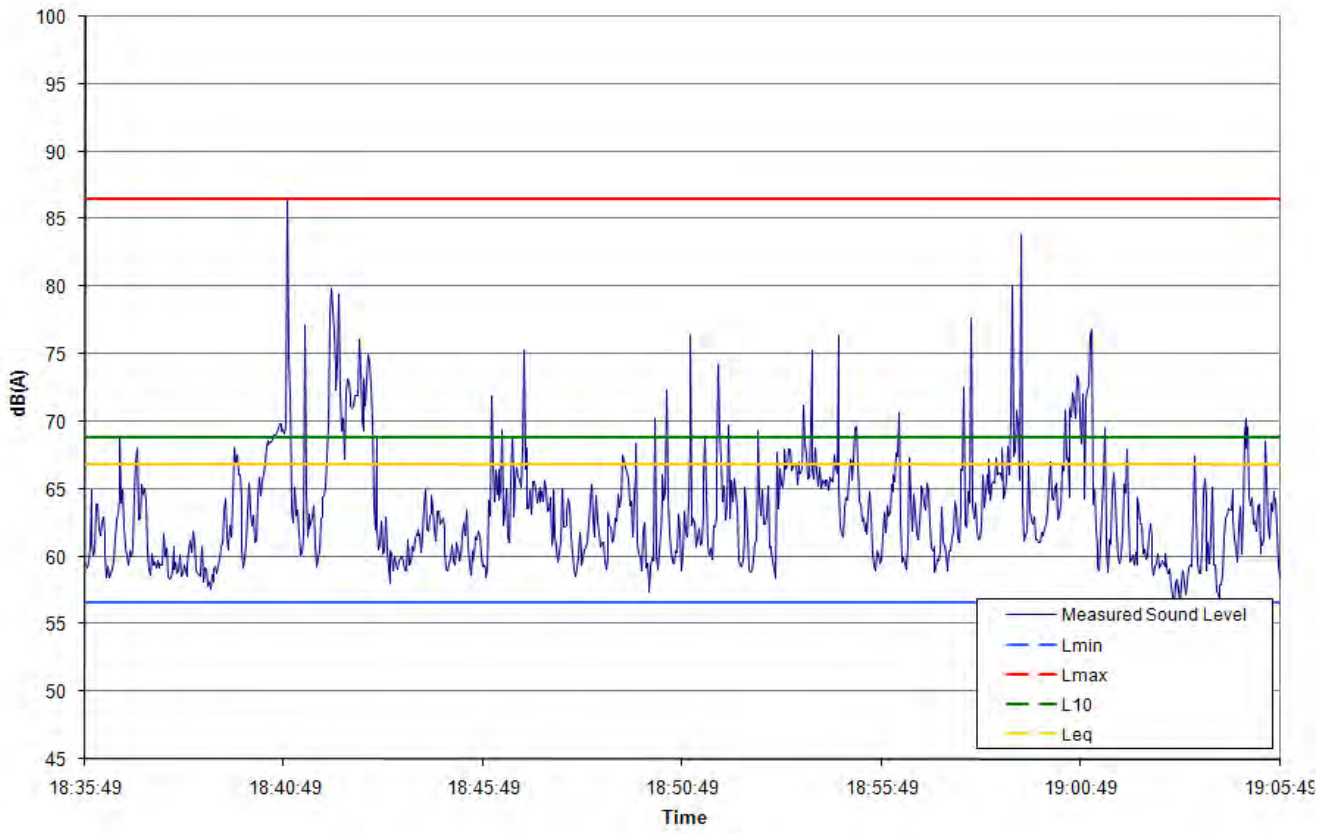


Figure 4-3. Measured Sound Levels – Receptor 2 Daytime

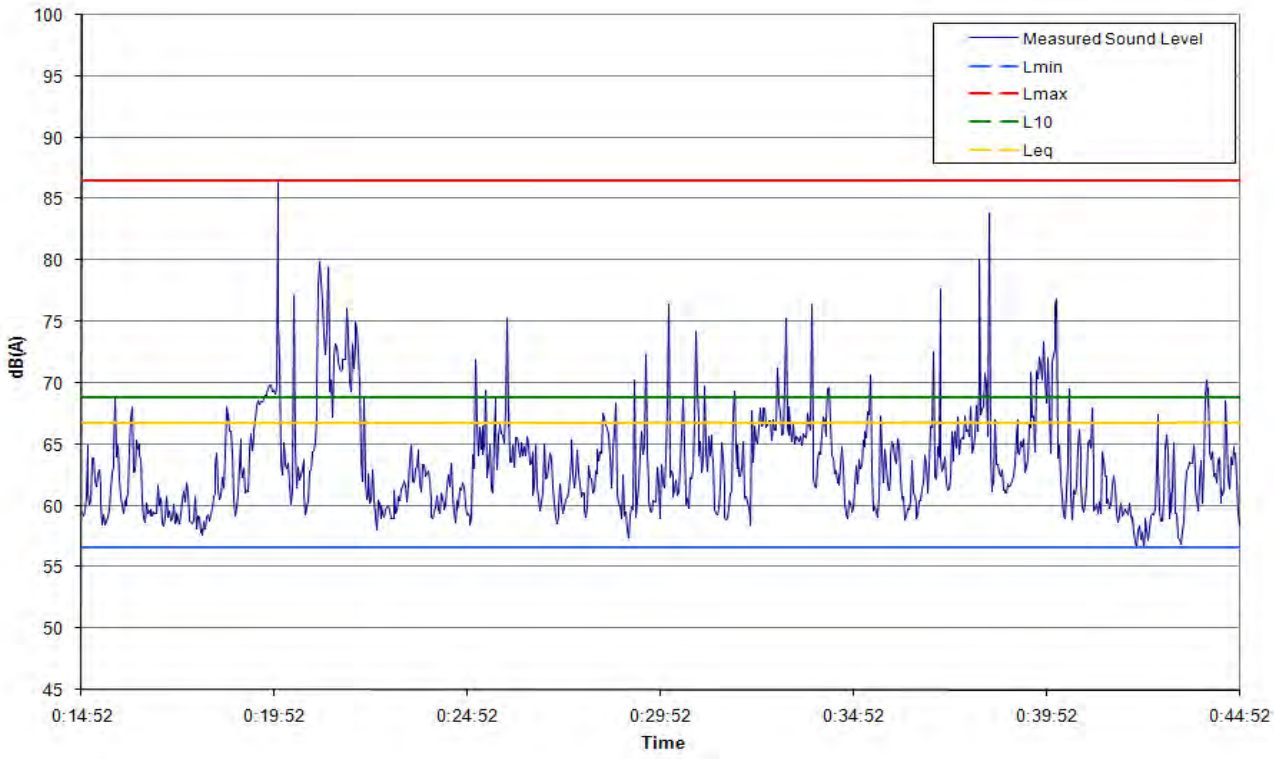


Figure 4-4. Measured Sound Levels – Receptor 2 Nighttime

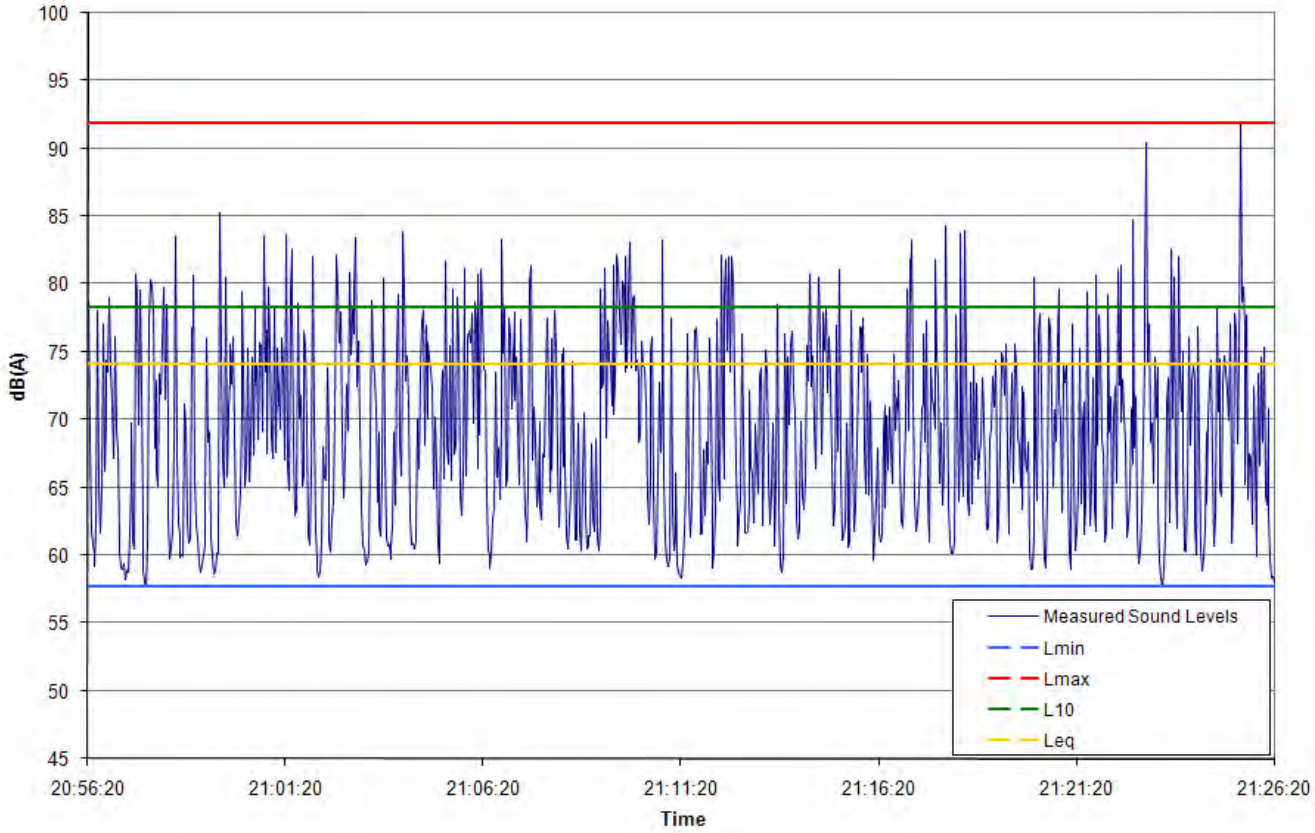


Figure 4-5. Measured Sound Levels – Receptor 3 Daytime

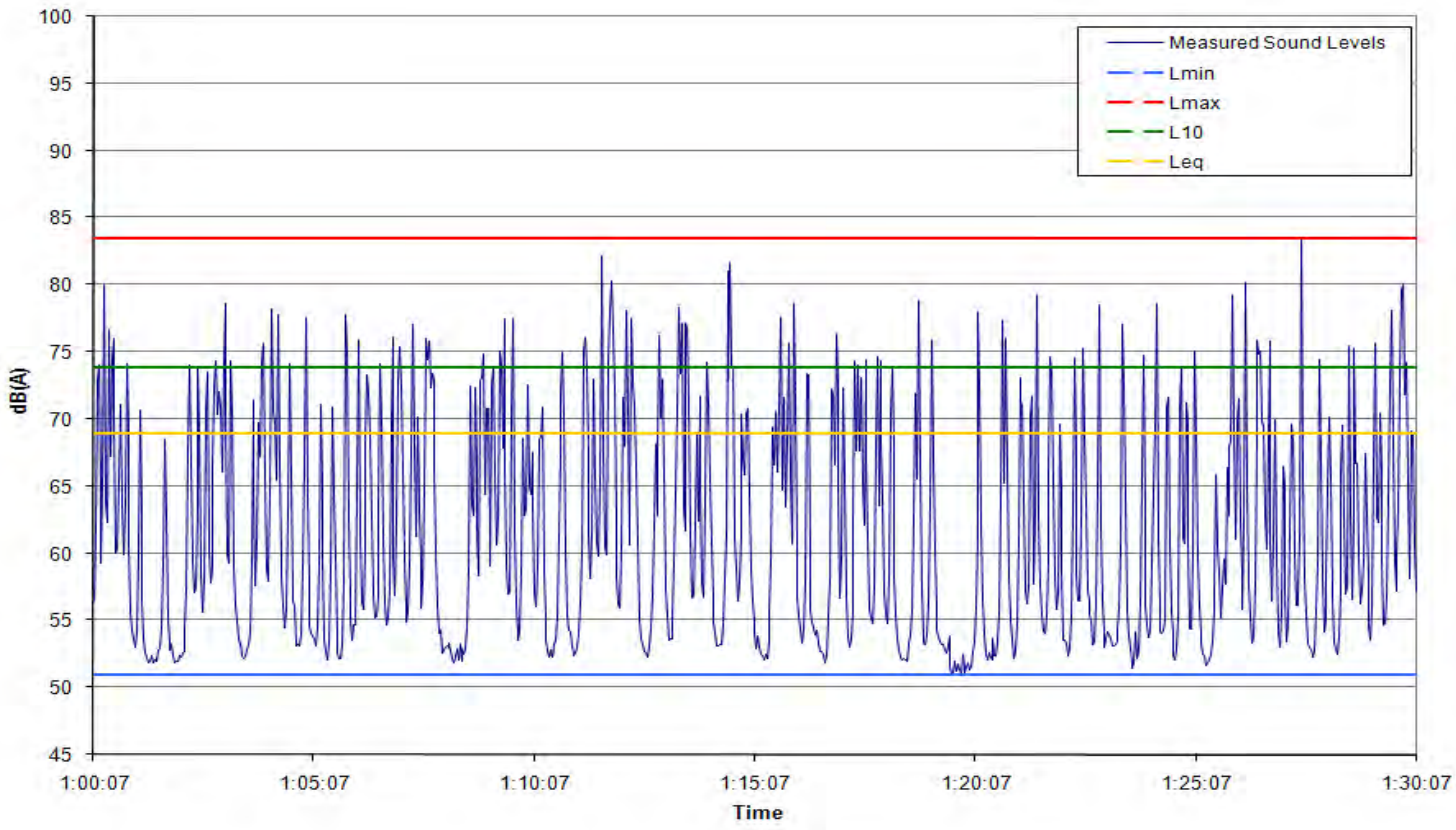


Figure 4-6. Measured Sound Levels – Receptor 3 Nighttime

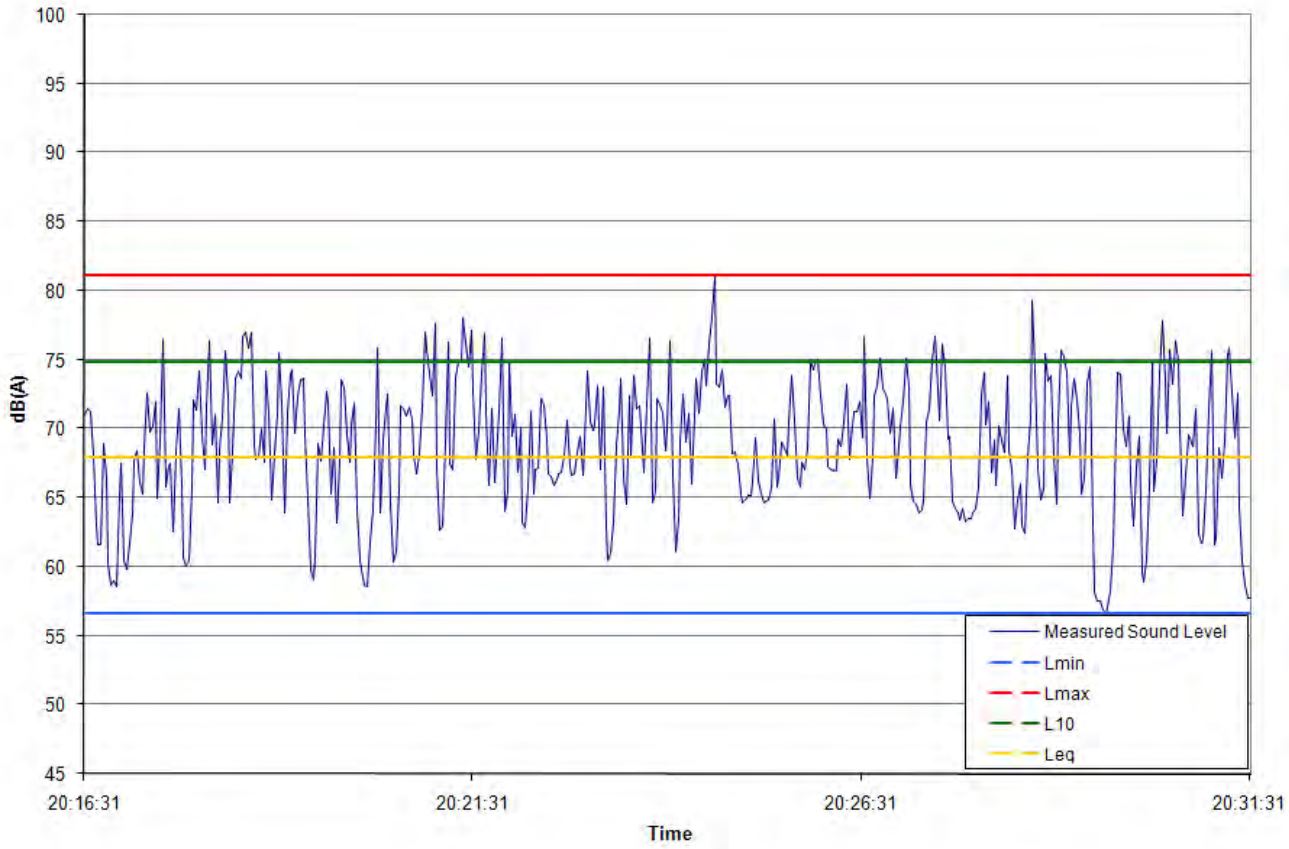


Figure 4-7. Measured Sound Levels – Receptor 4 Daytime

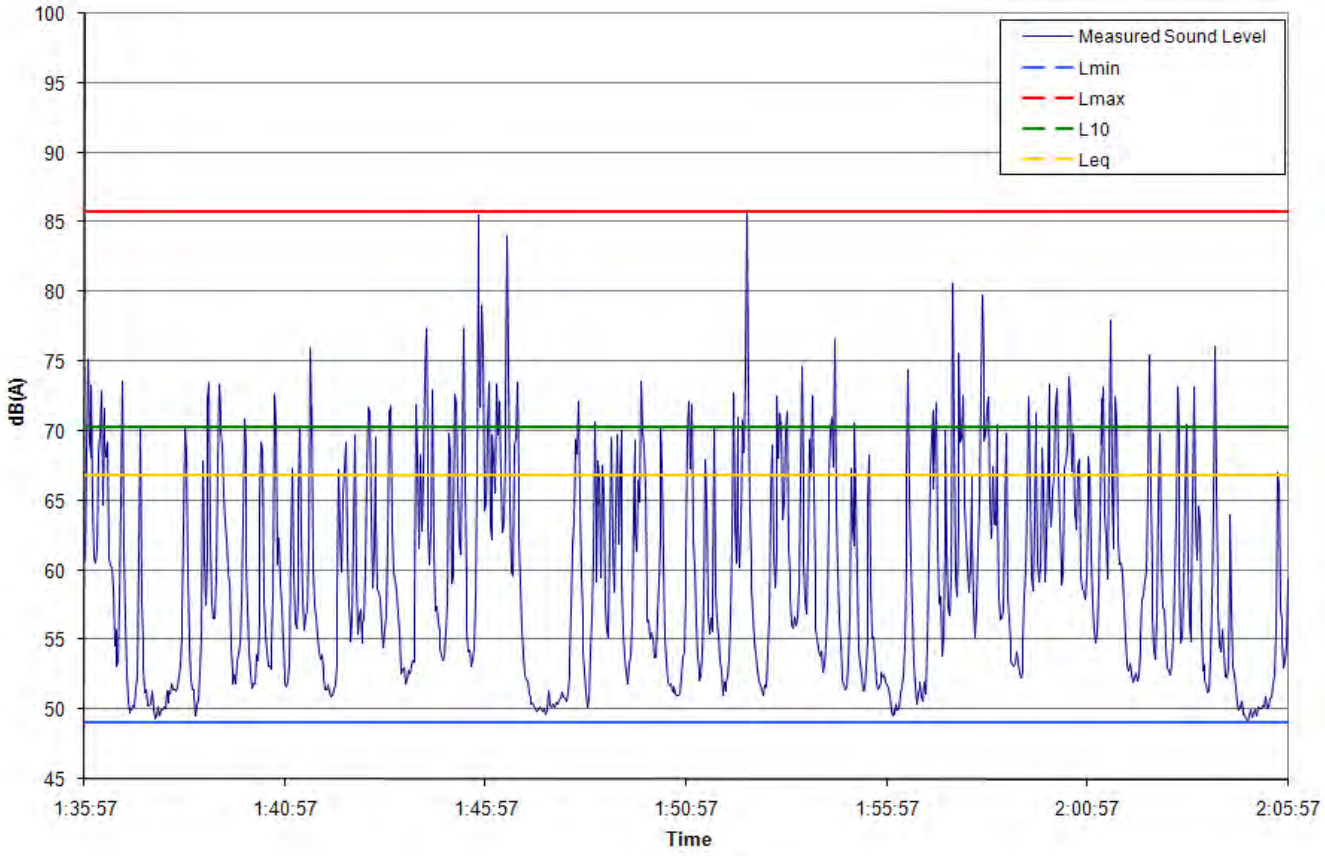


Figure 4-8. Measured Sound Levels – Receptor 4 Nighttime

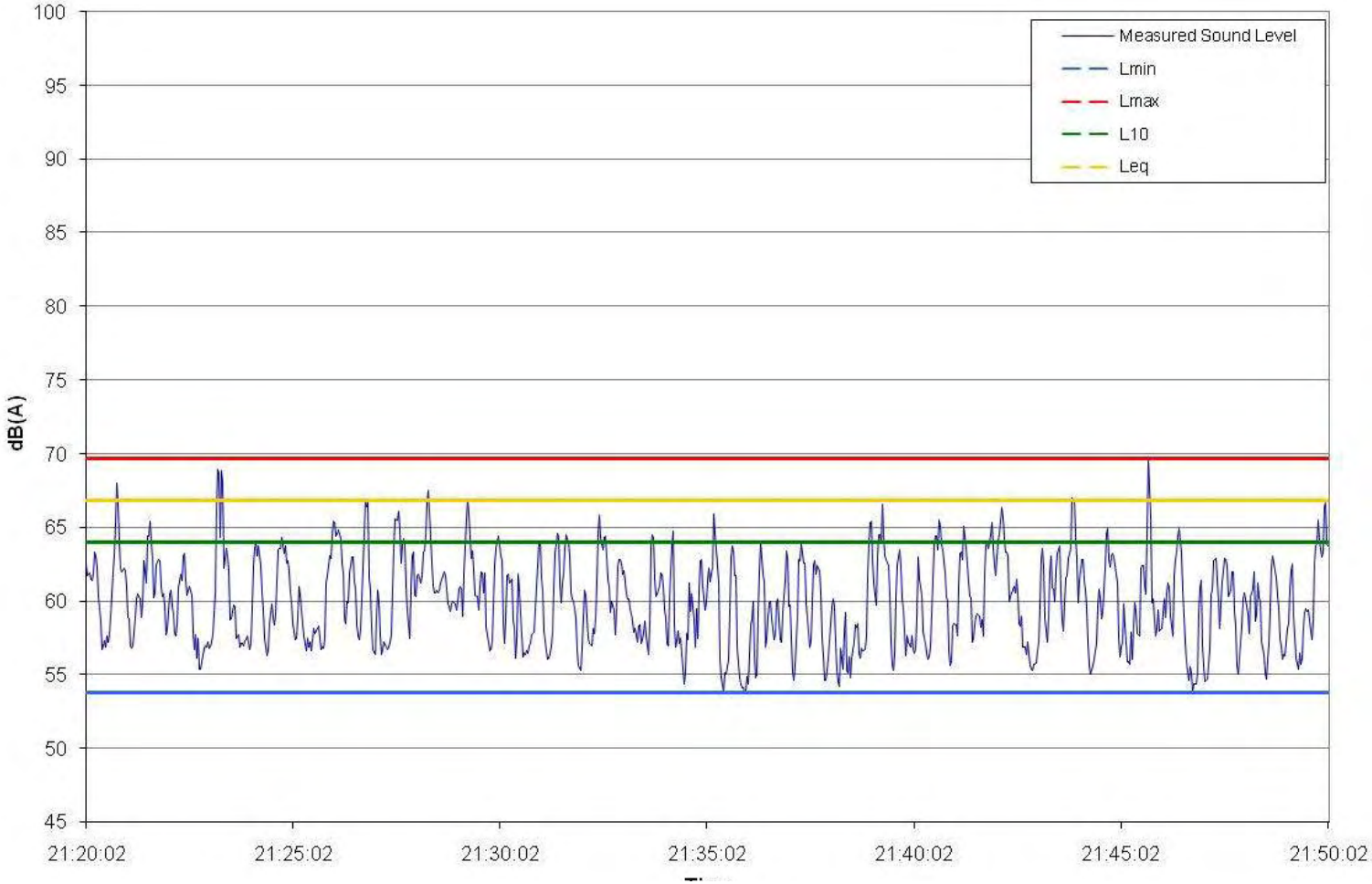


Figure 4-9. Measured Sound Levels – Receptor 5 Daytime

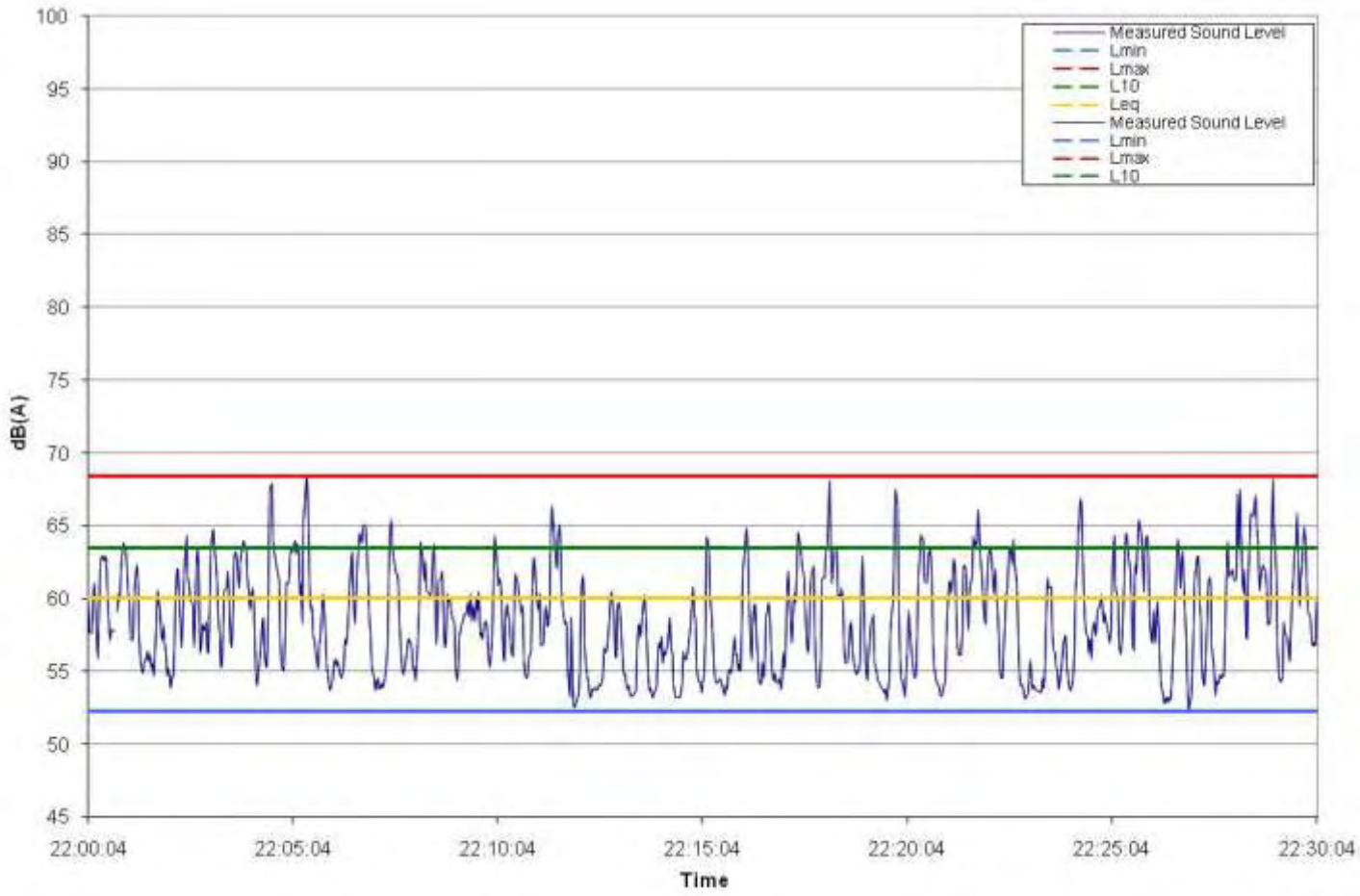


Figure 4-10. Measured Sound Levels – Receptor 5 Nighttime

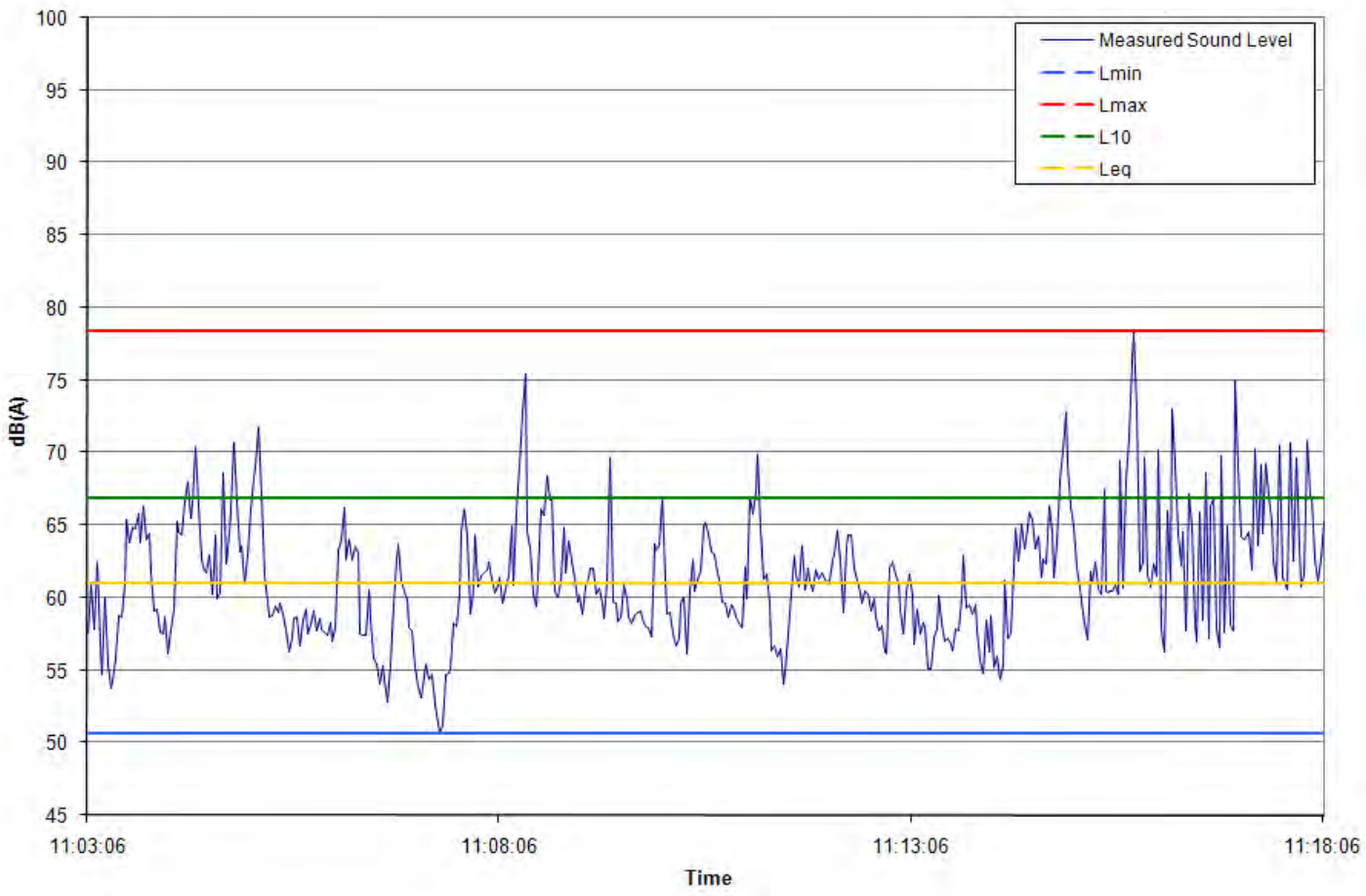


Figure 4-11. Measured Sound Levels – Receptor 6 Daytime

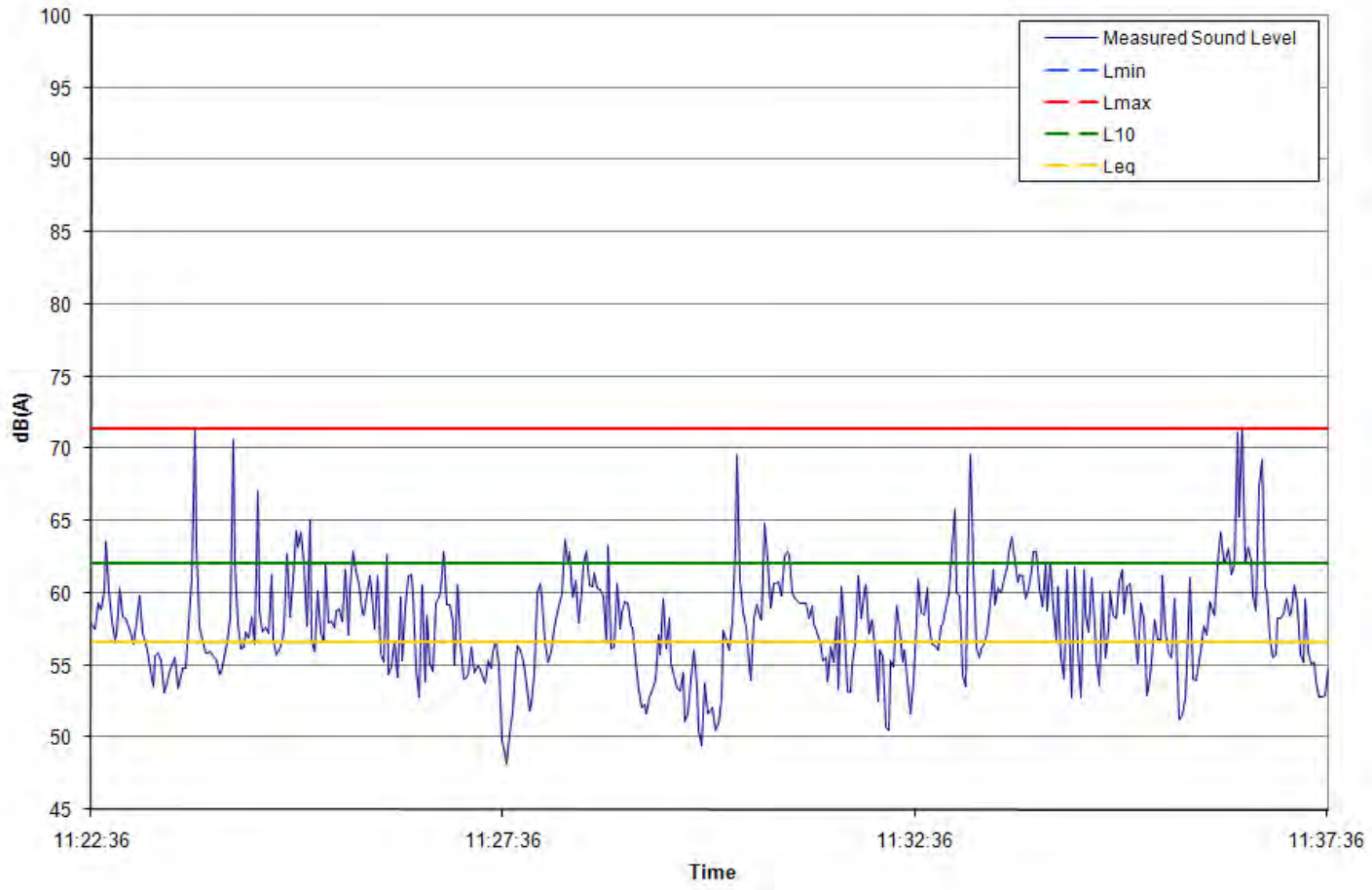


Figure 4-12. Measured Sound Levels – Receptor 7 Daytime

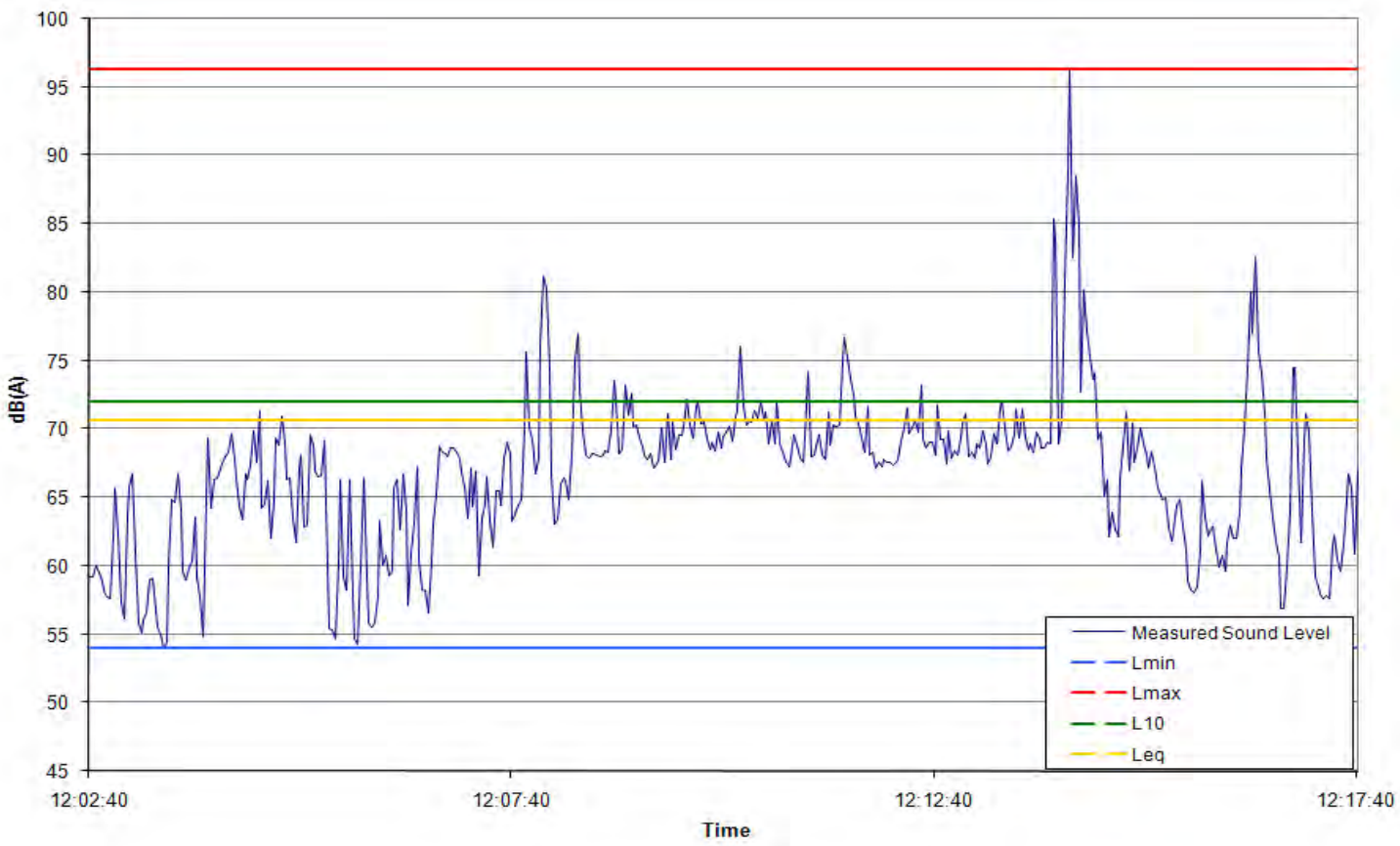


Figure 4-13. Measured Sound Levels – Receptor 8 Daytime

The values corresponding to the L_{10} parameter for each receptor were compared against the maximum levels of environmental noise stipulated by the EQB. **Table 4-3** summarizes these levels. For this evaluation, the emitting source is the Proposed Project site. This is considered as an industrial zone. Although at this time there is no industrial operation in the property, the Proposed Project will be used for industrial purposes. The sound levels from **Table 4-3** that apply will be for Zone III as the emitting source.

Table 4-3. Environmental Quality Board's Noise Emission Limits [dB(A)] [Noise Level Exceeded in 10% of the Measurement Period (L10)]

Emitting Source	Zone I (Residential)		Zone II (Commercial)		Zone III (Industrial)		Zone IV (Tranquility)	
	Day	Night	Day	Night	Day	Night	Day	Night
Zone I	60	50	65	55	70	60	50	45
Zone II	65	50	70	60	75	65	50	45
Zone III	65	50	70	65	75	75	50	45

1. The daytime period corresponds to the hours between 7:01 AM and 10:00 PM.
2. The nighttime period corresponds to the hours between 10:01 PM and 7:00 AM.
3. Source: Environmental Quality Board's Noise Pollution Control Rules, amended version (EQB, 1987)

According to the EQB noise regulations, the limits in **Table 4-3** are adjusted depending on the quantity of environmental background noise in one of the following forms:

1 If existing sound levels are less than the level specified in **Table 4-3** by more than 5 dBA, the limits specified in **Table 4-3** are applied;

2 If existing sound levels are less than the level specified in **Table 4-3** by less than 5 dBA, 3 dBA are added to the specified limits in **Table 4-3**;

3 If existing sound levels are greater than the level specified in **Table 4-3**, 5 dBA are added to the specified limits in **Table 4-3**; and,

4 For any stationary noise-emitting source that emits noises in changing cycles, or repetitions of impulsive noises, the limits specified in **Table 4-3** are reduced at a rate of 5 dBA.

The Federal Highway Authority (FHWA) noise regulations were reviewed for the evaluation of a potential increase in trucks traffic in the area due to the operation of the Proposed Project.

Table 4-4 describes the noise abatement criteria used by the FHWA for any mitigation required for an increase in noise levels due to an increase in traffic. Based on the FHWA regulations, the receptors 6 through 8 are classified as activity category B (Residences).

Table 4-4 Noise Abatement Criteria (NAC) Hourly A-Weighted Sound Level in Decibels (dBA)

Activity Category	L_{10} (h)	Description of Activity Criteria
B	70	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.

Table 4-5 summarizes the sound levels exceeded in 10% of the period of measurement and the limits of noise for each receptor established by the EQB. **Table 4-6** summarizes the noise levels exceeded in 10% of the period of measurement and the limits guidelines of noise for each receptor established by the FHWA.

Table 4-5. Sound Level Exceeded 10% of the Sample Period (L_{10}) in dB(A)

Receptor	Day (dB(A))		Night (dB(A))	
	Background Noise	Regulatory Level	Background Noise	Regulatory Level
1	68.1	75	66.0	73
2	**68.8**	55	**61.2**	50
3	78.3	80	73.9	78
4	**74.9**	70	**70.3**	55
5	64.0	70	**63.5**	55

Table 4-6. Sound Level Exceeded 10% of the Sample Period (L_{10}) in dB(A) For Additional Receptors

Receptor	Day (dB(A))	
	Background Noise	Regulatory Level
6	66.9	70
7	62.1	70
8	**72.0**	70

During the daytime period, existing sound levels exceeded the regulatory limit at receptors 2 through 4. Receptor 2 represents the tranquility zone and Receptor 4 represents a residential zone. Receptor 2 noise levels were exceeded because of the high volume of vehicular traffic in the zone. Receptor 4 noise levels exceeded the EQB threshold because the residential properties are located adjacent to PR-2, were high volume of vehicular traffic is present on a daily basis.

Receptor 1 represents a commercial zone and Receptor 3 represents an industrial zone. At receptors 1, 2, 3 and 4 the main source of noise is the traffic through PR-2. As shown in

Figure 4-14, these receptors are located more than 100 meters distance of the Proposed Project.

Receptor 2 is located approximately 1.25 miles (2 km) towards the northwest of the Property. Noise from the Proposed Project site is not expected to cause significant impacts at this receptor because of large distance, structures and vegetation between both, which attenuate noise from the Proposed Project site.

Receptors 2, 4, and 5 exceeded the EQB background noise limits during the nighttime period. Noise levels are mostly influenced by the vehicular traffic along PR-2 during the nighttime period. Receptor 5 noise levels are mostly influenced by the operation of a dragging race track located approximately 350 meters to the east in relation to the receptor. The racetrack operates 3 to 4 days a week from 6:00pm to 2:00am.

Receptors 6 and 7 did not exceed the FHWA guidelines of 70 dB(A) for noise abatement in highway projects. However, Receptor 8 exceeded the FHWA guideline limit.

4.2 Sound Level Impacts

Sound levels in the areas surrounding the Proposed Project site may slightly increase during the construction of the Proposed Project. The increase in noise will most likely be caused by the operation of the construction equipment. The amount of impact to each receptor will vary upon its location, the type, location and the number of construction equipment being used, among other factors.

During the construction phase of the Proposed Project, the impact may occur at receptors located in the surrounding areas, represented by Receptors 1, 2, 3, 4, and 5.

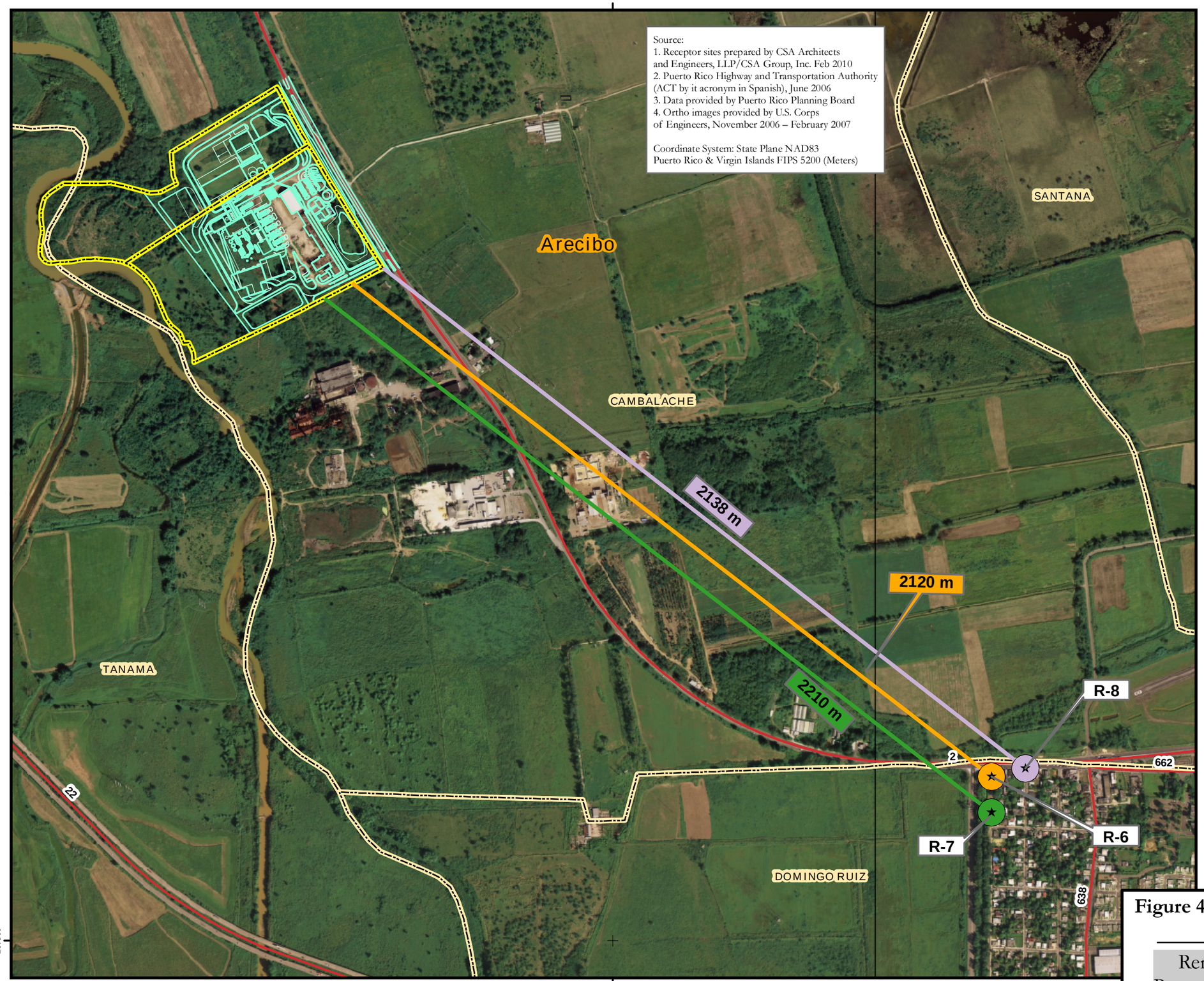
It's expected that all receptors, except Receptor 2, may be directly impacted by the potential increase in truck traffic along PR-2 during the operation of the proposed project.

The construction activities expected to produce the most amount of noise is pile driving and sheet pilling installation.

The sound level impact at each receptor during the pile driving or sheet pile driving activities are estimated for each receptor following the formulas presented in **Section 3.5.2.1**. **Table 4-7** presents these values.

Table 4-7 Construction Phase Estimated Sound Level Impact during Pile Driving Activities

Receptor	Distance to Pile Driving Activity (feet)	Noise Level (dB(A))				
		Background L_{10}	Maximum Level Expected During Pile Driving	L_{10} Due to Pile Driving	Total L_{10}	Daytime Regulation
1	5379	68.1	54.4	50.4	68.2	75
2	6212	68.8	53.1	49.1	68.9	55
3	3362	78.3	58.4	54.5	78.3	80
4	1794	74.9	63.9	59.9	75.1	70
5	1916	64.0	63.3	59.3	65.3	70



N
W E
S

Scale: 1:10,000

0 100 200 400 Meters

Legend:

Receptors[1]

- R-6, Residential Properties
- R-7, Residential Properties
- R-8, Residential Properties
- Roads[2]
- Site Layout
- Proposed Waste To Energy Project Limits
- Municipal Limit[3]
- Ward Limit[3]

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Figure 4-14 Receptors Location Aerial Map Construction Phase

Renewable Power Generation and Resources Recovery Facility Arecibo, PR

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The total L_{10} sound level presented in **Table 4-7** sums the existing sound level at each receptor and the L_{10} value expected from pile driving activities. The regulatory sound level at each receptor was adjusted as specified in the noise regulations for impulsive noises. The estimated L_{10} values during pile driving activities exceed noise regulations at Receptors 2 and 4. However, pile driving activities did not contribute significantly to the background noise levels, since background noise levels for these receptors already exceeded the EQB threshold noise limits. Noise level increases for Receptors 1 through 5 were from 0.1 to 1.3 dB(A) compared to the background noise levels alone. Receptors 1, 3, and 5 did not exceed the noise levels threshold limits.

The largest noise level increase during pile driving activities was at Receptor 5, with a background noise levels increase of 1.3 dB(A). Nonetheless, this result did not exceed the EQB threshold noise limits. According to the *FHWA Highway Traffic Noise Analysis and Abatement Policy and Guidance*, this increase in noise levels is barely perceived by the human ear.

4.3 Sound Levels Impacts DURING The Operation

The proposed project's operation is expected to slightly increase the noise levels at the receptors surrounding the property. **Table 4-8** describes most of the equipment that will be used within the Property that could generate noise impacts on the surrounding areas to the site.

Table 4-8. Equipment Noise Sources

Potential Noise Sources	dB(A) (At 16,000 hz)
Trucking (Along Site Roads)	-
Truck Maneuver Area	75
Tipping Floor Activities	86
Shredders	-
Ash Processing Building	-
Conveyors	-
Shakers	55

Potential Noise Sources	dB(A) (At 16,000 hz)
Boilers	78
Cooling Tower	85*
Blowers	95*
ID Fans (Casings)	43
Building Vent Fans	63
Dust Collector System	70
Condensers	92
Transformers	60
Steam Generators	75
Deareators	100
Precipitators	96
Pumps	-
Stack	93

Notes:

1. Sound levels are for all three system modules combined without sound attenuation by silencers, buildings, barriers, and shielding.
2. Dashes given sound power entries imply insignificant contributions.

Source: Cavanaugh Tocci Associates (1981)

* Assumed value by CSA

Most of the equipment described in **Table 4-8** will be located within the buildings of the facility. Therefore, it is estimated that the noise generated from these equipment will be reduced from 10 to 15 dB (A).

Figure 4-16 describes the location of each Receptor (1 through 5) evaluated and its distance to the proposed process equipment area that could generate the most noise impacts in the surrounding areas to the site.

Table 4-9 and Table 4-10 describes the noise levels generated by the equipment operation to the receptors located closer to the proposed project. The location of the equipment was estimated using the proposed Project's site plan. Calculations were performed using the noise levels generated by the deareators operation (100 dB(A)), since it will be the noisiest equipment in the facility. Deareators will be located inside a building structure within the facility. Therefore, the interior of the building may

provide some noise attenuation to the emission source and the receptors under evaluation. Therefore, a reduction of 20 dB(A) is estimated. A deaerator is a device that is widely used for the removal of air and other dissolved gases from the feedwater to steam-generating boilers.

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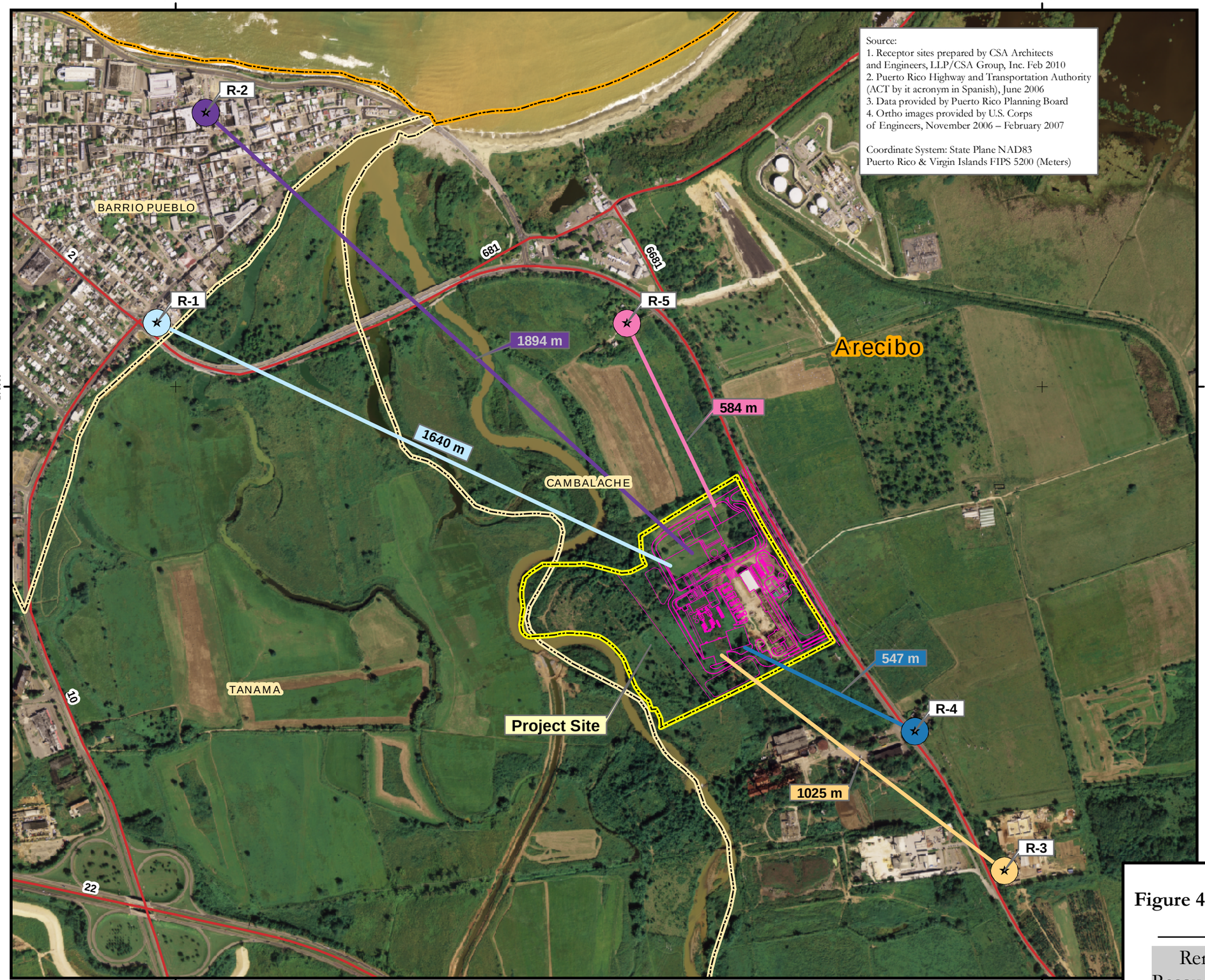

Source:
1. Receptor sites prepared by CSA Architects and Engineers, LLP/CSA Group, Inc. Feb 2010
2. Puerto Rico Highway and Transportation Authority (ACT by it acronym in Spanish), June 2006
3. Data provided by Puerto Rico Planning Board
4. Ortho images provided by U.S. Corps of Engineers, November 2006 – February 2007

Coordinate System: State Plane NAD83
Puerto Rico & Virgin Islands FIPS 5200 (Meters)

N
W E
S

Scale: 1:11,000

0 100 200 400 Meters

Legend:

Receptors[1]

- R-1, Farmacia del Carmen, Commercial
- R-2, Hospital Dr. Susoni, Tranquility
- R-3, Battery Recycling, Industrial
- R-4, Residential Properties
- R-5, Residential Properties

Roads[2]

Huella Planta

Project Limit

Municipal Limit[3]

Ward Limit[3]

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Figure 4-15 Receptors Location Aerial Map Operation Phase

Renewable Power Generation and Resources Recovery Facility Arecibo, PR

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Table 4-9. Estimated Sound Level Impact during Daytime Operation

Receptor	Closest Distance to Operational Noise Sources (feet)	Noise Level (dB(A))				
		Background L_{10}	Maximum Level Expected	L_{10} Due to Operation	Total L_{10}	Daytime Regulation (for Operation)
1	5740	68.1	38.8	41.8	68.1	70
2	6626	68.8	37.6	40.6	68.8	55
3	3641	78.3	42.8	45.8	78.3	80
4	2230	74.9	47.0	50.0	74.9	70
5	2788	64.0	45.1	48.1	64.2	68

Table 4-10. Estimated Sound Level Impact during Nighttime Operation

Receptor	Closest Distance to Operational Noise Sources (feet)	Noise Level (dB(A))				
		Background L_{10}	Maximum Level Expected	L_{10} Due to Operation	Total L_{10}	Nighttime Regulation (for Operation)
1	5740	66	38.8	41.8	66.0	70
2	6626	68.8	37.6	40.6	68.8	50
3	3641	73.9	42.8	45.8	73.9	78
4	2230	70.3	47.0	50.0	70.4	55
5	2788	63.5	45.1	48.1	63.7	55

The noise levels during the operation phase for the daytime period showed a slightly increase in receptors 1, through 5, from 0.1 to 0.2 dB(A). An increase in 0.2 dB(A) noise level is barely perceptible (detectable) to the human ear. Receptors 2 and 4 exceeded the EQB thresholds limits for a tranquility zone. However, background noise levels from these receptors already exceeded the EQB threshold limits for this zone.

Operation noise levels for the nighttime period also showed a minor increase at Receptor 5; of 0.2 dB(A). An increase of 0.2 dB(A) is barely perceptible to the human ear. Receptors 2, 4, and 5 exceeded the EQB threshold limits for the nighttime period. However, existing background noise levels for these Receptors already exceeded the EQB noise limits for the nighttime period.

CSA estimates that due to the operation of the proposed project an increase in vehicular traffic through the PR-2 are expected, specifically solid waste trucks that will unload waste into the proposed project. Traffic of trucks could pose an increase in noise levels to residential and commercial areas adjacent to PR-2.

However, all receptors are currently affected by the noise generated by the traffic of trucks through PR-2, since the area is basically commercial and industrial. Therefore, noise increase in the zone due to the operation of the proposed project is estimated to be slightly moderate.

5 CONCLUSIONS AND RECOMMENDATIONS

CSA Group was contracted by Energy Answers International to conduct a *Noise Survey* as part of the environmental studies that are being performed for the planning phase of the Renewable Power Generation and Resources Recovery Facility. A field investigation was performed as part of the *Noise Survey,* with the purpose of determining existing sound levels around and within the Proposed Project area.

During the site visit, five (5) sampling locations (R-1 through R-5) were selected. The locations of sampling points near the Proposed Project area were determined based on the assumption that these receptors would be the most impacted during the construction and operation of the Proposed Project. These receptors were distributed throughout *Residential*, *Commercial*, *Tranquility*, and *Industrial Zones*, as defined by the *EQB Noise Reg*ulation (1987). In addition, three (3) receptors located adjacent or near PR-2, were included to evaluate existing noise levels generated by vehicular traffic along PR-2.

Based on the analysis described above, the following findings, conclusions, and recommendations were drawn:

- During the daytime period, existing sound levels exceed the regulatory limits at Receptors 2 and 4. At Receptors 1, 3, 4, and 5 the main source of noise is traffic along PR-2. At Receptor 2, the main source of noise was the vehicular traffic along Palma Street and Victor Rojas Avenue.

- Receptors 2, 4, and 5 exceeded the EQB background noise limits during the nighttime period. Noise levels at Receptors 4 and 5 are mostly influenced by the vehicular traffic along PR-2 during the nighttime period. Meanwhile, Receptor 2 nighttime noise levels are mostly influenced by the traffic along Palma Street and Victor Rojas Avenue.

- Receptors 6 and 7 did not exceed the FHWA guidelines of 70 dB(A) for noise abatement in highway projects. However, Receptor 8 exceeded the FHWA guideline limit. CSA estimates that due to the operation of the proposed project an increase in

vehicular traffic through PR-2 is expected, specifically solid waste trucks that will unload waste at the proposed project. Traffic of trucks could pose an increase in noise levels in the residential and commercial areas adjacent to PR-2. However, currently all receptors are affected by the noise generated by the traffic of trucks through PR-2, since the area is basically a commercial and industrial zone. Therefore, the noise increase in the zone due to the operation of the proposed project is estimated to be slightly moderate.

- The construction phase of the Proposed Project is estimated to last 2 years. The construction activities expected to produce the most amount of noise is pile driving and sheet piling installation. These activities are expected to occur during the first three (3) months of the project. Based on the noise impact results during the construction phase of the project, no significant increases in noise levels are expected during the pile driving activities at all receptors, since the closest receptor (Receptor 4) to the proposed project is approximately 547 meters of distance. Also pile driving activities will be conducted during the daytime period.

- The operation of the Proposed Project is not expected to increase the noise levels already experienced in the area or surrounding areas during the daytime period.

It is advisable to implement sound control measures during the construction and operation phases of the Proposed Project, in order to minimize the increase of background noise levels in the area. The measures must include controls at the noise source (e.g., sound mufflers) and in the trajectory of the sound, such as barriers and other attenuation structures.

The following noise control measures are recommended:

- Planning of construction activities during the diurnal period;

- Ensure that all construction equipment have noise mufflers and are in good working order;

- Position the noisiest equipment as far away as possible from the most sensitive areas;

- Diminish the time of operation of the machinery in the proximity of the most sensitive areas; and

- Incorporate the use of silencers, permanent barriers, and/or shielding into the equipment to be used during the operation of the proposed project.

6 REFERENCES

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