## APENDICE G

# Estudio de Niveles de Ruido

Octubre 2010

Declaración de Impacto Ambiental – Preliminar

**Planta de Generación de Energía Renovable y Recuperación de Recursos**

BARRIO CAMBALACHE DE ARECIBO

EnergyAnswers Arecibo

# Noise Study

## Preliminary Environmental Impact Statement

## Renewable Power Generation and Resources Recovery Facility

CAMBALACHE - ARECIBO


CSA Group

**CSA ARCHITECTS AND ENGINEERS, LLP**

1064 Ponce de León Ave., CSA Plaza Suite 500
San Juan, PR 00907-3740
T 787.641.6800 F 787.641.6850
**www.csagroup.com**

# TABLE OF CONTENTS

**1 EXECUTIVE SUMMARY ..... 1**

**2 INTRODUCTION ..... 5**

**3 METHODOLOGY ..... 8**

3.1 Field Study ..... 8
3.2 Sound Level Meter ..... 10
3.3 Impact Analysis ..... 12
3.4 Data Collection ..... 12
3.5 Analysis of Data ..... 14
3.5.1 Background Noise (Existing Sound) Levels ..... 14
3.5.2 Sound Level Impacts ..... 15

**4 RESULTS ..... 20**

4.1 Existing Sound Levels ..... 20
4.2 Sound Level Impacts ..... 37
4.3 Sound Levels Impacts DURING The Operation ..... 40

**5 CONCLUSIONS AND RECOMMENDATIONS ..... 46**

**6 REFERENCES ..... 49**

# LIST OF TABLES

Table 3-1. Receptors Identification ..... 9
Table 3-2. Sound Level Meter Specifications ..... 10
Table 3-3. Typical Sound Levels Generated by Construction Equipment ..... 18
Table 4-1. Existing Sound Levels ..... 20
Table 4-2. Existing Sound Levels for Receptors 6 to 8 ..... 20
Table 4-3. Environmental Quality Board's Noise Emission Limits [dB(A)] [Noise Level Exceeded in 10% of the Measurement Period (L10)] ..... 34
Table 4-4 Noise Abatement Criteria (NAC) Hourly A-Weighted Sound Level in Decibels (dBA) ..... 35
Table 4-5. Sound Level Exceeded 10% of the Sample Period ($L_{10}$) in dB(A) ..... 36
Table 4-6. Sound Level Exceeded 10% of the Sample Period ($L_{10}$) in dB(A) For Additional Receptors ..... 36
Table 4-7 Construction Phase Estimated Sound Level Impact during Pile Driving Activities ..... 38
Table 4-8. Equipment Noise Sources ..... 40
Table 4-9. Estimated Sound Level Impact during Daytime Operation ..... 44
Table 4-10. Estimated Sound Level Impact during Nighttime Operation ..... 44

# LIST OF FIGURES

Figure 2-1. Location Map ..... 6
Figure 2-2. Receptors Location ..... 7
Figure 4-1. Measured Sound Levels – Receptor 1 Daytime ..... 21
Figure 4-2. Measured Sound Levels – Receptor 1 Nighttime ..... 22
Figure 4-3. Measured Sound Levels – Receptor 2 Daytime ..... 23
Figure 4-4. Measured Sound Levels – Receptor 2 Nighttime ..... 24
Figure 4-5. Measured Sound Levels – Receptor 3 Daytime ..... 25
Figure 4-6. Measured Sound Levels – Receptor 3 Nighttime ..... 26

Figure 4-7. Measured Sound Levels – Receptor 4 Daytime ..... 27
Figure 4-8. Measured Sound Levels – Receptor 4 Nighttime ..... 28
Figure 4-9. Measured Sound Levels – Receptor 5 Daytime ..... 29
Figure 4-10. Measured Sound Levels – Receptor 5 Nighttime ..... 30
Figure 4-11. Measured Sound Levels – Receptor 6 Daytime ..... 31
Figure 4-12. Measured Sound Levels – Receptor 7 Daytime ..... 32
Figure 4-13. Measured Sound Levels – Receptor 8 Daytime ..... 33
Figure 4-14. Receptors Location Aerial Map: Construction Phase ..... 39
Figure 4-15. Receptors Location Aerial Map- Operation Phase..... 43

## LIST OF APPENDICES

Appendix A: Sound Level Meter Instruction Manual and Calibration Certificate
Appendix B: Registry of Sound Measurements
Appendix C: Sound Level Data

# 1 EXECUTIVE SUMMARY

CSA Architects & Engineers and CSA Group, Inc. (CSA) was contracted by Energy Answers International, Inc., to conduct a *Noise Survey* as part of the environmental studies for the planning phase of the proposed Renewable Power Generation and Resources Recovery Facility, which will be located on Highway PR-2, Km. 73.1, Cambalache Ward in Arecibo, Puerto Rico.

The purpose of the Noise Survey was to characterize existing noise levels and estimate potential noise level impacts, during the Project's construction and operational phases. The Study Area covered the Cambalache Ward, the project's parcel area, and the closest developed or settlement areas (Pueblo Ward and Dominguez Ruiz Ward) (**Figure 2-1. Location Map**). The survey identified five (5) sensitive receptors (shown as 1 through 5) within the study area. Each represents a type of noise receptor (residential, commercial, etc.) that could be potentially impacted by noise generated from the Project. (**Figure 2-2. Receptors Location**).

Receptor 1 is a commercial zone located 1,785 meters toward the northwest of the Proposed Project. Receptor 2 is a tranquility zone located at 2,035 meters to the northwest of the Proposed Project site. Receptor 3 is an industrial zone located at 1,112 meters toward the southeast of the Proposed Project area and receptor 4 is a rural residential zone located at 658 meters toward the southeast of the Proposed Project area. Receptor 5 is a residential zone located at 861 meters towards the north of the Proposed Project area. All these receptors are located at a distance greater than 500 meters measured from the center of the Project site.

The Environmental Quality Board's (EQB) classification and location of all the receptors evaluated are provided below.

- **Receptor 1** (Zone II – Commercial) - Farmacia del Carmen at PR-2;
- **Receptor 2** (Zone IV-Tranquility) - Hospital Dr. Susoni at Victor Rojas Ave. (PR-680).
- **Receptor 3** (Zone I – Industrial) – Battery Recycling, Inc. at PR-2 Km 72.2.

- **Receptor 4** (Zone I – Residential) –Group of Rural Residential Properties located at PR-2 Northbound;

- **Receptor 5** (Zone I – Residential) - Residential Properties located at toward the north of the Land Authority Property.

In addition, noise levels were measured at three (3) receptors located along PR-2 to establish existing noise conditions influenced by the traffic of trucks and other vehicles.

Existing sound levels were measured with an Extech sound level meter, Model 407764. Predictive methods were used to study the sound levels generated by the facilities and empirical equations were used for the computation of future sound levels that may be perceived at each receptor. Predicted sound levels were then compared with the noise criteria established by the EQB's Noise Pollution Control Regulation, amended version (EQB, 1987).

The results of the noise analysis for the daytime and nighttime periods are summarized in **Section 4** of this document. Based on the analysis described above, the following findings, conclusions, and recommendations were drawn:

- During the daytime period, existing sound levels exceeded the regulatory limits at Receptors 2 and 4. At Receptors 1, 3, 4, and 5 the main source of noise was 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 Federal Highway Administration (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 the PR-2 is expected, specifically solid waste trucks that will unload waste at the proposed project. The traffic of trucks could cause 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 along PR-2, since the area is basically commercial and industrial. Therefore, a slightly moderate noise increase is anticipated in the zone due to additional truck traffic volume.

- The construction phase of the Proposed Project is estimated to last 2 years. The construction activities expected to produce the most amount of noise are pile driving and sheet piling installation. These activities are expected to occur during the first three (3) months of construction. Based on the noise impact results during the project's construction phase, no significant increases in noise levels are expected during the pile driving activities at all receptor locations, since the closest one (Receptor 4) to the proposed project is at approximately 547 meters of distance from corresponding proposed building area within the site. 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 recommended that sound control measures be used during the construction and operation of the Proposed Project, to minimize potential increases of background noise levels in the area. The noise reduction measures must include controls at the noise source (e.g., sound mufflers) and controls in the trajectory of the sound, such as barriers and other attenuation structures. The following noise control measures are suggested:

- Plan 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 as possible from the most sensitive areas;

- Diminish the equipment's time operation in the proximity of the most sensitive areas; and

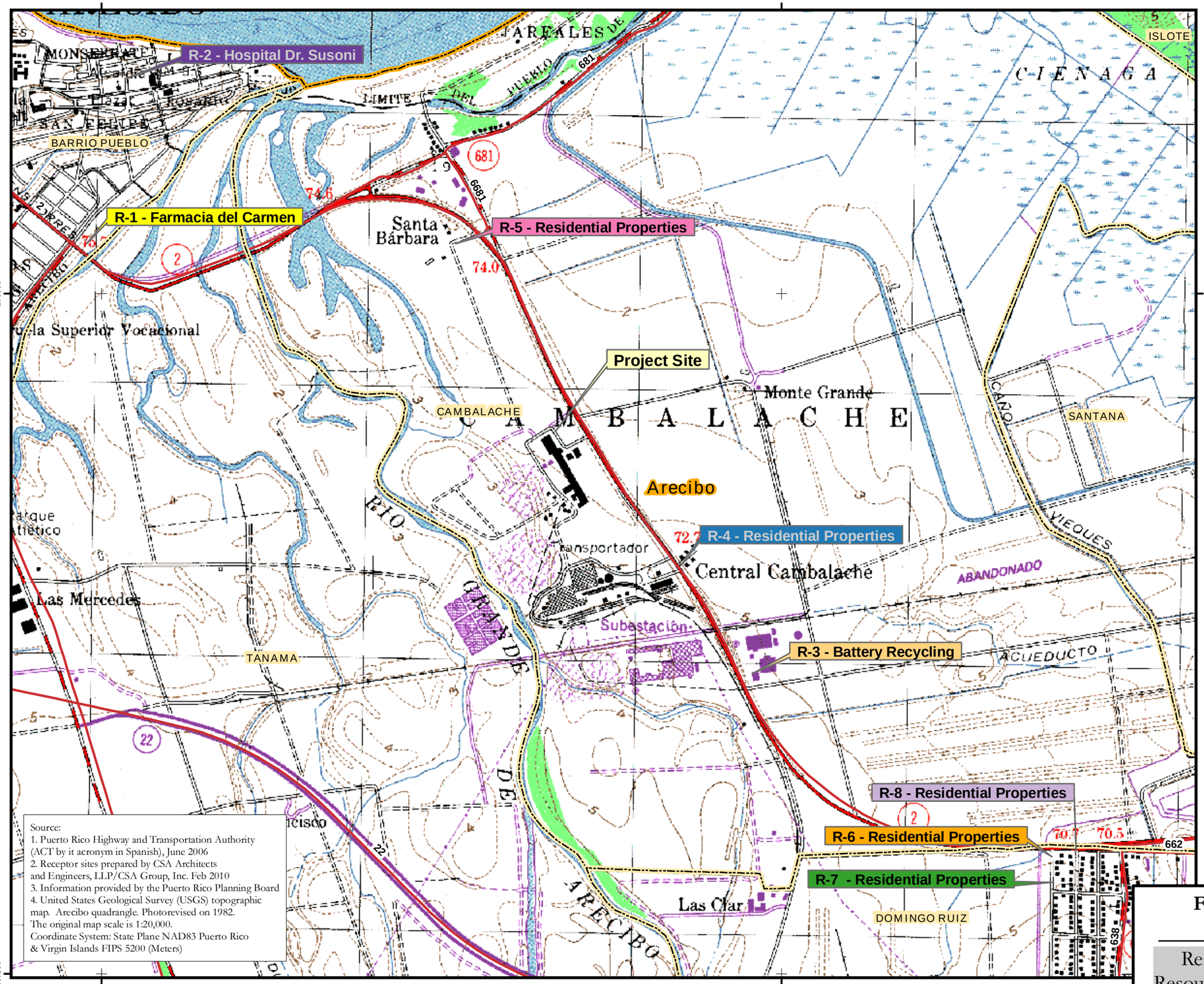
- Incorporate the use of silencers, permanent barriers, and/or shielding into the equipment to be used during the operation of the proposed project.

# 2 INTRODUCTION

CSA Architects & Engineers and CSA Group, Inc. (CSA) 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 in the Municipality of Arecibo. Receptor selection and noise measurements were performed following the Puerto Rico Environmental Quality Board (EQB) Noise Regulation (.*Article I* of the *Puerto Rico Noise Pollution Control Regulation, Amended Version*, (EQB, 1987).

CSA identified five (5) sensitive receptors (identified as 1 through 5) that could be impacted by noise associated with the construction and operation of the Proposed Project (**Figure 2-1. Location Map**).

In addition, three (3) receptors were selected south of PR-2 to evaluate the existing noise conditions related to the traffic in the area and evaluate the potential impacts due to an increase in truck traffic as a result of the operation of the proposed project (refer to **Figure 2-2. Receptors Location**).




Source:
1. Puerto Rico Highway and Transportation Authority (ACT by it acronym in Spanish), June 2006
2. Receptor sites prepared by CSA Architects and Engineers, LLP/CSA Group, Inc. Feb 2010
3. Information provided by the Puerto Rico Planning Board
4. United States Geological Survey (USGS) topographic map. Arecibo quadrangle. Photorevised on 1982. The original map scale is 1:20,000.
Coordinate System: State Plane NAD83 Puerto Rico & Virgin Islands FIPS 5200 (Meters)

N
W E
S

Scale: 1:14,000

0 150 300 600 Meters

**Legend:**

Receptors[2]

- R-1, Farmacia del Carmen, Commercial
- R-2, Hospital Susoni, Tranquility
- R-3, Battery Recycling, Industrial
- R-4, Residential Properties
- R-5, Residential Properties
- R-6, Residential Properties
- R-7, Residential Properties
- R-8, Residential Properties
- Roads[1]
- Project Limit
- Municipal Limit[3]
- Ward Limit[3]

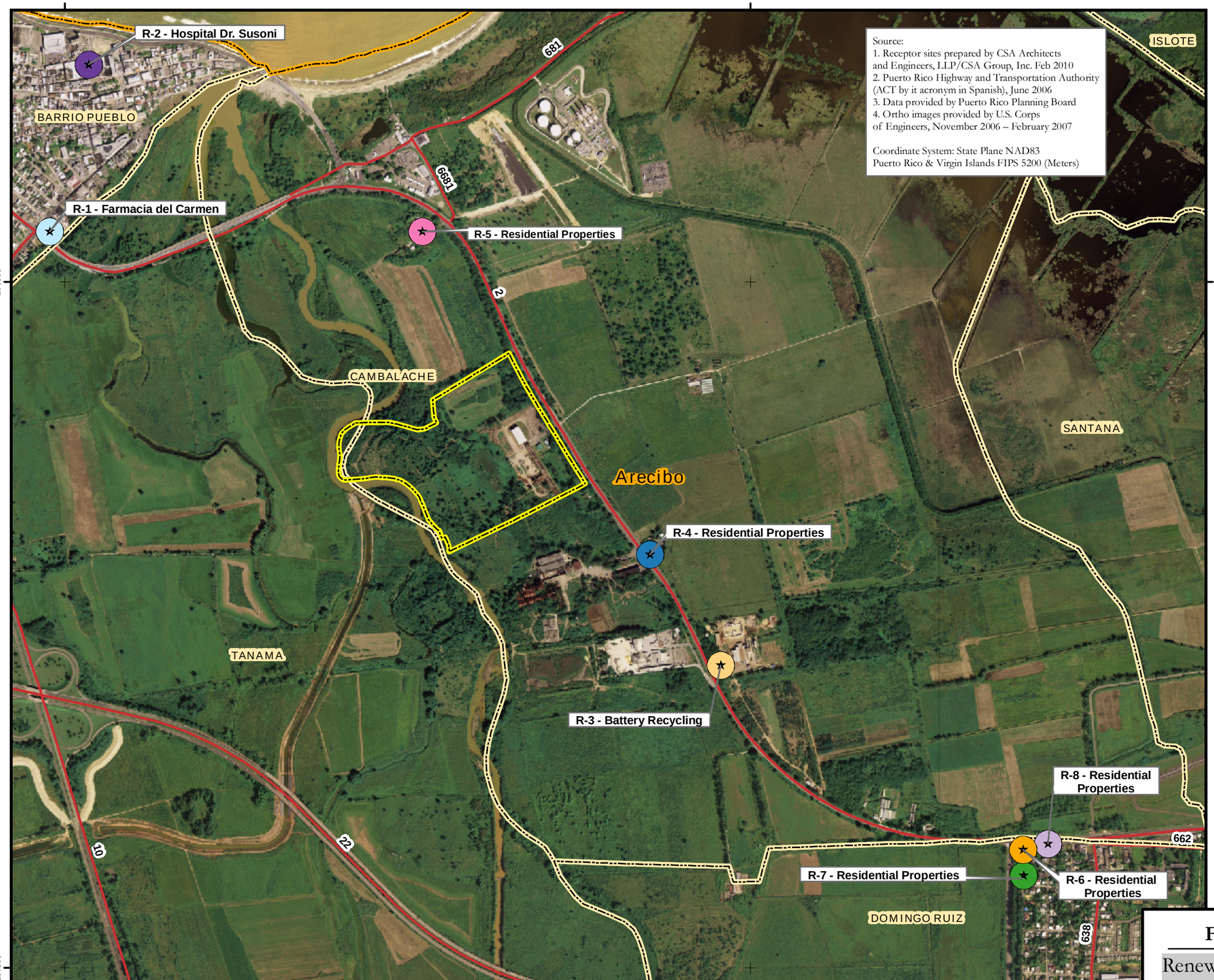
CSA Group

**Figure 2-1 Receptors Location Topographic Map**

Renewable Power Generation and Resources Recovery Facility Arecibo, PR

"REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CSA GROUP AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CSA GROUP"

H:\09PR0778\C00\ZGIS\General\mxd\ReceptorsLocTopo.mxd gis team 1 feb 10 rdarcher AV 9.2




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: 1:14,000

0 150 300 600 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
- R-6, Residential Properties
- R-7, Residential Properties
- R-8, Residential Properties
- Project Limit
- Roads[2]
- Municipal Limit[3]
- Ward Limit[3]

CSA Group

**Figure 2-2 Receptors Aerial Map**

Renewable Power Generation and Resources Recovery Facility Arecibo, PR

"REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CSA GROUP AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CSA GROUP"

H:\09PR078.C00\Z-GIS\General\mxd\Receptors\Loc\Aerial.mxd gis team 22 feb 10 rdarcher AV 9.2

# 3 METHODOLOGY

## 3.1 Field Study

The field investigation was performed on January 21st. and 22nd, 2010; it was continued on February 16th, 2010 and on March 27, 2010. The purpose of the study was to determine existing background noise (sound) levels around the Proposed Project area.

During the site visit, five (5) sampling points were chosen. The locations of the sampling points surrounding the project area are based on the receptors that potentially 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 Regulation (1987). The selected receptors represent the set of environmental noise conditions that characterize the proposed site and its surroundings.

In addition, three (3) additional receptors adjacent to PR-2 (south of) and near the Proposed Project were included in the field investigations. These receptors are identified as 6 through 8 and were mainly residential areas. The purpose of collecting these sampling points was to evaluate the existing noise levels generated by vehicular traffic along PR-2.

**Table 3-1** provides the description and location of each receptor. A graphical representation of receptor locations is illustrated in **Figure 2-1. Location Map**

**Table 3-1. Receptors Identification**

| Receptor | Zone Classification | Coordinates | | Location Description Latitude |
|---|---|---|---|---|
| | | Latitude | Longitude | |
| 1 | Zone II – Commercial | 18°28'1.69"N | 66°43'4.21"W | Farmacia Del Carmen |
| 2 | Zone IV – Tranquility | 18°28'22.95"N | 66°42'59.56"W | Hospital Dr. Susoni |
| 3 | Zone III – Industrial | 18°27'9.95"N | 66°41'41.73"W | Battery Recycling, Inc. |
| 4 | Zone I – Residential | 18°27'23.93"N | 66°41'49.77"W | Residential Properties |
| 5 | Zone I – Residential | 18°28'2.14"N | 66°42'17.99"W | Residential Properties Santa Barbara Parcel |
| | | | | |
| 6 | Zone I – Residential | 18°26'49.15"N | 66°41'3.17"W | Domingo Ruiz Ward (Residential) |
| 7 | Zone I – Residential | 18°26'46.53"N | 66°41'3.26"W | Domingo Ruiz (Residential) |
| 8 | Zone I – Residential | 18°26'49.41"N | 66°41'0.16"W | Domingo Ruiz (Residential) |

## 3.2 Sound Level Meter

An EXTECH sound level meter (model 407764) was used to obtain baseline sound measurements. This sound level meter allows for the digital analysis of 1/3 octave bands real time, and meets Occupational Safety and Health Administration (OSHA) and Department of Transportation (DOT) standards. Using the signal produced by a single microphone, the EXTECH sound monitor can determine and store sound pressure levels.

**Table 3-2** summarizes the technical specifications of the sound level meter. The instruction manual and calibration certificates are included in **Appendix A**.

**Table 3-2. Sound Level Meter Specifications**

| | |
|---|---|
| **Equipment** | Datalogging Sound Level Meter |
| **Model** | 407764 |
| **Manufacturer** | EXTECH Instruments Corporation<br>285 Bear Hill Road<br>Waltham, MA 02451-1064 |
| **Class** | Type 2 portable |
| **Range** | 30 – 130 dB |
| **Accuracy** | ± 1.5 dB (under reference conditions) |
| **Uses** | Compliance with OSHA and DOT, noise levels vs. time analysis, noise surveys |
| **Scale** | A |
| **Sound Level Calibrator Range** | 94 and 114 dB |

The sound level meter provides an instant sound pressure reading that may be used to estimate the following measurement functions:

- Equivalent continuous sound level ($L_{eq}$);
- Maximum and minimum sound wave pressure levels ($L_{max}$ and $L_{min}$); and
- Sound wave pressure level percentile ($L_{10}$, $L_{50}$, $L_{90}$, etc.).

The sound level meter frequency weightings may be selected by the user for the “A,” “C” or “Flat” sound scales. With the ‘A’ weighting selection, the meter responds like the human ear, boosting and cutting the noise amplitude over the frequency spectrum. ‘A’ weighting scale is used for environmental measurements, OSHA regulatory testing, law enforcement, and workplace design. Select ‘C’ weighting is utilized for flat response measurements (not used for boost or cut). ‘C’ weighting scale is suitable for analyzing the sound level generated by machines, engines, etc.

The sound level meter measurement time may also be pre-selected. Timing between readings may be selected to be fast or slow. The fast mode captures noise peaks and noises that occur very quickly. In fast mode, the meter responds in 200ms. The slow mode (meter responds in 500ms) monitors a sound source that has a reasonably consistent noise level or to average quickly changing levels. Selection of fast or slow is determined by the application and any directives or standards related to that application.

Most OSHA related testing is performed using 'A' weighting and slow response time settings. For this survey, the testing was performed using ‘A’ weighting and slow response time settings.

The sound level meter is calibrated with a 94/114 decibel (dB) sound level calibrator. This calibrator is a small translator moved by an integrated-circuit oscillator which, when placed over a microphone, generates a noise level of 94 dB or 114 dB. Sound pressure level measurements were taken using a pre-polarized condenser microphone. Moreover, to counteract the possibility of incorrect measurements due to the wind, a windscreen was placed on the microphone to attenuate the wind’s effects. The unit has a measurement range of 30-130 dB and a precision of ± 1.5 dB resolutions in the average frequency reaches.

The sound level measurements were set to take readings every 2 seconds, during a 30-minute period, and at a frequency-weighted sound ‘A’ scale. The field calibration, which was performed daily, was done with the unit calibrator, using the 94/114 dB Acoustical Calibrator.

The sound level meter's technical specifications are included in **Appendix A**.

### 3.3 Impact Analysis

Once background noise (existing sound) levels were determined at each receptor, prediction methodologies were used to determine potential impacts to these receptors during construction and operation of the Proposed Project. These methodologies are discussed in detail in **Section 3.5 Analysis of Data**.

### 3.4 Data Collection

The purpose of determining current sound levels within areas surrounding the Proposed Project at the time of the study was to assess the impact of the Proposed Project on the neighboring community sound levels. Background noise (existing sound) level studies are needed to establish the design criteria necessary to avoid adverse impacts caused by noise. Existing sound level measurements, recorded as a part of the *Noise Survey Report*, will also help in the characterization process of the sound levels in the area for the Proposed Project.

Noise Pollution Control Regulations adopted by the EQB establish different sound level criteria for daytime and nighttime hours. To evaluate existing sound levels against those limits, sound level measurements were taken during the daytime and nighttime hours, for each one of the previously identified receptors. As defined by the EQB, the daytime period begins at 7:01 AM and ends at 10:00 PM, with the nighttime period beginning at 10:01 PM and ends at 7:00 AM. The selected receptors (R1 through R5) correspond to the closest locations that represents each of the four zones (Zones I, II, III and IV) as defined in *Article I* of the *Puerto Rico Noise Pollution Control Regulation, Amended Version*, (EQB, 1987), in which the greatest noise impact from a proposed project is expected to occur. In addition, three (3) receptors were selected along the PR-2 adjacent areas to assess the existing noise conditions of the areas and evaluate impacts related to potential traffic increases.

The sound level meter described in the previous section was used to compile field data needed to characterize the area's acoustical environment. Whenever feasible, the line of vision was used as a criterion to locate the sound level meter. The microphone was placed over a tripod, at a height of approximately 1.2 to 1.5 meters and a distance of, at least, 5

meters from any vertical surface capable of reflecting the noise. The tip of the instrument was pointed towards the direction of the main source of noise at each receptor location. The main source of noise per receptor is described in the Noise Survey Report field notes at **Appendix B**. The sound level meter was programmed to measure and collect the noise data every 2 seconds over a period of time of at least 30 minutes. The $L_{10}$ parameter (i.e., the "A" scale sound level dB(A) exceeded 10% of the time) was then estimated and compared to the noise emission levels established by the EQB regulation.

Several measures were implemented during the sampling event in order to prevent sample contamination. The microphone was covered with a plastic filter (wind screen) during the period of data collection to attenuate the noise caused by the wind. The samples were also taken during suitable climatologic conditions: never during periods of precipitation or when wind velocity exceeded 18 km/hr.

A written registry of general field conditions was prepared during sampling. The registry includes the following information:

- Instrument model and serial number;
- General climatic conditions, such as temperature, wind direction and speed, humidity, and weather conditions at the time of the measurement;
- Site diagram, showing sound source and receptor location;
- Sample ID;
- Date and time of sample collection;
- Location and type of the receptor; and,
- Relevant observations of the sample location.

Copies of these registries (noise survey field notes) are included in **Appendix B** of this report. The measurements taken are summarized in the graphs included in **Section 4**.

## 3.5 Analysis of Data

### 3.5.1 Background Noise (Existing Sound) Levels

Once the survey period was completed, data was analyzed to determine sound levels within the vicinity of the Proposed Project.

The variations in noise pressure associated with the audible experience of everyday life comprise a range of factors of more than one million to one. On the superior portion of the range may be the sound generated by a motor jet and on the inferior portion of the range may be the sound generated by a pin falling on the floor. Instead of expressing sound pressure in units that vary from a million to one, it results more convenient to condense the range to a scale from 0 to 120 and designate the unit as a decibel (dB).

The levels of sound pressure were considered using scale 'A'. The ear is not as effective detecting low frequency (LF) sounds like those of high frequency. This means that LF sounds at the same level of dB are not heard as high as sounds of high frequency. The sound level meter imitates the human ear using an electronic filter called filter 'A'. A level of noise measured with this filter is named as dB(A). Practically all the sounds are moderate using filter A. The level of sound pressure in dB (A) gives a more precise instruction of the noise intensity.

The following levels of sound pressure were considered for the existing conditions:

$L_{eq}$ Level of pressure of equivalent sound, defined as the level of constant noise that on a of specific time period, 30 minutes in this case, would produce the energy equivalent to the fluctuating sound that happens in reality.

$L_{10}$ Level of sound pressure that exceeds 10% the time of which the sound is measured.

The impact analysis is carried out using an estimated $L_{10}$, which was compared to the limits of noise emissions established by the EQB.

### 3.5.2 Sound Level Impacts

The sound pressure level (SPL) of a localized emitting source may diverge, and the SPL in a specific point follows generally predictable rules, diminishing in proportion to increased distance from the emission source. Variations in the propagation of sound in open spaces are a function of frequency, environmental factors, and certain directional characteristics of the emission source. To estimate sound levels in areas neighboring the proposed facilities, a hypothetical series of actions were formulated based on a conservative scenario for each one of these factors. These hypothetical series of actions assume that:

- The terrain is flat and there is no surface capable of reflecting and obstructing sound; and,
- The wind's velocity is sufficient to cancel any ground sound absorption effect.

The prediction of anticipated sound levels resulting from the Proposed Project was determined by using the distance effect and an empirical equation. The sound pressure levels issued from a noise source decrease uniformly in all directions as the sound moves away from the source, according to the following equation:

$$\mathbf{L_r = L_s - 20 * LOG\ 10\ (D_r/D_s) - DT}$$

where:

$L_r$ – is the sound pressure level experienced by the receptor as a result of the sound pressure level $L_s$ produced by the noise-emitting source.

$L_s$ – is the effective sound pressure level at a distance of 1-meter from the noise-emitting source.

$D_r$ – is the distance, in meters, between the noise-emitting source and the receptor.

$D_s$ – is the base distance for the sound pressure level of the emission source – 1 meter.

DT – is the distance term used to account for several natural and environmental causes of sound attenuation; assuming the worst-case scenario for a hypothetical series of actions, DT = 0

The sound pressure levels experienced by the receptor due to two separate noise emitting sources can be combined for a resulting or net sound pressure level using the following empirical equation:

$$\mathbf{L_n = MAX\ (L_1\ and\ L_2) + 3 * EXP - (0.18 * |L_1 - L_2|)}$$

where:

$L_n$ – is the net, or additive, sound pressure level, experienced by the receptor.

$L_1$ – is the sound emission level from a noise-emitting source (or the combination of multiple sources) experienced by the receptor.

$L_2$ – is the sound pressure level of a second noise-emitting source, or the background environmental noise level experienced by the receptor.

MAX ($L_1$ and $L_2$) – is the highest value for $L_1$ or $L_2$.

$|L_1 - L_2|$ – is the absolute value of the difference between sound pressure levels $L_1$ and $L_2$.

#### 3.5.2.1 Sound Level Impacts Due to Construction of the Proposed Project

The construction of the Proposed Project would cause an increase in the sound levels of the surrounding area based on the use of construction equipment and the construction's traffic. The increase in sound levels is a result of the operation of the engines of stationary equipment, equipment used for the earthwork, and transportation of materials; as well as to the interaction of the equipment with these materials. The increase in sound levels during construction depends on many factors, such as the number and type of equipment being used, the location of the equipment within the construction site, and the time that the equipment is used on the construction site, among other things.

Following the Federal Highway Administration (FHWA) Highway Construction Noise Handbook (2006), the sound level perceived at a receptor due to the noise generated by construction equipment may be predicted using the following formula:

$$\mathbf{L_{10} = L_{max.\ @\ 50\ ft} - 20\ Log\ (D/50) + 10\ Log\ (UF/100) + 3}$$

where,

$L_{max\ @\ 50\ ft}$ – is the emission level for the equipment at 50 feet.

D – is the distance in feet between the equipment and the receptor.

UF – is the time-averaging equipment usage factor, expressed in percent.

The 3 dB(A) adjustment factor at the end of the formula was empirically determined by the FHWA as the average difference between $L_{eq}$ and $L_{10}$ sound levels during construction. The previous formula may also be used to determine the maximum sound level predicted at the receptor by eliminating the usage factor term and the 3 dB(A) term from the algorithm.

The sound levels and usage factors for different construction equipment are included in **Table 3-3.**

**Table 3-3. Typical Sound Levels Generated by Construction Equipment**

| Equipment Description | $L_{max\ @\ 50\ feet}$ dB(A) | Usage Factor % |
|---|---|---|
| Auger Drill Rig | 85 | 20 |
| Backhoe | 80 | 40 |
| Chain Saw | 85 | 20 |
| Compactor (ground) | 80 | 20 |
| Compressor (air) | 80 | 40 |
| Concrete Mixer Truck | 85 | 40 |
| Concrete Pump Truck | 82 | 20 |
| Concrete Saw | 90 | 20 |
| Crane | 85 | 16 |
| Dozer | 85 | 40 |
| Dump Truck | 84 | 40 |
| Excavator | 85 | 40 |
| Front End Loader | 80 | 40 |
| Generator | 82 | 50 |
| Grader | 85 | 40 |
| Impact Pile Driver | 95 | 20 |
| Jackhammer | 85 | 20 |
| Paver | 85 | 50 |
| Pumps | 77 | 50 |
| Roller | 85 | 20 |
| Scrapper | 85 | 40 |
| Vibratory Concrete Mixer | 80 | 20 |
| Welder/Torch | 73 | 40 |

Source: Adapted from FHWA Highway Construction Noise Handbook (2006)

The noise impact caused by multiple construction equipment operations at a specific receptor may be determined by the addition of the sound levels from each source, using the formula presented in **Section 3.5.2**.

**Section 4** describes the noise impacts to identified receptors from construction activities of the Proposed Project. The construction activity that could potentially have the most noise impact is pile driving. From **Table 3-3**, pile driving has the highest maximum noise emission

level (L max @ 50 feet=95 dBA). Therefore; noise generator calculations were performed using this noise emission level, as a conservative assumption.

#### 3.5.2.2 Sound Level Impacts Due to Operation of the Proposed Project

The Proposed Project is a Renewable Power Generation and Resources Recovery Facility that generates electrical power and recovers recyclable materials (metals, etc.) from Processed Refused Fuel (PRF™) and Supplementary Fuels. Most of the project site is inactive but one building that is used for commercial (service) purposes. However, zoning at project site and at nearby areas is classified as industrial. This is important to note since the operation of the proposed project will provide a new source of noise in the area.

Secondly, it is expected that an increase in traffic volume will occur at PR-2 due to the operation of the proposed project. Consequently, an increase in noise levels in the area should be expected. However, according to the *Highway Traffic Noise and Abatement Policy and Guidance (Department of Transportation),* the level of highway traffic noise depends on three factors: the volume of traffic, the speed of traffic, and the number of trucks in traffic flow. Generally, the loudness of traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks[1].

[1] U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning, *The Highway Traffic Noise and Abatement Policy and Guidance*, June 1995, pg 5