2.0 WORK PERFORMED

An Aerial Photo interpretation of the property was performed in 2005, followed by a geophysical program (2010), both designed to identify the location of possible caverns or possible sinkhole development. These two explorations are necessary steps taken before a limestone terrain is to be developed.

An Engineering Geologic Plan was prepared to delimit sinkholes or sinkhole prone areas and buildable areas.

General alternatives for foundations are presented as recommendations taking into consideration the findings of this due diligence assessment and the fact that this is a planning stage where conceptual drawings are prepared and provisions made for future design and construction stages of the project.

Geotechnical explorations are to be planned and executed in the Buildable Areas at later stages of design to better define the final foundations recommendations, including additional Electrical Resistivity Surveys and Seismic Refraction surveys (both under the footprint of the proposed structures). Additional explorations after the conceptual phase are also to be planned in the sinkholes or sinkhole related areas identified in this report. This is usually performed in a phased approach where detailed geophysical tools are used to refine the perimeter rock or rim of the sinkhole.

3.0 SITE LOCATION

The site is bounded to the north and west by road #637 on Sector Biáfra which is sitting east of road PR#10 as well as Río Grande de Arecibo, and it is south of road PR#22 of the municipality of Arecibo, Puerto Rico. **Figure 1** is a portion of the USGS Arecibo Quadrangle with the property approximately depicted.

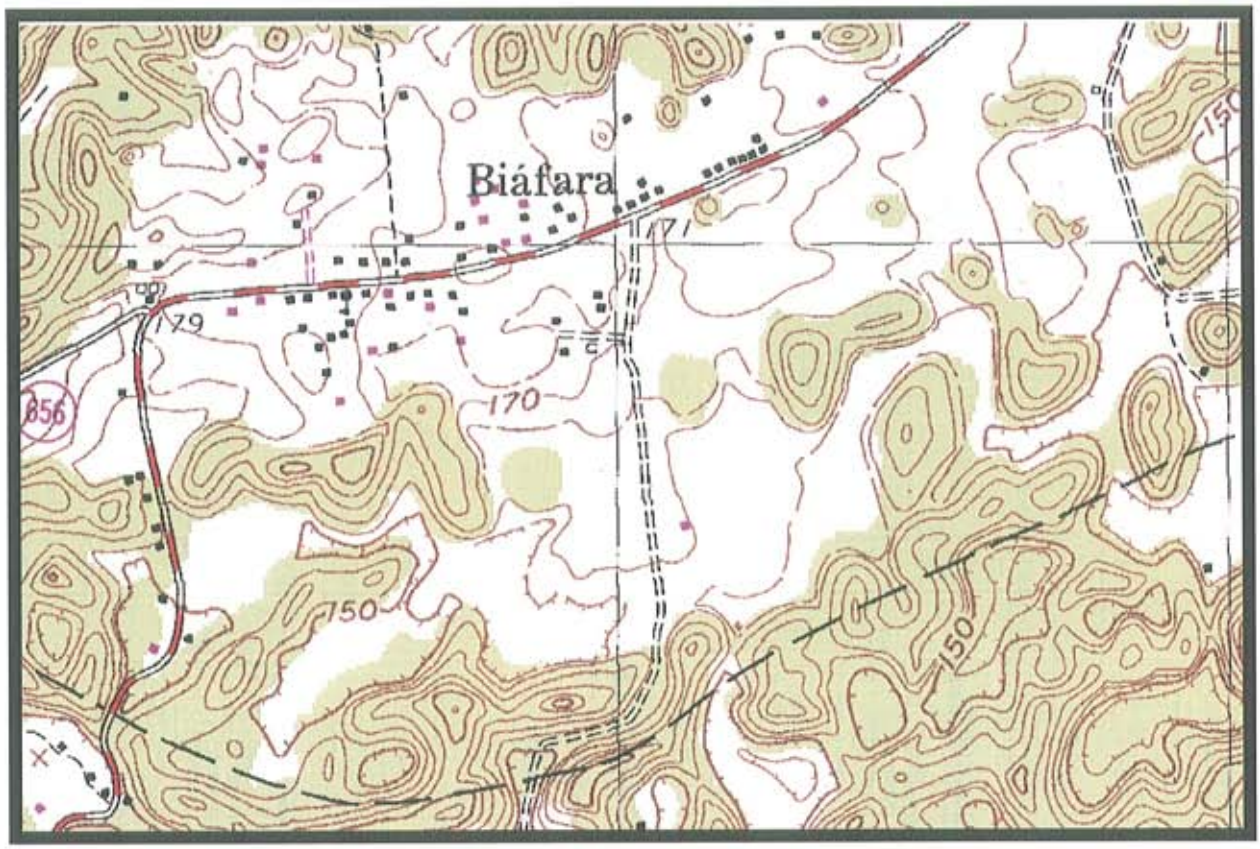

Figure 1

4.0 GENERAL GEOLOGY

This site is dominated by blanket sands sitting on valleys between typical "mogotes" of northern Puerto Rico's karst topography. U.S. Geological Survey personnel have mapped the geology of the region. Exposed limestone on "mogotes" are of the Aymamón and Aguada limestone members. Some of the foothills are filled with colluvium deposits composed of fragments of limestone from the "mogotes" and superficial sediments (sands and top soil). Some of this material has been transported down into the valleys doe to water flow.

Blanket sands and alluvium overlie most north coast limestone formations on places like this. The blanket sands occur chiefly in the outcrop belt of the Aguada and Aymamón formations, where they fill and form relatively flat plains between residual limestone hills. These deposits are believed to be former beach sands similar in composition to present day beach deposits, which were left stranded above sea level following late Tertiary-early Quaternary (?) marine regression and possibly uplift of the Puerto Rico landmass. Subject to intense chemical weathering under tropical climatic conditions many original sand grains have been altered to clay, mainly kaolinite. Only highly stable quartz grains have remained unchanged so that the blanket deposits consist predominately of clay minerals and quartz. Normally quartz-clay ratios vary greatly.

5.0 PROJECT GEOLOGY

The site is located within the outcrop belt of the Aguada and Aymamón Formations, which in turn are partially buried by blanket sands (Reginald P. Briggs; 1968; Geologic Map of the Arecibo Quadrangle, Puerto Rico; U.S. Geological Survey; Miscellaneous Geologic Investigation; Map I-551). **Figure 2** is a portion of the above-mentioned map showing the appropriate location of the site, as well as the different geologic deposits underlying the site.

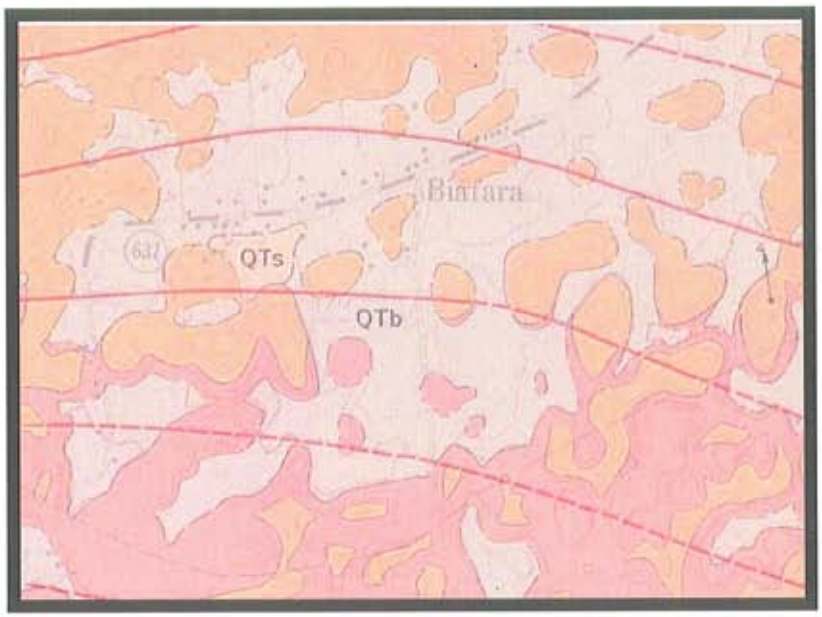

Figure 2

The geologic deposits are:

1. Blanket Sands (Qtb/Qts)

Reddish-blown, yellowish-brown, tan brown, pinkish gray, and blue gray clayey quartz sand, sandy clay, silty clay, and/or clay (depending on the degree of leaching). Sometimes only quartz sand, medium to fine, light-gray to white.

2. Aymamón Limestone (Tay)

The Aymamón consists of very fine white to pale gray with moderate shades of orange, pure limestone and calcarenite. It is usually found to be thick bedded and chalky.

3. Aguada Limestone (Ta)

The Aguada consists of medium to fine grained, locally very fine grained, pale gray, yellowish orange, and yellowish brown, limestone interbedded with chalk and marl.

The Aymamón and the Aguada outcrop in the form of residual limestone hills, which rise abruptly from relatively flat plains surrounding them. Outcrops of the Aymamón and the Aguada formations are only found confined between the dense vegetation of the "mogotes" at this site. The Aymamón was observed to be solution riddled with several small cavernous openings (as far as we could see).

6.0 METHODOLOGY (Electrical Resistivity)

The true resistivity of earth material is dependent upon several factors including composition, grain size, water content and physical characteristics. In general, fine-grained materials such as clays and silts have lower resistivity than coarse-grained materials such as sands and gravels. Unweathered and unfractured hard rocks such as lithified sedimentary rocks (limestone, sandstone, etc.), volcanic rocks, plutonic rocks, and some metamorphic rocks generally have high resistivity. The presence of fracturing (or vugs) and weathering lowers the resistivity of these rocks. Open or partially open caverns will have extremely high resistivity values because of the presence of air in the voids. Clay filled voids entrapped within sand and rock also produce high values.

The electrical resistivity method is based upon the response of earth materials to the flow of current at low frequencies (typically 0.03 to 3.0 Hz). Although the method is often referred to as direct current (dc) resistivity, noise and measurement problems make the use of low frequency alternating (ac) currents necessary. In resistivity surveys, a current is introduced into the ground via two electrodes and the potential difference is measured between a second pair of electrodes. The four electrodes may be arranged in any of several possible patterns, and then the current and potential measurements are used to calculate resistivity (generally expressed in ohm-meters) according to an Ohm's Law ratio of measured voltage (**V**) and applied current (**I**), with a geometric constant (**K**) that depends upon the electrode array (**K*V/I**).

The measured resistivity value is termed apparent resistivity ($\mathbf{r_a}$), which is equivalent to true resistivity only when the resistivity is uniform (i.e., homogeneous and isotropic) throughout the subsurface. Over an inhomogeneous and/or anisotropic earth the measured apparent resistivity will vary with the position and/or direction of the electrode array. While the apparent resistivity is not representative, necessarily, of the true resistivity of any element within the earth nor is it necessarily representative of a simple average of true resistivities, it is a useful normalization for any given array. Apparent resistivity will vary systematically across a geologic section and can be diagnostic of both layering and the presence of conductive or resistive inhomogeneities.

There are three basic modes of operation for any resistivity method: sounding, profiling, and sounding-profiling. In the sounding mode, the separation of the current electrodes is increased for each reading (larger separations result in deeper investigations) with results interpreted in terms of a layered earth. Since this is not often geologically valid the sounding mode has limited applications. In profiling, the current or potential electrodes, or both, are moved along the earth's surface to detect lateral anomalies. Increasing the separation of the current and potential electrodes in the sounding-profiling mode will map both vertical and lateral variations in resistivity.

A typical electrode configuration for the sounding-profiling mode is the dipole-dipole array. The dipoles are considered the two current electrodes and the two potential electrodes. In this array the dipole lengths are termed 'a' spacing and the separation between the electrode pairs is termed 'na'. By increasing either 'a' or 'na', the earth is investigated deeper. Sounding-profiling surveys can be conducted using a multi-electrode system. A multi-electrode system typically consists of 56 electrodes and a resistivity meter that is capable of electronically switching the electrodes. The rule-of-thumb for the maximum depth of investigation of a dipole-dipole array is generally taken as 15% of the total multi-electrode spread or length. The minimum '*a*' spacing value is selected relative to the desired investigation depth and the amount of resolution (i.e., larger minimum '*a*' spacing will result in greater investigation depths but decreased resolution). Data from a multi-electrode system are typically analyzed with a 2-D forward and inverse modeling computer program. In the computer

program, a forward model is initially made to represent the field data and then a non-linear least-squares optimization technique is used to automatically invert and determine the best fit to the model data. The inverted data are shown as a cross-section of resistivity versus depth and are used for interpretation of subsurface materials and geologic structures. In general, resistivity data have shown a 10% to 15% variation between the actual depths to the anomalies, as verified by test hole drilling, and the depth predicted by the inversion. The nearby presence of conductors such as electrical power lines, buried metal pipes or drill stem, or chain-linked fences with metal posts will result in electrical noise that may affect the quality of the data.

7.0 DATA ACQUISITION AND PROCESSING

Profile resistivity data was acquired with a 56-electrode Advanced Geosciences, Inc. (AGI) SuperSting resistivity system in the dipole-dipole electrode configuration along 10 lines of survey coverage. The location of the survey lines were selected in the field by Suelos' personnel. Electrodes were located either at 2 or 3 meters apart and dipole lengths ('a' spacings) ranged from 2 to 12 meters (for 'a' = 2 meters) or 3 to 18 meters (for 'a' = 3 meters) with values recorded out eight dipole pair separations (n = 8). Using the general rule-of-thumb described above for dipole-dipole electrical resistivity surveys, this survey was designed to investigate to approximately 17 or 22 meters depth (50 ft or 72 ft) with 2 or 3 meter a spacings respectively (i.e., approximately 15% of 110 or 165 meters). The decision to use either the 2 or 3 meter 'a' spacing was based upon the initial designed length of each profile and the geophysical constraint that a minimum spread length of 110 meters (a spacing of 2 meters) was necessary to reach investigative depths of interest even though the 110 meters spread length was longer than some of the initially designed line lengths.

Both the current and potential electrodes were stainless steel stakes driven into the ground at least eight centimeters and watered with salt water to lower contact resistance and insure that a maximum amount of current could be injected into the ground. Overall the quality of the resistivity data acquired for this project was considered good.

The electrical resistivity data was downloaded from the SuperSting instrument each evening into a laptop computer using a program supplied by the manufacturer that calculated the apparent resistivity using the standard dipole-dipole formula. Only data with errors less than 2% were downloaded (approximately 99% to 100% of each profile). The data was modeled using AGI's EarthImager 2D (version 1.6.6) computer program. Any existing bad data points were edited out for each profile (generally only a few data points, if any, per line that were obviously too large or small compared with neighboring points), and then the data was least-squares inverted (generally 3 to 5 times) using the finite-element method with a Jacobian matrix calculation.

Based on data gathered at the site and located within the areas surveyed geophysically, a general correlation between geology and resistivity values was initially made as follows in Table 1.

TABLE 1- Initial Correlation of Resistivity vs. Materials

RESISTIVITY	MATERIALS
Less than about 100 ohm-meters	Clayey silts
Less than about 500 ohm-meters	Silty clays
Between about 500 & 2,000 ohm-meters	Severely weathered limestone with some silty clays
Between about 1,500 & 3,000 ohm-meters	Porous, moderately hard, fractured limestone
Between about 3,000 & 10,000 ohm-meters	Limestone of varying competency (with higher values indicating more competent rock)
Greater than about 10,000 ohm-meters	Voids (sometimes small voids mask a thick clay filled cavity)

Note that there are some overlaps between the interpreted geology and resistivity values, particularly within the limestone unit. These overlaps are related to the amount of weathering or fracturing of the limestone and the presence of silty clays within the limestone's matrix or vugs. For example, relatively lower limestone resistivities are interpreted as areas with more silty clays within the limestone itself. Resistivity values greater than about 10,000 ohm-meters are not appropriate for any geological unit and thus are interpreted as voids. However, voids may be several feet thick, or a clay matrix riddled of medium soft consisting or void zones may exhibit also large resistivity values (10,000 ohm-meters and larger) when actually clay filled cavities have been found elsewhere

with boreholes. This is the reason why geotechnical boreholes have to be drilled to calibrate or better correlate the geophysical values with the physical conditions of the earthy materials. The near surface materials (ranging from about one to three meters depth) primarily consists of either clayey silts or silty clays with resistivity values generally less than about 500 ohm-meters. This low resistivity unit extends to the ultimate depths of investigation in portions of all the areas.

8.0 INTERPRETATION

The apparent depressions studied are identified as Site 1 (Lines 3 and 4), Site 2 (Lines 1 and 2), Site 3 (Line 5 and 6), Site 4 (Lines 7 and 8), and Site 5 (Lines 9 and 10).

The interpretation of the Electrical Resistivity survey can be observed in the tomography figures for each of the lines that will be presented in the following sections. **Plate 1** shows the study areas (Sites 1 through 5) within the subject site.

Based on data gathered at the site several areas (Sites 1 and 5), and were identified to apparently contain colluvial deposits over blanket sand deposits. The colluvium comes from the adjacent Mogotes in the form of limestone debris falling off the hills and covering portions of the flat plains between the mogotes. The colluvium was identified in the field visits during the preparation of the photo interpretation exploration and during the field geologic reconnaissances done for this exploration. Further geophysical and geotechnical studies have to be performed in these sites, but it appear the sites may not conform to sinkholes.

Sites 2, 3 and 4, on the other hand may have sinkhole related activities or they have the characteristics of sinkholes (from an electrical resistivity point of view). In these sites we have a small cover of apparent colluvium covering thick deposits of clays and these are underlaid by weathered limestone. These are typical of sinkholes or areas with sinkholes related activities. Additional geophysical and geotechnical explorations have to be made to fine tune and complement

these findings. Sites 2, 3 and 4 show and irregular, pinnacled limestone surface overlaid by soils or colluvium. All the previous pairs of lines corresponds each to single depression.

Color tomography interpretation of each of the lines are shown in **Figures R-1, R2, R-3, R-4, R-5, R-6, R-7 R-8, R-9,** and **R-10**. Lines 5 and 6 were used jointly to interpreted two depressions at the same time (Site 3).

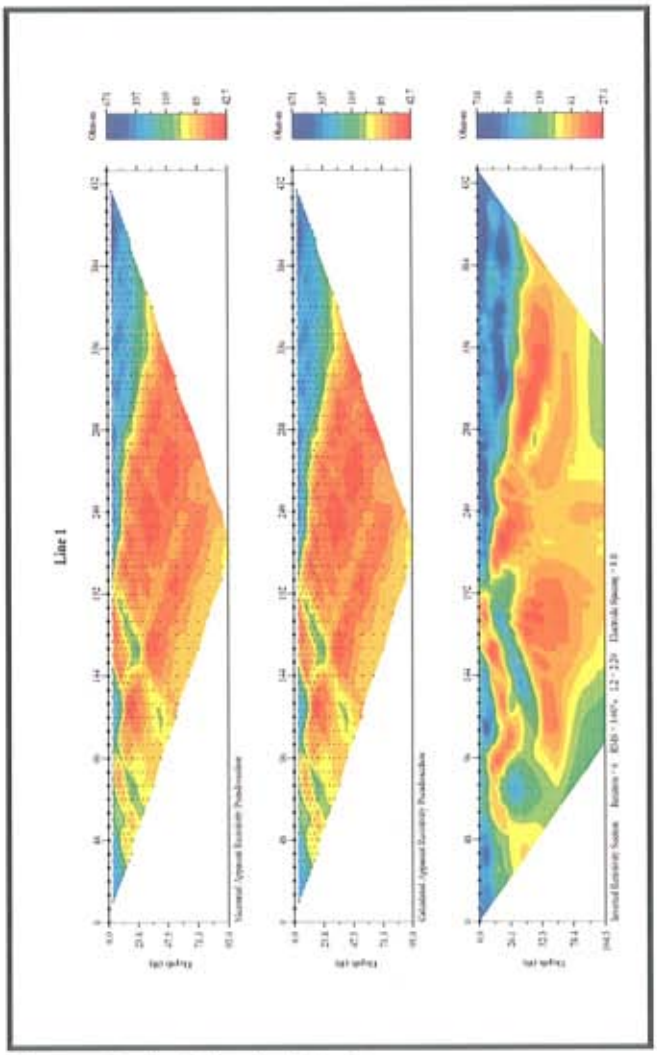

Figure R-1. Line1, Site 2

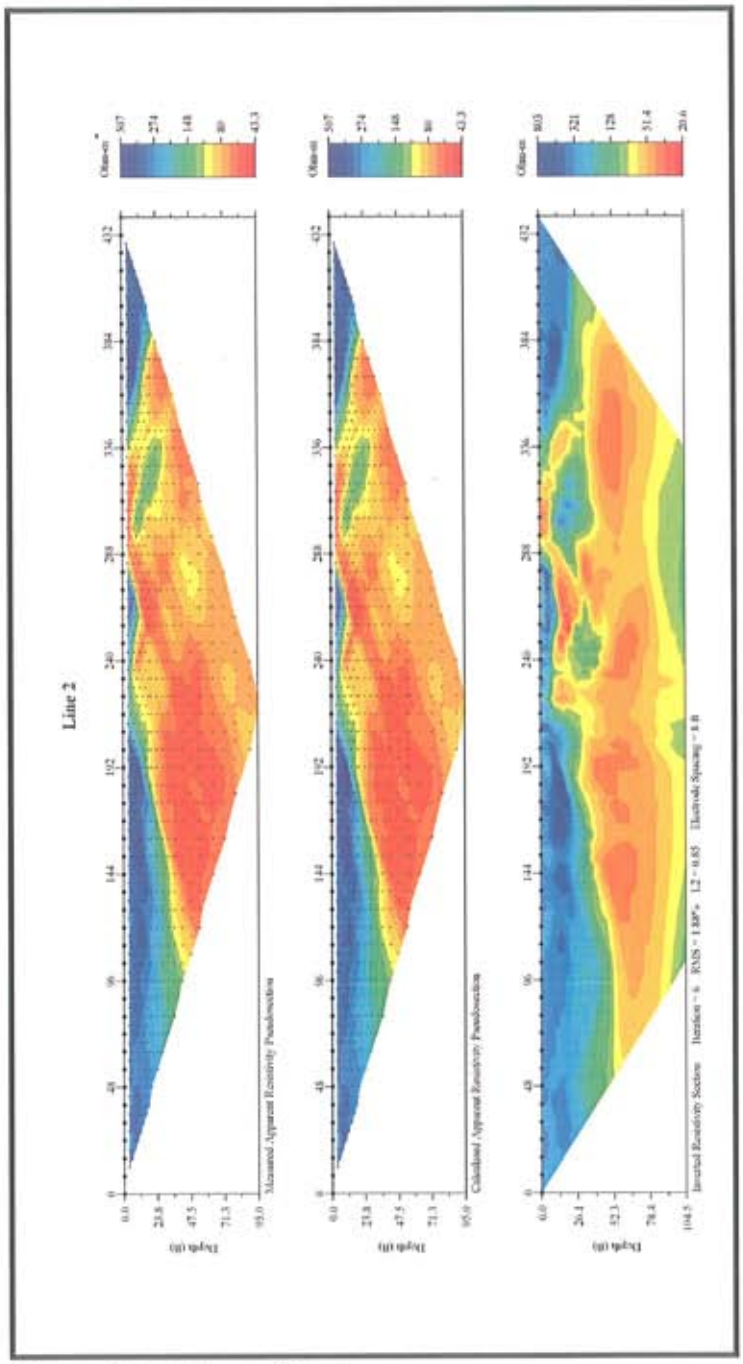

Figure R-2. Line 2, Site 2

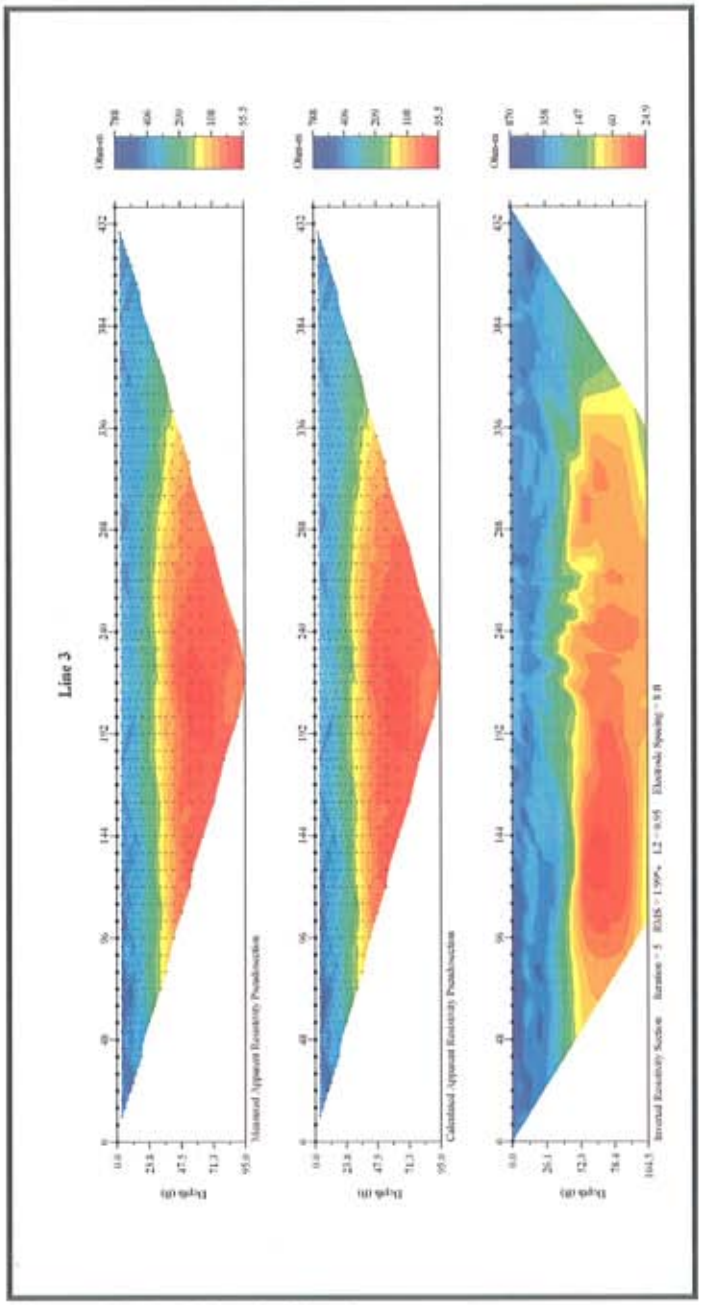

Figure R-3. Line 3, Site 1

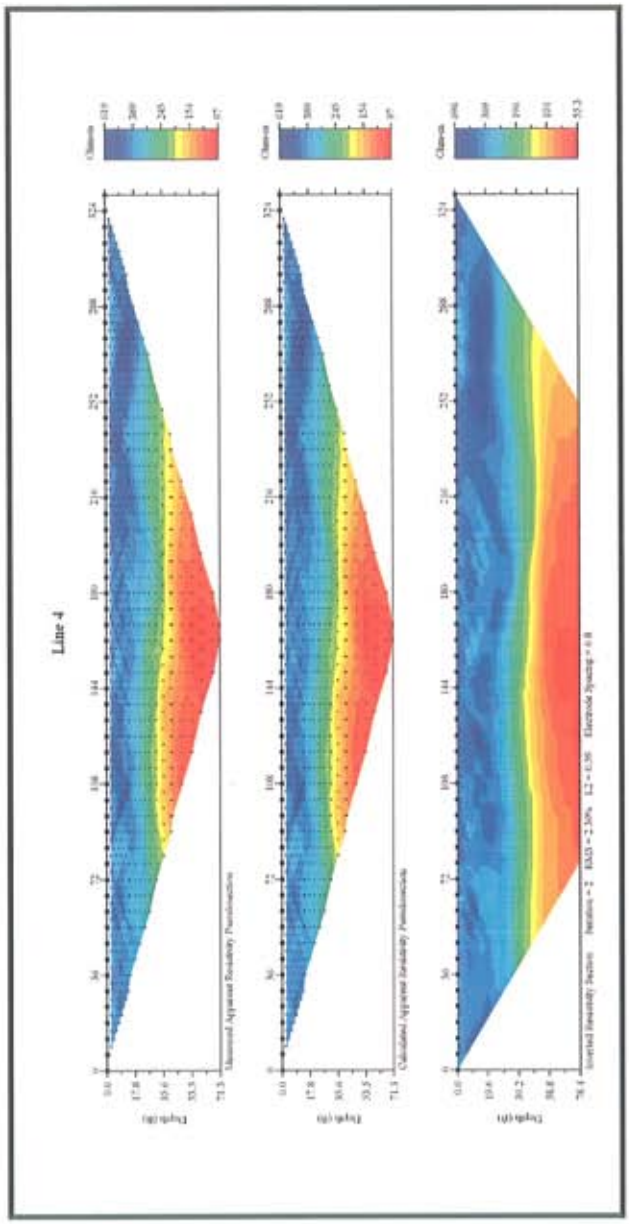

Figure R-4. Site 1

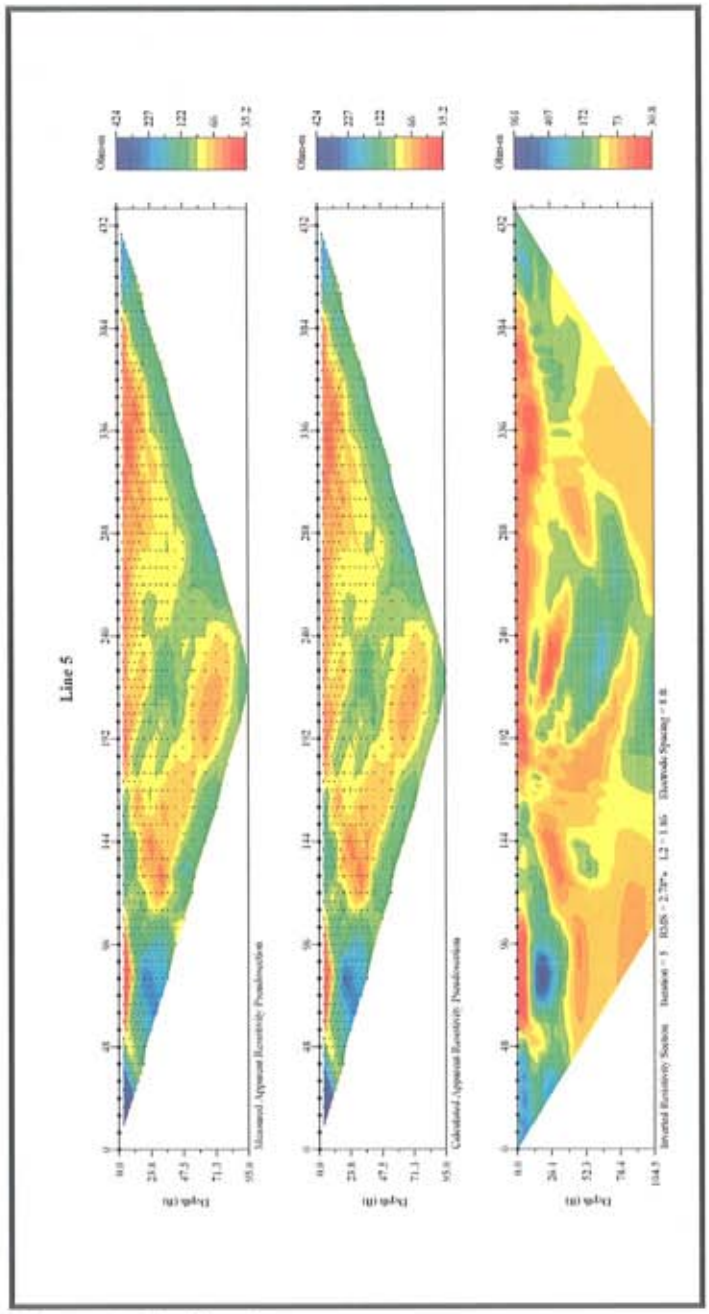

Figure R-5. Site 3

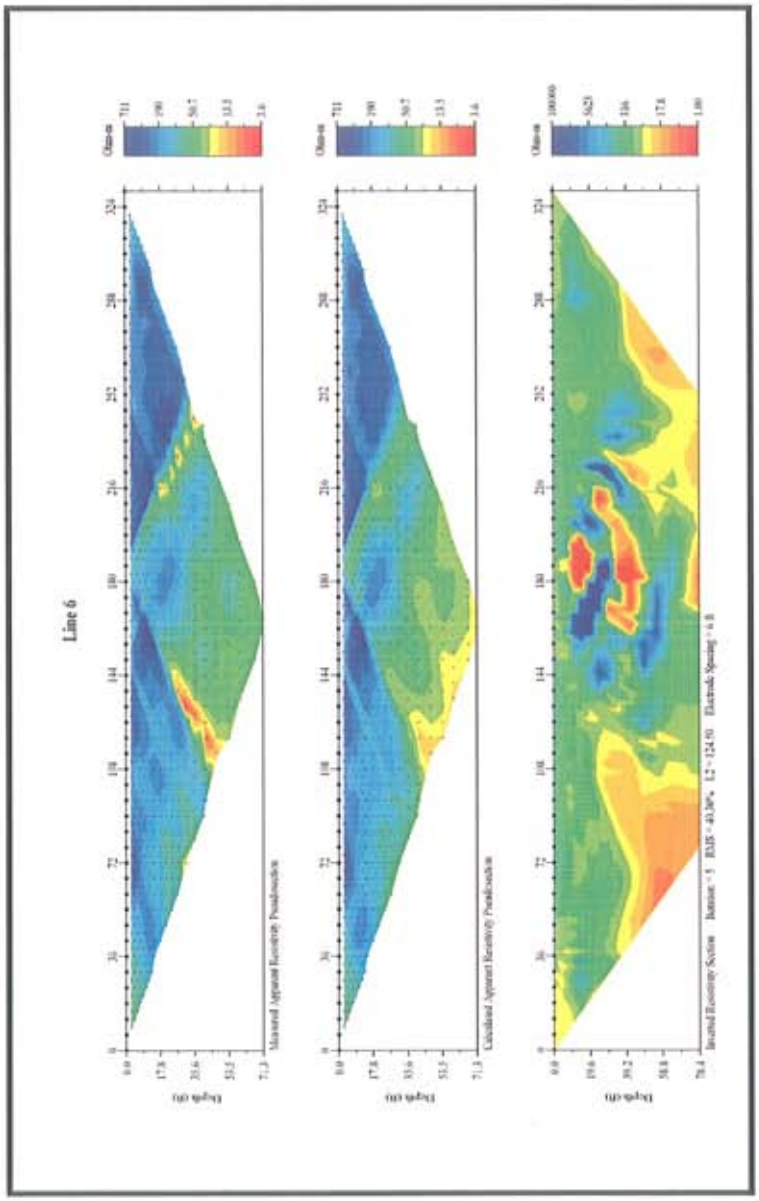

Figure R-6. Site 3

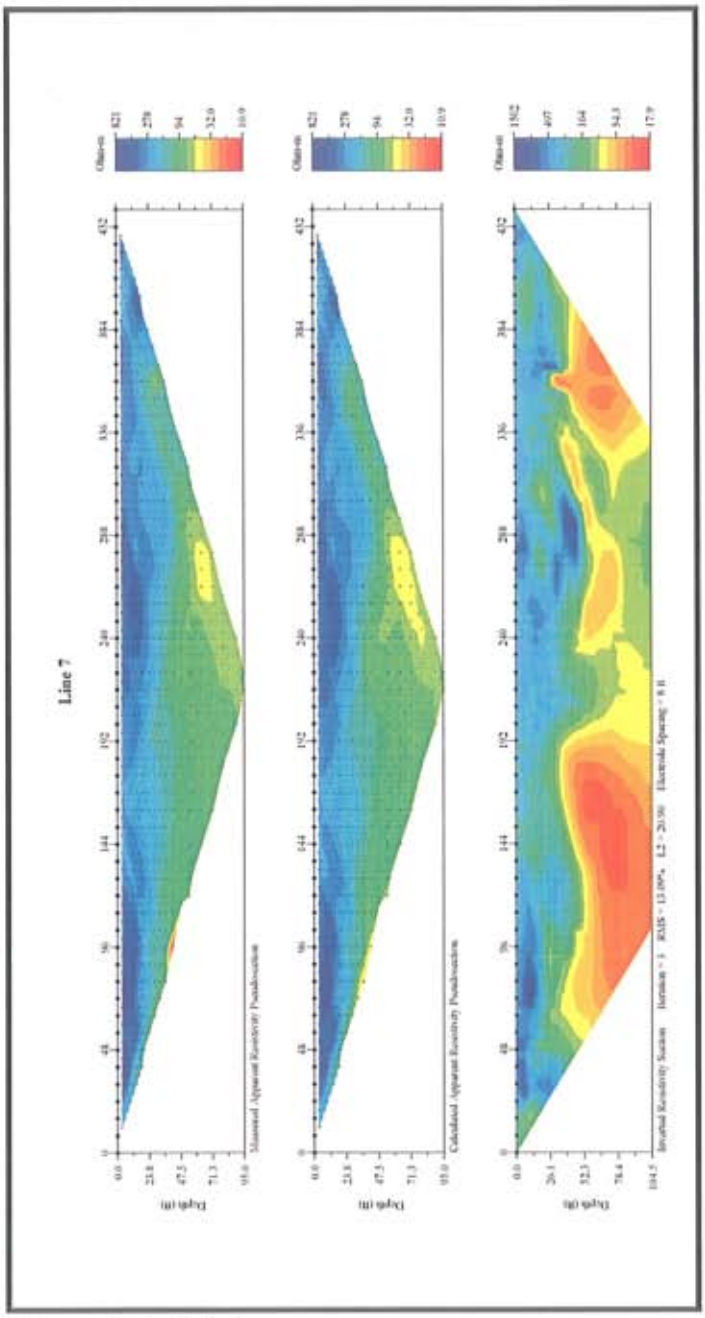

Figure R-7. Site 4

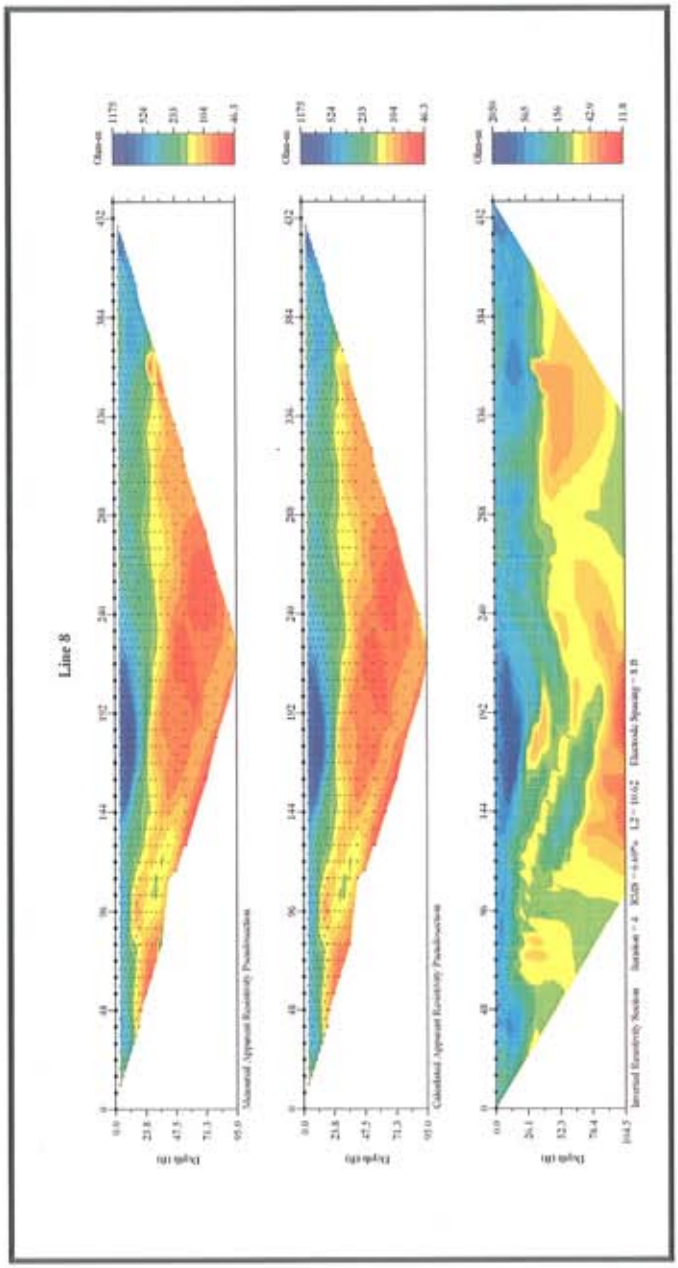

Figure R-8. Site 4

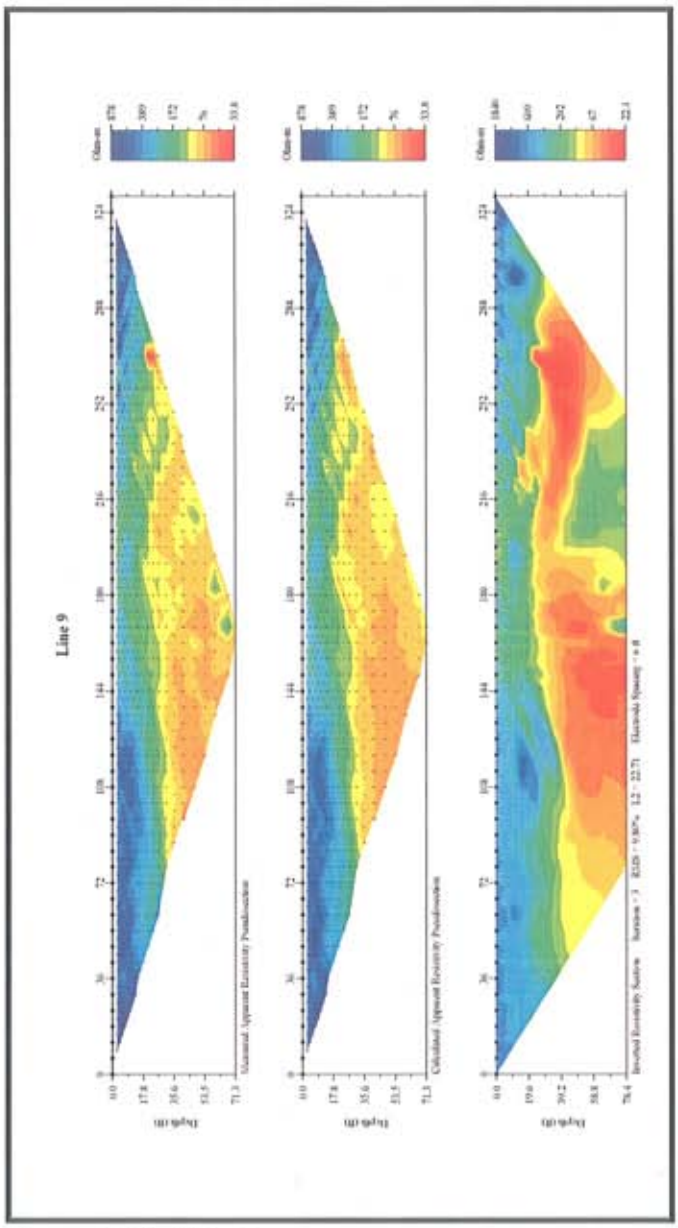

Figure R-9. Site 5

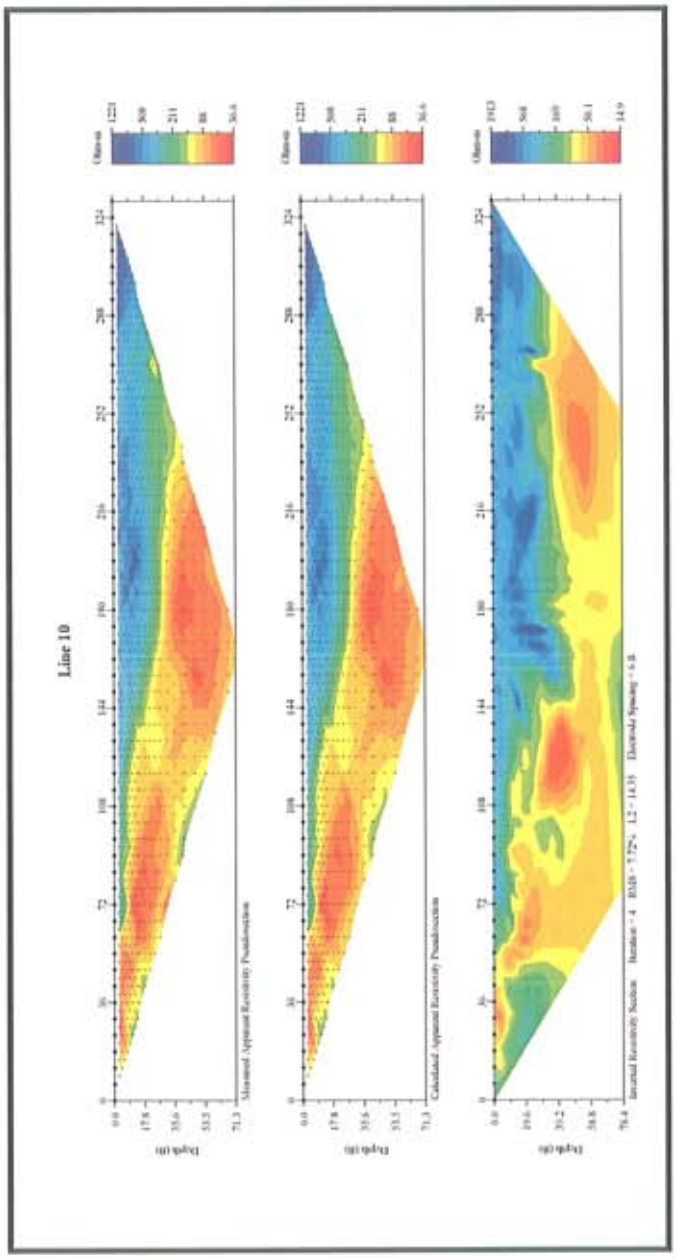

Figure R-10. Site 5

8.a General Electric Resistivity Findings

Predominant zones of weathered or fractured to more competent limestone is present within the approximate center of the geophysically surveyed area beginning at a depth of about 5 to 10 feet in Sites 2,3, and 4. At depths greater than approximately 40 or 50 feet the interpreted limestone becomes fresher but still contains more silty clay constituents (this accounts for clay pockets within otherwise weathered rock materials. (The latter is very typical of limestone terrains in the Barceloneta and Arecibo areas). The limestone has been interpreted to exist in a pinnacled form with jagged peaks followed by soil between the peaks.

9.0 PRELIMINARY DEVELOPMENT SITE PLAN

A map called; **"Preliminary Development Site Plan"** was prepared. A reduction of this map is shown as **Plate 1-2**.

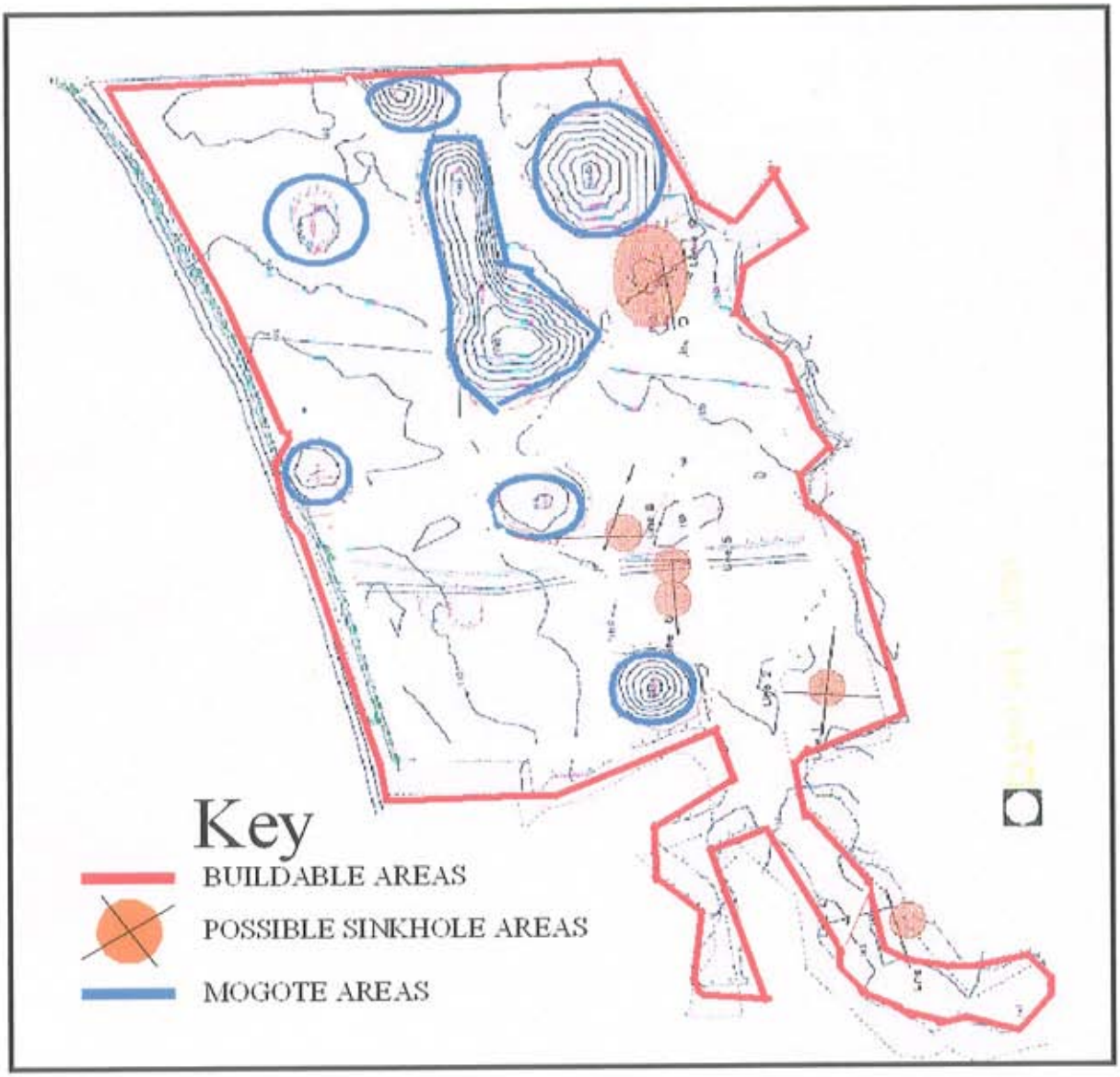

Plate 1-2. Preliminary Development Plan. Engineering Geologic Map.

The depth to limestone cross sections are of the utmost importance for the project. Engineering characteristics of the area relative to the development of sinkholes can be obtained from the resistivity lines on the map. The engineering characteristics are:

1. **Depth to bedrock.**
2. **Thickness of overburden.**
3. **Configuration of the top of limestone and thus depressions indicative of possible sinkholes.**
4. **Lineaments or trends connecting possible sinkholes.**
5. **General physical properties of soil materials.**
6. **General physical properties of limestone.**
7. **Schematic two dimensional representation of the morphology of the buried sinkholes.**

The preliminary development site plan **(Plate 1-2)** map was prepared to categorize areas within the lot in terms of the subsurface conditions revealed by the exploration. The categories used were chosen based on the anticipated foundation problems, mainly the progressive subsidence or sudden collapse of the ground surface as a direct result of sinkholes or sinkhole related phenomena. The subsidence or sudden collapse can cause detrimental effects to structures founded above sinkholes or sinkhole prone areas.

Three categories were defined and are described as follows:

9.a Buildable Areas

9.b Possible Sinkhole Areas

9.c Mogotes Areas

These areas are delimited on the Development Site Plan **(Plate 1-2)**. As it can be observed the property has been divided into these areas.

The following is an explanation of the categories:

9.a Buildable Areas

Buildable areas refer to areas that will require normal geotechnical explorations (including borings and mechanical soundings) for future developments. The area has average rock depths between 5 and 50 feet. No physical indications of sinkhole development were observed within these areas like open collapse sinkholes or cavities. The latter does not mean sinkhole related features cannot develop within this area, rather that no specific sinkhole related feature has been observed during the exploration.

These areas may require sporadic and/or perimeter grouting. Perimeter grouting refers to strictly quality controlled injection of a design cement-grout mix, where only the footprint of proposed structures is treated, as opposed to uncontrolled, "grout to refusal" techniques used and accepted in the past. The grouting will be used for impermeabilization of porous subsurface materials, or for an increase in subsurface material strength.

Strictly quality controlled earthwork procedures are anticipated for these areas including cuts, excavations and replacement of in-situ soils. Impermeabilization of the footprint of proposed structures, as well as adjacent areas, is mandated. Proper collection and disposal of surface runoff, roof runoff, and underground pipelines is mandated. Normal foundations, such as spread and continuous footings or shallow slab-mats, are anticipated for these buildable areas.

9.b Sinkhole Areas

Sinkhole areas refer to areas having active sinkholes, or having the potential for the development of sinkholes. The category refers to areas that will require further exploration, both geotechnical and geophysical, and special treatments prior to development. The area has rock depths in excess of 30 feet.

There are physical indications, either revealed by the exploration or suspected, of buried depressions in limestone where the formation of new collapse sinkholes may develop. Some of these depressions may be active sinkholes, especially buried depressions near the east portion and central portion of the property.

The drainage regime of the known active sinkholes, including flow direction and drainage capacity must be known prior to development.

The areas will require additional explorations to ascertain that if active, the natural flow of run-off waters into the sinkholes will never be blocked. Enhancement of the drainage capacity of the sinkholes may be required. That is most of these sinkholes are naturally plugged sinkholes. This means that over geologic time the sinkhole's internal drainage capacity has been diminished due to natural uncontrolled runoff waters rich in sediments. Special provisions and recommendations can be taken to enhance or renew that drainage capacity of the sinkhole by:

9.b.1 Removing and replacing natural impermeable clays with properly designed inverted filters.

9.b.2 In the event the depth of removal of natural plugging sediments is too deep, special provision can be taken to design run-off waters infiltration wells. These wells are designed to bypass the overburden plug natural of soils and direct the run-off directly into the limestone. This minimizes continued subsidence and sudden collapse of sinkholes due to uncontrolled runoff waters.

9.b.3 Reducing the time of infiltration by placing retention ponds designed to control the inflow of natural runoff into the sinkhole. This minimizes or mitigates un-wanted floods in the area due to naturally plugged sinkholes

9.b.4 A combination of two or all of the above has been used in many projects depending on the sinkholes condition, the hydrology and hydraulics of the property, and the project's final layout.

9.b.5 Grouting for impermeabilization and increase in rock strength is sometimes used in very weathered limestone conditions, but done in a strict manner as not to influence the drainage capacity of the sinkhole.

9.b.6 Impermeabilization of footprint and adjacent areas is also needed. Large foundations are anticipated. Deep foundations may be necessary. Relocation, by shifting proposed structures to avoid sinkholes, may be necessary.

9.c Mogotes

This area corresponds to the mountainous and densely vegetated area within the property. This is an area characterized by abrupt and irregular vertical relief in the order of 100 meters and more, as approximately measured from the relatively flat terrain of the surrounding land.

The mountainous area consists of an northeast-southwest trending residual limestone hills, locally referred to as "mogotes", "pepino hills", "hay stack hills", or "keggle karst". These are formations carved by dissolution of limestone with water.

The following section will cover general foundation recommendations that should be borne in mind by the designers of the future development when dealing in limestone terrains.

10.0 GENERAL RECOMMENDATIONS

This final section deals with general foundation recommendations that should always form part of any development on limestone terrain. Several foundation solutions for the sinkhole areas are brought up for possible consideration. The information shown in this section is in no way intended to be taken as final recommendations for final design, for any future development within the property shall be preceded by a formal exploration as expressed in the Development Site Plan. This information is only intended as general guidelines to be accounted for during the planning stages of the future projects.

11.0 FOUNDATION SOLUTIONS

In order to minimize the factors that may initiate failure or to control the possible damages, which might result from subsidence or collapse of the overburden above a cavity, the following foundation methods are usually considered:

1. Use large foundations (i.e. Mat Foundations) to resist failure from cavity collapses (refer to **Figure 3-1**).

2. Use of deep foundations by-passing collapsible material and founding in competent material. Pile foundations (**Figure 3-2**), caissons (**Figure 3-3**), piers (**Figure 3-4**).

3. Cap grouting or pressure grouting to impermeabilize and/or strengthen the load bearing materials (**Figures 3-5** and **3-6**).The grout material should be relatively incompressible, so as to prevent collapse and at the same time be water resistant so that it will not be washed away and will minimize water circulation. The design of a void filling program requires a thorough understanding of the size and shape of the cavities to be filled and the selection of a grouting agent appropriate to the voids. If

the grout is too viscous or coarse-grained, it will not fill the small voids. On the other hand, if the grout is too fluid, it will flow well beyond the limits of the area to be improved and produce little value at high cost.

4. Optimizing the buildings location by shifting positions to avoid sinkholes or sinkhole prone areas. (**Figure 3-7**).

5. Any foundation to lay closer than 75 ft from an existing sinkhole, shall require a very detailed investigation prior to its approval and casting.

6. Surface waters must be carried sufficiently away (via paved drainage ways) from the structures so that ravelling induced by downward drainage is minimized.

7. Underground utilities should be installed on concrete-lined channels so that leakages can be detected and repaired. In this way water, or any other liquid will not seep readily into the ground.

8. All downspouts and splash blocks should be placed so that roof run-off is carried away from the structures. These waters should be collected by paved drainageways and disposed into proper outfalls.

9. All surface connections to the structure's utilities shall be of the flexible type in order to avoid breakage resulting from the occurrence of minor differential settlements.

10. Processed waters should not be disposed of, by channeling them into nearby opens sinkholes. This practice is not encouraged since the hydraulic capacity of the sinkholes is not known, and continued practice will result in collapse of the ground surface adjacent to them.

11. All earthwork procedures during actual construction shall be done under strict quality controlled conditions and under the supervision of a full time geotechnical technician. It is during the earthwork procedures that most of potential sinkhole problems are discovered, specially on cut areas where open cavities or sinkhole related phenomena might go unnoticed to the untrained eye.

12. For the evaluation of hydraulic capacity of any of the sinkholes and in the event the there is an approved need to evaluate the possibility to dispose runoff water through any of them using drainage disposal pits and wells, it is mandatory to conduct Vertical Seismic Profiling and Electrolyte Tracing techniques. Also, the current volume of surface waters run-off produced by the property should be calculated as well the increase in runoff resulting from the proposed project. Only by knowing these quantities will a design of a disposal drainage pit be complete.

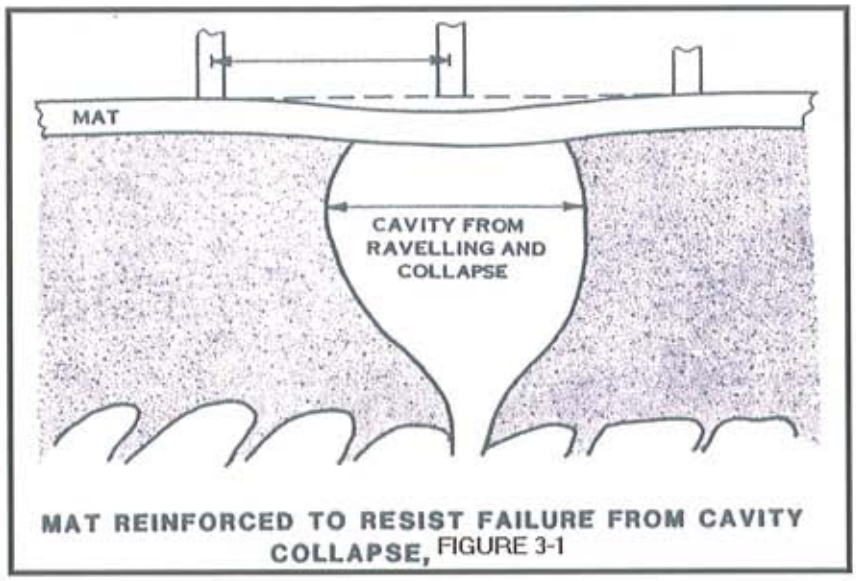

Figure 3-1

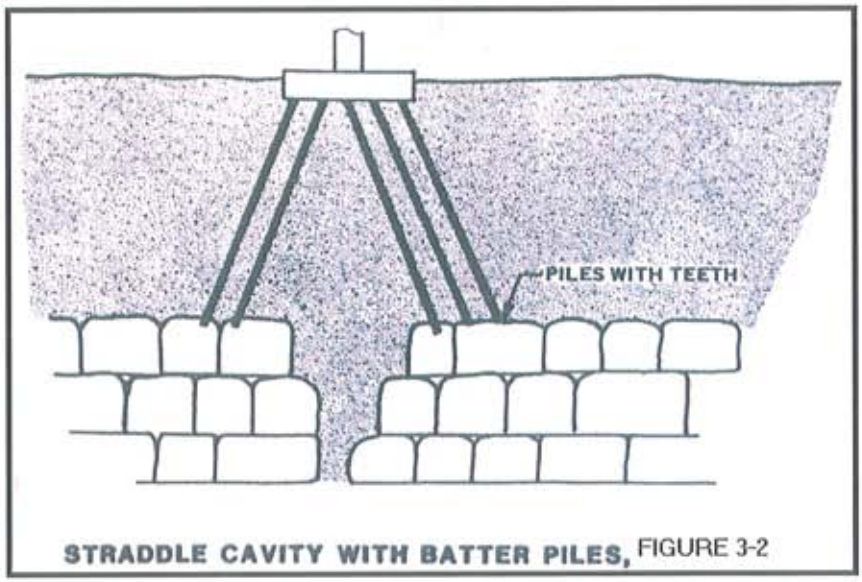

Figure 3-2

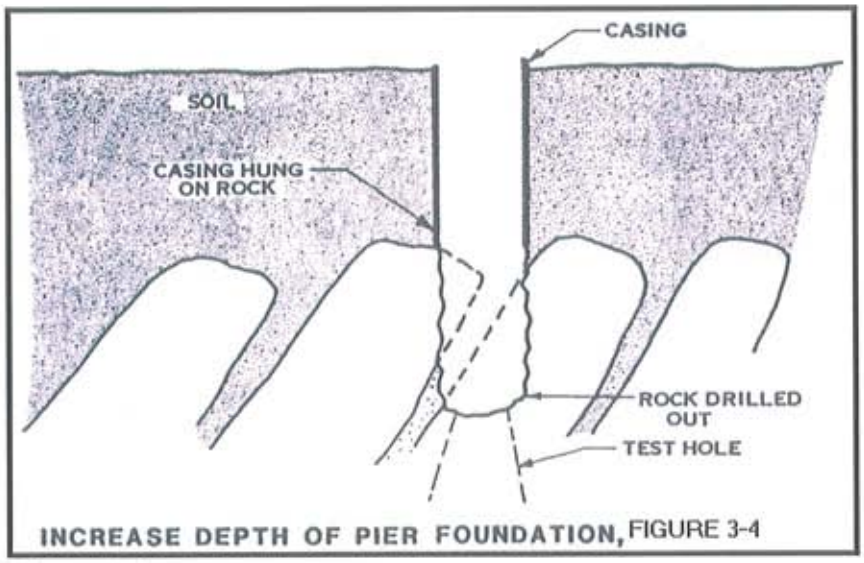

Figure 3-3

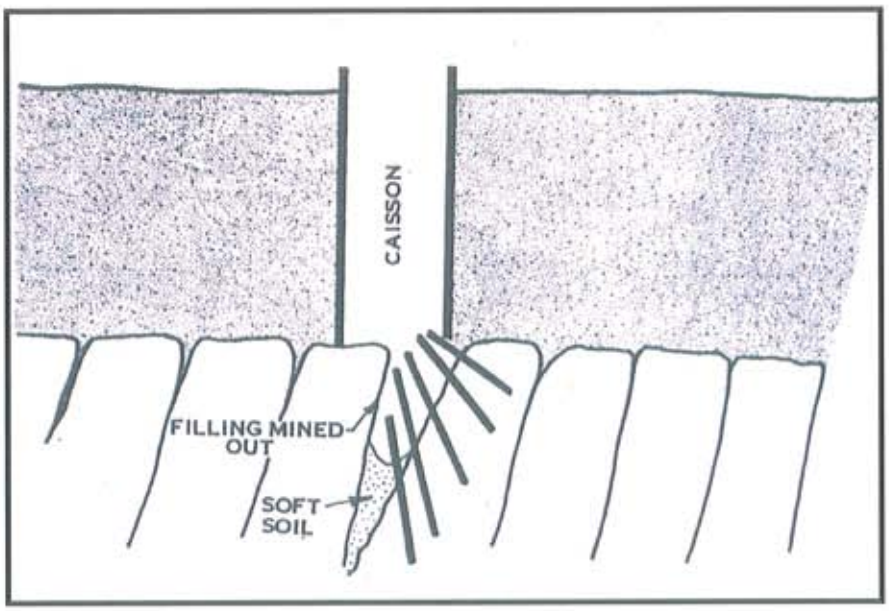

Figure 3-4

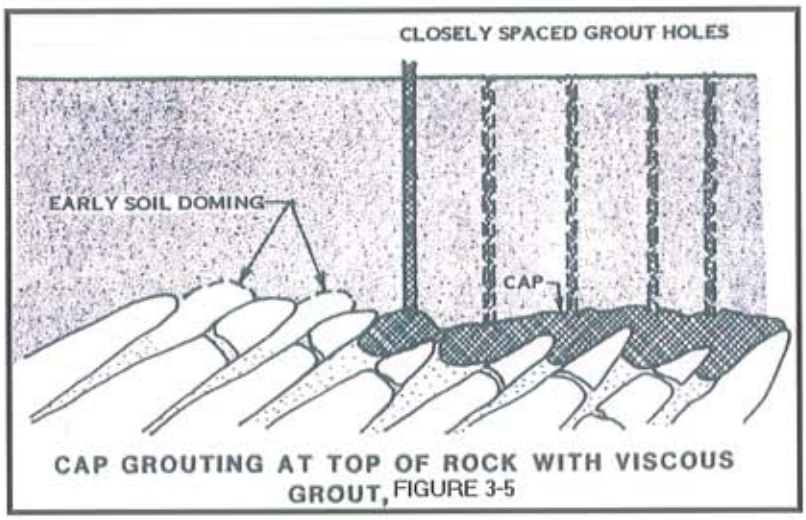

Figure 3-5

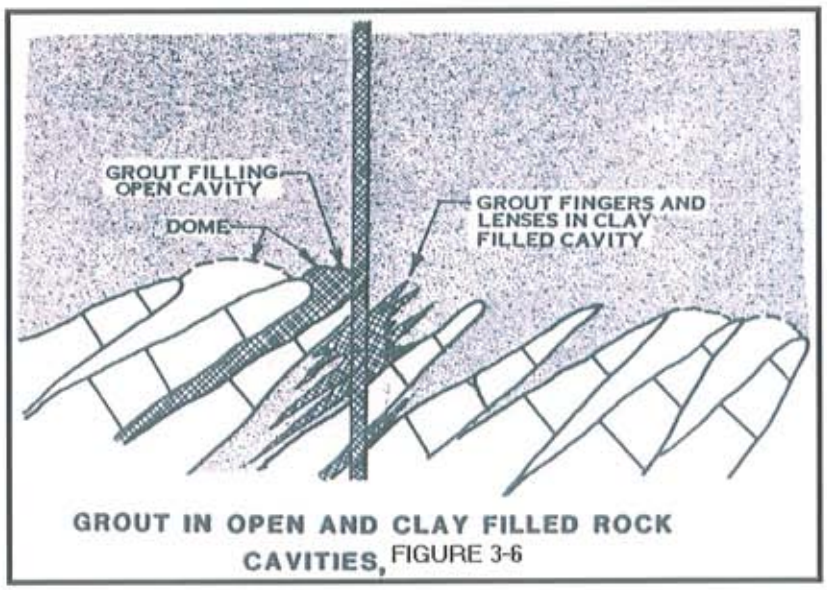

Figure 3-6

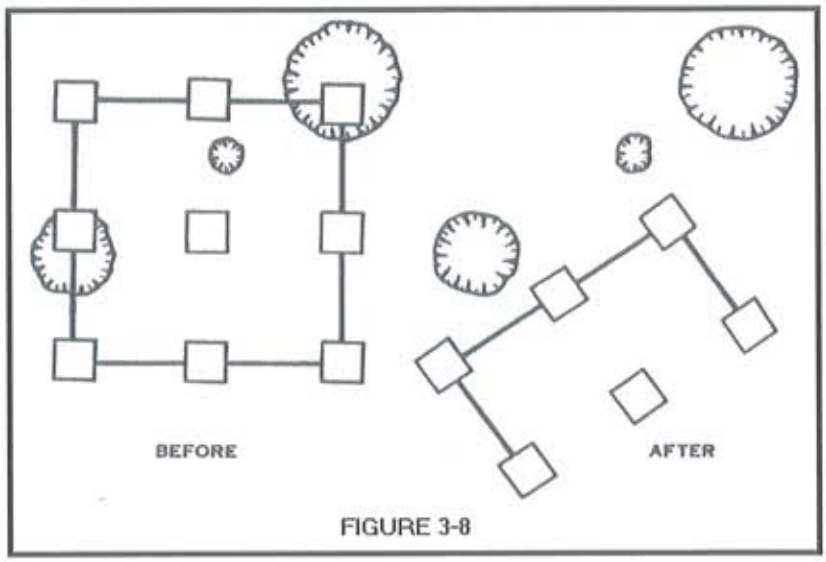

Figure 3-7

12.0 COMMENTS

This report presents guidelines that can be used for planning and budgeting of the proposed development of the Biáfra Property in Arecibo, Puerto Rico. Future structures shall be carefully planned according to the findings of this report in latter design phases. These shall be geotechnically explored prior to their actual construction.

It is important to note that the subsurface conditions depicted by the cross sections in this report are schematic subsurface representations interpreted from geophysical exploration methods and aided by aerial photography remote sensing techniques. Any future project planned shall be preceded by site specific geotechnical and geophysical exploration. Therefore, site specific foundation recommendations shall be required for any future project on the west property.

Respectfully submitted,

Carlos Rodríguez Molina, P.G., P.E., M.S.,
Engineering Geologist & Geotechnical Engineer

mgn

Reference No. 3600-2.rep

CARLOS RODRÍGUEZ MOLINA
LICENCIA NUM 020
PG
GEÓLOGO PROFESIONAL LICENCIADO

CARLOS RODRIGUEZ MOLINA
INGENIERO LICENCIADO
LIC. #12550
PUERTO RICO

Apéndice 13
Estudio de Ruidos

ESTUDIO DE IMPACTOS POR RUIDO

PARA

PROYECTO SENDEROS DE MIRAFLORES

Carretera Estatal PR-637

Barrio Biafra
Arecibo, Puerto Rico

Preparado para:

ORPESA DEVELOPMENT

Preparado por:

Moreno Associates
Environmental and Engineering Consultants

ABRIL 2006

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1.0 Introducción

La compañía **OROPESA Development** propone el desarrollo de un proyecto residencial en el Sector Biáfara del Barrio Miraflores, en el municipio de Arecibo. El desarrollo, que considera la construcción de estructuras comerciales y residenciales de varias densidades, se encuentra localizado en una finca a la cual se accesa a través de la carretera estatal PR-637, en el kilómetro 2.5. Se conocerá al desarrollo como **Senderos de Miraflores.** El proyecto propone la construcción de un desarrollo mixto compuesto de unidades residenciales con varias densidades y una zona comercial. También se proveerán las amenidades recreativas para un proyecto de este tipo. En su concepción, se planifica el desarrollo de cinco componentes o elementos. Estos elementos serán construidos dependiendo de la respuesta del mercado al proyecto. A continuación se presentan en forma tabulada las características de cada uno de estos componentes.

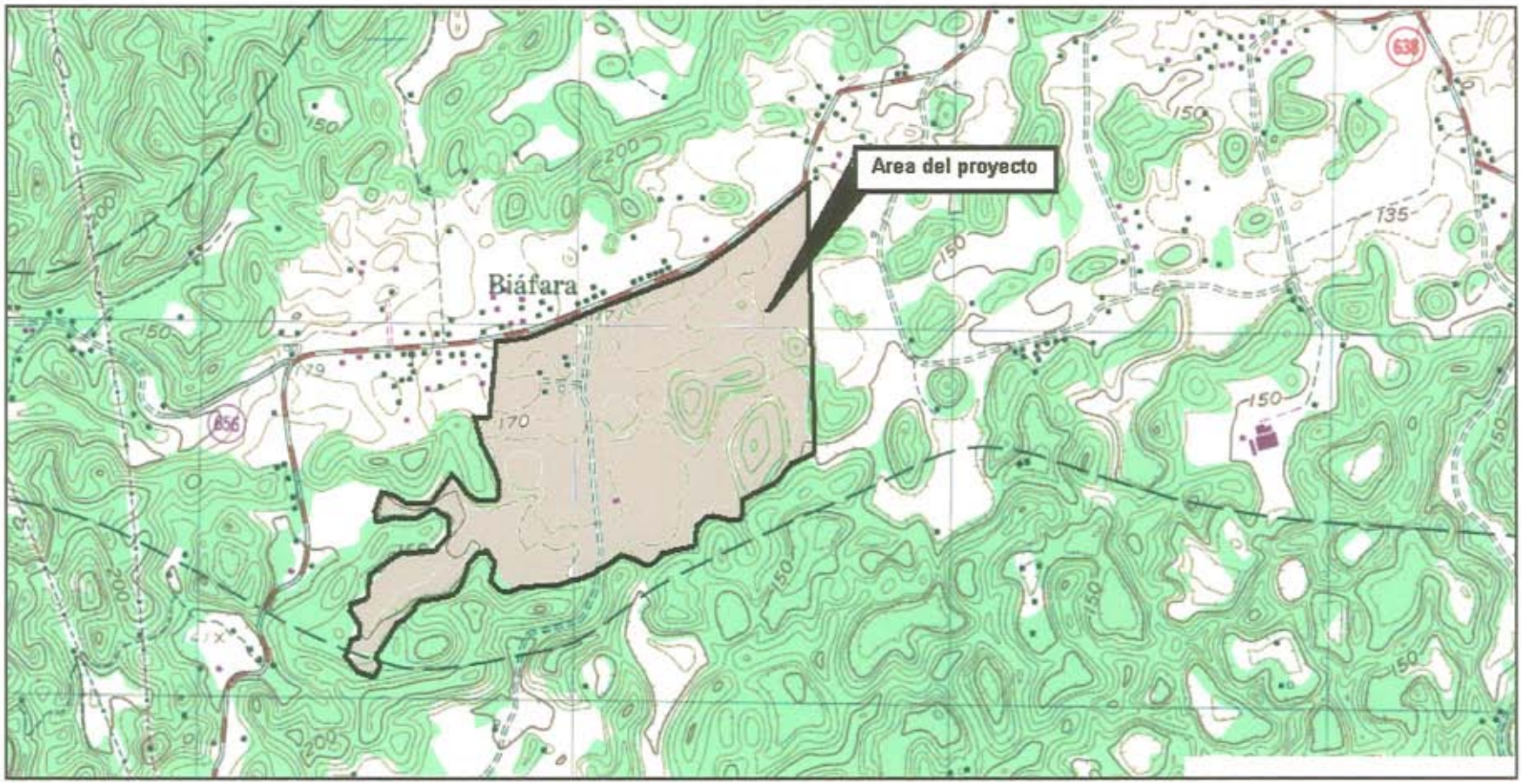
COMPONENTE	AREA (en acres)	DESCRIPCION	INFORMACION GENERAL
Town Center (A)	8.7	Area comercial, área para iglesias o centro comunal. También tendrá un área residencial para 76 unidades de tipo multifamiliar.	26,000 pies^2 área comercial 76 residencias
Área Residencial B	34.17	200 Unidades unifamiliares con sus respectivas facilidades recreativas.	108 solares de 400 mt.^{2} 61 solares de 300 mt.^{2} 31 solares de 600 mt.
Área Residencial C	15.3	146 Unidades unifamiliares con sus respectivas facilidades recreativas.	77 solares de 400 mt.^{2} 69 solares de 300 mt.^{2}
Área Residencial D	31.0	213 Unidades unifamiliares con sus respectivas facilidades recreativas.	121 solares de 400 mt.^{2} 92 solares de 300 mt.^{2}
Área Residencial E	31.22	120 Unidades unifamiliares con sus respectivas facilidades recreativas.	120 solares de 600 mt.^{2}

Todos los componentes tendrán entradas individuales, para controlar sus respectivos accesos

internos, pero sólo un acceso común hacia la carretera estatal **PR-637**.

Debido a que el proyecto se ubica en una zona rural no zonificada, se presentó ante la consideración de la Junta de Planificación de Puerto Rico una Consulta de Ubicación. Dicha consulta se identificó para fines de referencia y seguimiento con el número **2005-06-0623-JPU**. Como parte de los trámites pertinentes a la consulta, se consultó con la **Autoridad de Carreteras y Transportación (ACT)**. Esta agencia mediante carta del 2 de febrero de 2006 (ver copia en **Apéndice 1**) solicitó la realización de un Estudio de Sonido Ambiental para determinar los Niveles de Ruido Ambiental a que estarán expuestas las viviendas debido al tránsito en las vías estatales en su condición actual y proyectada a 20 años. Del examen de la información disponible, se desprende que las viviendas que colinden con la carretera estatal **PR-637**, serán las viviendas que estarán expuestas a los posibles impactos debido al ruido que ocasionen los vehículos que transiten por el lugar. Por tal razón este estudio pretende analizar esta condición y considerar el horizonte de 20 años especificado por la **ACT** en su comunicación. De ser necesario, se formularán las recomendaciones de mitigación de ruido que resulten efectivas para minimizar estos impactos sónicos.

La localización del proyecto, se ilustra en copia del cuadrángulo topográfico de Arecibo según publicado por el **Servicio Geológico Federal (USGS** por sus siglas en inglés) e identificado como la **figura 1**. Como puede apreciarse, la carretera estatal PR-637 se constituye en la carretera estatal cuya operación puede afectar a los futuros residentes del proyecto. En las cercanías del proyecto la PR-637 posee dos (2) carriles, uno (1) en cada dirección. No se observan paseos de emergencias ni isletas centrales en la carretera. Esta sección de carretera muestra unas características mínimas, puesto que los carriles tienen cerca de 3.0 metros de ancho.



Referencia: Cuadrángulo topográfico de Arecibo, publicado por el Servicio Geológico Federal
Escala aproximada: 1;20,000

Estudio de Impactos por Ruido	**MAPA DE LOCALIZACION** Senderos de Miraflores Arecibo, Puerto Rico	Figura 1

1.1 Descripción del proyecto

El proyecto según conceptualizado al presente, considera el desarrollo de un total de 810 unidades de vivienda y una pequeña área comercial de 26,000 pies cuadrados. Este desarrollo tendrá lugar en un área de 124 cuerdas, aunque la finca tiene una cabida total de 442 cuerdas. Es decir que se desarrollará sólo el 28% de la totalidad de la finca, quedando como remanente el 72% restante (equivalentes a 318 cuerdas). Este remanente será preservado y utilizado para áreas verdes del proyecto.

En el **Apéndice 2**, se incluye copia del plano conceptual del proyecto, mientras que en el **Apéndice 3** se incluyen fotos del área del proyecto y de la carretera **PR-637**. El área tiene una topografía mayormente semi-llana, con declives graduales hacia el sur. Estos espacios llanos, son interrumpidos en su mayormente en su porción sur por varios mogotes que forman parte de la finca que no será desarrollada. No se observan cuerpos de agua superficiales dentro de la propiedad.

1.2 Propósito de evaluación

Como se indicara con anterioridad, el propósito de este estudio, es el determinar el impacto por ruido, si alguno, que experimentarían los residentes de las unidades residenciales más cercanas hacia la carretera estatal **PR-637,** que discurre hacia las colindancia norte del proyecto. En la eventualidad de que estas áreas se vean afectadas, se formularán las medidas de mitigación que se estimen pertinentes para aminorar este impacto. Se utilizarán los criterios comparativos establecidos por la **Agencia Federal de Carreteras (FHWA** por sus siglas en inglés). Los detalles de estos criterios, se proveerán más adelante en este informe.

2.0 Análisis de la Información

De acuerdo a los requerimientos de la **ACT**, el Estudio de Ruido debe analizar los impactos por ruido en el proyecto. Es decir, que de acuerdo a la información provista por el dueño, el análisis y determinación de los impactos se han dirigido a la porción del proyecto que encuentran a una distancia relativamente corta de la carretera estatal antes mencionada. A continuación se presenta una descripción de la colindancia hacia la carretera estatal **PR-637**.

Colindancia hacia carretera estatal PR-637

Según indicado anteriormente, el acceso hacia el proyecto se realizará a través de la carretera estatal PR-637, en las inmediaciones del kilómetro 2.5. Esta colindancia se constituye en el lugar en el cual debido a la configuración del proyecto, los futuros residentes podrían estar sujetos a niveles de ruido altos asociados al tráfico vehicular que discurre por la PR-637. En esta colindancia del proyecto, la carretera muestra una configuración típica de las carreteras en áreas rurales del país. Es decir, la carretera tiene dos carriles, uno en cada dirección y carece de paseos e isleta central. Se estima el ancho de estos carriles en cerca de 3.00 metros.

La carretera posee una pendiente suave que aumenta en sentido norte a sur. Es decir que los puntos más bajos de la carretera se observan hacia el norte de la porción de la carretera que colinda con el proyecto. Por tal razón el modelaje considerará que el carril más lejano va subiendo con respecto al proyecto. El límite de velocidad observado antes de llegar al área del proyecto se establece en 30 millas por Hora (ver copia de letrero indicando límite de velocidad en el Apéndice 3). Para fines del modelaje, se utilizó la velocidad de 31 millas por hora, aunque la velocidad indicada por los letreros era de 30 millas por hora, debido a que el modelo realiza un ajuste a la velocidad cuando la misma es menor de 31 millas por hora.

Como parte de la construcción del proyecto, y de acuerdo a los datos suministrados, no realizarán movimientos de tierra extensos, por lo cual se puede indicar que los niveles finales propuestos, se mantendrán similares a los existentes. Es decir, que los niveles del área del proyecto una vez realizados los trabajos de movimiento de tierra estarán un poco más bajos (en el orden de un metro) en la colindancia del proyecto con la **PR-637**.

Las estructuras residenciales que se formarán hacia la carretera estatal **PR-637** estarán a una distancia medida desde el borde de la carretera, que fluctúa entre los 21.0 y 52 metros, medidos entre el borde de la carretera y la estructura residencial. Aproximadamente 800 metros lineales de esta colindancia son paralelos a la carretera estatal **PR-637**. Es de notarse el hecho de que se percibió un flujo vehicular bastante espaciado durante el tiempo que se observó el área del proyecto. Esta vía aparenta ser una típica de las zonas rurales de la Isla.

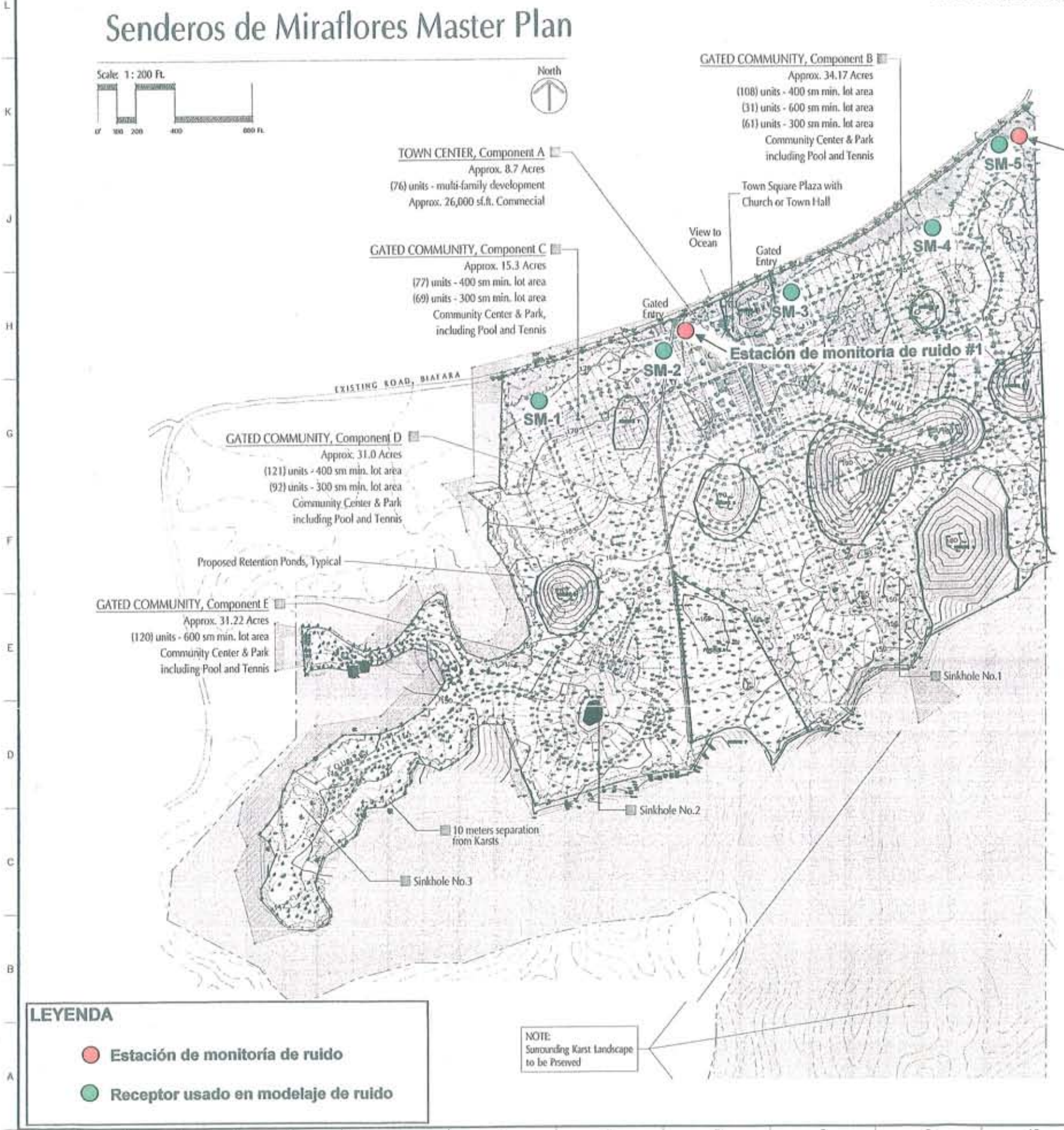
Se seleccionaron localidades que para efectos de este estudio se conocerán como receptores de ruido a lo largo de la colindancia con la carretera estatal PR-637. Estos se seleccionan basados en su relativa cercanía a la mencionada carretera. En total se seleccionaron cinco (5) localizaciones para realizar los estimados de niveles de ruido. Estos fueron identificados como **SM-1, SM-2, SM-3, SM-4** y **SM-5**. En la **figura 2**, se presenta una ilustración en donde se observa la ubicación de estos receptores, así como la localización de dos (2) puntos de monitoría de ruido. Estos puntos de monitoría sirven para documentar el ambiente sonoro existente en el lugar.

3.0 Criterios de Evaluación y Resultados de Modelaje

Para fines de caracterizar el ambiente sonoro existente, se realizaron mediciones de ruido en dos (2) localidades diferentes. Ambos puntos se localizaron en la colindancia hacia la carretera estatal **PR-637.** Se realizaron mediciones de ruido el 28 de marzo de 2006 (entre las 10:00 A.M. y 12:30 P.M.). Estos datos sirven para establecer o cuantificar los posibles impactos. La descripción de estos receptores se incluye a continuación.

Identificación de punto	Comentarios
1	Este lugar se localizó hacia la parte más al sur de la colindancia del área del proyecto con la carretera estatal **PR-637**. Se localizó a una distancia de aproximadamente 25 metros del borde de la carretera. Se encuentra localizado en el lugar en donde se construirá el componente **C** del proyecto.
2	Este lugar, se localizó hacia la parte más hacia el norte de la colindancia del área del proyecto hacia la carretera estatal **PR-637**. Se localizó a una distancia aproximada de 20 metros del borde de la carretera. Cerca de esta lugar se construirá el componente **B** del proyecto y se encuentra localizado en el lugar que estará más cercano a la carretera.

LOCALIZACION DE RECEPTORES Y PUNTOS DE MONITORIA DE RUIDO



SENDEROS DE MIRAFLORES

MASTER PLAN FOR "FINCA BIAFARA"

PROPOSED LAND USE TABLE

	DESCRIPTION	QUANTITY
COMPONENT A	COMMERCIAL - 26,000 SF *	LS
	MULTI-FAMILY DEVELOPMENT - 850 SF **	76
COMPONENT B	300 SQUARE-METER LOTS	61
	400 SQUARE-METER LOTS	108
	600 SQUARE-METER LOTS	31
COMPONENT C	300 SQUARE-METER LOTS	69
	400 SQUARE-METER LOTS	77
COMPONENT D	300 SQUARE-METER LOTS	92
	400 SQUARE-METER LOTS	121
COMPONENT E	600 SQUARE-METER LOTS	120

* NET FLOOR AREA DEDICATED TO COMMERCIAL USE

** AVERAGE GROSS FLOOR AREA FOR EACH APARTMENT UNIT

LAND USE SUMMARY (FOR ALL PHASES)

COMMERCIAL	LS	33,800 SF
MULTI-FAMILY DEVELOPMENT	76	80,750 SF
300 SQUARE-METER LOTS	222	N/A
400 SQUARE-METER LOTS	306	N/A
600 SQUARE-METER LOTS	206	N/A

VARCHITECTURE
1701 Ponce de León Avenue
San Juan, Puerto Rico 00909
p. 787.622.3900
f. 787.622.3910
e. info@varchitecture.com

SAN JUAN, PUERTO RICO

FIGURA 2

A-2.00

NOT RELEASED FOR CONSTRUCTION

En la **figura 2**, se ilustra la localización de los puntos de monitoría de ruido antes descritos.

Antes de continuar, es conveniente repasar algunos términos técnicos referentes al ruido y la forma de medirlo. Se define un decibel, como una unidad de medición de la intensidad del sonido, igual a 20 veces el logaritmo a la base 10 de la razón de presión del sonido, medido a una presión de referencia (20 micropascales). Se utiliza la escala de medición de ruido A, debido a que es la que más se asemeja a la respuesta del oído humano al sonido. Los niveles de ruido expresados en dBA son entonces utilizados para compararlos contra estándares establecidos en proyectos de tráfico vehicular. La Agencia Federal de Carreteras (**FHWA** por sus siglas en inglés) ha desarrollado dichos estándares que como hecho conocido establece que un aumento de un (1) dBA cuando se compara con niveles existentes, no puede ser percibido por el oído humano. Por otra parte, un incremento de tres (3) dBA es apenas perceptible, mientras que un incremento de cinco (5) dBA o más se percibe como un cambio significativo. Un aumento de diez 10 dBA se percibe como la duplicación del nivel de ruido existente. En la **Tabla 1** se resumen los criterios para establecer acciones de mitigación definidos por la **FHWA**.

Los niveles de ruido (L_{10}) medidos para cada uno de los puntos de monitoría de ruido se presentan a continuación:

Punto de monitoría	**Niveles de ruido L_{10} medidos (dBA)**
1	51.0
2	53.1

Tabla 1: Criterios para Mitigación por Ruido (CMR)
Nivel de sonido en decibeles escala A (dBA)

Categoría de Actividad	L_{eq} (h)	L_{10} (h)	Descripción de actividad en categoría
A	57 (Exterior)	60 (Exterior)	Terrenos en los cuales la serenidad y silencio son de significado extraordinario y sirven a un interés público importante en donde la preservación de estas cualidades es esencial para que el área se mantenga en su uso propuesto
B	67 (Exterior)	70 (Exterior)	Areas de pasadías, áreas recreativas, áreas de juego, áreas para deportes, parques, residencias, moteles, hoteles, escuelas, iglesias, bibliotecas, y hospitales.
C	72 (Exterior)	75 (Exterior)	Areas desarrolladas, propiedades, o actividades no incluídas en las categorías A o B de arriba.
D	–	–	Terrenos sin desarrollar.
E	52 (Interior)	55 (Interior)	Residencias, moteles, hoteles, lugares de reunión públicos, escuelas, iglesias, bibliotecas, hospitales, y auditorios.

Nota: Sólo se pueden usar L_{10}(h) o L_{eq}(h) en un proyecto, pero no ambos.

La presencia de la carretera **PR-637** fue evidente durante el periodo de medición, en particular cuando pasaban camiones pesados por el lugar. Los niveles fueron medidos con un sonómetro marca Quest, modelo 2900, con integrador de datos. Este sonómetro tiene al día su calibración, copia de la cual se incluye en el **Apéndice 4**. La calibración del aparato fue verificada previo a cada evento de medición.

Para poder evaluar los impactos por ruido que recibirán los residentes del proyecto, una vez finalizado el mismo, se utilizó un modelo de predicción de ruido conocido como **Stamina 2.0**. Este modelo fue desarrollado por la Administración Federal de Carreteras, como una herramienta para pronosticar los impactos por ruido en proyectos de construcción de carreteras. Mediante la utilización del mismo, es posible pronosticar la intensidad del sonido que recibirá un receptor específico con relación a uno o varios segmentos rectos de carretera evaluado, considerados en conjunto como una fuente emisora de ruido. Las características de la fuente emisora están definidas por el volumen de tránsito que utilicen la vía, la velocidad de los vehículos, tipos de vehículos, y los niveles de emisión de ruido para cada tipo específico de vehículo. Para este estudio, se han considerado los tres (3) tipos de vehículos más comunes en las carreteras de la Isla. Estos son: automóviles, camiones livianos y camiones pesados. El modelo considera además, las características de la trayectoria entre el receptor y la fuente, incluyendo efectos de la topografía, árboles, edificios, barreras y la adsorción atmosférica. Entre los parámetros requeridos para la aplicación del modelo están:

- Datos de tránsito vehicular del área
- Distribución vehicular de tránsito por categorías. Es decir, vehículos pesados, vehículos medianos y automóviles.

- Coordenadas de los segmentos rectos de la carretera a evaluarse (X,Y,Z)
- Velocidad del tráfico en la carretera
- Dimensiones de la carretera

- Características del trayecto entre la carretera y la zona residencial

Antes de comenzar a discutir los resultados de la corrida, es importante señalar que se obtuvieron datos sobre el volumen de tráfico vehicular que pasa por el lugar, de un Estudio de Tránsito preparado por la firma **Traffic Consulting Group (TCG)** durante el año 2005. Esta firma realizó un conteo de vehículos en la intersección de las carreteras PR-638 con la PR-637 (ver **Apéndice 5** para detalles). Los conteos realizados reflejaron que un total de 972 vehículos discurrieron a través de la carretera estatal PR-637 durante un período de 12 horas (entre las 6:00 AM y la 6:00 PM). Para llevarlo a un tráfico diario se multiplicó el valor por 2, lo que lleva los valores a un periodo de 24 horas. Con este procedimiento se estimó entonces que el Trafico Promedio Diario (AADT por sus siglas en inglés) de esta carretera es de 1,944 vehículos. Es importante observar que durante la toma de datos de ruido se observó que el nivel de tráfico era bajo, y estos resultados confirman la observación. Si se presume un incremento anual de 1.5 % en un horizonte de 21 años (hasta el año 2026) y comenzando en el 2005, se proyecta un tráfico vehicular de 2,657 vehículos. A este valor se le añadió la cantidad de viajes que generará el proyecto y que fueron estimados por **TCG** en 1,150 vehículos por día. Esto resulta en un flujo de tráfico vehicular diario para el año 2026 estimado en 3,807 (2,657 + 1,150) vehículos. Se consideró para efectos del análisis de impacto por ruido, que un 10% del total de vehículos que se estima pasen para esta colindancia para el año 2026 (es decir 381 vehículos por hora). Además de esta información, la distribución del tipo de vehículos que utilizan la vía se basaron en estudios previos en donde se establece un 2% de tráfico de vehículos pesados, 4% de vehículos medianos y 94% de vehículos livianos o automóviles. En cuanto a la distribución vehicular direccional se asumió que un 60 % del tráfico vehicular transitando hacia la dirección sur- norte (o sea hacia la PR-2). Esto resulta en un caso más crítico puesto que este carril hacia Barceloneta sería el que llevaría el volumen de tráfico mayor. La información con respecto a la elevación de la carretera y los receptores se tomaron de los planos preparados para el proyecto. En términos generales, la carretera estatal **PR-637** tiene elevaciones que aumentan gradualmente en dirección norte a sur.

Una vez definidos los parámetros antes mencionados, se realizaron las corridas del modelo en lugares que se identificaron como receptores de ruido, por entenderse que los resultados de la corrida son representativos del ambiente

sonoro al cual estarán expuestos los residentes del proyecto. Estos fueron identificados como **SM-1, SM-2, SM-3, SM-4** y **SM-5**. Por otra parte, se desea mencionar que para el período nocturno, se utilizó un volumen vehicular equivalente a un 15% del volumen diario. Los resultados de las corridas se incluyen en el **Apéndice 6** de este documento, mientras que la localización de estos receptores se ilustra en la **figura 2**. Para fines de discusión, los resultados de la corrida se han incorporado en la **tabla 2.**

Resultados de modelaje

Como puede observarse de los resultados obtenidos de la corrida sin barreras, se anticipan niveles de exposición más altos a los actuales como resultado al ruido causado por el tráfico vehicular en la colindancia hacia la carretera estatal **PR-637**. Los niveles de ruido L_{10} pronosticados por el modelo para el periodo diurno para el año 2026 fluctúan entre los 57.5 y 62.0 dBA. El valor más alto se observa en la parte más al norte de la colindancia del proyecto con la carretera estatal **PR-637** y que se identifica como el receptor **SM-5**. Este receptor es el más cercano a la **PR-637**. Los siguientes receptores con respecto a los niveles de ruido proyectados son los receptores **SM-2 y SM-3**. Para ambos receptores, se pronostica un nivel de ruido de 59.6 dBA. Los receptores para los cuales se pronostica un valor de nivel de ruido más bajo están asociados a los receptores **SM-1** y **SM-4**. Ambos receptores se encuentran a una distancia cercana a los 50 metros de la carretera. Si analizamos estos resultados observamos que se ajustan a la realidad física, en el sentido de que en los receptores más cercanos a la **PR-637**, se pronostican niveles de ruido más altos. No obstante, es de notarse el hecho de que en ninguno de los casos el nivel de ruido proyectado excede el nivel máximo permitido para un uso residencial como el propuesto, si se compara con el valor de 70.0 dBA establecido por la **FHWA**.

Por otra parte, para el período nocturno, los niveles de ruido L_{10} varían entre los 49.3 dBA y los 53.6 dBA.

Los resultados de modelaje sustentan la conclusión de que no es necesario proveer medidas de mitigación con respecto a impactos debido al tráfico vehicular que transite por la carretera estatal **PR-637**. En la tabla 2 que sigue, se resumen los resultados de las corridas del modelo tanto para el periodo diurno como el periodo

Tabla 2: Resultados de corrida de modelo Stamina 2.0
Proyecto Senderos de Miraflores
Arecibo, Puerto Rico

Receptor (Distancia entre borde de carretera y estructura)	Resultado periodo diurno (L_{10})	Resultado periodo nocturno (L10)	Estándar de Administración Federal de Carreteras (FHWA)
Colindancia hacia PR-637 (sin barrera)			
SM-1 (48 metros)	57.5	49.3	70.0
SM-2 (32 metros)	59.6	51.4	70.0
SM-3 (24 metros)	59.6	51.3	70.0
SM-4 (52 metros)	57.5	49.4	70.0
SM-5 (21 metros)	62.0	53.6	70.0

nocturno. Se entiende que setos resultados reflejan la situación de una carretera localizada en una zona rural.

4.0 Conclusiones y/o recomendaciones

Los resultados de las corridas del modelo Stamina sustentan la aseveración de que no es necesario el desarrollo de medidas de mitigación para atenuar los niveles de ruido que experimentarán los futuros residentes del proyecto Senderos de Miraflores. Esta aseveración se fundamenta en los niveles de ruido proyectados y obtenidos de las corridas del modelo Stamina, los cuales indican que no se excederán los niveles máximos permitidos para un uso residencial como el propuesto en un horizonte de 20 años. Estas conclusiones se basan en las consideraciones descritas en este informe y en base a los datos de elevaciones y distribución del proyecto provistas por el dueño. De variarse alguna de las mismas, será necesario re-evaluar este estudio.

5.0 Certificación

Certifico que la información presentada en este estudio, es cierta, correcta, y completa a mi mejor entender y saber. También se certifica que los resultados fueron obtenidos utilizando los criterios de la práctica usual y aceptada para este tipo de estudios. Para la realización del modelaje, se solicitó al dueño información sobre las elevaciones del terreno y la configuración del proyecto. Cualquier cambio en las condiciones aquí descritas, resultará en la necesidad de revisar estos cálculos.

David Moreno Vázquez, P.E.
Lic. 9835

APENDICES

APENDICE 1
COPIA DE CARTA DE ACT SOLICITANDO ESTUDIO DE RUIDO

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AUTORIDAD DE CARRETERAS Y TRANSPORTACION

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1 de febrero de 2006

Arq. José Bird
V Arquitectura
Avenida Ponce de León #1701
San Juan, Puerto Rico 00909

URB. SENDEROS DE MIRAFLORES
(734 UNIDADES UNIFAMILIARES, 76 APARTAMENTOS
Y 26,000 PIES CUADRADOS DE ÁREA COMERCIAL)
CARRETERA PR-637, KM 2.5
BARRIO MIRAFLORES, ARECIBO

Estimado arquitecto Bird:

Hacemos referencia a su comunicación del 21 de julio de 2005, recibida en la Oficina de Control de Accesos de esta Área el 3 de agosto de 2005, relacionada con este asunto.

La División de Estudios de Tránsito de esta Área evaluó el estudio de tránsito sometido y los planos esquemáticos para el proyecto mencionado en el asunto e informó que el proyecto tendrá un impacto significativo en el sistema vial que le sirve de acceso al mismo, basado en los datos de tránsito y los resultados de los análisis de capacidad de las intersecciones evaluadas dentro del área de influencia del proyecto a desarrollarse. No obstante, el estudio tomó en consideración varias recomendaciones que mejoran el sistema vial en dicha área incluyendo lo siguiente:

1. En la intersección de las Carreteras PR-2 y PR-663, se deberá proveer un carril corto de viraje a la derecha en el acceso sur (Carretera PR-663) y optimizar los tiempos en el sistema de semáforos, existente.

2. En la intersección de las Carreteras PR-638 y PR-637, se deberá proveer carriles cortos de virajes a la izquierda y a la derecha, en el acceso este (Carretera PR-638) y sur (Carretera PR-637), respectivamente y la instalación de un sistema de semáforos en esta intersección.

3. En las intersecciones de acceso al proyecto, se deberán proveer carriles de viraje a la izquierda y carriles cortos de aceleración y deceleración.

En cuanto al acceso para el proyecto propuesto, según una inspección de campo realizada por personal técnico de la Oficina de Control de Accesos de esta Área se pudo observar que existe un camino hacia la finca ubicado al este y oeste de la propiedad alineado con una calle existente al norte de dicho camino en donde se ubica el negocio El Mamey. Se deberá ampliar dicho camino y proveer una calle principal con una sección de 20.60 metros y radios de curvatura de 12.00 metros en su enlace con la Carretera PR-637, para así darle acceso al desarrollo propuesto por dicho camino. Se deberá proveer una isleta canalizadora para el viraje a la derecha desde la Calle Principal hacia la Carretera PR-637. Esto es condicionado a que se puedan proveer los carriles de viraje a la izquierda y derecha en la Carretera PR-637 frente a dicho camino con sus respectivas transiciones.

Además, se deberán cumplir con los siguientes requisitos:

1. La media sección futura de la Carretera PR-637 en este sector es de 7.50 metros, medidos desde el eje central y consiste de un pavimento de rodaje de 6.00 metros y acera de 1.50 metros. Sin embargo, deberá ampliarse y proveer un carril de viraje a la izquierda frente al acceso al proyecto de 3.05 metros de ancho con una isleta protectora de 0.60 metro y carriles de aceleración y deceleración de 3.65 metros de ancho con el largo y transiciones que cumplan con el Manual de Diseño de Carreteras.

2. Se construirán las obras de ensanche para la Carretera PR-637 de acuerdo a las mejoras requeridas.

3. Deberá dedicar a uso público, a favor del Departamento de Transportación y Obras Públicas, la franja de terreno necesaria para completar las mejoras requeridas de la Carretera PR-637, mediante la escritura correspondiente. En donde la servidumbre de paso existente de la carretera sea mayor que la requerida la misma permanecerá inalterada.

4. Se deberá ilustrar en el plano los límites de colindancia de la propiedad.

5. Debido a la magnitud del proyecto y su impacto significativo en el sistema vial del área, es necesario que sometan un plano "as built" para determinar si es posible ampliar y completar un pavimento de rodaje de 7.30 metros en la Carretera PR-637 desde la intersección de la Carretera PR-638 hasta el límite del proyecto en donde se provea las transiciones correspondientes entre el pavimento de rodaje existente y el requerido.

6. No se permitirán accesos adicionales desde los solares hacia la Carretera PR-637. Estos deberán canalizarse a través de las calles internas del proyecto.

7. Deberá incluir en los planos el diseño del sistema de semáforos requerido, el plan de mantenimiento de tránsito, marcado de pavimento, la señalización y el alumbrado necesario que cumplan con el Manual de Señales de Tránsito para las Vías Públicas de Puerto Rico, el Manual de Dispositivos Uniformes para el Control del Tránsito en las Vías Públicas de Puerto Rico y el Manual de Diseño de Carreteras.

8. Se deberá preparar un estudio de sonido ambiental para determinar los niveles de sonido a que estarán expuestas las viviendas debido al tránsito en las vías estatales en su condición actual y proyectada a 20 años. Se deberá incluir en el estudio las medidas de mitigación que serán necesarias para no sobrepasar los niveles de sonido permitidos por la reglamentación vigente.

9. Para el establecimiento de cualquier sistema o dispositivo para el control de tránsito en la calle de acceso al proyecto (entiéndase portones, brazos mecánicos, sistemas de comunicación con la residencia, etc.), se deberá solicitar el endoso del Departamento de Transportación y Obras Públicas, de acuerdo al Reglamento de Planificación Número 20. Dicha solicitud deberá hacerse a la División de Estudios de Tránsito de esta Área, una vez recibido el endoso final de la Oficina de Control de Accesos, en donde se deberá someter un diseño de estas facilidades (caseta de guardia de seguridad, barreras permanentes, barreras de control de tránsito y portón de acceso de peatón) para la evaluación y recomendación correspondiente. Para más información puede comunicarse con el Sr. Erick Centeno Navarro o el Sr. Ansoel Agosto Quiñones al 787-721-8787, extensión 2858.

10. El cargo de exacción por impacto correspondiente a este proyecto es de $867,000.00 para las mejoras necesarias a la infraestructura vial en el área de influencia del proyecto, según establecido en el Reglamento Núm. 11-001 conocido como Normas para la Imposición de la Aportación por Concepto de Exacción por Impacto, el cual faculta a la Autoridad de Carreteras y Transportación a establecer un programa de exacción por impacto. El endoso de la Autoridad de Carreteras y Transportación, para la obtención del permiso reglamentario estará condicionado a la formalización de un acuerdo de pago con el Asesor Legal de esta Autoridad. Para más detalles relacionados con la aportación deberá comunicarse con el Sr. Renny Parrilla Navarro al 787-721-8787, extensión 2805, los martes y jueves.

Se está realizando una consulta a la Oficina de Planificación Estratégica de esta Autoridad para la evaluación de dicho proyecto. Posteriormente le informaremos los comentarios de dicha oficina en lo relacionado a los proyectos viales a largo plazo.

Deberá someter a la Oficina de Control de Accesos de esta Área dos copias del estudio de sonido ambiental y cuatro copias del plano corregido, de acuerdo a nuestras recomendaciones y a las mejoras al sistema vial del área y el acceso al proyecto, para la evaluación correspondiente. Las mismas deberán estar firmadas y selladas por el profesional colegiado autorizado que las prepare.

Esta comunicación tiene un año de vigencia, no constituye una autorización para comenzar obra de construcción alguna en el proyecto, por lo que se deberán cumplir con los requerimientos indicados en la misma y aplica para el proyecto residencial y comercial Senderos de Miraflores, de 810 unidades de vivienda y 26,000 pies cuadrados de área comercial, a ser construido en el predio de terreno de referencia. Cualquier otro proyecto a desarrollarse en este predio de terreno, deberá ser sometido a esta Autoridad para la evaluación y comentarios que apliquen.

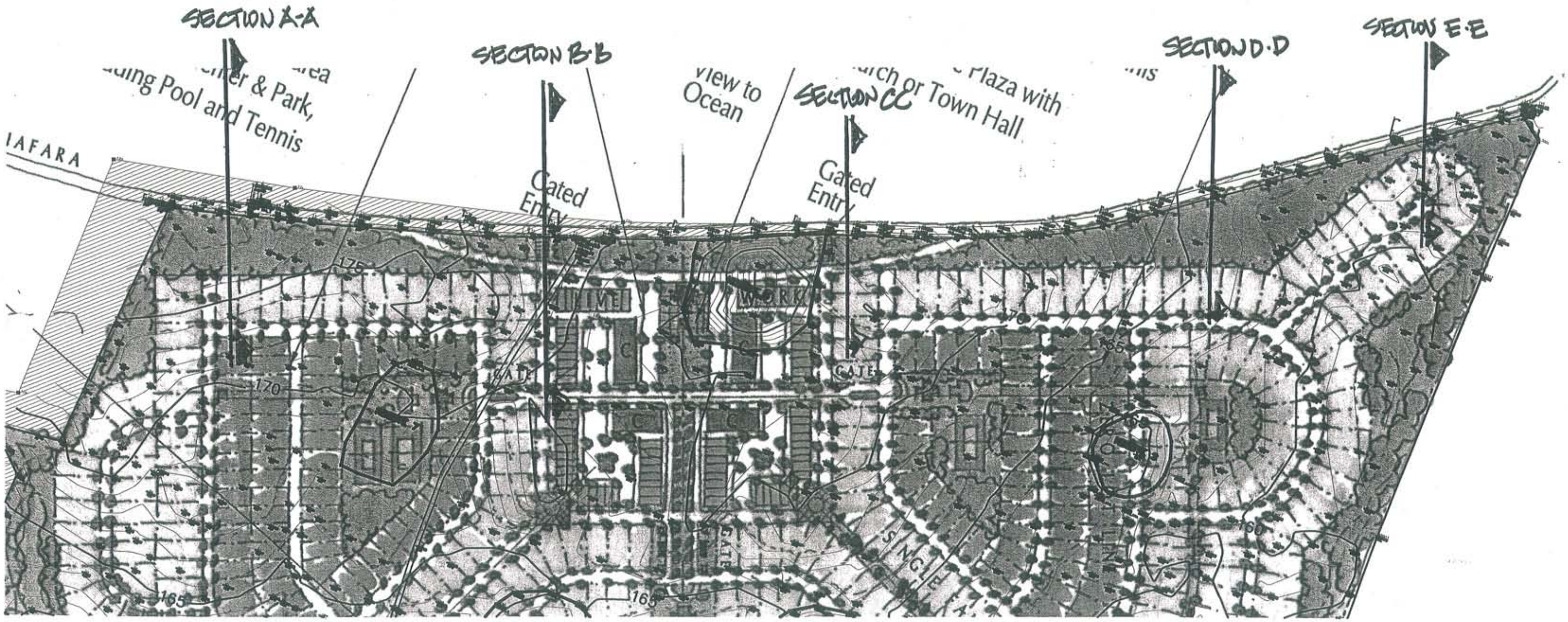
Para cualquier aclaración o información adicional relacionada con este asunto, puede comunicarse con la Oficina de Control de Accesos de esta Área al 787-721-8787, extensión 2805, haciendo referencia al número de control de esta carta. Las llamadas serán atendidas los lunes, martes, jueves y viernes de 8:00 a 11:00 de la mañana. Las visitas serán atendidas por cita previa.

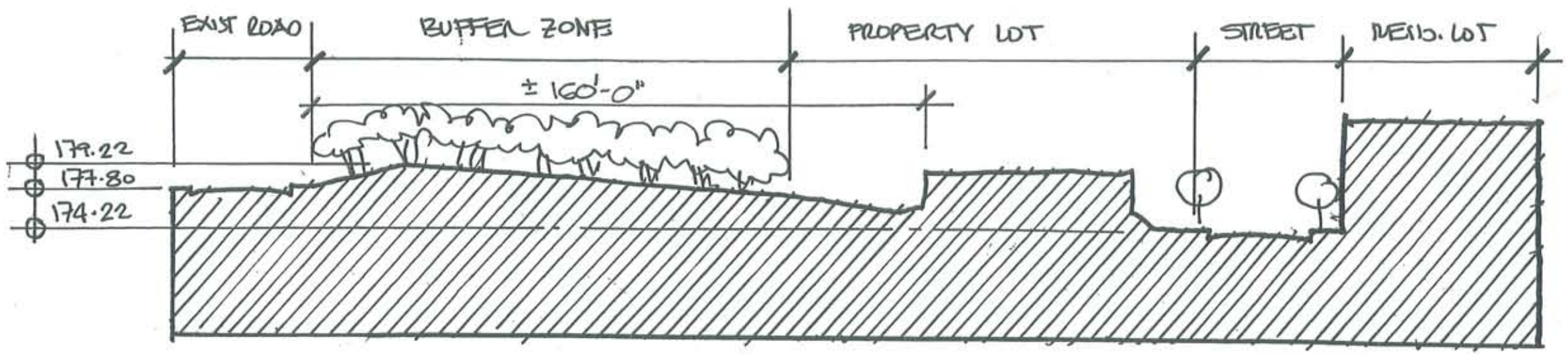
Cordialmente,

Javier R. Zayas Hernández
Director Interino
Área de Ingeniería de Tránsito y Operaciones

5005-MDR-JAB-grh
C#05-00001416

APENDICE 2
COPIA DE PLANO CONCEPTUAL DE PROYECTO Y SECCIONES


SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
View to Ocean
Gated Entry
Gated Entry
Plaza with
or Town Hall
Pool and Tennis
IAFARA
GATE
GATE
GATE
175
170
165
165
165



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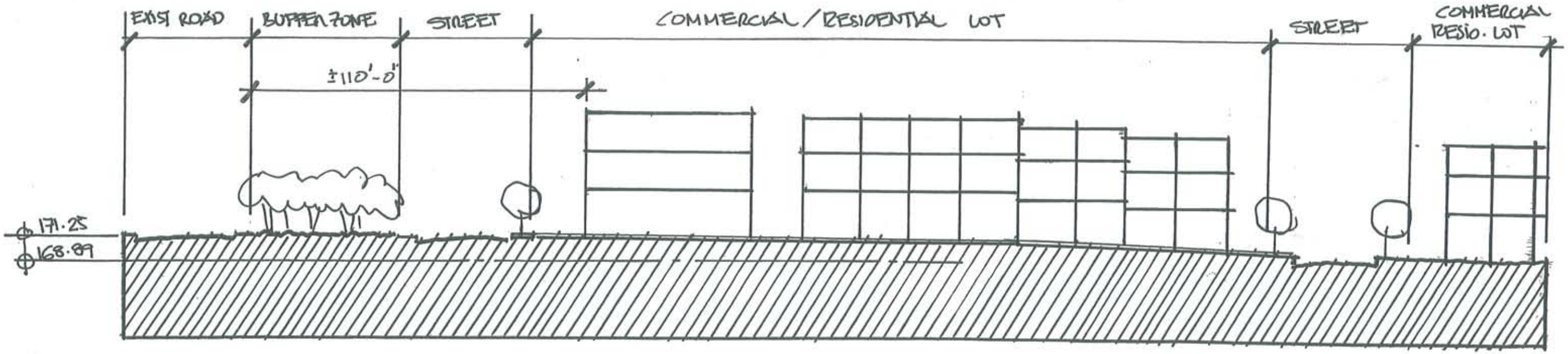

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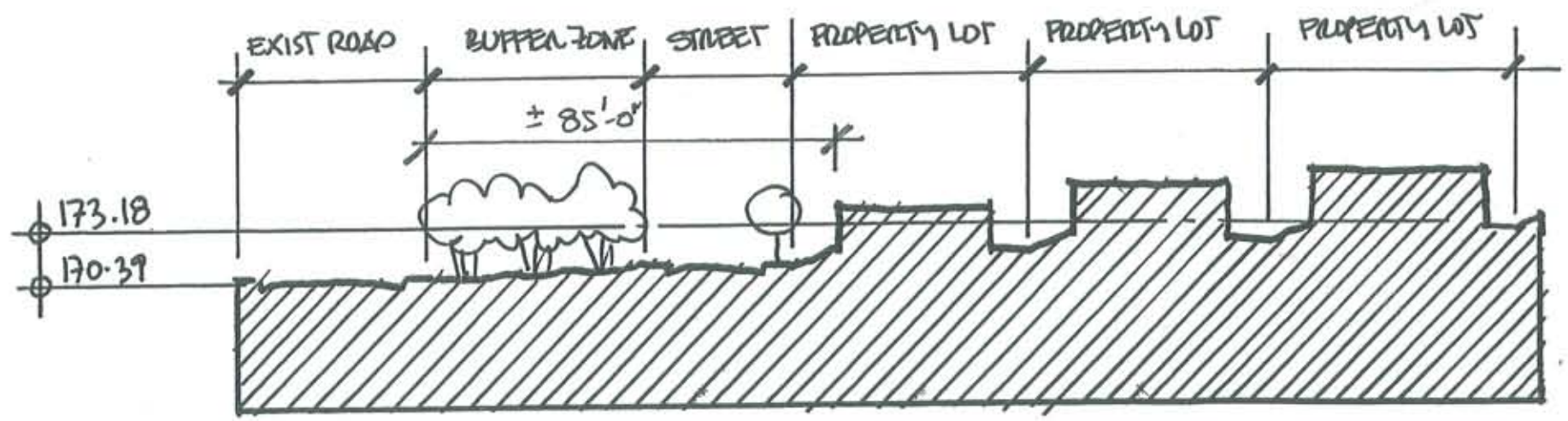

SECTION C-C

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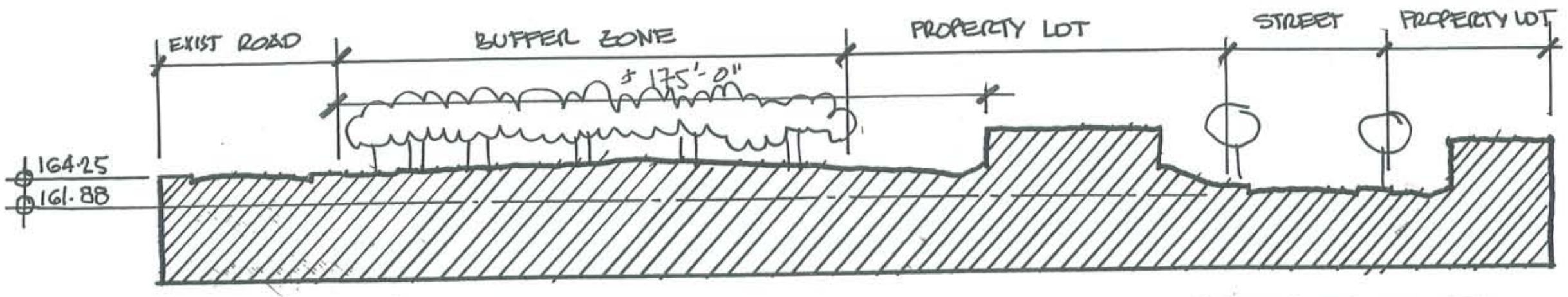

SECTION D-D
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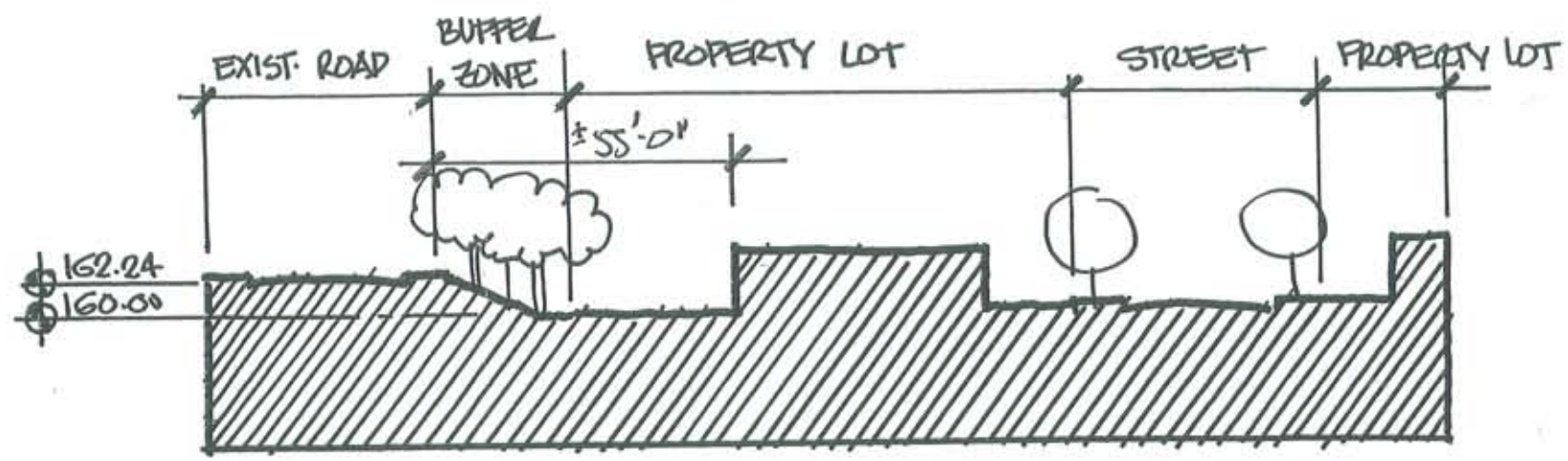


SECTION E-E
SCALE: 1:400'
0 10 20 50

APENDICE 3
FOTOS DE AREA DEL PROYECTO

FOTO DE PROPIEDAD DESDE CARRETERA ESTATAL PR-637

FOTO DE CARRETERA ESTATAL PR-637 JUSTO FRENTE A PROYECTO (EN DIRECCION NORTE A SUR)

FOTO DE LETRERO INDICANDO LIMITE DE VELOCIDAD DE CARRETERA

FOTO DE ESTACION DE MONITORIA DE RUIDO #1

FOTO DE ESTACION DE MONITORIA DE RUIDO #2

APENDICE 4
CERTIFICADO DE CALIBRACION DE SONOMETRO

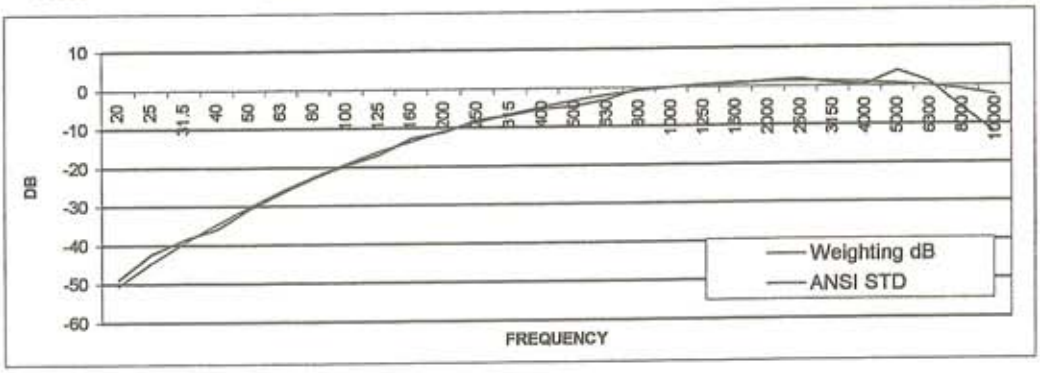
CIH EQUIPMENT COMPANY

CERTIFICATE OF CALIBRATION

SOUND LEVEL METER

Manufacturer:	Quest Technologies	**Calibration Date:**	August 11, 2005
Model Number:	2900	**Date Due:**	August 11, 2006
Serial Number:	CDA080024	**Temperature:**	68.4 F
Service Order:	2001	**Relative Humidity:**	61%
Reference Number	2001-Q2900-CDA080024	**Barometric Pressure:**	30.03

Frequency (HZ)	Meter Actual Display (dB)	Meter Weighting dB	ANSI STD	Tolerance	Relative Diff
20	65.1	-48.9	-50.5	± 3	1.6
25	71.6	-42.4	-44.7	± 3	2.3
31.5	75.4	-38.6	-39.4	± 3	0.8
40	78.1	-35.9	-34.6	± 2	-1.3
50	83.3	-30.7	-30.2	± 2	-0.5
63	87.3	-26.7	-26.2	± 2	-0.5
80	91.2	-22.8	-22.5	± 2	-0.3
100	94.5	-19.5	-19.1	± 1.5	-0.4
125	97.0	-17.0	-16.1	± 1.5	-0.9
160	101.3	-12.7	-13.4	± 1.5	0.7
200	102.9	-11.1	-10.9	± 1.5	-0.2
250	105.9	-8.1	-8.6	± 1.5	0.5
315	107.1	-6.9	-6.6	± 1.5	-0.3
400	108.6	-5.4	-4.8	± 1.5	-0.6
500	109.3	-4.7	-3.2	± 1.5	-1.5
630	111.0	-3.0	-1.9	± 1.5	-1.1
800	113.7	-0.3	-0.8	± 1.5	0.5
1000	114.0	0.0	0.0	± 1.5	0.0
1250	114.4	0.4	0.6	± 1.5	-0.2
1600	114.7	0.7	1.0	± 2	-0.3
2000	115.3	1.3	1.2	± 2	0.1
2500	115.9	1.9	1.3	± 2.5	0.6
3150	114.7	0.7	1.2	± 2.5	-0.5
4000	114.2	0.2	1.0	± 3	-0.8
5000	117.8	3.8	0.5	± 3.5	3.3
6300	114.9	0.9	-0.1	± 4.5	1.0
8000	108.0	-6.0	-1.1	± 5	-4.9
10000	101.7	-12.3	-2.5	+ 5 to -∞	-9.8



CIHE Calibration Laboratory certifies that the instrument specified above meets the manufacturer's specifications and was calibrated using standards and instruments also listed below where the accuracy is traceable to National Institute of Standards and Technology (NIST), and the calibration systems and records are in compliance to ANSI S1.4-1983

STANDARDS USED

Manufacturer	Description	Model No.	Serial No.	Certificate No.	Due Date
GRAS	Pistonphone	42AA	16295	12341-1	5/16/2006
Hewlett Packard	Function Generator	3325A	2625A26619	03J0198	10/20/2005
Bruel & Kjaer	Measuring Amp	2607	846843	12074-3	1/5/2006
Larson Davis	Real-Time Analyzer	3100 RTA	1227	2003-53517	10/9/2005
Krohn Hite	Distortion Analyzer	6800A	350	0310094	10/14/2005

Calibrated By: Chuck Allen Date: 8-11-05

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Toll Free: (888) 873-2443 • Website: www.cihequip.com

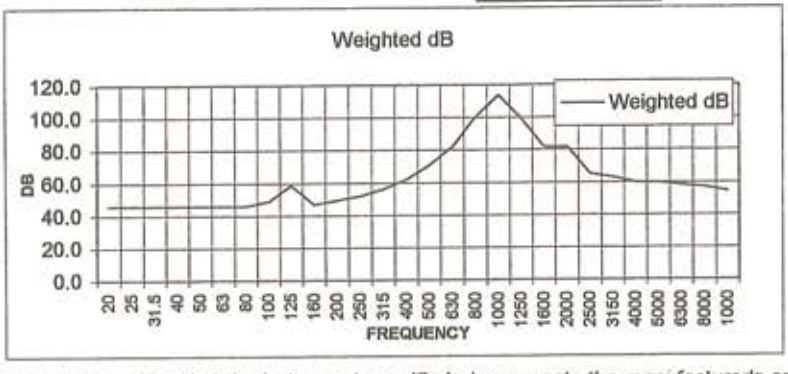
CIH EQUIPMENT COMPANY INC

CERTIFICATE OF CALIBRATION

ACOUSTICAL CALIBRATOR

Manufacturer:	QUEST	**Calibration Date:**	August 11, 2005
Model Number:	QC-10	**Date Due:**	August 11, 2006
Serial Number:	QAI080187	**Temperature:**	68.4 F
Service Order:	2001	**Relative Humidity:**	61%
Other:	2001-QC10-QAI080187	**Barometric Pressure:**	30.03

Frequency (HZ)	Weighting dB
20	45.7
25	45.7
31.5	45.7
40	45.7
50	45.7
63	45.7
80	45.9
100	48.9
125	58.5
160	46.5
200	49.4
250	51.8
315	56.1
400	62.0
500	70.6
630	81.9
800	100.3
1000	114.0
1250	99.3
1600	81.5
2000	81.9
2500	65.1
3150	62.8
4000	59.9
5000	59.4
6300	58.0
8000	56.8
10000	54.3



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STANDARDS USED

Manufacturer	Description	Model No.	Serial No.	Certificate No.	Due Date
GRAS	Pistonphone	42AA	16295	3912	5/16/2006
Hewlett Packard	Function Generator	3325A	2625A26619	03J0198	10/20/2005
Bruel & Kjaer	Measuring Amp	2607	846843	10274-3	1/5/2006
Larson Davis	Real-Time Analyzer	3100 RTA	1227	2003-53517	10/9/2005
Krohn Hite	Distortion Analyzer	6800A	350	0310094	10/14/2005

Calibrated By: Chuck Allen Date: 8-11-05

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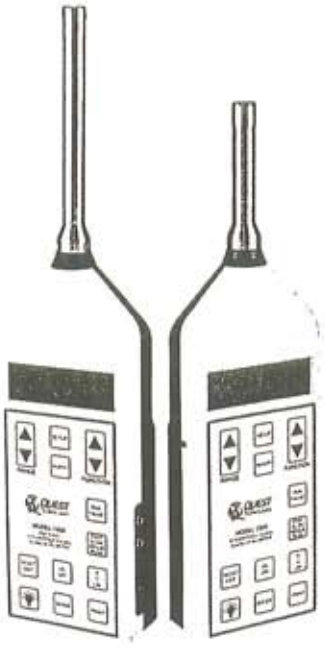
instructions for

Models 1900 and 2900

Integrating and Logging Sound Level Meter



QUEST TECHNOLOGIES

56-352
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1. INTRODUCTION TO THE MODELS 1900/2900

The Quest Models 1900 and 2900 are advanced sound level meters which perform a wide variety of acoustical measurements. Both exponential averaged and time integrated measurements may be made, with the capability of either internal or external data logging. The output of an independently weighted peak detector may also be displayed or logged. Applications include laboratory, industrial, community and audiometric measurement and analysis.

The models 1900 and 2900 provide a numerical readout of measurements as well as a moving bar graph indication. The results of individual sound studies may be stored in internal memory for future reference. Meter operation is controlled from either the membrane keypad or through the communications port. AC and DC output jacks are provided for connecting to external devices such as audio recorders, chart recorders, oscilloscopes, etc. Data may be sent to a parallel printer by using a special interface cable. The meters are housed in a tough injection molded plastic case with internal shielding to protect against external electrical interference, such as that from motors or portable radios.

The Model 1900 delivers Type 1 accuracy for critical measurements, while the model 2900 is a Type 2 instrument for general field survey work. The model 2900 uses a 0.52 inch electret microphone, while the 1900 accommodates a variety of microphones to meet even the most unconventional applications. As both meters are operationally identical, this manual will refer only to the model 1900 except where appropriate.

Options include expanded logging memory and a second RMS detector to allow simultaneous measurement of C-A frequency weighted LEQ or LAVG.

Plug in the Model OB-300 combination 1/3 - 1/1 Octave Filter Set and create a 1/3 or 1/1 octave band analyzer covering 33 bands from 12.5 Hz to 20 kHz. The addition of the Model OB-100 Octave Filter Set will create an octave band analyzer covering 10 bands from 31.5 Hz to 16 kHz.

If sound measurements need to be made from a distance, simply remove the microphone/pre-amplifier and insert either an ICM-10 (10 foot) or an ICM-50 (50 foot) extension cable. Distances of up to 100 feet can be accommodated by adding two ICM-50 extension cables in series.

With the microphone and preamplifier removed, the meter can accept other input devices such as the Quest Model VI-90 Vibration Integrator. The VA-508C Vibration Assembly, combined with the Models 1900 or 2900, provides a quick and precise method of measuring and analyzing many types of industrial vibration.

1.1 Assembling the Meter

The microphone and preamplifier must be assembled prior to making any measurements.

Microphone Handling and Storage

The microphones used with the model 1900 will provide years of reliable use, but certain precautions should be followed with regard to handling and storage.

1. Never remove the microphone grid. This will expose the diaphragm, making it susceptible to physical damage. When removing a microphone from the preamplifier be careful not to unscrew only the grid.

2. Never touch the diaphragm.

3. Electret (prepolarized) microphones should never be stored at high temperatures, as long term degradation of the polarization charge may occur. This results in a decrease in microphone sensitivity.

4. An electret microphone should be stored in its protective box when not in use for long periods of time.

To attach the microphone to the preamplifier, screw the microphone onto the threaded end of the preamplifier. Attach the preamplifier to the meter by placing the connector ends together and rotating the preamplifier until it drops onto the meter. Finger tighten the black locking ring by screwing it onto the meter.

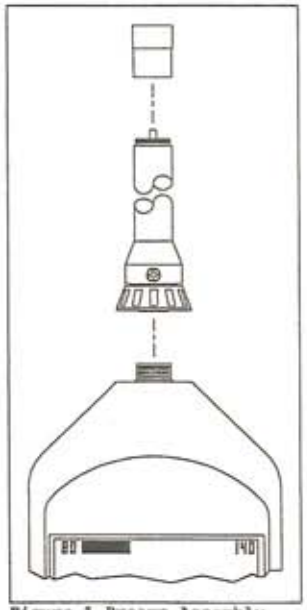

Figure 1 Preamp Assembly

MODEL 1900 ONLY:Microphone Polarization Voltage - 200VDC

Check that the microphone polarization voltage switch is set properly. This switch is located inside the battery compartment on the rear of the meter. To locate this switch, remove the battery door with a phillips head screwdriver and pull the 9 volt batteries out of the compartment. Electret, or prepolarized microphones such as the QE4146 or QE224 should be operated with the 200 Volt microphone polarization voltage turned OFF. Condenser microphones must be operated with the 200 Volts turned ON.

CAUTION: Be careful not to turn on the 200 volt polarization switch if a prepolarized (electret) microphone is attached. The microphone may be damaged.

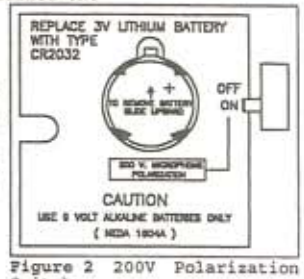

Figure 2 200V Polarization Switch

1.2 Initial Turn On and Check

Before taking measurements with the Model 1900, there is a series of quick checks that should be performed. Turn the unit on by pressing the ON/OFF key. The display will indicate that a brief warmup is taking place. Check for the BAT indicator in the display. If it indicates a low battery condition, replace the batteries.

A measurement display such as SPL or LEQ will appear in the display. Pressing the FUNCTION key will select a different display. Press FUNCTION to review the possible measurements. When you have done this, set the display to read SPL. The meter is now displaying current Sound Pressure Level. Press the A/C/LIN key to change the frequency weighting. Press the FAST/SLOW/PEAK/IMPULSE key to change the response time of the reading.

To perform an Acoustic Study, press RUN/PAUSE. Allow the meter to run for a while and press RUN/PAUSE again to end the study. The FUNCTION key may now be used to review the results.

Although the Model 1900 will maintain accurate calibration over a long period of time, the calibration should be checked and the meter slightly adjusted, if necessary, before each use. To check the calibration of the Model 1900, perform the following procedure using a Quest Calibrator.

1. Turn the Calibrator ON. If optional, set the frequency to 1 kHz. Note the SPL of the calibrator.

3. Insert the microphone fully into the calibrator adapter ring, if required for the size microphone in use.

4. Slowly place the Calibrator onto the adapter/microphone.

5. Using the FUNCTION key, set the Model 1900 to read SPL and set the weighting, response and range as appropriate. Note: SPL must be one of the display options enabled in the Setup Menu.

6. Use a screwdriver to adjust the calibration control, located through the small hole on the left side of the meter, until the display matches the calibration level.

Storing the Calibration Value

The model 1900 can store the time, date and SPL of a calibration, which will be included in the printout and in downloaded data for each study. Enter the PARA Setup Menu and go to CAL by pressing the following keys:

SETUP,
▲ or ▼ to " PARA ",
ENTER,
▲ or ▼ to " CAL "

The meter will display current SPL. Perform a calibration as directed in the previous section. Range and weighting keys will be operational, but the response time will be set to FAST. When the reading on the display is correct, press ENTER to store. The display will briefly read " CAL_{OK} " and return to the "PARA" menu display. The calibration SPL, time and date are now stored. Press SETUP to return to the measurement displays, such as SPL.

2. ABOUT THE METER

2.1 The Display

The LCD display provides the user with the selected measurement and the current measurement parameters. The measurement range, as well as instrument status such as low battery (BAT), RUN (▸), PAUSE (▮▮), and OVERLOAD (OL) is also displayed. The numeric display normally updates every second, while the bargraph provides a continuous indication of the sound level.

The bar indicator portion of the display always indicates the current SPL (Sound Pressure Level). The range of the bar indicator is the same as that of the instrument and is indicated by the numbers on either side of the bargraph. Each segment of the bargraph represents 2 dB.

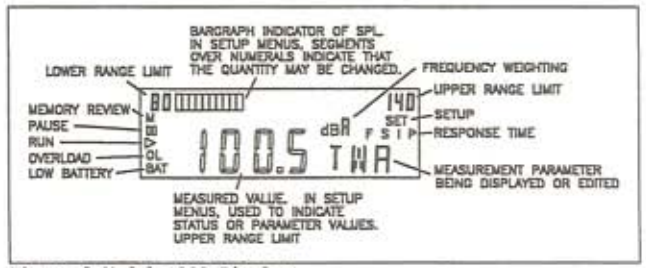

Figure 3 Model 1900 Display

2.2 Keypad Functions

ON OFF

Press this key to turn the meter on. After a warmup period of several seconds, the meter is ready to use. Pressing and holding this key for five seconds until " OFF$_{OFF}$ " is displayed, and then releasing, will turn the meter off.

Momentarily pressing this key turns the LCD backlight on for several seconds. Pressing and holding for 3 seconds will turn the backlight on until the switch is again pressed to turn it off.

Note: Leaving the backlight on for extended periods will reduce battery life.

RUN PAUSE

Press this key to begin a study, which automatically increments the memory location counter by 1. The number of the location appears on the display briefly after pressing RUN. Pressing RUN/PAUSE again ends the study and stores the data in that memory location.

RANGE

Press the ▲ or ▼ to increase or decrease the 60dB measuring range in 10dB steps. Pressing this key while in RUN ends the current study and begins a new study. When this happens, the memory location will momentarily appear on the screen so that the operator may make note of his time and location for that study. (Key locked out while in Session mode and RUN.)

While inside the SETUP menus, the RANGE key may be used as UP and DOWN arrows for incrementing or decrementing numeric values.

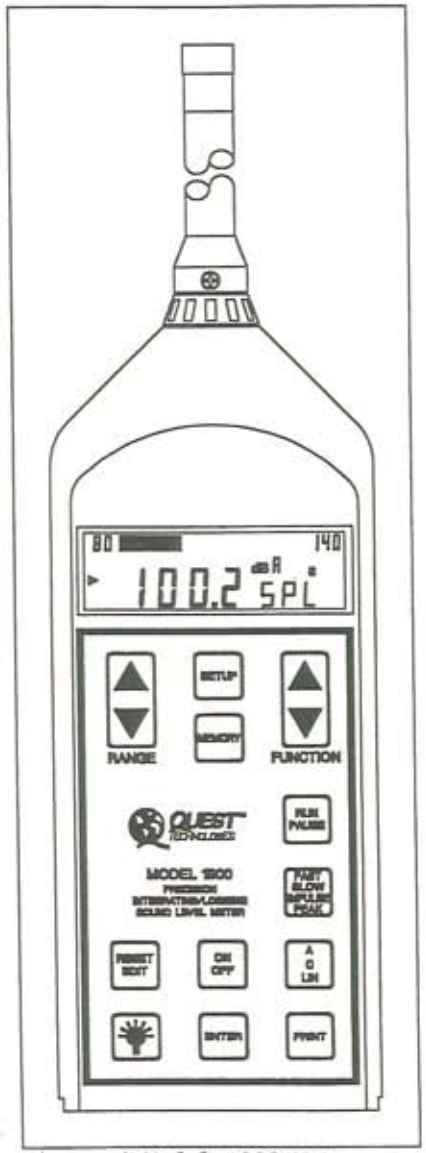

Figure 4 Model 1900 Meter

FAST SLOW IMPULSE PEAK

Press this key to select the time averaging from the four choices of FAST, SLOW, IMPULSE or PEAK. A display annunciator indicates the response by displaying " F ", " S ", " I " or " P ". Pressing this key while in RUN mode will end the current study and begin a new study. (Key locked out while in Session mode and RUN.) Refer to section 6.8 for details on time averaging.

A C LIN

Press this key to cycle the frequency weighting through the choices of A, C or Linear. The choice is shown by a letter following 'dB' in the display (A, C or L). Pressing this key while in RUN mode will end the current study and begin a new study. (Key is locked out while in Session mode and RUN.)

FUNCTION

Press FUNCTION ▲ or ▼ to select any of the following displays that have been selected via the SETUP key:

SPL, LEQ (LAVG), TWA, LMAX, LMIN, LN1, LN2, LN3, LN4, LDN, CNEL, % OL time, exposure in Pa2S or Pa2H, LPK, SEL, elapsed TIME (min/sec), elapsed TIME (hour/min), LLOG (LAVG or LEQ last logged - this value updates every logging interval), BATT, or TAKM. If the C-A option is installed, C-A Leq or Lavg may also be displayed. Refer to section 3.1, Measured Quantities.

While in RUN mode, the display shows the current value for the study. While in PAUSE mode the final value for the previous study is displayed. SPL will always show the current 1 second MAX according to the response selected (F/S/I/P). While in PAUSE, if selecting quantities such as LMAX, LEQ, etc. after the meter has been RESET (had it's memory cleared) the display will show "----". FUNCTION is also used while in the setup mode as an up/down arrow key for selecting menus or parameters.

SETUP

While in PAUSE mode, press SETUP to access one of five Setup Menus which allow the user to define the operation of the meter. There are many quantities that may be displayed, logged or printed, and most users will not be interested in all of them. SETUP allows the user to select only the items of interest, for example SPL, LAV and L10, excluding all others. The five menus are:

COMM	Communications Parameters
PARA	Measurement Parameters
PRNT	Data to be Printed
LOG	Data to be Logged
DISP	Data to be Displayed

Refer to section 3.3 for details on meter SETUP.

MEMORY

This key is used to group studies stored in memory into a File for printout, and to review individual studies stored in memory. While in PAUSE, press MEMORY to display " FILE ". Press ENTER to group the previously stored

studies into a File . Pressing FUNCTION ▵ or ▿ causes " XX_{LOC} " to be displayed, where XX is the number of the last study (as in memory LOCation #XX). Press ENTER to display a measured quantity such as LAV. The FUNCTION key may be used to display other quantities (LMAX, SEL, etc.). Press ENTER again to return to the " XX_{LOC} " display. The function key may be used to increment or decrement memory locations. If incrementing past the last location the display will read " 1 LOC ", or the first study. If 10,000 or more studies have been performed, the display will read " XXXX_{LOC} ". Press MEMORY again to exit study review. (Refer to section 3.2 for more details)

Pressing MEMORY while in RUN briefly displays the number of the current memory location (study number and session number).

PRINT — Press this key while in PAUSE to print all studies in memory to a parallel printer or computer. Press this key while in Memory Review to print only the study currently under review. To interrupt a printout, press again.

ENTER — The ENTER key is used in SETUP to enter or exit any of the five setup menus. When changing a numeric value in the PARA menu, it will store that value and turn off the bar graph segments above that parameter.

RESET EDIT — This key has two functions. While in SETUP, it is used to turn on or off display, logging or print choices, or to cycle through certain parameter selections (3>4>5>6>3..:..dB exchange rate for example). When not in setup (i.e. in PAUSE), pressing and holding RESET/EDIT will clear the internal memory.

2.3 Output Jacks

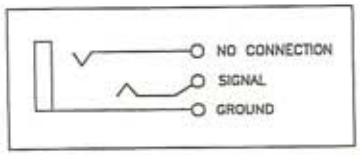

Figure 5. Output Jack Connections

DC - The Sound Pressure Level (SPL) over the 60 dB range selected is linearly represented by a 0 to 1 volt DC output. Zero volts is equal to the bottom of the range and 1 volt is equal to full scale. This output is provided for connecting to a 0 to 1 volt input data acquisition system or chart recorder. See section 4.4 "Chart Recording" for details.

AC - This jack provides an amplified, weighted AC signal. Full scale output (SPL) equals 3.16VAC.

COMM - The COMM jack is used for direct connection to an RS-232 compatible device such as a personal computer via the supplied cable. An optional Parallel Interface Module is used to connect to a parallel printer.

3. OPERATING PROCEDURE

Pressing the ON/OFF key will turn the meter on. The initial display is " 1900_{128K} " where 128k bytes is the amount of memory installed. The next display, " $X.X_{REV}$ " shows the revision of the installed firmware. A 5 second warmup will follow, and the display will read " 5_{WMUP} " counting down to " 1_{WMUP} ". If the logging memory has been filled, the display will read " $FULL_{MEM}$ " for those 5 seconds. If this occurs, reset the unit before performing any studies.

3.1 Measured Quantities

The FUNCTION switch steps through the following possible measurements performed by the model 1900. This list may be shortened as desired via the DISP Setup Menu. Refer to section 3.3 "Setup Menus" for details.

SPL - Sound Pressure Level will be displayed, with the selected weighting and response characteristics. The value displayed is the maximum SPL during the previous second. (SPL is also always shown in the display bar indicator.)

LEQ - The average integrated sound level accumulated while in the RUN mode is shown in the numeric display. LEQ indicates that a 3dB exchange rate was used for the measurements.

LAVG - The same type of measurement as LEQ, except that a 4, 5 or 6dB exchange rate was used. The display will be correct for the exchange rate selected.

TWA - Time Weighted Average. The average level accumulated during a study, but calculated with an eight hour integration time.

LMAX - The Maximum SPL obtained while in the RUN mode is shown in the numeric display. With PEAK response selected, this functions as a Peak Hold.

LMIN - The Minimum Sound Pressure Level obtained while in the RUN mode is shown in the numeric display.

LN - The SPL exceeded for N% of the time during a study. Four user selectable values are calculated. The default values are L5, L10, L50 and L90. The values may be changed in the PARA Setup Menu.

LDN - Day/Night Sound Level. The average sound pressure over a 24 hour study, with additional factors for time of day. Sound pressures between the hours of 10 pm and 7 am are increased by 10dB prior to being averaged. A 3dB exchange rate should be used and is generally assumed. If an exchange rate other than 3dB is selected via the Setup Menu, LDN will not be calculated and " $----_{LDN}$ " will be displayed.

CNEL - Community Noise Exposure Level. The average sound pressure over a 24 hour study, with additional factors for time of day. Sound pressures between the hours of 7 pm and 10 pm are increased by 5dB prior to being averaged. Sound pressures between the hours of 10 pm and 7 am are increased by 10dB prior to being averaged. A 3dB exchange rate should be used and is generally assumed. If an exchange rate other than 3dB is selected via the Setup Menu, CNEL will not be calculated and the display will show " $----_{CNEL}$ ".

%OL - Percentage of time during the study that an overload (OL) condition occurred. Overload indicates that the signal has exceeded the measuring range.

PA2S - PA2H Sound Exposure in Pascal-squared seconds or Pascal -squared hours, switching from Pa2S to Pa2H at 3600 Pa2S. The display will show " $----_{PA2}$ " if the exchange rate is not 3dB.

SEL - The Sound Exposure Level is the constant sound level which, if lasting for one second, would deliver the same amount of acoustical energy as that accumulated over the entire study.

RTMS or RTHM - The total RUN time will be displayed. Time may be displayed in MIN:SEC and HRS:MIN. The MIN:SEC display for a study that lasts over one hour will wrap around to 00:00. The HRS:MIN display will count to 99:59 and then wrap around to 00:00 but the actual time will be stored in memory.

LPK - The Peak Level. The output of a second peak detector may be viewed as LPK or logged. The frequency weighting is independent of the main RMS detector and may be set in the PARA setup menu as 2PK. The selection of whether or not to log peaks is made in the LOG Setup Menu. The weighting selection (A, C or LIN) is made in the PARA Setup Menu. While viewing LPK the weighting of the second peak detector is displayed, and the Weighting and Response keys are disabled.

LLOG - The LEQ (or LAVG) last logged during a study. Data is logged at a user defined interval. This feature may be used to display a timed LEQ for the previous logging interval. This display updates at the end of each logging interval. The display will show " $----_{LLOG}$ " if LEQ is not being logged.

TAKM The time integration of individual Taktmaximal values. Taktmaximal is the maximum level (L_{MAX}) encountered over either a 3 or 5 second interval. 3 or 5 second Taktmaximal is selected in the PARA Setup Menu. Individual Taktmaximal (L_{MAX}) values may be logged by setting the logging interval to 3 or 5 seconds in the LOG Setup Menu. Taktmaximal measurements are required by some countries' noise regulations. A Taktmaximal measurement calculates a higher average level for highly impulsive sounds than does a LEQ measurement. TAKM is affected by the Exchange Rate and should be run with an Exchange Rate of 3dB.

BATT Displays the voltage of the weaker of the two 9 volt batteries to give an indication of remaining life. The low battery indication (BAT) on the display occurs at approximately 6.8 volts.

LC-A An optional second RMS detector may be used to provide a simultaneous C-A weighted LEQ or LAVG of the measured sound. Refer to section 3.6 "C-A Option".

Acoustic Study Options

An acoustic **Study** is a set of measurements performed over a user defined period of time, referred to as the **Run Time**. The study begins at the **Start Time** and ends at the **Stop Time**. Each study is stored in a consecutively numbered **Memory Location** which is displayed briefly at the beginning of each study. Consecutive studies may be grouped into a **File**. When printing data, each File will have its own individual header, which makes it easier to locate related groups of data in the printout. Alternately, place the meter in **Session Mode** to create a cummulative summary of the data from consecutive studies with identical measuring parameters.

Up to five quantities may be logged at user defined time intervals. Final summary data for all measured quantities is also stored for each study.

The study may be initiated and ended in several ways (refer to Figure 6):

Manual Study - Press RUN/PAUSE to begin a study, causing the RUN indicator to light. " X_{loc} " will be displayed briefly, where X is the number of the current memory location. Press RUN/PAUSE again to end the study, causing the PAUSE indicator to light.

NOTE: During a study, pressing a key to change a parameter such as weighting, range or response time will stop the current study and, after a brief settling time, begin a new study.

Manual Timed Study - Press RUN/PAUSE to begin a study. If a Programmed Run Time duration has been set and enabled in the Parameter (PARA) setup menu, the study will run for this time duration and automatically stop. The study may be interrupted by pressing the PAUSE key.

Auto Timed Study - An Auto ON time and date must be set and enabled in the setup menu and the meter must be turned OFF. When the internal clock/calendar reaches this time and date, the meter will turn on and begin a study. The duration of the study will be that of the Programmed Run Time stored via the setup menu. At the end of the study, the unit will PAUSE and turn itself OFF. The study may be interrupted by depressing the PAUSE key.

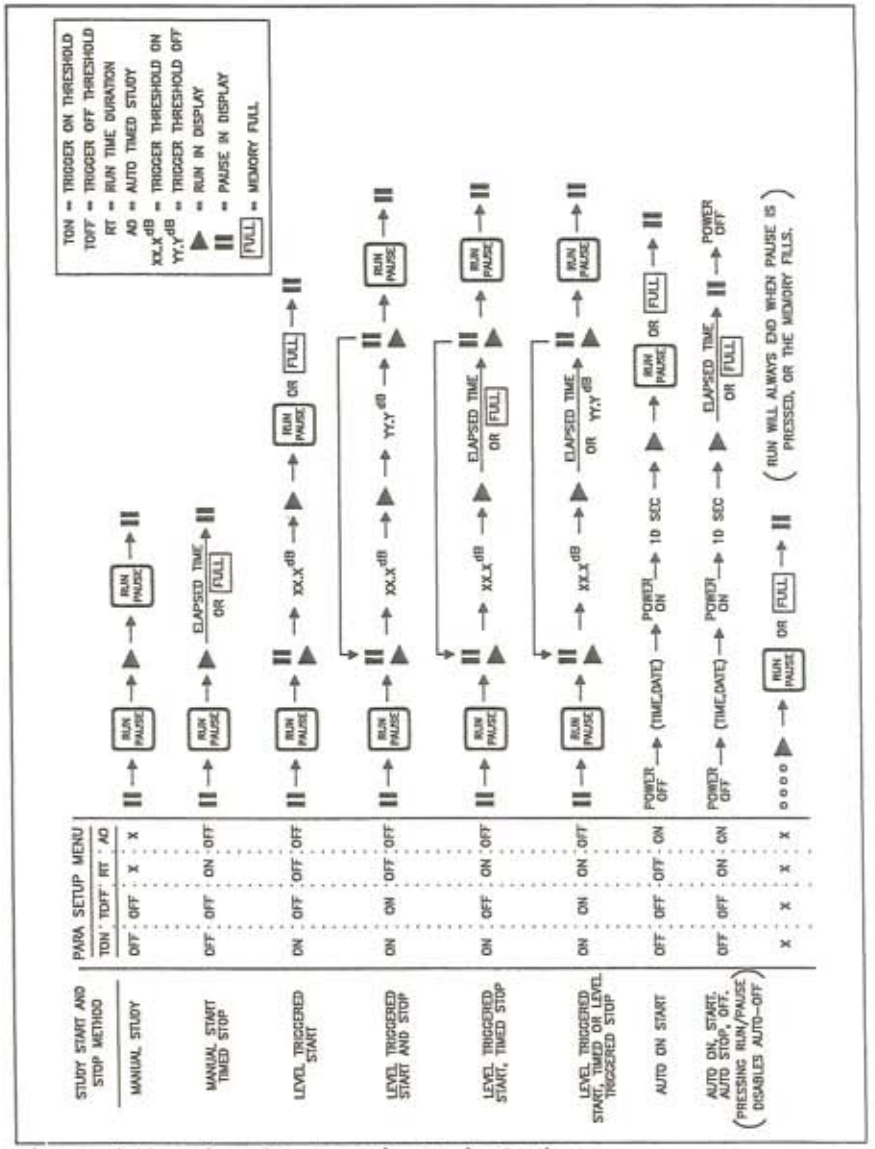

Figure 6 Manual and Automatic Study Options

Threshold Triggered Study - A Trigger Threshold ON level in dB must be set and enabled in the setup menu. While in PAUSE mode, press RUN to arm the meter. If the SPL reaches the desired level a study will begin. The study will end in one of three ways. If a Trigger Threshold OFF level in dB is set, the study will end when the SPL falls to this level. (Note: This level cannot be greater than the Trigger Threshold ON level.) If a Programmed Run Time duration is enabled, the study will last for the specified length of time unless the OFF level is reached. If the SPL is still above the ON level a new study will begin. The study may be interrupted by pressing PAUSE.

NOTE: Both Threshold Triggered and Auto Timed studies may not be enabled simultaneously. While in the Setup Menu, one may not be enabled without first disabling the other.

Filter Controlled Study - Each time the filter band on the optional bandpass filters (OB-100 or OB-300) is changed, either manually or automatically, the current study is ended and, after a brief settling time, a new study will begin.

NOTE: For long term unattended measurements where the possibility of power interruption exists, it is recommended that the meter be set up to run shorter term consecutive studies, such as one hour threshold-triggered studies with a Trigger Threshold ON level sufficiently low to always retrigger at the end of the hour. If power is interrupted during a RUN, all data for that study will be lost. The data from previous studies will be retained.

File Creation (Grouping Studies)

It may be desirable to separate a group of studies into a File. For example, if several studies were performed at a single site using various weightings, response times or filters, you might wish to separate the printout of these studies from that of a similar group of studies performed at a different site. Grouping consecutive studies into a File accomplishes this. A File is created after performing the last study to be grouped, and prior to beginning the first study of the next group.

To create a File, press MEMORY while in Pause mode. " FILE " will appear in the display. Press ENTER. This will group all studies performed since the last File was created into a new File. When printing data, each File will have a Header section to separate it from the previous File. Refer to Figure 7.

File creation is not available if the meter is set to run in session mode. Refer to the next section.

Session Mode (Combined Studies)

To obtain a cumulative measurement of consecutive studies (which must have identical measurement parameters), enable Session mode in the Parameters Setup Menu. (The meter must first have its memory cleared by performing a RESET.) A Session consists of individual studies stored in their memory locations with the addition of an overall summary of all of those studies. Any number of consecutive studies may be grouped into a Session. For example Session 1 might consist of studies 1 through 5, session 2 might consist of studies 6 through 9 and session 3 might consist of studies 10 through 31.

Pressing RUN after performing a RESET begins Session 1 and Study 1 (memory location 1). A session is closed in one of four ways:

1) Press MEMORY , then RESET
2) Change a measurement parameter such as weighting or exchange rate while in PAUSE (Weighting, Response and Range keys are locked out while in RUN only in Session mode)
3) Change the state of an optional bandpass filter. This may be done in either RUN or PAUSE.
4) Turn the meter off. This session cannot be reopened.

After closing a session, the next time RUN is pressed will begin the next session and study. Measurements for individual studies cannot be viewed while measuring Session mode. The displayed data is for the overall session. Individual studies can be viewed by reviewing data in memory. (Refer to section 3.2)

Viewing Measured Results

While performing a study (unit is in RUN mode) the FUNCTION key may be used to view the various measurements as they are occurring. Only measurements selected via the DISP Setup Menu will be available for viewing. If the meter is in Session mode, the value displayed will be the overall summary for the entire session. The displayed value will be updated each second, except for LLOG which is updated each logging interval as selected in the Setup menu. Pressing the MEMORY key during a study will briefly display " XX_{LOC} ", where XX is the current memory location. If the meter is in Session mode, pressing MEMORY will briefly display " XX_{SESS} "" followed by " XX_{LOC} "" to indicate the current session and memory location.

While the unit is in PAUSE mode, the FUNCTION key may be used to view the results of the previous study, or the results of the current session if the meter is in Session mode. The exceptions to this are SPL, which always shows the current SPL updated once per second, and LLOG, the value of which is not displayed. Again, only measurements selected via the Setup Menu will be available for viewing.

While in PAUSE mode, any change to range, weighting or response will make the data from the previous study or session available only by reviewing its memory location. Turning on the optional bandpass filter or changing its frequency will also cause this to happen.

3.2 Reviewing Memory Locations

The results of all currently stored studies are available by pressing the MEMORY key. The memory review process is slightly different depending upon whether or not Session mode was used to create the data in memory.

If Session mode was not enabled, pressing MEMORY will cause " FILE " to appear in the display (refer to File Creation). Press the FUNCTION ▲ or ▼ key. This will display the memory location of the last study performed. For example " 19_{LOC} " would indicate that the last study was the 19th study stored in memory. The ▲ or ▼ keys are used to select other memory locations. Pressing ▼ would select " 18_{LOC} ", but pressing ▲ would wrap around to the first study and select " 1_{LOC} ". Refer to Figure 7.

If Session mode is enabled, pressing MEMORY will display " XX_{SESS} ", which is the last session completed (a currently open session cannot be viewed in memory). The FUNCTION arrow keys select the desired session. The RANGE arrow keys select either individual memory locations of studies within that session or the overall session data.

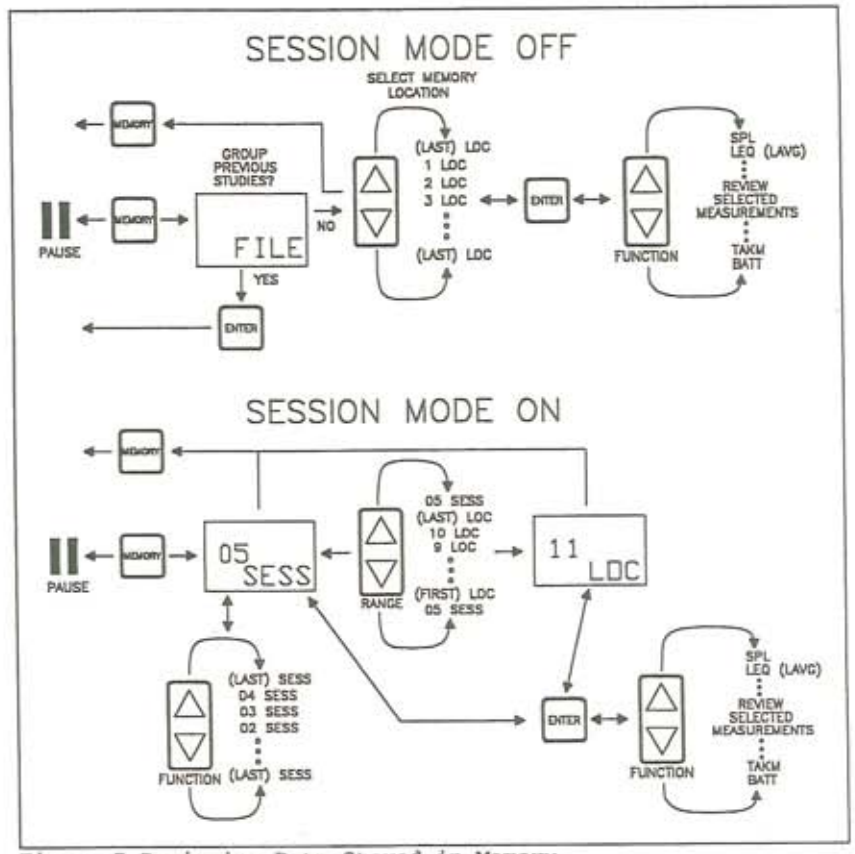

Figure 7 Reviewing Data Stored in Memory

Once the memory location of the desired study is selected, press ENTER to view the measurement results. The measurement parameters such as range , weighting and response will be shown in the display and the " M " indicator will be lit. If an optional bandpass filter was used during the study, the frequency will be briefly displayed. Use the FUNCTION key to select the measurements of interest. Only measurements currently selected via the Setup menu will be available for viewing, but these can be changed at any time by going back to the Setup menu. Pressing ENTER will return to the memory location or session number display. Pressing MEMORY returns to Pause mode.

The data in the memory location being reviewed may be printed using the PRINT key. Refer to section 4.4, "Printing Data". Data logged during a study may be viewed by printing the Time History portion of the printout.

Memory Capacity

The number of studies (memory locations) that can be created is limited by the amount of memory. The amount of data that is logged, if any, during a study will also fill the available memory. Logging data every second will fill memory faster than logging every minute. Session mode will also use more memory due to the extra summary information that must be stored. If the memory fills during a study, the unit will PAUSE and display " FULL ".

In addition to the problem of filling the memory, the total amount of energy accumulated during a study can cause the unit to overflow, causing calculation errors. This is dependent upon the range setting and how high the SPLs are during the study. This can be determined from the value of SEL at various exchange rates as follows:

Exchange Rate	Maximum SEL Without Overflow
3 dB	150 dB + Range
4 dB	200 dB + Range
5 dB	250 dB + Range
6 dB	301 dB + Range

For example, with an exchange rate of 3dB on the 60 - 120 dB range, the maximum SEL without overflow would be 150 dB + 60 dB = 210dB.

The following chart shows approximate time available versus logging rate and number of items logged for the standard 128Kbyte memory.

Maximum number of studies with no data logged: 796 for 128k memory.

Logging Rate	Number of items logged				
	1	2	3	4	5
1 second	21 hr	10.5 hr	7 hr	5 hr	4 hr
3 seconds	2.6 dy	1.3 dy	21 hr	15 hr	12.5 hr
5 seconds	4.4 dy	2.2 dy	1.4 dy	1.1 dy	21 hr
10 seconds	8.7 dy	4.4 dy	2.8 dy	2.2 dy	1.7 dy
15 seconds	13.3 dy	6.5 dy	4.4 dy	3.3 dy	2.6 dy
30 seconds	26 dy	13.2 dy	8.7 dy	6.6 dy	5.3 dy
1 minute	53 dy	26 dy	17.6 dy	13.3 dy	10.5 dy
3 minutes	159 dy	79 dy	53 dy	39 dy	31 dy
5 minutes	265 dy	132 dy	88 dy	66 dy	53 dy
10 minutes	1.3 yr	265 dy	176 dy	132 dy	106 dy
15 minutes	2.2 yr	1 yr	265 dy	198 dy	159 dy
30 minutes	4.3 yr	2.2 yr	1.3 yr	1 yr	318 dy
1 hour	8.6 yr	4.3 yr	2.9 yr	2.2 yr	1.7 yr
2 hours	17 yr	8.6 yr	5.7 yr	4.3 yr	3.4 yr
4 hours	34 yr	17 yr	11.6 yr	8.6 yr	6.9 yr
8 hours	69 yr	34 yr	23 yr	17 yr	13.9 yr
24 hours	209 yr	104 yr	69 yr	52 yr	41 yr

If the 512K memory option is installed, the above times would increase by a factor of 4.

The total number of logged items (LEQ, LMAX, LPK, L10 or L90) possible can be calculated by the following formula:

# of logged items = 2/3 [M - (144 x # of studies) - (3072 x # of studies with stats logged)]

where M = 114687 w/ 128k memory or 507903 w/ 512k memory. The total run time is calcuated by multiplying the number of logged items by the logging rate divided by the number of items logged.

Erasing Stored Data

To erase the data in the memory locations, the meter must be in the Pause mode. Press and hold the RESET/EDIT key for five seconds. The display will read " 5_{RST} " , count down from 5 to 1, and " $----_{RST}$ " will be displayed. The memory is now cleared and the next study will be stored in memory location 1.

3.3 Setup Menus

The operation of the model 1900 may be customized through the Setup menus. While in PAUSE mode, pressing the SETUP key lights the SET annunciator in the display and allows access to the various menus. Pressing the FUNCTION ▵ or ▿ keys selects from among the five Setup menus. Once the desired menu is displayed, pressing the ENTER key enters that menu and displays the first item that may be modified. Refer to figures 8 - 11. The five menus are:

DISP - Displayed Data, or the measurements that may be viewed by pressing FUNCTION while in RUN or PAUSE.

LOG - Logged Data and Logging parameters, or which measurements are logged, where the data is stored and how often the data is stored.

PRNT - Printout format, or printout data presentation.

PARA - Measurement Parameters, or variables affecting the way a measurement is performed. These include thresholds, percentage values for LN, peak detector weighting, etc. as well as clock/calendar setting and calibration value storage.

COMM - Communications parameters for using the COMM port.

The key sequence to exit a Setup Menu is the reverse of the one used to enter the menu.

DISP Setup Menu (Displayed data) Refer to Figure 8

Press SETUP and the FUNCTION ▵ or ▿ keys until "DISP" is displayed. Pressing ENTER gets you into the Display Setup Menu and will, for example, display " on_{SPL} ". You may now choose whether or not SPL will be among the active displays by pressing RESET/EDIT, which toggles between " on_{SPL} " and " oFF_{SPL} ". Pressing FUNCTION ▿ cycles to the next selection, " on_{LAV} " which may be turned on or off with the RESET/EDIT key. The displayed quantities that are selected in this manner are:

SPL (Sound Pressure Level), LEQ or LAVG (Equivalent Level), TWA (Time Weighted Average), LMAX (Maximun Level), LMIN (Minimum Level), LN1, LN2, LN3, LN4 (% Exceedance Levels), LDN (Day Night Level) , CNEL (Community Noise Exposure Level), %OL (Percent Overload Time), PA2S or Pa2H (Exposure), LPK (Peak Level) , SEL (Sound Exposure Level), RTMS (Run Time MIN:SEC), RTHM (Run Time HR:MIN), LLOG (Last LEQ Logged), BATT (Battery Voltage), TAKM (Taktmaximal) and/or LEQ (LAVG) C-A if the C-A option is installed. (TAKM and LC-A cannot both be enabled.)

Press ENTER to exit the DISP Setup Menu, displaying "DISP". The FUNCTION ▵ or ▿ keys may now be used to select another Setup menu.

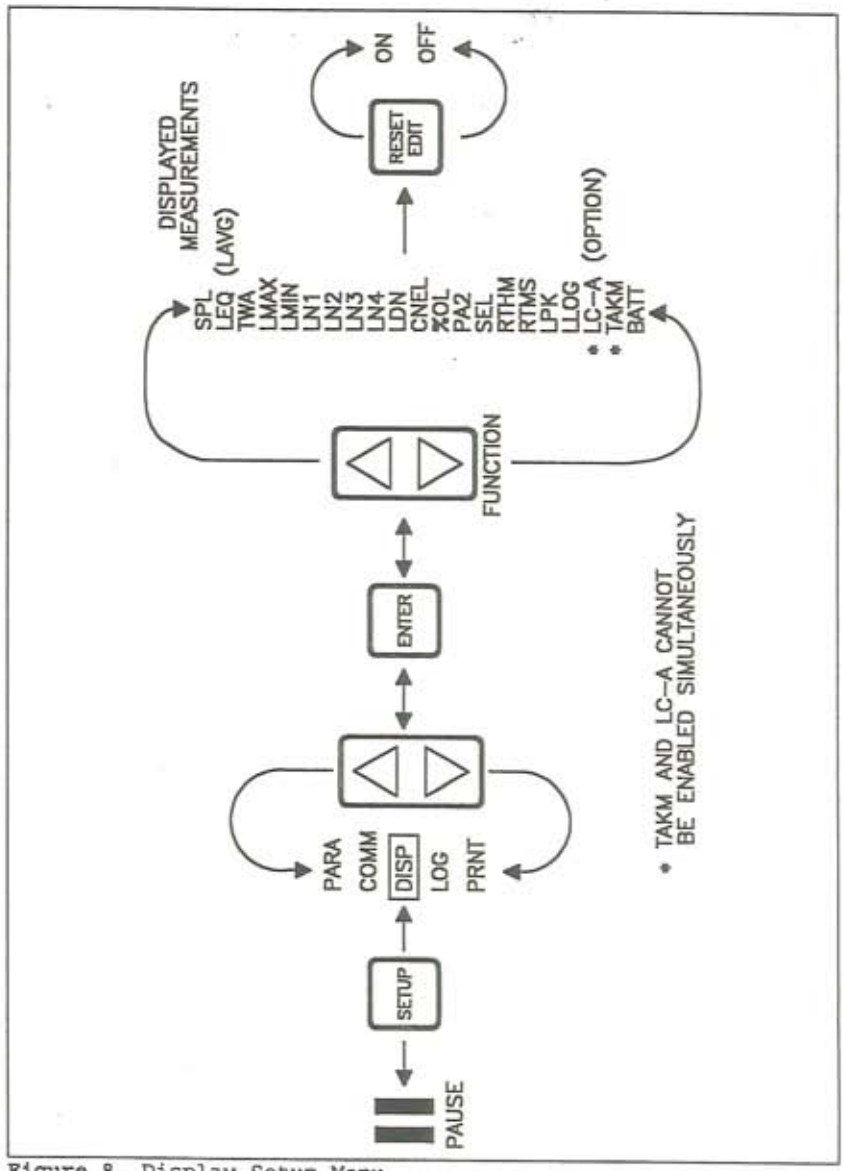

Figure 8. Display Setup Menu

LOG Setup Menu (Data to be logged) Refer to Figure 9

After pressing SETUP, the ▵ or ▿ keys may be pressed until "LOG" is displayed. Pressing ENTER gets you into the Logging Setup Menu and will, for example, display " on_{LEQ} ". You may now choose whether or not LEQ will be among the data that will be periodically logged. Press RESET/EDIT to toggle between " on_{LEQ} " and " oFF_{LEQ} ". Pressing FUNCTION cycles to the next selection, " on_{LPEAK} ", which is turned on or off in the same way. The measured quantities available for logging are:

LAV(or LEQ), Peak, LMAX, L10, L90.

Note that the Peak value that is logged has independently selectable weighting from that of the main measurement. This is set in the PARA Setup Menu.

In addition, whether or not to log to internal memory, whether or not to log to the COMM port, and the time interval (logging rate) may be selected. Saving statistics tables (STAT on or off) for each study may also be selected. The statistics tables provide useful information when downloaded to the optional PC support software, but are not available to the user directly from the meter.

At each of the five measured quantities, press RESET/EDIT to turn that quantity on or off. Do the same for STAT.

To select the destination for logged data, depress FUNCTION to display " on_{COMM} " or " on_{MEM} " which sends logged data to the COMM jack or internal memory respectively. Use the RESET/EDIT key to turn these options on or off.

To select the **logging interval**, press EDIT/RESET which will light the bargraph over the time interval shown on the display. Use the UP or DOWN arrow key to select the desired time interval. The choices are:

1, 3, 5, 10, 15 or 30 seconds
1, 3, 5, 10, 15 or 30 minutes
1, 2, 4, 8 or 24 hours

When the desired interval is displayed, press ENTER to store your selection.

Press ENTER again to exit the LOG Setup menu.

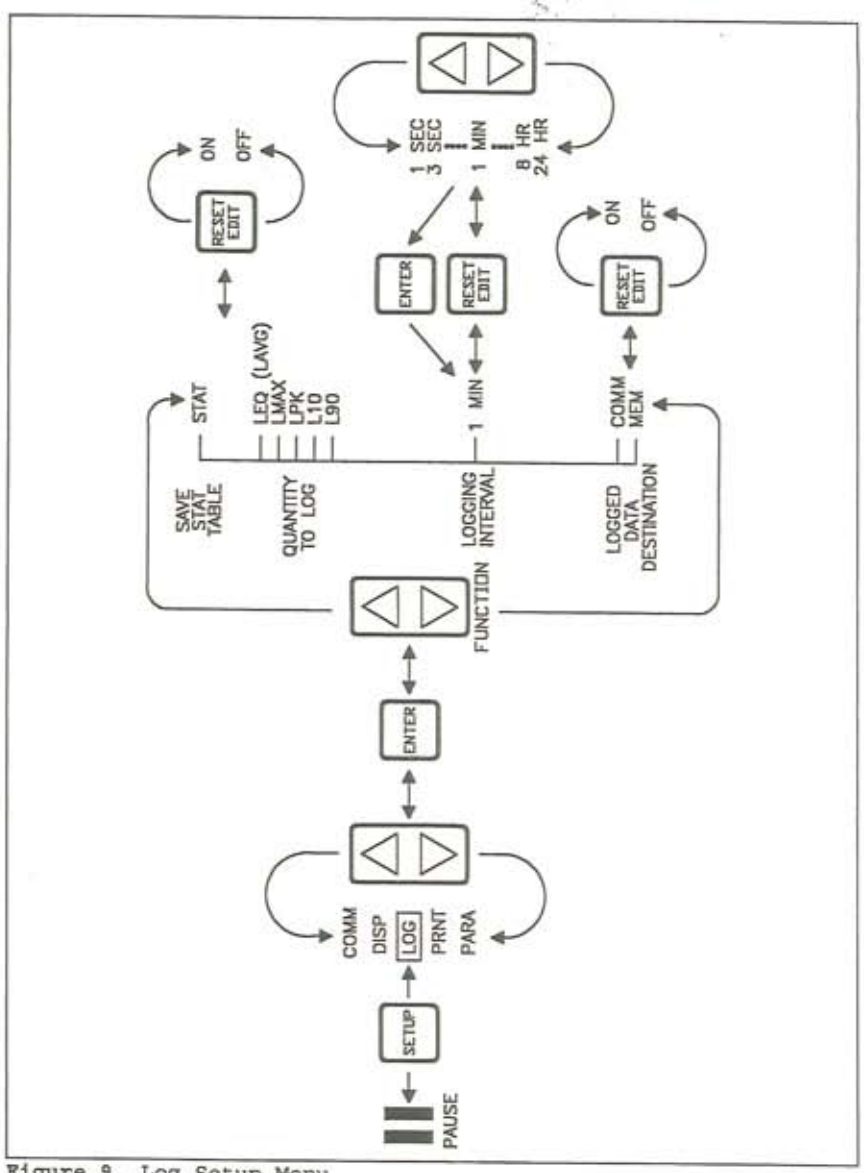

Figure 9. Log Setup Menu

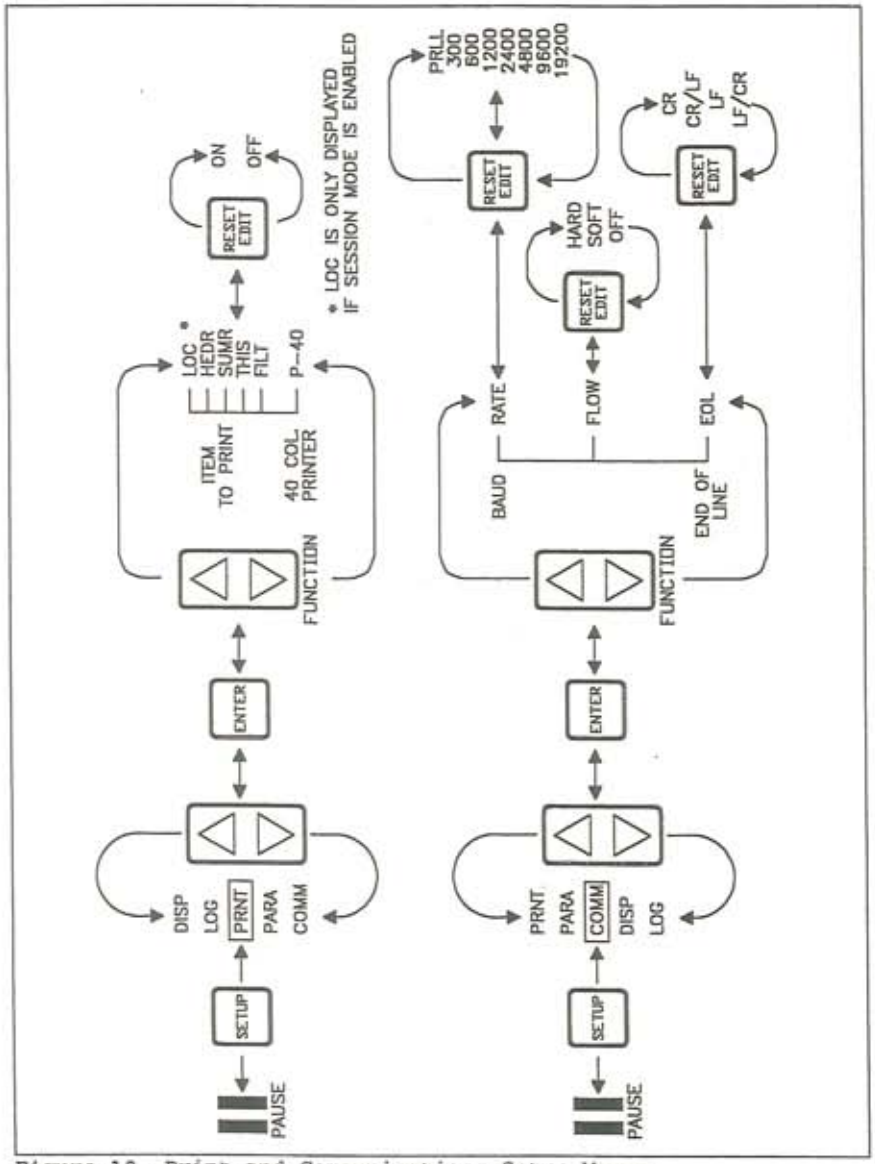

Figure 10. Print and Communications Setup Menus

PRNT Setup Menu (Data to be printed) Refer to Figure 10

After pressing SETUP, the ▵ or ▿ arrow keys may be pressed until PRNT is displayed. The data presentation for the printout may be selected in the Print setup menu. Pressing ENTER gets you into the menu and will, for example, display " on_{HDR} ". You may now choose whether or not the header is included in the printout. Pressing EDIT/RESET toggles between " on_{HDR} " and " oFF_{HDR} ". Pressing FUNCTION cycles to the next selection, " on_{SUMR} ", which is turned on or off in the same way. The printout options are:

HEDR - Header, on or off

SUMR - Summary of all measurements, on or off

THIS - Numeric Time History, on or off

FILT - Filter Data Grouping, on or off. Data collected using an optional bandpass filter may be grouped under a common header (ON) or printed as an individual study (OFF).

P-40 - Compressed print mode. This will fit the printout onto a small 40 column printer.

LOC - Print individual memory locations along with session data (Session mode only)

A sample printout is shown in Section 4.4, "Printing Data".

COMM Setup Menu (Communications parameters) Refer to Figure 10

While in SETUP, press the FUNCTION key to display "COMM". Press ENTER to access the Communications Setup Menu where the following selections involving data communications are made:

BAUD - Baud Rate. Choice of 300, 600, 1200, 2400, 4800, 9600, 19200 baud or parallel printer output (PRLL).

FLOW - Flow control or handshaking. Select HARDware, SOFTware or OFF. This is important for transfers of large amounts of data to prevent lost data.

EOL - End of Line Characters. Choice of :
Cr (carriage return)
CrLF (carriage return and line feed)
LF (line feed)
LFCr (line feed and carriage return)

Cycle through these parameters by pressing the ▵ and ▿ keys. Press the RESET/EDIT key to change the values. Pressing ENTER returns to the "COMM" display. Refer to section 4, Communications, for more information.

PARA Setup Menu (Measurement parameters) Refer to Figure 11

After pressing SETUP, the ▲ or ▼ keys may be pressed until PARA is displayed. Pressing ENTER gets you into the Measurement Parameter setup menu, where the following parameters may be set:

ER - Exchange Rate selection of 3, 4, 5 or 6dB. Changing this parameter from 3dB changes LEQ to LAVG for all displays.

TH - Threshold level for averaging (set dB level from 0 to 180, or turn off). If the threshold is enabled, the meter will not integrate SPL below the threshold.

LNX - Four selectable exceedance (LN) values (X = 1 through 4). For each LNX, set N from 1 to 99 in 1% increments.

Ton - Threshold Trigger ON level (set dB level from 0 to 180 or turn off). Sets Threshold triggered study initiation level.

ToFF - Threshold Trigger OFF level (set dB level < or = Threshold Trigger ON level). Sets Threshold triggered study termination level (this is overridden if Programmed Run Time Duration is enabled).

RTHM or RTMS - Programmed Run Time Duration in Hours/Minutes or Minutes/Seconds (set hours/minutes/seconds, or turn off). Sets study length for manual, threshold, or Auto-On initiated study. 99 hour, 59 minute 59 second maximum. Setting to 00:00:00 will default to OFF.

AOMD, AOHM or AOMS - Auto-On Time in Month/Day, Hours/Minutes or Minutes/Seconds (Set Month, Day, Time, or turn off). Sets time to automatically turn on unit and begin study. 24 hour military time format is used for Hours/Minutes.

YEAR, MODY or HRMN - Clock/Calendar (Set year, month/day, hours/minutes). 24 hour military time format is used.

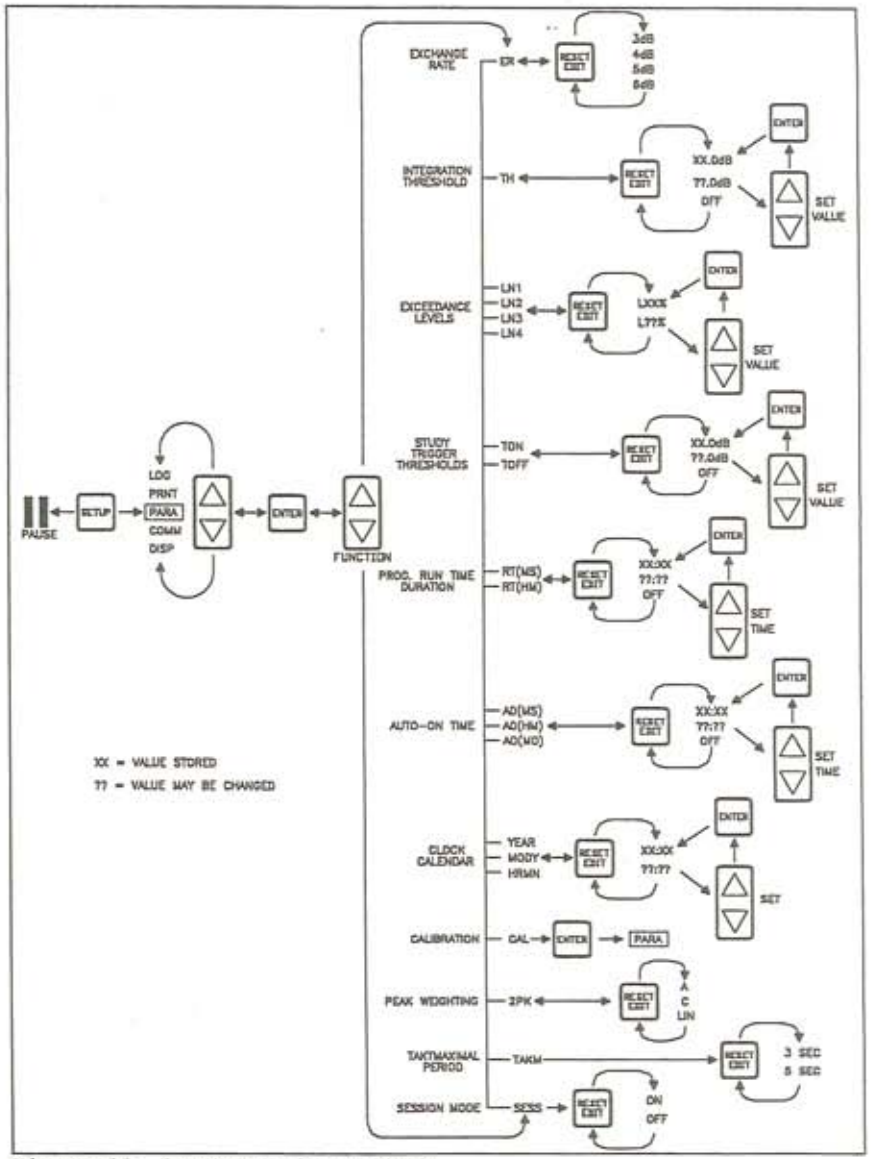

Figure 11. Parameter Setup Menu

- Calibration Value. Stores calibration value for SPL and peak detector. SPL calibration value and time and date of calibration will appear on the printout. The instrument's range settings may be adjusted to compensate for microphones that differ in sensitivity from the standard mics. Refer to section 5.1 "Calibration" for details.

2PK - Select Weighting of Second Peak Detector (A, C, LIN) used for LPK display or for logging data.

TAKM - 3 or 5 second L_{MAX} for Taktmaximal measurements.

SESS - Session mode ON or OFF. ON combines consecutive studies into a cumulative summary. See section 3.2 for details. If there is data in memory, this cannot be changed without first resetting the unit.

The user cycles through these parameters by pressing the ▲ and ▼ keys. Pressing the EDIT/RESET key allows the user to change the values or enable/disable the parameter. When setting numeric values the bargraph sections above the quantity to be changed will be lit. The ▲ and ▼ keys are used to change numeric values. Pressing ENTER stores the value. Pressing ENTER again returns to the "PARA" display.

Typical Setups

OSHA NOISE COMPLIANCE

Threshold = 90dB
Weighting = A
Exchange Rate = 5dB
Response = Slow

OSHA HEARING CONSERVATION

Same as above except with Threshold = 80dB

DEPARTMENT OF DEFENSE NOISE COMPLIANCE

Threshold = 80dB
Weighting = A
Exchange Rate = 4dB
Response = Slow

IEC NOISE MONITORING

Threshold = OFF
Weighting = A
Exchange Rate = 3dB
Response = Slow

TAKTMAXIMAL

Weighting = A
Response = Fast
TAKM = 3 or 5 Seconds as desired, with Logging Interval set to 3 or 5 seconds to log TAPts as LMAX values if LMAX is enabled in LOG Setup Menu

3.4 Overload Detection

While viewing SPL the overload indicator (OL) is displayed whenever the incoming signal saturates (overloads) the circuitry. If the OL indicator is on, increase the RANGE until the OL condition is removed. If an OL condition occurs while in the RUN mode, the OL indicator will light and remain on for the duration of the study.

The percentage overload time is a display option that may be enabled via the DISP setup menu and then selected using the FUNCTION key. The overload time will also be printed on the hard copy printout. While reviewing a study stored in memory, the OL indicator will remain on if an overload occurred during that study. Percentage overload time may be useful in determining the validity of a study during which overload occurred. A small percentage indicates that the data is fairly accurate, while a larger percentage indicates that significant errors occurred.

An overload will also be indicated while logging to the serial port or printing a time history of a study. For each logging interval that contained an overload condition, OL will print at the end of that line of data.

3.5 Battery Replacement

The BAT indicator in the display means that one or both 9V batteries is weak and should be replaced. Make sure the meter is turned off when replacing the batteries. Use a phillips head screwdriver to remove the battery cover on the rear of the unit. Remove the old batteries and replace with fresh alkaline batteries.

A lithium coin cell (type CR2032) is accessible through the battery compartment. This battery maintains the data memory, clock/calendar and setup information when the meter is turned off. A dead lithium cell will cause the meter to lose information stored in the setup menus, the serial number and any data. As long as the meter is turned on, this information will not be lost. If the meter is to be turned off while changing the lithium cell, retrieve any data stored in the meter and make note of setup parameters as these will be erased. Refer to figure 2.

1. Remove the 9 volt batteries from the battery compartment. Using a fingernail or other thin non-metallic object, push the bottom edge of the battery toward the top (microphone end) of the meter until it comes out of the holder.

2. Insert the new lithium cell, edge first and + side up, into the top of the holder. Press the bottom edge of the battery toward the top of the meter until it snaps into the holder.

APENDICE 5
COPIA DE RESULTADOS DE CONTEO EN INTERSECCION ENTRE PR-638 Y PR-637

Tabla 17 Resultados modelación aaSIDRA PR-663 y PR-638

	DEMORA PROMEDIO POR VEHÍCULO (D) [SEG.], NIVEL DE SERVICIO (NS) Y COLA PROMEDIO (CP) [METROS]									
	Acceso Sur N/A		Acceso Este PR-638		Acceso Norte PR-663		Acceso Oeste PR-638		Total Int.	
	D, NS	CP	D, NS	CP	D, NS	CP	D, NS	CP	D, NS	CP
Base 2005										
AM	**N/A**	**N/A**	1, A	0	12.1, B	0	5.9, A	1	6	1
PM	**N/A**	**N/A**	1, A	0	12.3, B	1	7.1, A	0	7.1	1
Futuro 2015										
AM	**N/A**	**N/A**	1, A	0	13.6, B	2	10.9, B	9	10.1	9
PM	**N/A**	**N/A**	0.9, A	0	17.9, C	8	8.7, A	2	11.5	8
Futuro 2020										
AM	**N/A**	**N/A**	1, A	0	14.6, B	2	12.2, B	13	11.2	13
PM	**N/A**	**N/A**	0.9, A	0	18.7, C	10	8.7, A	2	11.9	10

Esta intersección, a diferencia de la anterior, cuenta con capacidad suficiente para manejar el aumento en tránsito esperado.

5.6.3 Intersección PR-638 y PR-637

Esta intersección tiene una configuración en "T" y esta controlada por Pare. Todos sus accesos consisten de un carril por dirección y la vía prioritaria lo es la PR-638 (Este – Oeste)

Figura 6 Esquema geométrico de la intersección entre la PR-638 y la PR-637

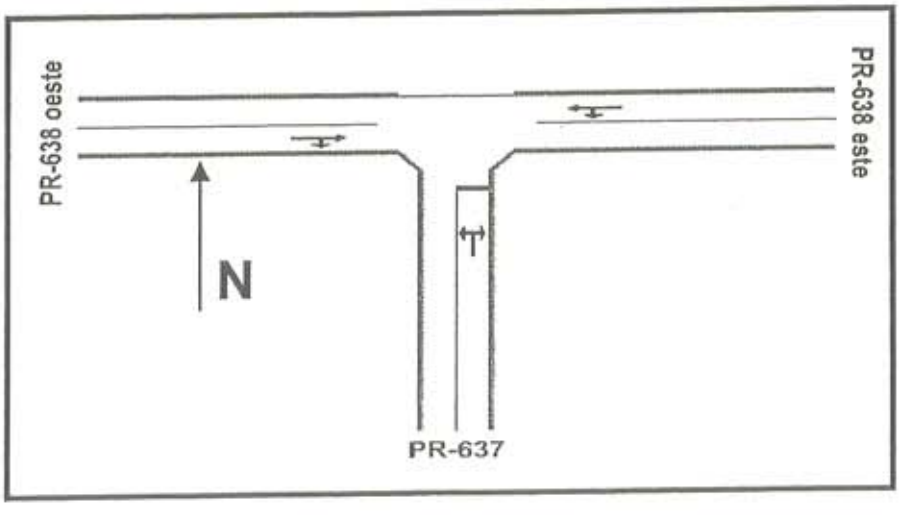

Tabla 23 Conteo PR-638 con PR-637

Beginning	Movement												Total	Total
of Period	S-L	S-T	S-R	E-L	E-T	E-R	N-L	N-T	N-R	W-L	W-T	W-R	15 min	Hora
06:00	5		5	2	27						40	2	81	392
06:15	7		5	2	33						42	1	90	441
06:30	7		8	4	34						45	1	99	566
06:45	8		15	5	41						51	2	122	729
07:00	15		12	6	46						48	3	130	850
07:15	21		24	6	83						77	4	215	971
07:30	32		14	7	82						124	3	262	864
07:45	21		25	7	67						115	8	243	705
08:00	18		19	20	81						106	7	251	563
08:15	15		12	11	29						33	8	108	403
08:30	10		19	4	29						32	9	103	376
08:45	10		14	7	26						37	7	101	349
09:00	8		11	5	24						41	2	91	334
09:15	9		10	9	21						30	2	81	337
09:30	5		9	8	19						33	2	76	353
09:45	7		2	10	26						39	2	86	365
10:00	11		9	11	22						38	3	94	366
10:15	10		11	9	23						40	4	97	375
10:30	9		10	7	26						31	5	88	388
10:45	5		8	10	30						29	5	87	415
11:00	8		12	13	27						31	12	103	437
11:15	7		13	10	34						32	14	110	450
11:30	12		13	3	24						45	18	115	475
11:45	14		6	11	34						28	16	109	512
12:00	7		5	16	39						43	6	116	524
12:15	12		4	14	44						49	12	135	526
12:30	14		7	10	55						50	16	152	513
12:45	12		10	10	28						47	14	121	478
13:00	12		14	8	32						42	10	118	473
13:15	10		11	9	42						39	11	122	466
13:30	8		10	8	41						40	10	117	461
13:45	7		5	11	39						45	9	116	468
14:00	9		9	10	35						40	8	111	476
14:15	11		5	8	39						42	12	117	523
14:30	12		8	9	40						41	14	124	582
14:45	8		11	11	43						40	11	124	653
15:00	5		10	14	64						46	19	158	718
15:15	9		8	21	54						63	21	176	742
15:30	7		11	8	72						69	28	195	709
15:45	12		13	14	69						54	27	189	691
16:00	6		5	18	77						58	18	182	692
16:15	12		9	18	50						37	17	143	646
16:30	8		8	11	78						50	22	177	664
16:45	16		4	19	69						67	15	190	648
17:00	12		7	8	39						57	13	136	620
17:15	9		6	11	50						70	15	161	0
17:30	11		4	9	53						60	24	161	0
17:45	8		10	7	67						59	11	162	0
18:00													0	0
18:15													0	0
18:30													0	0
18:45													0	0

APENDICE 6
COPIA DE RESULTADOS DE CORRIDA DE MODELO

```
*YNNNY
PR637 Senderos de Miraflores sin barrera para año 2026-dia
1  3
2  2
EASTBOUND TO ARECIBO
'CARS'   215  50
'MT'       9  50
'HT'       5  50
'L'/
'E-1'      0.0   96.0   179.34  1
'E-2'     91.5  115.8   177.69  1
'E-3'    183.0  141.7   177.16  1
'E-4'    274.5  172.2   175.26  1
'E-5'    366.0  204.2   170.16  1
'E-6'    457.5  245.4   168.70  1
'E-7'    549.0  283.5   170.75  1
'E-8'    640.5  321.6   168.88  1
'E-9'    732.0  381.0   165.66  1
'E-10'   823.5  452.7   162.60  1
'E-11'   915.0  519.7   162.06  1
'E-12'   960.8  603.6   161.50  1
'E-13'  1006.0  695.1   161.07  1
'L'/
WESTBOUND TO MANATI
'CARS'    143  50
'MT'        6  50
'HT'        3  50
'L'/
'W-1'      0.0    93.0  177.34  0
'W-2'     91.5   112.8  177.69  0
'W-3'    183.0   138.7  177.16  0
'W-4'    274.5   169.2  175.26  0
'W-5'    366.0   201.2  170.16  0
'W-6'    457.5   242.4  168.70  0
'W-7'    549.0   280.5  170.75  0
'W-8'    640.5   318.6  168.88  0
'W-9'    732.0   378.0  165.66  0
'W-10'   823.0   449.7  162.60  0
'W-11'   915.0   516.7  162.06  0
'W-12'   960.8   600.6  161.50  0
'W-13'  1006.0   692.1  161.07  0
'L'/
5 5
RECEIVERS AT SENDEROS DE MIRAFLORES
'SM-1'    149.4   77.75  179.30
'SM-2'    344.5  157.90  172.75
'SM-3'    551.8  246.30  171.89
'SM-4'    782.0  347.60  163.38
'SM-5'    890.2  478.66  161.50
6 2
ALPHA VALUES
0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5
6 2
SHIELDING FACTORS
2 2 2 2 2
2 2 2 2 2
7/
```

SMD

STAMINA 2.0/BCR
FHWA VERSION 3 (MARCH 1983)
TRAFFIC NOISE PREDICTION MODEL

(INPUT UNITS- METRIC , OUTPUT UNITS- ENGLISH)

PR637 Senderos de Miraflores sin barrera para año 2026-dia

PROGRAM INITIALIZATION PARAMETERS

HEIGHT	CODE	DESCRIPTION
0.00	1	RECEIVER HEIGHT ADJUSTMENT
1.00	2	A-WEIGHTED SOUND LEVEL ONLY
0.00	3	HEIGHT ADJUSTMENT FOR PASSENGER CARS (CARS)
8.00	4	HEIGHT ADJUSTMENT FOR HEAVY TRUCKS (HT)
2.30	5	HEIGHT ADJUSTMENT FOR MEDIUM TRUCKS (MT)

ROADWAY 1 EASTBOUND TO ARECIBO

VEHICLE TYPE	VEHICLES/HOUR	SPEED
CARS	215.	31.
HT	5.	31.
MT	9.	31.

	COORDINATES			
	X	Y	Z	GRADE
E-1	0.	315.	588.	1
E-2	300.	380.	583.	1
E-3	600.	465.	581.	1
E-4	901.	565.	575.	1
E-5	1201.	670.	558.	1
E-6	1501.	805.	553.	1
E-7	1801.	930.	560.	1
E-8	2101.	1055.	554.	1
E-9	2402.	1250.	544.	1
E-10	2702.	1485.	533.	1
E-11	3002.	1705.	532.	1
E-12	3152.	1980.	530.	1
E-13	3301.	2281.	528.	1

ROADWAY 2 WESTBOUND TO MANATI

VEHICLE TYPE	VEHICLES/HOUR	SPEED
CARS	143.	31.
HT	3.	31.
MT	6.	31.

	COORDINATES			
	X	Y	Z	GRADE
W-1	0.	305.	582.	
W-2	300.	370.	583.	
W-3	600.	455.	581.	
W-4	901.	555.	575.	

		SMD	
W-5	1201.	660.	558.
W-6	1501.	795.	553.
W-7	1801.	920.	560.
W-8	2101.	1045.	554.
W-9	2402.	1240.	544.
W-10	2700.	1475.	533.
W-11	3002.	1695.	532.
W-12	3152.	1970.	530.
W-13	3301.	2271.	528.

RECEIVERS AT SENDEROS DE MIRAFLORES

	----------COORDINATES----------		
	X	Y	Z
SM-1	490.	255.	588.
SM-2	1130.	518.	567.
SM-3	1810.	808.	564.
SM-4	2566.	1140.	536.
SM-5	2921.	1570.	530.

ALPHA FACTORS - RECEIVER ACROSS,ROADWAY DOWN

1 * 0.0 0.0 0.0 0.0 0.0
2 * 0.0 0.0 0.0 0.0 0.0

SHIELDING FACTORS - RECEIVER ACROSS,ROADWAY DOWN

1 * 2.0 2.0 2.0 2.0 2.0
2 * 2.0 2.0 2.0 2.0 2.0

RECEIVER	LEQ(H)	L10
SM-1	54.5	57.5

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	1	2	3	4
	44.7	49.6	44.5	40.6
2	1	2	3	
	42.8	48.0	42.7	

RECEIVER	LEQ(H)	L10
SM-2	57.2	59.6

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	3	4	5
	44.3	53.9	46.6
2	3	4	5
	42.3	50.6	44.9

RECEIVER	LEQ(H)	L10
SM-3	56.7	59.6

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	5	6	7	8
	42.5	51.4	49.3	41.6
2	5	6	7	
	40.5	49.8	47.8	

RECEIVER	LEQ(H)	L10
SM-4	54.4	57.5

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	8	9	10
	47.0	49.1	41.7
2	8	9	
	44.6	47.2	

RECEIVER	LEQ(H)	L10
SM-5	59.7	62.0

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	9	10	11
	44.8	56.4	46.5
2	9	10	11
	42.3	55.1	44.8

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*YNNNY
PR637 Senderos de Miraflores sin barrera para año 2026-noche
1  3
2  2
EASTBOUND TO ARECIBO
'CARS'     33  50
'MT'        2  50
'HT'        1  50
'L'/
'E-1'       0.0    96.0    179.34  1
'E-2'      91.5   115.8    177.69  1
'E-3'     183.0   141.7    177.16  1
'E-4'     274.5   172.2    175.26  1
'E-5'     366.0   204.2    170.16  1
'E-6'     457.5   245.4    168.70  1
'E-7'     549.0   283.5    170.75  1
'E-8'     640.5   321.6    168.88  1
'E-9'     732.0   381.0    165.66  1
'E-10'    823.5   452.7    162.60  1
'E-11'    915.0   519.7    162.06  1
'E-12'    960.8   603.6    161.50  1
'E-13'   1006.0   695.1    161.07  1
'L'/
WESTBOUND TO MANATI
'CARS'      22  50
'MT'         1  50
'HT'         1  50
'L'/
'W-1'       0.0     93.0   177.34  0
'W-2'      91.5    112.8   177.69  0
'W-3'     183.0    138.7   177.16  0
'W-4'     274.5    169.2   175.26  0
'W-5'     366.0    201.2   170.16  0
'W-6'     457.5    242.4   168.70  0
'W-7'     549.0    280.5   170.75  0
'W-8'     640.5    318.6   168.88  0
'W-9'     732.0    378.0   165.66  0
'W-10'    823.0    449.7   162.60  0
'W-11'    915.0    516.7   162.06  0
'W-12'    960.8    600.6   161.50  0
'W-13'   1006.0    692.1   161.07  0
'L'/
5 5
RECEIVERS AT SENDEROS DE MIRAFLORES
'SM-1'     149.4    77.75   179.30
'SM-2'     344.5   157.90   172.75
'SM-3'     551.8   246.30   171.89
'SM-4'     782.0   347.60   163.38
'SM-5'     890.2   478.66   161.50
6 2
ALPHA VALUES
0.5 0.5 0.5 0.5 0.5
0.5 0.5 0.5 0.5 0.5
6 2
SHIELDING FACTORS
2 2 2 2 2
2 2 2 2 2
7/
```

SMN

STAMINA 2.0/BCR
FHWA VERSION 3 (MARCH 1983)
TRAFFIC NOISE PREDICTION MODEL

(INPUT UNITS- METRIC , OUTPUT UNITS- ENGLISH)

PR637 Senderos de Miraflores sin barrera para año 2026-noche

PROGRAM INITIALIZATION PARAMETERS

HEIGHT	CODE	DESCRIPTION
0.00	1	RECEIVER HEIGHT ADJUSTMENT
1.00	2	A-WEIGHTED SOUND LEVEL ONLY
0.00	3	HEIGHT ADJUSTMENT FOR PASSENGER CARS (CARS)
8.00	4	HEIGHT ADJUSTMENT FOR HEAVY TRUCKS (HT)
2.30	5	HEIGHT ADJUSTMENT FOR MEDIUM TRUCKS (MT)

ROADWAY 1 EASTBOUND TO ARECIBO

VEHICLE TYPE	VEHICLES/HOUR	SPEED
CARS	33.	31.
HT	1.	31.
MT	2.	31.

	COORDINATES			
	X	Y	Z	GRADE
E-1	0.	315.	588.	1
E-2	300.	380.	583.	1
E-3	600.	465.	581.	1
E-4	901.	565.	575.	1
E-5	1201.	670.	558.	1
E-6	1501.	805.	553.	1
E-7	1801.	930.	560.	1
E-8	2101.	1055.	554.	1
E-9	2402.	1250.	544.	1
E-10	2702.	1485.	533.	1
E-11	3002.	1705.	532.	1
E-12	3152.	1980.	530.	1
E-13	3301.	2281.	528.	1

ROADWAY 2 WESTBOUND TO MANATI

VEHICLE TYPE	VEHICLES/HOUR	SPEED
CARS	22.	31.
HT	1.	31.
MT	1.	31.

	COORDINATES			
	X	Y	Z	GRADE
W-1	0.	305.	582.	
W-2	300.	370.	583.	
W-3	600.	455.	581.	
W-4	901.	555.	575.	

		SMN	
W-5	1201.	660.	558.
W-6	1501.	795.	553.
W-7	1801.	920.	560.
W-8	2101.	1045.	554.
W-9	2402.	1240.	544.
W-10	2700.	1475.	533.
W-11	3002.	1695.	532.
W-12	3152.	1970.	530.
W-13	3301.	2271.	528.

RECEIVERS AT SENDEROS DE MIRAFLORES

	----------COORDINATES----------		
	X	Y	Z
SM-1	490.	255.	588.
SM-2	1130.	518.	567.
SM-3	1810.	808.	564.
SM-4	2566.	1140.	536.
SM-5	2921.	1570.	530.

ALPHA FACTORS - RECEIVER ACROSS,ROADWAY DOWN

1 * 0.0 0.0 0.0 0.0 0.0
2 * 0.0 0.0 0.0 0.0 0.0

SHIELDING FACTORS - RECEIVER ACROSS,ROADWAY DOWN

1 * 2.0 2.0 2.0 2.0 2.0
2 * 2.0 2.0 2.0 2.0 2.0

RECEIVER	LEQ(H)	L10
SM-1	47.6	49.3

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY	SEGMENT
1	2
	42.3
2	2
	41.7

RECEIVER	LEQ(H)	L10
SM-2	50.4	51.4

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	4
	46.7
2	4
	44.3

RECEIVER	LEQ(H)	L10
SM-3	49.9	51.3

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	6	7
	44.2	42.1
2	6	7
	43.6	41.6

RECEIVER	LEQ(H)	L10
SM-4	47.6	49.4

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	9
	41.9
2	9
	40.9

RECEIVER	LEQ(H)	L10
SM-5	52.9	53.6

ROADWAY SEGMENT SOUND LEVEL CONTRIBUTIONS EXCEEDING 40.0 DBA

ROADWAY SEGMENT

1	10
	49.2
2	10
	48.9