TECHNICAL REPORT No. 1

GEOTECHNICAL STUDY for
BPPR VILLALBA BRANCH
VILLALBA DÍAZ, PUERTO RICO

GMTS PROJECT No. G251700

Prepared For:

Mrs. Isabel Miranda
BANCO POPULAR DE PUERTO RICO
PO Box 362708
San Juan, PR 00936-2708

Manuel E Ochoa Lavergne
Ingeniero Licenciado
Lic. 22275 PE
Puerto Rico
Fecha de Expiración: 2029-01-11

February 3, 2025

DN: email = meochoal@bioesign.com
Date: 2025.02.03 15:00:48 -04'00'

Prepared By:

GMTS

SPEC GROUP LLC
SOIL-ASPHALT-CONCRETE-WELDING-TESTING
FORENSIC & STRUCTURAL INVESTIGATIONS
CONSTRUCTION PROJECTS INSPECTIONS
VIBRATION MONITORING

This document consists of 36 pages.
Este documento consiste de 36 páginas.

COLEGIO DE INGENIEROS Y AGRIMENSORES
DE PUERTO RICO

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$19

6831-8941-1487-3907

ESTAMPILLA DIGITAL ESPECIAL (EDE)

Ing. Manuel E. Ochoa Lavergne, PE

DN: email = meochoal@bioesign.com
Date: 2025.02.03 15:01:16 -04'00'

SELLO PROFESIONAL

Práctica de:	Ingeniería
Licencia:	22275
Renglón:	Servicio Profesional
Descripción del Trabajo:	Realización de Estudios de Ingeniería
Fecha de Emisión:	02/03/2025
Monto Emitido:	$19
Número de Serie:	6831-8941-1487-3907
Número de Caso:	G251700
Proyecto / Unidad:	BPPR VILLALBA BRANCH
Rol del Profesional:	Consultor

Certificación:

El profesional certifica con la emisión de la estampilla digital especial del Colegio de Ingenieros y Agrimensores de Puerto Rico el haber cumplido con las disposiciones de la Sección 11 de la Ley 319 del 15 de mayo de 1938, según enmendada.

La colocación del sello profesional constituye la cancelación de la estampilla digital especial

RENOVACIÓN APROBADA: 20 de febrero, 2024

RENEWAL APPROVED ON: February 20, 2024

Gobierno de Puerto Rico
Government of Puerto Rico

DEPARTAMENTO DE ESTADO
Department of State

Secretaría Auxiliar de Juntas Examinadoras
Office of the Assistant Secretary of State for Examining Boards

La Junta Examinadora de Ingenieros y Agrimensores
The Examining Board of Engineers and Land Surveyors

por la presente certifica que
hereby certifies that

Manuel Enrique Ochoa Lavergne

habiendo cumplido todos los requisitos de Ley, se ha inscrito en el Registro de esta Junta como
having met all the requirements of law, has been registered as:

Ingeniero Licenciado
Licensed Engineer

En testimonio de lo cual, se expide esta licencia para el ejercicio de dicha profesión, bajo el sello de la Junta Examinadora.
In testimony whereof, this license is issued to practice this profession, under the seal of the Board of Examiners.

En San Juan, Puerto Rico, efectivo 12 de enero de 2024
In San Juan, Puerto Rico, effective January 12, 2024.

Número de Licencia: 22275
License Number

Vencimiento: 11 de enero de 2029
Expires: January 11, 2029

JUNTA EXAMINADORA DE INGENIEROS Y AGRIMENSORES
ESTADO LIBRE ASOCIADO DE PUERTO RICO
DEPARTAMENTO DE ESTADO

Presidente

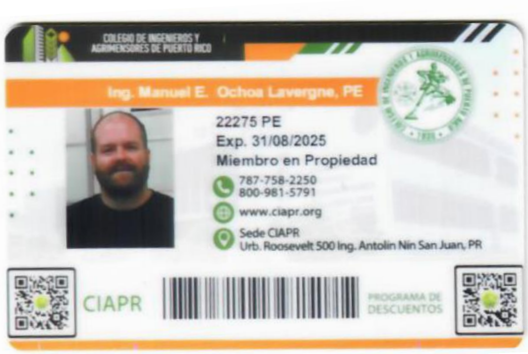
Secretario Auxiliar de Registros y Juntas Examinadoras

COLEGIO DE INGENIEROS Y AGRIMENSORES
DE PUERTO RICO

PO Box 363845 * San Juan, Puerto Rico 00936-3845
Tel.758-2250

# Factura	Cliente	# Licencia	Fecha	P.O.	Estatus	Términos
416955	Ing. Manuel E. Ochoa Lavergne,	22275	06/01/2024		Salda	Al contado

#	Código	Descripción	Unidades	Descuento	Precio	Total
34447		Cuota Colegiado 09/01/2024 - 08/31/2025	1		$ 200.00	$ 200.00



Subtotal	**$ 200.00**
IVU PR	**$ 0.00**
Tax Municipal	**$ 0.00**
Total Facturado	**$ 200.00**
Total Pagado	**$ 200.00**
Balance	**$ 0.00**

TECHNICAL REPORT No. 1

February 3, 2025

Mrs. Isabel Miranda
BANCO POPULAR DE PUERTO RICO
PO Box 362708
San Juan, PR 00936-2708

Re: **GEOTECHNICAL STUDY for**
BPPR VILLALBA BRANCH
VILLALBA, PUERTO RICO
PROJECT No. G251700

Dear Mrs. Miranda:

As requested, this technical report presents the findings of the **Geotechnical Study** performed at the above referenced project. The work was performed in general accordance with **SPEC Proposal PL-2024-136**, dated October 23, 2024.

1. PROJECT DESCRIPTION & SCOPE OF WORK

Based on the information provided to this office, the proposed project considers the design and construction of a new BPPR branch facility in Villalba. **Figure 1 (Site Location Map)** shows the location of the site. The structure footprint is estimated at about 2,500 sqft, on a 2,643 sqm lot. The area shall include drive-thru, parking (for about 37 vehicles), and transit areas. The site is partially occupied by asphalt pavement and heavy vegetation in the back area. No other information and/or requirements have been provided at the time of this report, other than an architectural layout.

The scope of work performed included a site reconnaissance, a subsurface exploration program with soil borings, laboratory testing of secured samples, and the preparation of this report, in general accordance with **Section 1803 (Geotechnical Investigation)** of **IBC**[1] (as referenced in the prevailing PRBC[2]). The subsoil exploration program consisted of **five (5) soil borings** to depths of about 10 to 29 feet below existing grade elevation. Borings were drilled using a CME55 drill rig, with automatic SPT hammer. The locations of the borings drilled are shown in **Figure 2 (Boring Location Plan)**.

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[1] PRBC = Puerto Rico Building Code
[2] IBC = International Building Code

A-5 Amur St., Reparto Landrau, Río Piedras, PR 00921 ● PO Box 270033, San Juan, PR 00928-2833
Tel (787) 792-8904 ● Fax (787) 782-7455 ● e-mail: gmts@gmtspr.com ● web page: www.gmts-pr.com

The samples secured were tested for:

a. visual-manual classification procedure in accordance with ASTM D 2488,
b. natural moisture content, as per ASTM D 2216, and
c. compressive strength values with spring tester and/or soil pocket penetrometer.

For a detailed description of the procedures followed for the drilling of the soil borings and laboratory testing, please refer to **Appendix 3.** All drilling, logging, and laboratory procedures followed the corresponding ASTM standard.

Furthermore, the scope of work included the performance of **three (3) superficial percolation tests,** to evaluate percolating characteristics at site. The procedures established in **Section 404 of the 2009 International Private Sewage Disposal Code** were followed. The locations are also shown in **Figure 2 (Boring Location Plan)**.

2. PERCOLATION TEST DATA

As requested, **three (3) superficial percolation tests** were requested at site. The procedures established in **Section 404** of the **International Private Sewage Disposal Code** were followed, described as follows:

1. A 1-ft by 1-ft excavation was performed to a depth of about 2 to 3-ft below existing grade at the proposed indicated absorption areas. The bottom of the excavation was cleaned and stabilized.

2. The hole was filled completely with water and allowed to be absorbed by soil for at least 24 hours (*i.e.* saturation phase).

3. After the 24-hour saturation period, the water level was adjusted to about 12 inches from the bottom, and water drop was observed for at least 4 hours (240 minutes), recording the water level every 15 minutes or less, as required.

4. The result of the percolation test is calculated by dividing the time elapsed per inch of drop of the water level, or minutes/inch.

The results of the average percolation rate, per location, are presented in **Table 1**.

Table 1: Average Percolation Rate per Location

Location	Total Test Drop (in)	Average Percolation Rate (mins/in)
PT1	4⅛	58.2
PT2	0	240+
PT3	7	34.3

It should be noted that the percolation test results are applicable to the locations and depths indicated, and may not necessarily be applicable at other areas and/or depths. Design of percolation/infiltration system is beyond the scope of our work, only factual findings of percolation testing program.

The locations of the percolation tests are shown in **Figure 2 (Boring Location Plan)**. It should be noted that **PT1** was relocated from the original indicated location due to accessibility to the area.

3. SOIL BORING DATA

The borings drilled generally disclosed mixtures and interbedded layers of granular and cohesive soils sources throughout the drilled depths. General layer information as follows:

Cohesive Source:

- Soil Description: silty clay
- SPT N-Values: 6 to over 50 bpf[3] (medium to hard)
- q_u[4]: 1 to over 4 tsf[5] (stiff to hard)
- Natural moisture content: about 6 to 32 percent

Granular Source:

- Soil Description: clayey sand / silty sand / rock fragments
- SPT N-Values: 11 to over 50 bpf (medium to very dense)
- Natural moisture content: about 1 to 15 percent

The approximate locations of the borings drilled is shown on **Figure 2 (Boring Location Plan)**.

The water level was **not** detected within the drilled depths at the time of fieldwork. The reader should be aware that ground water levels, although not expected at site, might fluctuate due to seasonal variations, precipitation, construction activities, and/or other factors not evident at the time of measurement. **Accurate phreatic levels, especially in fine-grained soils, could only be measured by monitoring observation wells until the water table is stabilized.** This is beyond the scope of this work. The undersigned will not be held responsible for assumptions made by others based on phreatic surface information provided in this document.

All depths mentioned in this report, unless otherwise specified, are referred to the exiting ground elevation prevailing during the period of our fieldwork. For a detailed description of soils found at site, please refer to boring logs included with this report **(Appendix 2)**. It should be noted that the boring logs indicate the SPT N-Values as sampled, without any corrections for hammer efficiency or other correction factors. Also, logs show only the subsurface conditions on the date and locations

[3] bpf = blows per foot
[4] q_u = unconfined compressive strength
[5] tsf = tons per square foot

indicated. Subsoil changes may occur within short distances. If this condition is observed, it is essential that this office be notified for a site visit.

4. DISCUSSION AND GEOTECHNICAL RECOMMENDATIONS

As indicated, the proposed project considers the design and construction of a new BPPR branch facility in Villalba. The structure footprint is estimated at about 2,500 sqft, on a 2,643 sqm lot. The area shall include drive-thru, parking (for about 37 vehicles), and transit areas. The site is partially occupied by asphalt pavement and heavy vegetation in the back area. No other information and/or requirements have been provided at the time of this report, other than an architectural layout.

The boring drilled disclosed mixtures and interbedded layers of cohesive and granular soils. The cohesive sources were generally within the uppermost portion of the profile, but not in all cases. The consistency of cohesive deposits varied from **medium to hard**, but predominantly **stiff or better.** The relative density of the granular deposits varied from **medium to very dense**, generally getting denser with depth.

It should be noted that refusal to penetration to hollow steam auger drilling methods was also achieved at site in **Borings B102 and B104** within the structure footprint, at shallow depths of less than 20 feet.

In general subsoil conditions are **considered adequate** to support the proposed structure on a shallow foundation system, provided the geotechnical recommendations provided in this report are followed for the design and construction of the proposed project foundations.

3.1 Shallow Foundations

Shallow foundations may be designed on the basis of a **maximum allowable soil bearing pressure (q_a) of 2,500 psf**, at a **minimum depth of foundation (D_f) of 1.5 feet** below existing grade elevation.

A **modulus of subgrade reaction (k_s) of 50 to 75 pci** may be considered for design of floor slabs and/or mat foundations. It should be noted that the modulus of subgrade reaction is not a single, fixed number. The modulus of subgrade reaction depends on: width of loaded area, shape of loaded area, depth below ground surface, loading position on mat, and time. Generally, k_s is larger toward the edge of mat foundations and lower near the center, and changes with time as soils reach their compression equilibrium. Furthermore, due to the width-to-thickness ratio, mats are rarely purely rigid, where pressures may be greater below loaded areas. Hence, k_s may be lower near center of mat foundations and loaded areas.

The range of values provided above is an average approximation of expected conditions below foundations/slabs. Lastly, it should be noted that using a low modulus of subgrade reaction only is not necessarily conservative, as differential settlements is more important than considering a uniform larger settlement (*i.e.* lower k_s). Instead, we recommend the use of a **Pseudo-Coupled** method, with two (minimum) or more concentric zones. The lower values should be applied on the inner zone progressively to the higher values on the outermost zone.

3.2 Subgrade Stability for Pavement Design

Pavements may be designed using a **California Bearing Ratio (CBR) value of 3 to 5** for the superficial in-situ subgrade below the proposed pavement section (*i.e.* subbase, base, binder *etc*), at a depth of about 6 to 12 inches below existing grade and after a satisfactory proof-roll is performed.

It should be noted that CBR testing was not performed at the site. These values are based on our experience with similar types of soil and considering the improvement indicated above. If these values require confirmation, or if higher design values are required, CBR testing (or equivalent, such as the Dynamic Cone Penetrometer per USACE) should be conducted.

The design of the proposed pavement should consider minimizing the possibility of infiltration of water (rain and runoff) under the pavement. This will maximize the performance and durability of the pavement structure.

3.3 Seismic Design Considerations

For the dynamic evaluation of soil-structure interaction, the following average soil profiles were determined:

- Based on SPT N-Values: S_D
- Based on unconfined compressive strength (q_u) values: S_C

The average soil profiles were determined per the prevailing **IBC, Puerto Rico Building Code (PRBC),** and **ASCE 7**. The designer should select the site class that gives **the highest site factors and design spectral response in the period range of interest**. The reader should note that this recommendation is based solely on the soil sample descriptions, SPT N-values and unconfined strength measurements obtained from **the borings to the drilled depths**, and inferring that the soil conditions below these depths should be equal to or better than those encountered within the depths explored. It should also be noted that the prevailing building codes require drilling down to 100 feet for a proper seismic site classification, **which was beyond the scope of our work**.

It should be noted, various faults have been identified in close proximity to the site, within less than a 1-mile radius. Refer to **Figure 3 (Geologic Setting)**. The technical definition of a fault is a fracture or surface zone in which difference in geologic units has been observed due to relative displacement. It should be noted that although faults are generally represented in maps with single lines, they usually are not single, clean fractures but rather a zone of fracturing patterns. There are active faults (generally associated with tectonic movements, or likelihood of producing an earthquake) and inactive faults (those that we can identify but are not expected to produce earthquakes). Faults in Puerto Rico are common due to its origin and geologic evolution.

However, the closest system of faults to site is what is known as **Great Southern Puerto Rico Fault zone (GSPRfz)**, estimated anywhere from about 2 to 5 miles. In fact, some of the faults identified in the geologic map are considered part of the **GSPRfz**. The **GSPRfz** system of faults is considered active and estimated to be capable of producing earthquakes with M > 7. It should be noted that near-fault sites are considered as sites within 9.5 miles of a fault capable of producing M>7, and 6.25 miles for faults capable of 7>M>6. Hence, this is considered a **near-fault site**. In any case, a **site-specific fault and/or seismic study was beyond the scope of the work**. **Figure 4 (Puerto Rico Inner Fault Zones)** shows Puerto Rico's inner faults systems.

3.3 Additional Design Considerations

Site Drainage: site drainage is of **paramount importance** to reduce the possibility of saturation of foundation soils, resulting in possible foundation and/or pavement stability problems.

All roof downspouts and surface drainage should be collected and disposed of away from structures/foundations. It is of utmost importance that the drainage provisions are designed and maintained properly. Periodic maintenance is required to maximize the performance and construction life of the proposed project, especially after heavy precipitation events. This includes the maintenance of the construction elements and replacement, as necessary, as well as cleaning of the adjacent areas from any debris that could affect drainage provisions.

Subgrade Stability for Slab-on-Grades and/or Mat Foundations: it should be noted that the exposed subgrade surfaces should be proof-rolled (refer to **Appendix 4: General Site Improvement / Earthwork** – *Proof Rolling)* to detect soft spots and confirm subgrade preparation prior to construction of mat foundation. In any case, soft spots encountered should be removed and replaced. The actual undercut depth at soft/loose areas should be determined directly at the field during earthwork operations, depending on the conditions observed, with a minimum undercut of 12 inches if encountered. These areas should be replaced with a compacted fill pad of engineered soil. This soil should consist of A-2 type of soil (AASHTO Soil Classification System), or better.

Slopes: slopes at/or near site, if any, should not be steeper than 2:1 (H:V). Slopes should also be protected against superficial erosion.

Percolation Testing: percolation test results disclosed high percolation characteristics at the testing location. Generally, percolations rates in **excess of 60 minutes per inch** are considered unsuitable for soil absorption systems. In any case, the designer should evaluate the results provided in **Section 2 (Percolation Test Data)** to determine viability of septic system at site, as/if required. Design of percolation/infiltration system is beyond the scope of our work, only factual findings of percolation testing program presented at the locations and depths indicated.

3.4 General Site Improvement / Earthwork

As indicated, grading information has been provided at the time of this report, although we understand grading shall remain essentially the same. No special considerations are considered based on project development and disclosed soil conditions other clearing and grubbing, and excavations. Once the final project design is in place, this office should be allowed to review the design drawings to confirm the recommendations are applicable, or provide additional applicable recommendations, as/if necessary. General guidelines for earthwork are also included in **Appendix 4**.

4. LIMITATIONS OF DOCUMENT

This report is based on all design concepts, parameters and constraints, which have been made known to this firm. The undersigned states that his professional services are in accordance with the generally accepted principles, professional practice, and standard of care in the field of Geotechnical Engineering. The conclusions and recommendations presented in this report are the result of the professional evaluation made by this firm of the stratigraphic properties of soils, as obtained from the **soil borings performed** at site. Interpretation and judgment based on these data may differ from actual conditions, since variations in the nature and behavior of subsurface materials may occur within short distances.

In general, geoprofessional services are a three-phase process. In the **first phase**, a subsoil investigation program takes place. In the **second phase**, geotechnical design builds upon the subsoil investigation and the preliminary design recommendations provided in **Phase I**. Field observation comprises the **third and last phase** of a complete geoprofessional service; permitting those who developed the geotechnical engineering report to observe subsurface conditions and thereby assess the reliability of their subsurface profile and appropriateness of their preliminary recommendations. Actual conditions may differ from those expected, and that situation can lead to serious problems unless a qualified individual is available to decide what to do about them, where and when they are found. Decisions such as these are "judgment calls", and the quality of judgment can have an impact on the project. Refer to **Appendix 5** for additional information on the above phases.

Furthermore, we **strongly** recommend that our team be retained for the field observation phase of this project, to assess whether the recommendations provided in this report are in agreement with the conditions observed during fieldwork, and to address any additional conditions that may present during earthwork, if any. However, conscious that this may not be necessarily possible, in the event the Field Observation Phase of the work is granted to another geoprofessional firm, they should review the report(s) pertaining to this project, and shall adopt it as its own, or conduct additional work as deemed necessary, thus **fully relieving GMTS/SPEC of ALL RESPONSIBILITY for the project**.

5. CLOSING

This document has been prepared specifically for **BANCO POPULAR DE PUERTO RICO,** for the design and construction of the **New BPPR Branch** project in the municipality of Villalba, Puerto Rico. **This report should not be used by any other entity or for a different project, even at this site, without the express written consent of GMTS, PSC and SPEC GROUP, LLC.**

We appreciate the opportunity to be of service and look forward to working with you again in the future. If you have any questions, please contact the undersigned at your convenience.

Respectfully submitted,

Manuel E. Ochoa Lavergne, MSCE, PE
Geotechnical Engineer

Enclosures: Appendix 1 - Figures
Appendix 2 - Soil Boring Logs
Appendix 3 - Field and Laboratory Testing Procedures
Appendix 4 - General Earthwork Guidelines
Appendix 5 - Geoprofessional Phases

APPENDIX 1

FIGURES

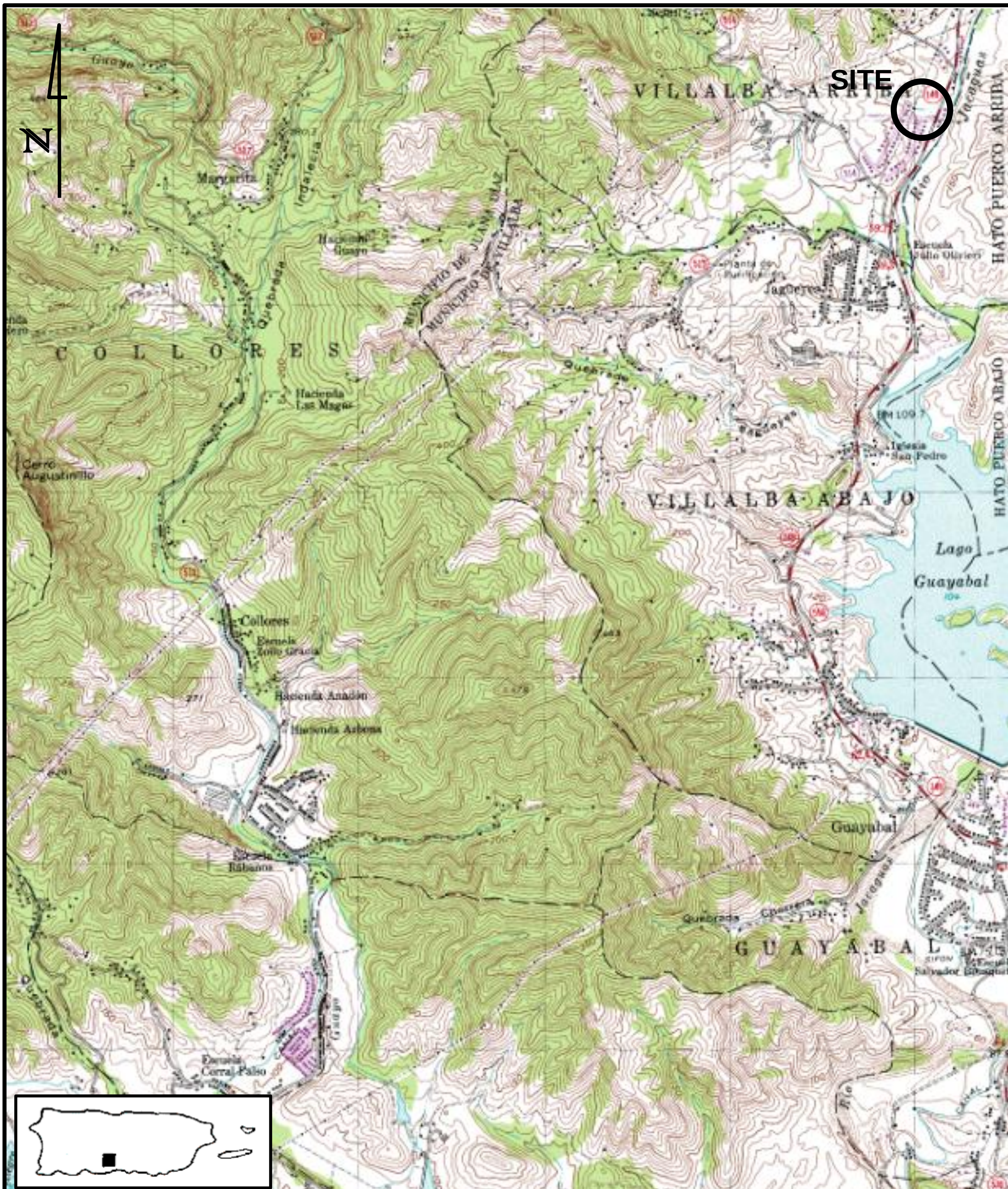
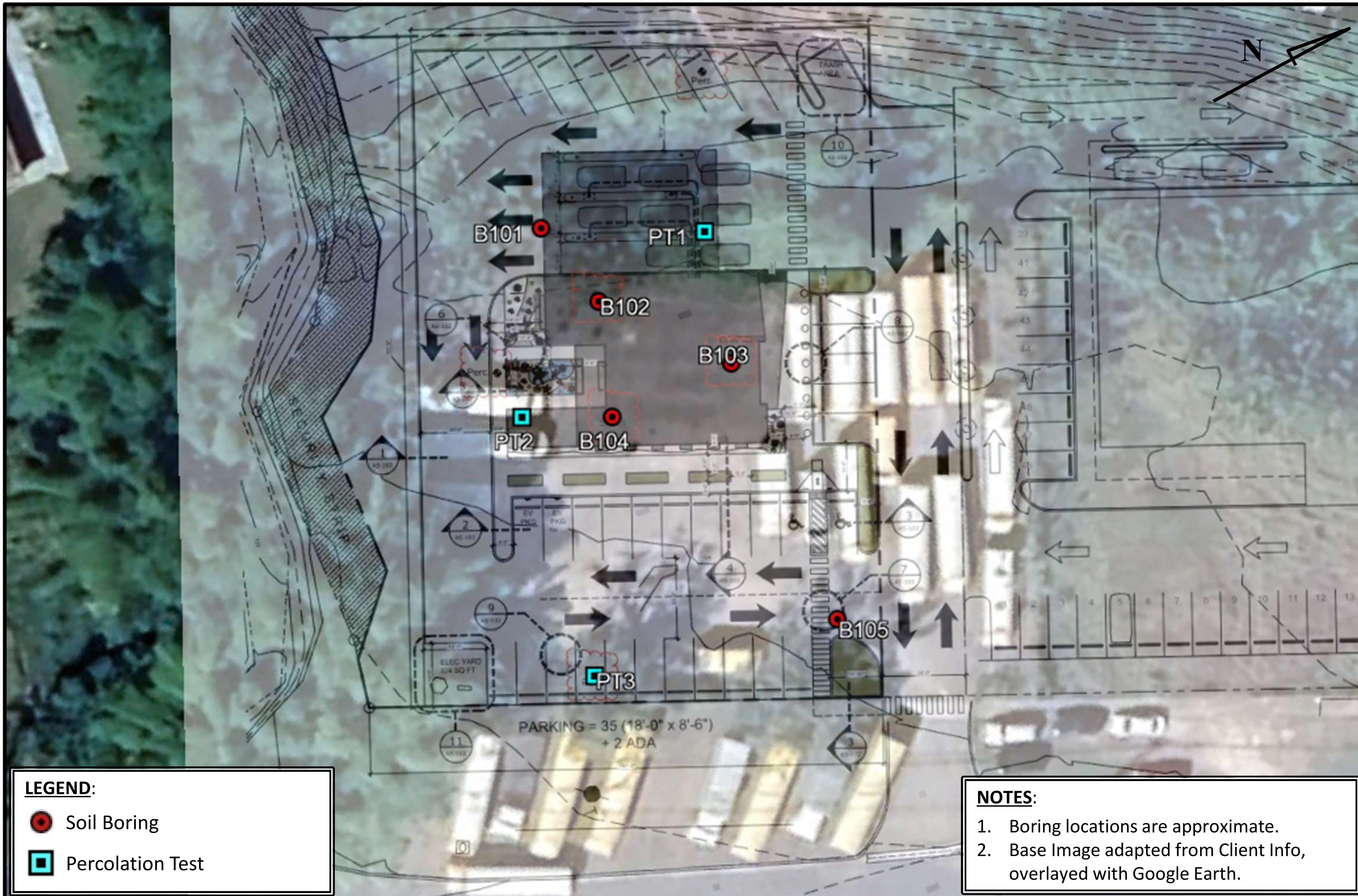


FIGURE 1 – SITE LOCATION MAP
BPPR VILLALBA BRANCH
VILLALBA, PUERTO RICO

Scale: NTS	Dwg. by: LRS	Rev. by: MOL	Project: G251700

GMTS



LEGEND:

- Soil Boring
- Percolation Test

NOTES:

1. Boring locations are approximate.
2. Base Image adapted from Client Info, overlayed with Google Earth.

Scale: NTS	
Dwg. By: LRS	
Rev. By: MOL	
Project No: G251700	
Client Code: N/A	

FIGURE 2 – BORING LOCATION PLAN
BPPR VILLALBA BRANCH
VILLALBA, PUERTO RICO

GMTS

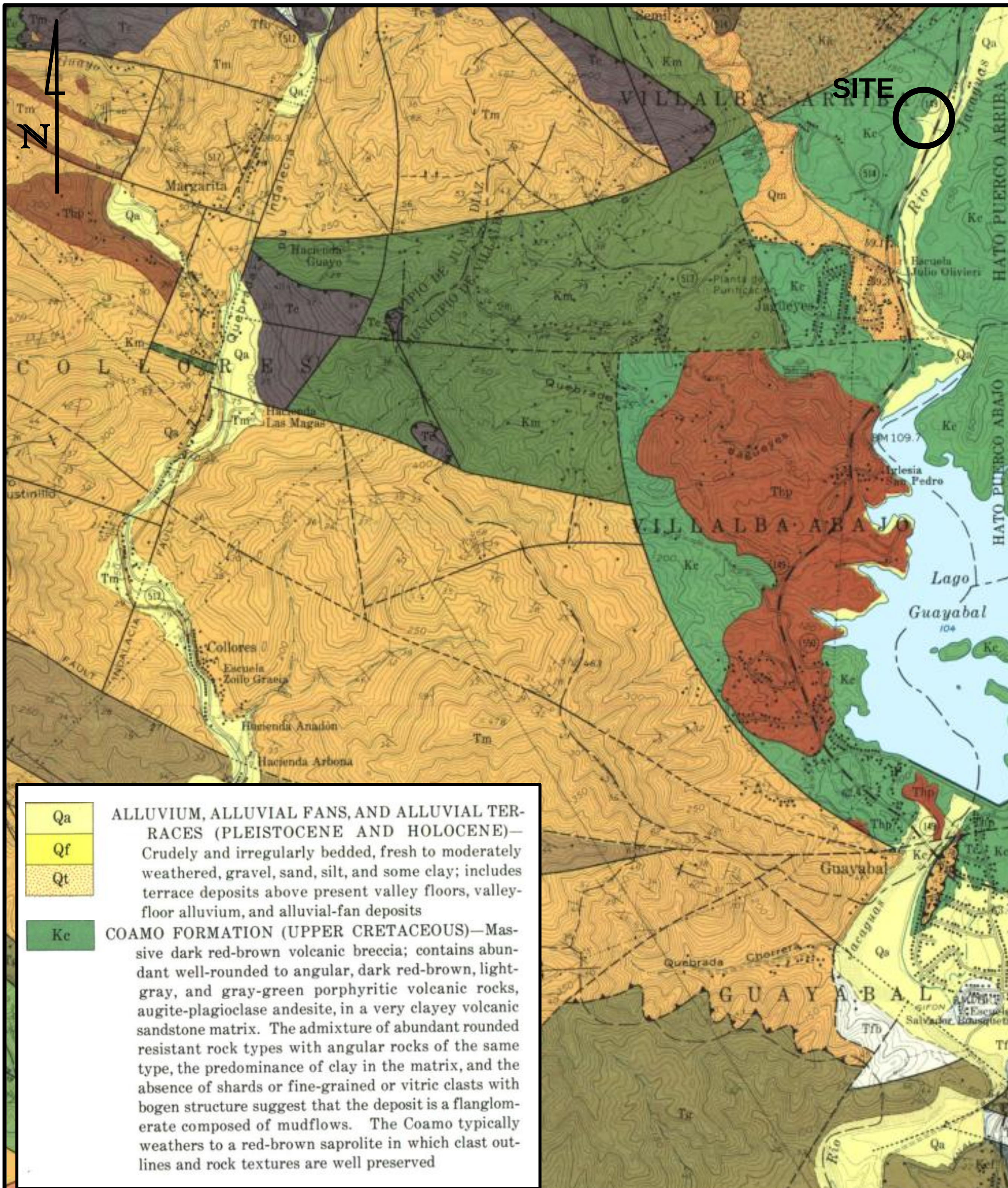
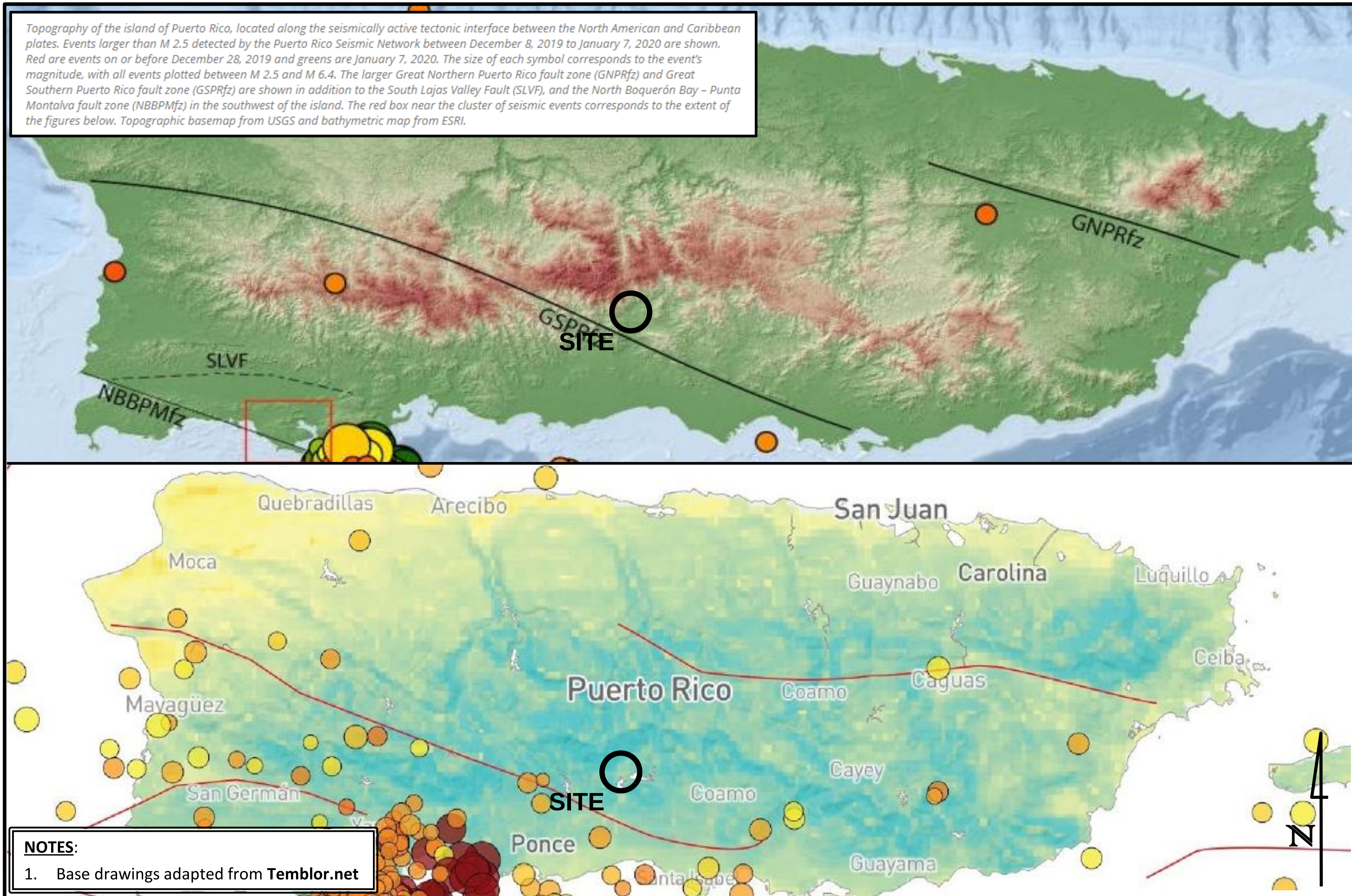


FIGURE 3 – GEOLOGIC MAP
BPPR VILLALBA BRANCH
VILLALBA, PUERTO RICO

Scale: NTS	Dwg. by: LRS	Rev. by: MOL	Project: G251700



Topography of the island of Puerto Rico, located along the seismically active tectonic interface between the North American and Caribbean plates. Events larger than M 2.5 detected by the Puerto Rico Seismic Network between December 8, 2019 to January 7, 2020 are shown. Red are events on or before December 28, 2019 and greens are January 7, 2020. The size of each symbol corresponds to the event's magnitude, with all events plotted between M 2.5 and M 6.4. The larger Great Northern Puerto Rico fault zone (GNPRfz) and Great Southern Puerto Rico fault zone (GSPRfz) are shown in addition to the South Lajas Valley Fault (SLVF), and the North Boquerón Bay – Punta Montalva fault zone (NBBPMfz) in the southwest of the island. The red box near the cluster of seismic events corresponds to the extent of the figures below. Topographic basemap from USGS and bathymetric map from ESRI.

NOTES:

1. Base drawings adapted from **Temblor.net**

Scale: NTS	**FIGURE 4 – PUERTO RICO INNER FAULT ZONES**
Dwg. By: LRS	**BPPR VILLALBA BRANCH**
Rev. By: MOL	**VILLALBA, PUERTO RICO**
Project No: G251700	
Client Code: N/A	

APPENDIX 2

SOIL BORING LOGS

BORING LOG

JOB No.:	G251700
BORING No.:	B101
PROJECT:	BPPR VILLALBA BRANCH
CLIENT:	BANCO POPULAR DE PR
LOCATION:	VILLALBA, PR
EASTING(X):	N/A
NORTHING(Y):	N/A
ELEVATION(Z):	N/A
DRILL RIG:	CME 55
DRILL METHOD:	HOLLOW STEM AUGER
SAMPLER:	2" OD X 24" L
HAMMER WEIGHT:	140 LBS (AUTO)
TOTAL DEPTH:	10 FEET
DRILLED:	P.RODRIGUEZ
LOGGED BY:	L. RAMOS
INITIAL WATER LEVEL:	NOT DETECTED
ELAPSED TIME:	N/A
FINAL WATER LEVEL:	N/A
ELAPSED TIME:	N/A
START DATE:	1/14/2025
FINISH DATE:	1/14/2025

Depth (Feet)	Sample No.	Blows (per 6 in.)	N	SOIL DESCRIPTION	q_u (tsf)	PEN (tsf)	Total Unit Wt. (pcf)	Water Content (%)
0	1	9-5-6-7	11	SILTY CLAY, little to some sand, trace rock fragments, stiff to very stiff, dark yellowish brown		2.5		15.3
	2	5-6-7-10	13	SAME AS ABOVE		2.5		15.1
	3	8-9-6-4	15	SILTY CLAY, some sand, trace rock fragments, very stiff, dark yellowish brown		2.5		7.6
	4	4-7-14-10	21	CLAYEY SAND, trace rock fragments, medium, dark yellowish brown		2.5		15.3
	5	13-13-7-6	20	CLAYEY SAND, some rock fragments, medium, dark yellowish brown				8.4
10				END OF BORING AT 10 FEET				

Notes: *All Depth Referred to Exsiting Grade*

"HW": Hammer Weight / Weight of Hammer

▼ Initial Water Level Reading

▽Final Water Level Reading

+ N: SPT N - Value (ASTM 01586)

◇ q_u: Unconfined Compressive Strenght (Spring Tester)

× PEN: Pocket Penetrometer

COMMENTS: 2-INCH ASPAHALT PAVEMENT AT SURFACE

BORING LOG

GMTS

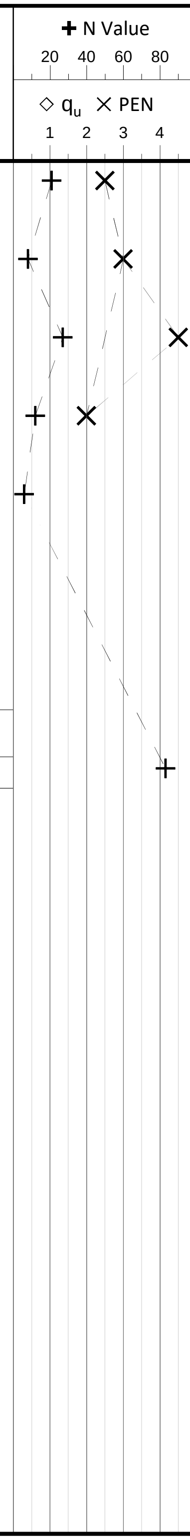
JOB No.: G251700 | **BORING No.:** B102
PROJECT: BPPR VILLALBA BRANCH
CLIENT: BANCO POPULAR DE PR

LOCATION:	VILLALBA, PR	DRILL RIG:	CME 55
EASTING(X):	N/A	DRILL METHOD:	HOLLOW STEM AUGER
NORTHING(Y):	N/A	SAMPLER:	2" OD X 24" L
ELEVATION(Z):	N/A	HAMMER WEIGHT:	140 LBS (AUTO)

TOTAL DEPTH: 16 FEET
DRILLED: P.RODRIGUEZ
LOGGED BY: L. RAMOS

INITIAL WATER LEVEL: NOT DETECTED | ELAPSED TIME: N/A
FINAL WATER LEVEL: N/A | ELAPSED TIME: N/A
START DATE: 1/13/2025 | FINISH DATE: 1/13/2025

Sample No.	Blows (per 6 in.)	N	SOIL DESCRIPTION	q_u (tsf)	PEN (tsf)	Total Unit Wt. (pcf)	Water Content (%)
1	9-13-8-5	21	SILTY CLAY, some sand, trace rock fragments, stiff to very stiff, dark yellowish brown, gray		2.5		10.7
2	3-3-5-7	8	SILTY CLAY, trace sand, trace rock fragments, stiff to very stiff, dark yellowish brown		3.0		15.9
3	4-14-13-11	27	SAME AS ABOVE, very stiff to hard, yellowish brown		4.5+		11.4
4	6-6-6-6	12	SAME AS ABOVE, stiff		2.0		11.5
5	4-3-3-8	6	SILTY CLAY, some rock fragments, trace to little sand, medium, dark yellowish brown				14.1
6A	15-21	21+	ROCK FRAGMENTS AND SILTY SAND, trace clay, medium, dark yellowish brown				6.4
6B	40-43	83	ROCK FRAGMENTS, some silty sand, very dense, gray				0.9
			END OF BORING AT 16 FEET (REFUSAL TO PENETRATION)				



Notes: *All Depth Referred to Exsiting Grade*
"HW": Hammer Weight / Weight of Hammer
▼ Initial Water Level Reading
▽ Final Water Level Reading
+ N: SPT N - Value (ASTM 01586)
◇ q_u: Unconfined Compressive Strenght (Spring Tester)
× PEN: Pocket Penetrometer

COMMENTS: 1-INCH ASPAHALT PAVEMENT AT SURFACE

GMTS

BORING LOG

JOB No.:	G251700
BORING No.:	B103
PROJECT:	BPPR VILLALBA BRANCH
CLIENT:	BANCO POPULAR DE PR
LOCATION:	VILLALBA, PR
EASTING(X):	N/A
NORTHING(Y):	N/A
ELEVATION(Z):	N/A
DRILL RIG:	CME 55
DRILL METHOD:	HOLLOW STEM AUGER
SAMPLER:	2" OD X 24" L
HAMMER WEIGHT:	140 LBS (AUTO)
TOTAL DEPTH:	29.1 FEET
DRILLED:	P.RODRIGUEZ
LOGGED BY:	L. RAMOS
INITIAL WATER LEVEL:	NOT DETECTED
ELAPSED TIME:	N/A
FINAL WATER LEVEL:	N/A
ELAPSED TIME:	N/A
START DATE:	1/14/2025
FINISH DATE:	1/14/2025

Sample No.	Blows (per 6 in.)	N	SOIL DESCRIPTION	q_u (tsf)	PEN (tsf)	Total Unit Wt. (pcf)	Water Content (%)
1	12-12-9-10	21	SILTY CLAY, some rock fragments, little sand, stiff to very stiff, dark yellowish brown		2.0		7.9
2	9-13-8-5	21	SAME AS ABOVE, very stiff				10.4
3	5-6-9-12	15	SILTY CLAY, trace sand, very stiff to hard, dark brown	4.6	2.0	130	14.9
4	10-9-7-5	16	SILTY CLAY, little rock fragments, very stiff, very dark brown		2.5		21.2
5	4-5-4-3	9	SILTY CLAY, trace sand, trace rock fragments, stiff, very dark brown		2.0		32.0
6	3-3-3-3	6	SILTY CLAY, some sand, medium to stiff, dark yellowish brown		1.5		15.3
7A	2-8	8+	CLAYEY SAND, some rock fragments, loose, dark yellowish brown	0.6		118	5.6
7B	10-13	23	SILTY CLAY, very stiff, very dark brown				22.3
8	15-14-32-25	46	ROCK FRAGMENTS AND SAND, trace silt, dense, yellowish brown				5.9
9	18-24-20-22	44	CLAYEY SAND, dense, very dusky red				12.3
10	45-50/6"	50/6"	SAME AS ABOVE, very dense				7.0
11	50/1"	50/1"	SILTY SAND, dusky red				4.5
			END OF BORING AT 29.1 FEET				

Notes: *All Depth Referred to Exsiting Grade*
"HW": Hammer Weight / Weight of Hammer
▼ Initial Water Level Reading
▽Final Water Level Reading
✚ N: SPT N - Value (ASTM 01586)
◇ q_u: Unconfined Compressive Strenght (Spring Tester)
✕ PEN: Pocket Penetrometer

COMMENTS: 6-INCH ASPAHALT PAVEMENT AT SURFACE

GMTS

BORING LOG

JOB No.:	G251700
BORING No.:	B104
PROJECT:	BPPR VILLALBA BRANCH
CLIENT:	BANCO POPULAR DE PR
LOCATION:	VILLALBA, PR
EASTING(X):	N/A
NORTHING(Y):	N/A
ELEVATION(Z):	N/A
DRILL RIG:	CME 55
DRILL METHOD:	HOLLOW STEM AUGER
SAMPLER:	2" OD X 24" L
HAMMER WEIGHT:	140 LBS (AUTO)
TOTAL DEPTH:	14.5 FEET
DRILLED:	P.RODRIGUEZ
LOGGED BY:	L. RAMOS
INITIAL WATER LEVEL:	NOT DETECTED
ELAPSED TIME:	N/A
FINAL WATER LEVEL:	N/A
ELAPSED TIME:	N/A
START DATE:	1/13/2025
FINISH DATE:	1/13/2025

Sample No.	Blows (per 6 in.)	N	SOIL DESCRIPTION	q_u (tsf)	PEN (tsf)	Total Unit Wt. (pcf)	Water Content (%)
1	11-6-5-5	11	CLAYEY SAND, trace rock fragments, medium / stiff, dark grayish brown		2.0		7.9
2	10-4-5-6	9	SILTY CLAY, trace to little sand, stiff, dark yellowish brown		1.5		21.3
3	3-5-4-4	9	SAME AS ABOVE		1.5		16.3
4	3-2-2-3	4	SAME AS ABOVE, little rock fragments, medium to stiff		1.5		23.5
5	3-3-3-5	6	SILTY CLAY, little sand, medium to stiff, dark yellowish brown		1.5		16.7
6	50/5"	50/5"	SAME AS ABOVE, some rock fragments, hard, dark yellowish brown				5.5
			END OF BORING AT 14.5 FEET (REFUSAL TO PENETRATION)				

Notes: *All Depth Referred to Exsiting Grade*

"HW": Hammer Weight / Weight of Hammer

▼ Initial Water Level Reading

▽ Final Water Level Reading

+ N: SPT N - Value (ASTM 01586)

◇ q_u: Unconfined Compressive Strenght (Spring Tester)

× PEN: Pocket Penetrometer

COMMENTS: 2.5-INCH ASPAHALT PAVEMENT AT SURFACE

GMTS

BORING LOG

JOB No.:	G251700
PROJECT:	BPPR VILLALBA BRANCH
CLIENT:	BANCO POPULAR DE PR

BORING No.: B105

LOCATION:	VILLALBA, PR	DRILL RIG:	CME 55
EASTING(X):	N/A	DRILL METHOD:	HOLLOW STEM AUGER
NORTHING(Y):	N/A	SAMPLER:	2" OD X 24" L
ELEVATION(Z):	N/A	HAMMER WEIGHT:	140 LBS (AUTO)

TOTAL DEPTH:	10 FEET				
DRILLED:	P.RODRIGUEZ	INITIAL WATER LEVEL: NOT DETECTED	FINAL WATER LEVEL: N/A	START DATE:	1/14/2025
LOGGED BY:	R. OCASIO	ELAPSED TIME: N/A	ELAPSED TIME: N/A	FINISH DATE:	1/14/2025

Depth (Feet)	Depth (Meters)	Sample No.	Blows (per 6 in.)	N	Graphic Log	SOIL DESCRIPTION	+ N Value (20 40 60 80) / ◇ q_u × PEN (1 2 3 4)	q_u (tsf)	PEN (tsf)	Total Unit Wt. (pcf)	Water Content (%)
0	0	1	11-13-17-11	30		SILTY SAND AND ROCK FRAGMENTS, dense, grayish brown					7.7
		2	5-3-4-5	7		SILTY CLAY, little sand, little rock fragments, medium, grayish brown			1.0		13.1
5		3	6-3-3-5	6		SILTY CLAY, little sand, little sand, medium, very dark gray			1.0		25.7
		4	4-4-6-8	10		SILTY CLAY, little sand, little rock fragments, stiff, dark grayish brown yellowish brown			2.0		18.8
		5	4-25-35-25	61		SILTY SAND AND ROCK FRAGMENTS, very dense, gray, bluish gray					10.9
10	3					END OF BORING AT 10 FEET					

Notes: *All Depth Referred to Exsiting Grade*

"HW": Hammer Weight / Weight of Hammer

▼ Initial Water Level Reading

▽ Final Water Level Reading

+ N: SPT N - Value (ASTM 01586)

◇ q_u: Unconfined Compressive Strenght (Spring Tester)

× PEN: Pocket Penetrometer

COMMENTS: 1-INCH ASPAHALT PAVEMENT AT SURFACE

APPENDIX 3

FIELDWORK AND LABORATORY TESTING PROCEDURES

APPENDIX 3:
FIELD AND LABORATORY TESTING PROCEDURES

DRILLING

Auger Borings (ASTM D 6151). These are performed by turning a hollow-stem auger into the ground a short distance. As the auger advances into the ground, the cuttings rise to the surface on the auger spirals. The depth from which the cut material comes cannot be accurately determined. By using hollow-stem augers, samples can be recovered from the bottom of the auger, thus eliminating the need for driving casing.

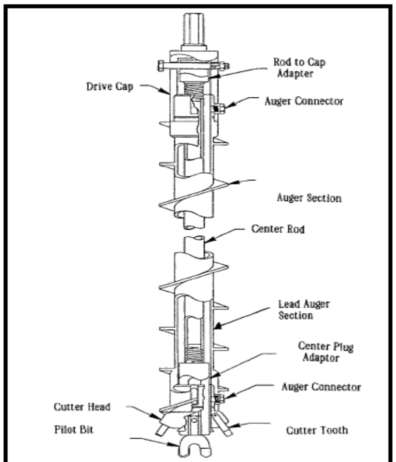
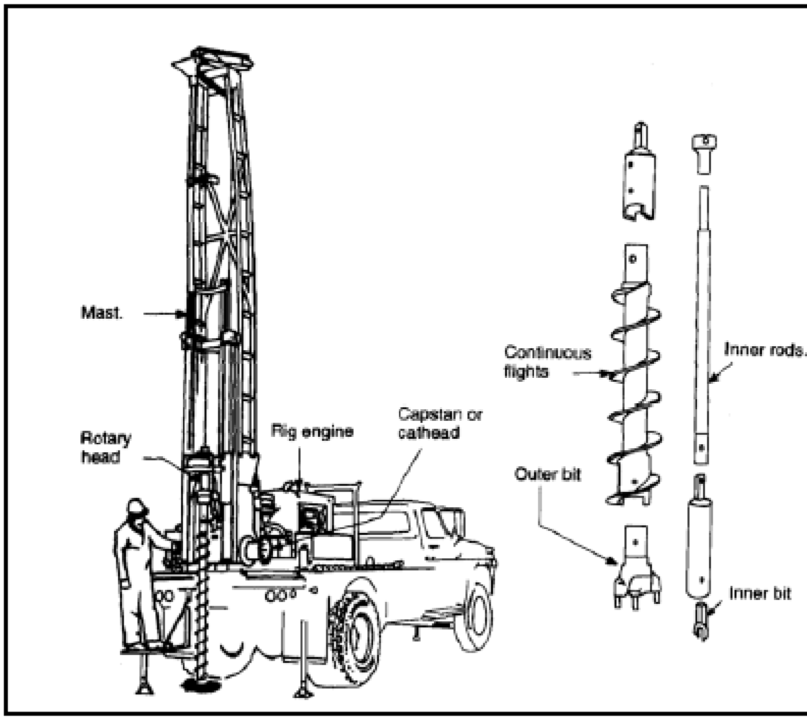


FIG. 1 Rod-Type Auger System With Pilot Bit[1]



When drilling in caving soils or cohesionless soils below the water table, there is the possibility for sand lock (plugging), heave or blow-up of the borehole bottom, or caving of the soils. In this case, water or drilling fluid is usually injected into the hollow-stem auger, to provide hydrostatic balance while drilling and sampling.

Core Borings (ASTM D 2113). Usually performed on rock formations, core borings are advanced by rotating drill rods, a core barrel and diamond bit. As the bit cuts into the rock, the rock core is free to move into the inner core barrel head, which is suspended on a swivel. Cooling water or bentonite slurry is circulated through the drill rods and the core barrel. Penetration depends on the length of the core barrel and the quality (amount of joints or fractures) of the rock. Core runs are longer as rock quality increases. As the core barrel is withdrawn, the core lifter, located inside the diamond bit, wedges itself around the bottom of the rock core, thus permitting it to be pulled free from the underlying rock.

SAMPLING AND HANDLING

Standard Penetration Test (ASTM D 1586). Standard Penetration Tests (SPT) are performed by driving a 1.375-in ID x 2-in OD x 18- or 24-in long, split spoon sampler, with 140-lb drop hammer falling freely from a 30-in height. The number of blows for every 6-in of sampler penetration is recorded, and the number of blows between 6 and 18 inches of penetration is reported as the uncorrected N-value. Furthermore, SPT N-Values are dependent on various factors, such as: hammer type (i.e. donut, safety, or automatic), driller experience and proficiency, depth of sampling, diameter of borehole, equipment conditions, etc.

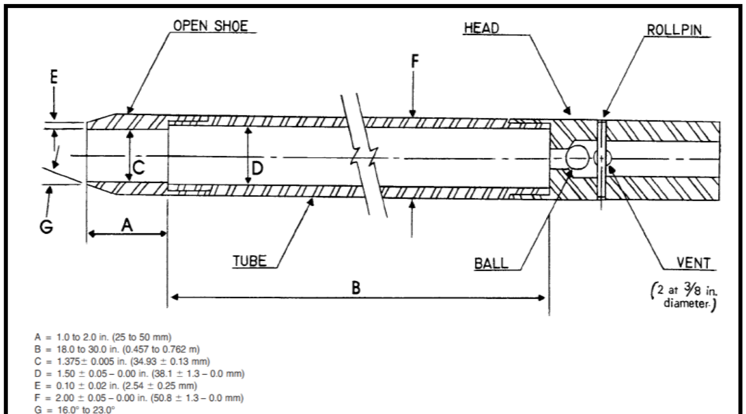


FIG. 2 Split-Barrel Sampler

Samples are immediately stored vertically and sealed in moisture-proof glass jars to avoid moisture loss and breakage. These are labeled and transported to the office laboratory for visual classification and other routine laboratory tests.

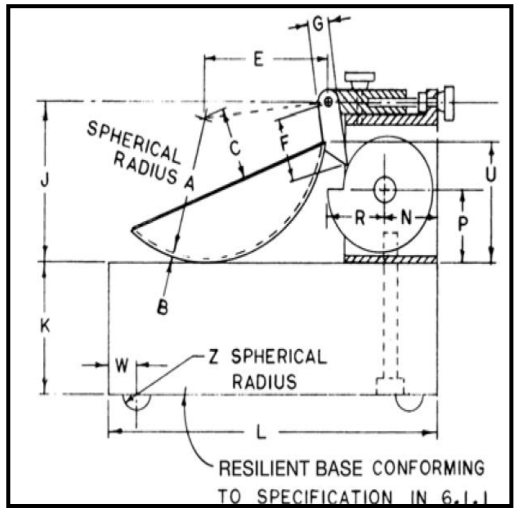
The SPT has been correlated with the consistency of fine-grained soils, and the angle of internal friction or the relative density of sands. However, these have been based on an energy efficiency of 60% of theoretical. Hence, correction factors, especially to the drop hammer, have to be applied. In the case of fine-grained soils, the correlation of the SPT with the undrained shear strength of medium and stiff silts and clays of low sensitivity have been found to be fairly good. However, in the case of soft silts and clays, the SPT yields poor estimates of the undrained shear strength. Therefore, testing undisturbed samples, and performing other in situ tests (e.g. vane shear, cone penetration, dilatometer, etc.) may be more reliable for these cases.

Undisturbed Sampling (ASTM D 1587). Undisturbed samples are obtained with thin-walled Shelby tube samplers, 2- to 5-in OD by 30-in long. The sampler is forced into the soil by applying constant downward pressure and is pulled out. These samplers are sealed in the field with wax and transported to the laboratory. Samples are then extruded at the time of testing by pushing in the same direction that the samples penetrated the sampler. Special care is taken in handling these samples to minimize disturbance.

Preserving and Transporting Soil Samples (ASTM D 4220). All soil samples recovered from SPT are stored vertically, and immediately transported to the office laboratory for visual classification and other routine laboratory tests. Undisturbed soil samples are transported vertically, and stored in custom-made wooden boxes that provide cushioning (urethane or foam) for each sample container, and, when necessary, shipped via FedEx to a trusted outside laboratory for specialized testing.

STANDARD LABORATORY TESTING

Natural Moisture Content (ASTM D 2216). This is the water content of the in situ soil. It is obtained from either disturbed or undisturbed samples. The procedure consists of placing a portion of the soil sample in an oven for 24 hours at a temperature of 110° C. The difference in weight between the natural and oven-dried states of the soil, divided by the dry weight of the dry samples, expressed in percentage, is reported as the natural moisture content (w_n).



Atterberg Limits (ASTM D 4318). The Atterberg limits refer to moisture content values where the soil mass changes between a semisolid, plastic, or liquid state. They are commonly used in geotechnical engineering for soil identification and classification purposes. They can also be correlated empirically to various soil parameters which are used for preliminary analyses. The procedure used to determine liquid and plastic limits are described in the referenced ASTM standard.

Particle Size Distribution (ASTM D 422). The particle-size analysis of soils provides the particle size distribution of soil samples for engineering classification purposes. This is performed by first oven-drying the soil sample, and then using a series of sieves to determine the percentage of soil retained at each sieve size. The results of this test, along with the Atterberg Limits, are used for soil classification purposes.

Unconfined Compression (UC) Test (ASTM D 2166). The best-quality samples recovered during SPT Tests are subjected to unconfined compression tests. These samples are disturbed and undrained shear strength obtained is usually lower than the "true" in-situ internal strength, depending on the degree of disturbance and the soil sensitivity. Therefore, the unconfined strength value determined from this test is only used as index property for classification and identification purposes. If more accurate strength values are required, undisturbed samples are used.

Pocket Penetrometer Test. This is a test used both in the field and laboratory for quick shear strength estimates. The test provides approximate unconfined shear strength, from which undrained shear strength can be estimated. This test is performed on samples recovered during SPT Tests and compared to UC Tests described above. The advantage of this tool is that it can be used quickly and easily, and can be used to test smaller soil samples.

Free Swell Test. This test consists of placing a known volume of dry soil (finer than No. 40 sieve) in a measuring cylinder, and filled to the top with distilled water. The free swell of the soil is measured as the ratio of change in volume over the initial volume of the soil sample, and it is expressed as a percentage.

SOIL DESCRIPTION / CLASSIFICATION

Visual-Manual Procedure (ASTM D 2488). The visual-manual description of soils includes the color, soil type (gravel, sand, silt, clay, organic), consistency (if soil is fine-grained), relative density (if soil is coarse-grained), particle size and roundness (if soil is coarse-grained), and other special characteristics which can assist in the identification and classification of the soil.

To describe the apparent particle size distribution based on visual-manual examination, the following terms are used:

Descriptive Term	Percent of Sample
Trace	1 - 10%
Some	10 - 20%
Sandy, Gravelly, Silty, Clayey	20 - 35%
And	35 - 50%

To describe the relative density of sands and consistency of clays, a correlation is used based on SPT N-values and unconfined compressive strength, as follows:

Sands		Clays		
N-Value	Relative Density	N-Value	Unconfined Compressive Strength (tsf)	Consistency
0 - 4	very loose	< 2	< 0.25	very soft
4 - 10	loose	2 - 4	0.25 - 0.50	soft
10 - 30	medium	4 - 8	0.50 - 1.00	medium
30 - 50	dense	8 - 15	1.00 - 2.00	stiff
> 50	very dense	15 - 30	2.00 - 4.00	very stiff
		> 30	> 4.00	hard

Unified Classification System (ASTM D 2487) and AASHTO (ASTM D 3282). These are the industry standards for engineering classification of soil. The information obtained from visual-manual procedures (i.e. color, consistency, relative density, etc) are complemented with the results of Atterberg limits and particle size distribution tests to provide a standardized classification of soil for engineering purposes.

ROCK DESCRIPTION

Geologic features used to describe rock cores are the degree of weathering, hardness, joint bedding and foliation spacing, percent recovery, RQD, etc. These are explained as follows:

Weathering.

Degree	Sample Condition
Fresh	Fresh, bright crystals, few joints, may show slight staining. Rock rings under hammer if crystalline.
Very Slight	Generally fresh, joint-stained, some joints may show clay if open, crystals in broken face show clay if open, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Generally fresh, joint-stained and discoloration extends into rock up to 1". Open joints contain clay. In granodiorite rocks, some feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granodiorite rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer, and show significant loss of strength as compared with fresh rock.
Moderately Severe	All rocks, except quartz, discolored or severely stained. In granodiorite rocks, all feldspars are dull and most show kaolinization. Rock shows severe loss of strength and can be excavated with geologist pick. Rock goes "chunk" when struck.
Severe	All rocks, except quartz, discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granodiorite rocks, all feldspars are kaolinized to some extent.
Very Severe	All rocks, except quartz, discolored or stained. Rock "fabric" not discernible, or discernible only in small scattered locations. Quartz may be present as dikes or stringers.

Joint Bedding and Foliation Spacing in Rock. Joint spacing refers to the distance normal to the plane of the joints of a single system, or "set" of joints which are parallel to each other or nearly so. The spacing of each "set" should be described if it is possible to establish.

Spacing	Joints	Bedding & Foliation
< 2"	very close	very thin
2" - 1'	close	thin
1' - 3'	mod. close	medium
3' - 10'	wide	thick
> 10'	very wide	very thick

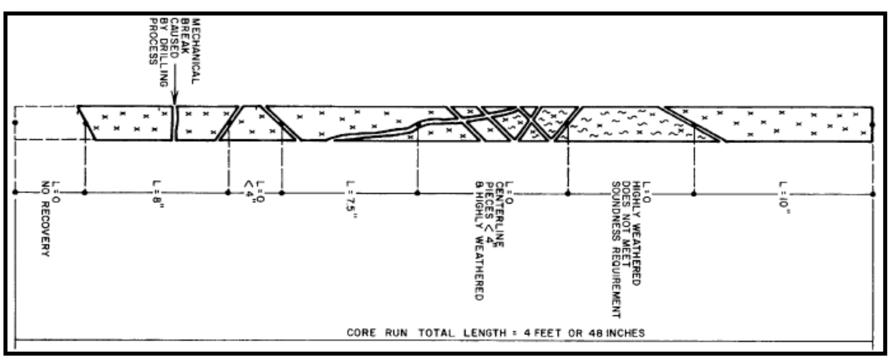
Hardness.

Degree	Sample Conditions
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows with geologist pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately Hard	Can be scratched with knife or pick. Deep gouges or grooves can be excavated by hard blow with point of geologist pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16" deep by firm pressure of knife or pick point. Can be excavated in small 1" chips with geologist pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips, several inches in size, by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces, one inch or more in thickness, can be broken by finger pressure. Can be scratched readily by finger nail.

*These measures of hardness are used for engineering description of rock, not to be confused with Moh's scale for minerals.

Core Recovery (CR) and Rock Quality Designation (RQD) (ASTM D6032). In addition to the inspection of the rock core, other valuable information to the engineer is the percent recovery, and the rock quality designation (RQD). The percent recovery is defined as:

$$\% \, RECOVERY = \frac{Length\ of\ Core\ Sample\ Recovered}{Length\ of\ Cored\ Run}$$



If the core is broken by hauling or by the drilling process (i.e., the fracture surfaces are fresh irregular breaks rather than natural joint surfaces), the fresh broken pieces are fitted together and counted as one piece, provided that they form the required 4-inch length. Some judgment is necessary.

The RQD is expressed in percent for NX or NWM cores as:

$$RQD = \frac{Sum\ of\ the\ Lengths\ of\ Core\ Pieces\ Longer\ than\ 4in}{Length\ of\ Cored\ Run}$$

The quality of the rock is described as follows:

RQD, %	Description of Rock Quality
0 - 25	very poor
25 - 50	poor
50 - 75	fair
75 - 90	good
90 - 100	excellent

APPENDIX 4

GENERAL EARTHWORK GUIDELINES

APPENDIX 4:
GENERAL EARTHWORK GUIDELINES

Earthwork operations required at site may consider the following general guidelines. Once final project requirements are established, additional earthwork recommendations may be required.

- *Clearing, Grubbing, Stripping and Excavations*

The site should be cleared and stripped of all surface and near-surface deleterious materials, including buried utility lines or structures, pavement, construction debris, vegetation and associated roots prior to fill placement or at the foundation areas. **The actual stripping / excavation depth should be determined directly at the field during earthwork operations, depending on the conditions observed, and the final design of foundations**.

All excavations at the site should be performed in accordance with 29 CFR Part 1926, **"Occupational Safety and Health Standards - Excavations; Final Rule,"** published by the U.S. Dept. of Labor, Occupational Safety and Health Administration.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY EXCAVATIONS AT THE SITE. This includes the design of any required temporary slopes, dewatering, and shoring and bracing, as necessary. Positive surface gradients should be provided to divert surface runoff away from excavations for foundations and construction areas. Ponding of water should be avoided to reduce damage of properly graded areas.

- *Proof Rolling*

Following excavation, once all loose materials are removed from the excavation process, the exposed surfaces should be proof-rolled to detect soft spots. Proof-rolling consists of rolling the area with a smooth roller (static or vibratory), observing the reaction (firmness or softness) of the exposed soil surface. In general, the area should be rolled with to the satisfaction of the Geotechnical Engineer, or his representative, retained by the owner.

In the case soft spots are encountered, the actual undercut depth at soft/loose areas should be determined directly at the field during earthwork operations, depending on the conditions observed. These areas should be replaced with a compacted fill pad of engineered soil.

- *Fill Materials*

Borrow materials for fill and/or backfill should consist of essentially granular material, as follows:

- **AASHTO Soil Classification system**: A-2, or better
- **Unified Classification system**: GW, GP, GM, GC, SW, SP, SM, or SC

All fill/backfill should be free from vegetable matter and should not contain rocks greater than 6 inches in size, and should be **approved by the Geotechnical Engineer-of-Record**.

- *Compaction*

Any fill and/or backfill required to attain finished grade, or in the case of over-excavations, should be placed as follows:

- **Layer thickness**: not exceeding 8 inches (loose measure)
- **Density**: 95% of Modified Proctor Maximum Dry Density (ASTM D1557)
- **Water Content**: within -2% to +4% of optimum (W_{opt})

As the placement of each layer progresses, continuous leveling and compaction should be performed to assure uniform density and satisfactory surface drainage. Compaction equipment selected by the contractor should be able to compact the fill to the specified minimum compaction at the proper moisture content. Water should be added or removed, as necessary.

Field density tests should be performed by the Geotechnical Engineer, or his representative, to measure the density of each layer of fill. If the density tests indicate that the attained density is less than that required, additional compactive effort should be applied by the contractor until the specified density is obtained. Sufficient density tests should be made to support the Geotechnical Engineer's approval of each fill layer.

- *General*

All earthwork activities, starting with clearing and grubbing, should be observed by a Geotechnical Engineer or his representative. Observations should be performed continuously throughout earthwork operations, including, but not limited to identification and removal of unsuitable materials, laboratory testing and approval of proposed fill materials, and in situ testing of compacted materials for quality control. This is general accordance with the guidelines of **IBC Table 1704.7.**

The above are general guidelines for earthwork activities. The actual project specifications should incorporate all requirements contained within this text. **Variations in soil conditions are possible and may be encountered during construction**. To correlate the soil data recovered in this exploration program and actual subsurface conditions encountered during construction, and to observe conformance with the project specifications, it is essential that a Geotechnical Engineer or his representative be retained during the earthwork phases of the project.

APPENDIX 5

GEOPROFESSIONAL SERVICES PHASES/LEVELS

APPENDIX 5:
STUDY LIMITATIONS & GEOPROFESSIONAL PHASES

The CLIENT recognizes that special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing program, implemented with the appropriate equipment and experienced personnel under the direction of a trained professional who functions in accordance with a professional standard of care may fail to detect certain conditions, because they are hidden and therefore cannot be considered in development of a subsurface exploration program.

For similar reasons, actual geological and geotechnical conditions between borings may differ significantly from those that actually exist. The passage of time must also be considered, due to natural occurrences or direct or indirect human intervention at the site or distant form it may quickly change. The CLIENT realizes that nothing can be done to eliminate this risk altogether, but certain techniques can be applied to help reduce them to that level tolerable by the CLIENT. **GMTS** is available to explain these risks and risk reduction methods.

Geoprofessional services can be divided into multiple phases/levels, as follows:

<u>Phase I</u>: ***Subsoil Investigation***

<u>**Level 1:**</u> ***Geotechnical Desktop Study*** is generally the first level available in the geotechnical toolbox. This type of study provides an overview of site conditions on a holistic level. Desktop studies are effective and valuable tools that are used as part of site investigation processes (for developed and/or undeveloped sites), especially for sites or projects that require an initial macro-level evaluation. A well-executed desktop study aids in identifying the likelihood of areas/zones exposed to specific risks without necessarily going into the micro (detailed) investigation level.

To perform the desktop study, **GMTS** utilizes its in-house comprehensive database, aerial photos, literature survey, and additional databases available, such as maps and public reports. The results are presented in a preliminary geotechnical desktop study report. The preliminary report may provide guidelines and recommendations of exploratory work at a given site as part of **Levels 2** and **3**.

<u>**Level 2:**</u> this level considers a ***Preliminary Subsoil Exploration*** program. The geoprofessional advises the client about project-specific risks and a preliminary subsurface exploration plan that responds to the CLIENT's risk tolerance levels, budget, schedule, and other vital concerns. The above results in the performance of a preliminary subsoil exploration of the site, preliminary evaluation of the encountered conditions and the preparation of a preliminary geotechnical engineering report, including opinions on the subsurface profile and general recommendations (generally performed with simplified procedures and presented in terms of ranges) for the preliminary design of the project. ***The recommendations provided are preliminary until confirmed with a final subsoil exploration program, geotechnical design, and field observation***, because of the uncertainty associated with the subsurface profile prepared, based on a statistically limited number of soil samples obtained on the subsoil exploration program.

<u>**Level 3:**</u> the third level considers a ***Final Subsoil Exploration*** program. Generally, this is conducted after **Level 2**, or may be conducted directly, depending on the client's requirements.

This level combines methods used in **Levels 1** and **2** to provide a more comprehensive study. As in **Level 2**, the geoprofessional advises the client about project-specific risks and a comprehensive subsurface exploration plan that responds to the CLIENT's risk tolerance levels, budget, schedule, and other vital concerns. The above results in the performance of a final subsoil exploration of the site (*e.g.* borings, geophysical work, geotechnical instrumentation, etc.), a more comprehensive evaluation of the encountered conditions and the preparation of a geotechnical engineering report, including opinions on the subsurface profile and recommendations for design of the project. ***Even if they are not labeled as such, these recommendations are also preliminary until confirmed with specific geotechnical design and field observation*****,** because of the uncertainty associated with the subsurface profile prepared, based on a statistically limited number of soil samples obtained on the subsoil exploration program.

Phase II: ***Geotechnical Design Phase***

Geotechnical design is the next phase of a complete geoprofessional service and is directly related with specific design aspects of foundations, site improvement, and any other specific aspects of each project, as part of the design process. This requires a final project design and final evaluation of design aspects. This may also require additional site investigation, especially if a preliminary phase (**Level 2**) was not performed and/or the final exploration (**Level 3**) disclosed unanticipated areas of concern. Detailed and advanced geotechnical evaluation is conducted in this phase to optimize, for example, foundation design of structures. This may require iterations of designed elements for efficient optimization and specialized/advanced analyses such as finite element or complex soil-structure interaction modeling.

Phase III: ***Field Observation***

Field observation during construction comprises the third phase of a complete geoprofessional service; permitting those who developed the geotechnical engineering report to observe excavation and/or installation and thereby assess the reliability of their subsurface profile and appropriateness of the ***preliminary recommendations*** provided in the geotechnical engineering report.