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January 11, 2011

Mr. José M. Rosado
Deputy Distric Engineer for the Antilles
Chief Antilles Regulatory Section
US ARMY CORPS OF ENGINEERS
Jacksonville District
400 Fernandez Juncos Avenue
San Juan, Puerto Rico 00901-3229

Dear Mr. Rosado:

Enclosed you will find a geotechnical report on the design and project entitled **VIA VERDE** proposed by the Puerto Rico Electrical Energy Authority. I include an analysis, conclusions with recommendations stemming from a three months rigorous study of the documents presented by the local agency.

As a very concern citizen preoccupy with the safety of my fellow countrymen, I felt compelled to make public my findings that from a technical and scientific point of view reveal serious flaws with this project. I urged you to considered them and **not approve** the proposed plan to construct a gas duct in this region.

Feel free to contact me If you have further questions of my analysis.

Thanking you in advance to your attention to this letter, I remain respectfully yours,

Pedro Jiménez Quiñones, Ph. D. F-ASCE

Colegio de Ingenieros Y Agrimensores de Puerto Rico - American Society of Civil Engineers
American Society of Professional Engineers
International Society of Soil Mechanics and Foundation Engineering

REPORT
ON
THE *VIA VERDE* PROJECT OF THE ELECTRIC ENERGY AUTHORITY TITLED *GASODUCTO* DE PUERTO RICO: A TECHNICAL EVALUATION

By

Dr. Pedro Jimenez Quinones, P.E., F-ASCE
Consulting Engineer – Geotechnics

Submitted to:
Mr. José M. Rosado
Deputy District Engineer for the Antilles
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REPORT
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1. Introduction

This report covers the technical engineering evaluation of the Gasoducto de Puerto Rico, a 91-mile natural gas line project running from Peñuelas on the south to Arecibo on the north and Guaynabo on the East. This technical evaluation is my analysis, as a civil engineer that can serve as a guideline to specialists, the people of Puerto Rico and the Federal Agencies in forming a learned opinion on the implications of such a project. Figure 1 shows the route of the Gasoducto as it was presented by Eng. Miguel Cordero in the newspaper **El Nuevo Día** of September 10, 2010.

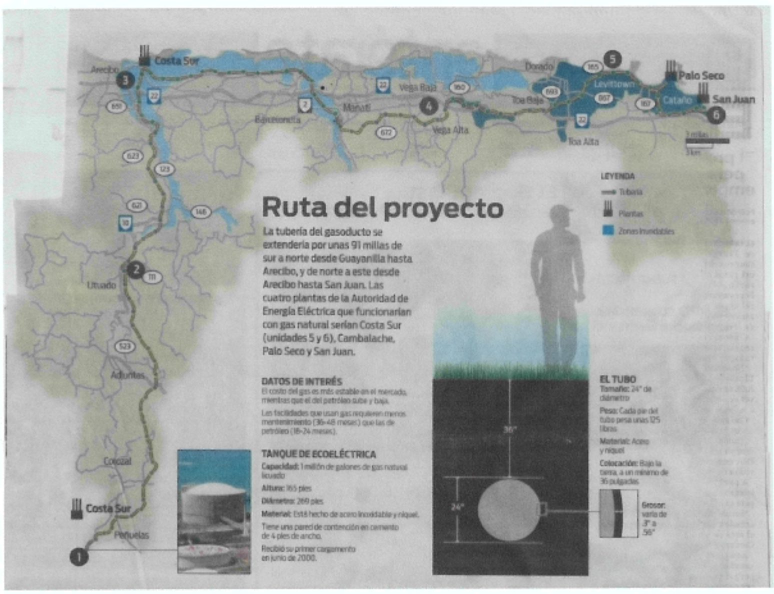

Figure 1. Map of the Gas Line, "Gasoducto" Project extending for 91 miles from Costa Sur electric plant in Penuelas to Arecibo and then east to Guaynabo. The gas line is a 24 inch steel pipe located at a depth of 5 feet below the ground surface as shown in the cross section presented above.

The study and analysis of the project is based on my background as a Civil Engineer, my graduate studies in the field of Soil Mechanics and Foundation Engineering and my experience as a Consulting Engineer during the past 53 years.

From the analysis of the project we want to establish the following:

a- Demonstrate with previous projects, constructed in similar geological settings, the problems and difficulties encountered that will be present in the construction of the gas line proposed by the Puerto Rico Power Electric Energy Authority.

b- From our assessment of the documents submitted by the agency they lack scientific studies of geotechnical engineering, general engineering drawings and construction specifications required for bidding, plans including longitudinal profiles, sections, technical design, including classification of soil to be used as fill material, the compaction of the soil around and beneath the steel pipe. From the document of the DIA-P prepared by DIVISION DE PROTECCION AMBIENTAL Y CONFIABILIDAD DE CALIDAD Y ASESORES AMBIENTALES Y EDUCATIVOS, we downloaded 24 topographic maps with the route of the gas line pipe at a certified scale of 1:20,000. We found in the documents great error in the scales of the topographic plans. Also 13 google earth maps with the route of the gas line pipe drawn were obtained from the DIA-P.

c- Study and analysis of Soil Classification, article 3.3 Tipos y Caracteristicas de los Suelos which reveal classification of soils is for agricultural purposes.

d- Study and analysis of Formaciones Geológicas and Overview of the Geology of the Proposed Via Verde Natural Gas Pipeline, Peñuelas to San Juan, Puerto Rico is very general and not applicable for construction purposes.

e- From previous accidents occurring in many countries and considering the island of Puerto Rico very small, it is unnecessary to build the gas line. Alternatives of increasing facilities and constructing additional tanks in Penuelas, as well as in Arecibo, Palo Seco and San Juan with the terminal facilities required are recommended.

2. Previous projects constructed in similar geological settings. Construction of Highway PR - 10

In 1985 my consulting services to the Highway and Transportation Authority covers the solution of landslide problems during the construction of highway PR-10, specifically projects AC-001084, AC-001081 and AC-001029 from Arecibo to Utuado[1]. The construction of PR-10 represents a very good example for the study of geotechnical engineering problems and its relationship with the construction of a highway in the geologic context of the island, one of the most complex in the world. On this site, the Lares limestone and extensive sinkholes are typical and the organic expansive clay of the San Sebastian Formation underlies the first and dips towards the North. Figure 2 shows a view of PR-10 during construction.

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[1] Deere, D. U., P. Jiménez Quiñones & D. Hernández. *Complex Landslides at Plateau Margins with an Example from Puerto Rico.* **The Art and Science of Geotechnical Engineering At the Dawn of the Twenty-First Century. A Volume Honoring RALPH B. PECK.** New Jersey: Prentice Hall. 1989.Pg. 349.

Figure 2. The photograph shows PR-10 under construction. On the background Lares limestone cliffs are shown..

The karst topography of the Lares limestone is characterized by mogotes and sinkholes. The annual rainfall of the area of Utuado and Arecibo is about 70 to 80 inches. The rainfall water rises to 10 and 15 feet in height in the sinkholes. Water seeps through the bottom and walls of the sinkholes since the Lares limestone is permeable. Figure 3 and 4 show sinkholes developed between the mogotes.

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Figure 3. In the photograph is shown a sinkhole located between the limestone mogotes of AC-0081 project of PR-10. Note that water is seeping toward the walls of limestone.

Figure 4. Shown is another sinkhole located between the limestone mogotes of AC-0081 project of PR-10 and investigated by a geologist of the Area of Technical Services of the Highway and Transportation Authority.

At the beginning of the middle Tertiary time, two embayments were formed in the island of Puerto Rico. One of the embayments was located on the Northwest and the other on the South as shown below in Figure 5. At the North embayment organic clays and silts were deposited. These were referred to as the San Sebastian Formation due to its prominence in the town of San Sebastian. The organic clay and silts deposited in the South embayment were identified as the Juana Diaz formation[2].

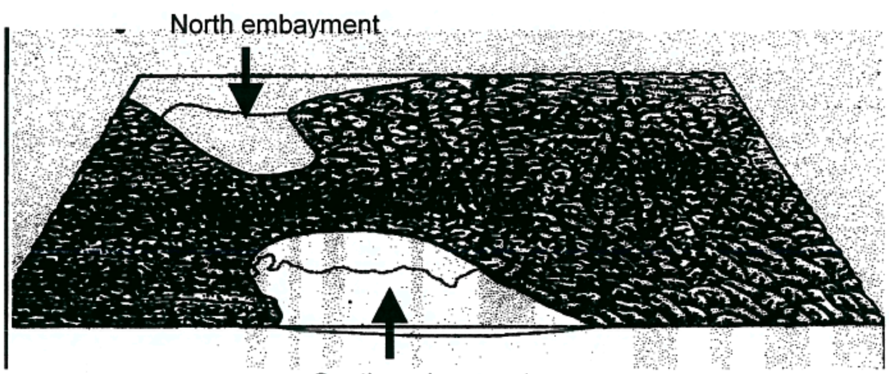

Figure 5. Puerto Rico at the beginning of Middle Tertiary Time. Organic clays and silts and organic matter were deposited in the embayments.

[2] Meyerhoff, G., Geology of Puerto Rico, San Juan, University of Puerto Rico, 1938.

During construction of PR-10 a brown gray expansive clay of the San Sebastian formation was found underlying the Lares limestone as shown in Figure 6. The San Sebastian formation dips toward the North as shown.

Figure 6. A view of the finished slope in PR-10 showing the gray expansive clay belonging to the San Sebastian formation.

The gray expansive clay has a very high volume change potential, is very sensitive and exerts very high swelling pressures. Heavily reinforced concrete box culverts constructed for the disposal of rainfall water were badly cracked and broken due to the high swelling pressures exerted by the expansive clay. X ray and differential thermal analyses performed in Moca clay which belongs to the San Sebastian Formation indicated the clay mineral present is montmorillonite.

The project is located in Barrio Río Abajo of Utuado. The vertical scarp is highly inclined and in some places rises to elevations of of 100 to 120 meters above the final grading of the highway. To the North of the scarp, exists the Karst topography characterized by mogotes or limestone hills rising to 70 or above 100 meters above depressions or water sinkholes as shown in Figure 7.

Figure 7. Typical mogotes and water sinkholes are shown above.

The final grading of AC-001081 was constructed along a step of 100 to 150 meters in width at the base of the scarp. It has an elevation that varies from 325.0 meters at station 172+80 at the beginning of the project to 288.5 meters at station 202 + 00. This indicates that the project is at an elevation of 190 to to 225 meters above the existing old PR-10 from Arecibo to Utuado.

During construction of AC-001081 extensive landslides occurred. Figures 8 and 9 shown below and in next page, indicate the scarp developed of large landslides. Special works like reinforced earth fills and stone keys in the roadway proper were part of the solutions.

Large sinkholes along the route were cleaned and filled with stone and gravel of various size to act as filter.

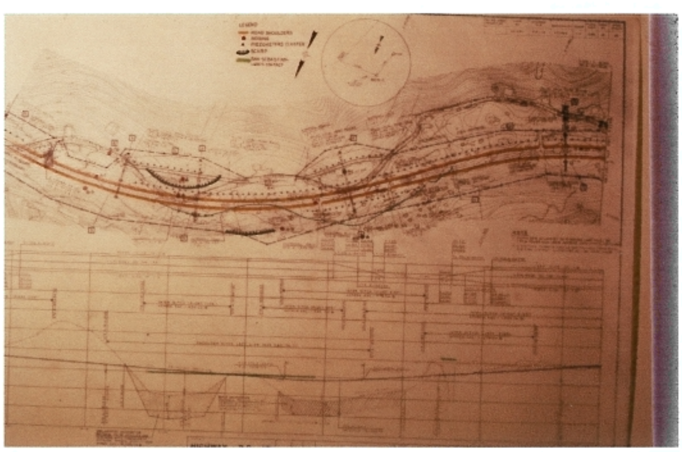

Figure 8. Plan view of highway and scarps of landslide.

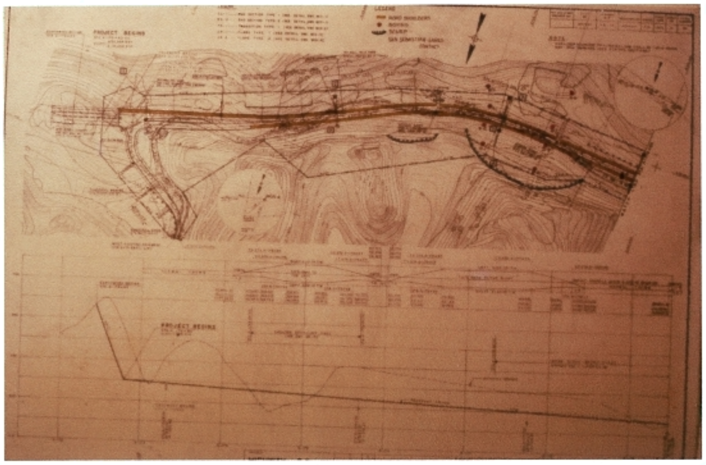

Figure 9. Another section of Plan view of highway and scarps of landslide.

Table–1 show the magnitude of cut and fill for the project. The maximum depth of cut and fill for the project was 20 and 13 meters, respectfully.

Table – 1 Summary of Cut and Fill
Project AC – 001081 PR – 10 Arecibo – Utuado

Station	Cut meters	Fill meters
172 + 43	20.0	
173 + 50	12.0	
176 + 00	7.0	
180 + 55	10.0	
182 + 00		13.0
184 + 00		9.0
188+ 50	10.8	
190 + 35		2.6
193 + 25	9.0	
196 + 00		5.0
197 + 80	9.0	
198 + 90	9.0	
201 + 00		4.0

Being the geology of Puerto Rico one of the most complex in the world, it is constituted by all types of rocks, highly weathered and with joints and faults, a varied geomorphology and a great number of depositional environments. This context, from the engineering point of view, results in a very variable topography, deep residual soil profiles subjected to landslides during periods of high rainfall, a great number of sinkholes and mogotes, the San Sebastian and Juana Diaz expansive clay formations underlying the limestone formations, alluvial and marsh organic deposits, difficult access locations and very high costs for cut and filling operations in the construction of public works.

3. Construction of the Super Aqueduct of Puerto Rico

The writer worked as Consultant to Engineer Carlos A. Ortiz, president of Geotech, a geotechnical engineering consulting firm of San Juan, who was hired to perform a geotechnical subsoil exploration and recommendations for the Super Aqueduct project.

The work assigned to the writer dealt with the engineering analyses of the foundation structures located in the reservoir area known as the Retention Lagoon, the pumping station designed to a depth of 53 feet below the ground surface and the stability analyses of slopes in the lagoon. See Figure 10 below.

Soil borings drilled at the site of the Retention Lagoon clearly indicate that the subsoil consists of loose and medium sands and silty clays. In the next pages are shown three typical soil profiles used for the pseudo-static slope stability analyses under earthquake forces.

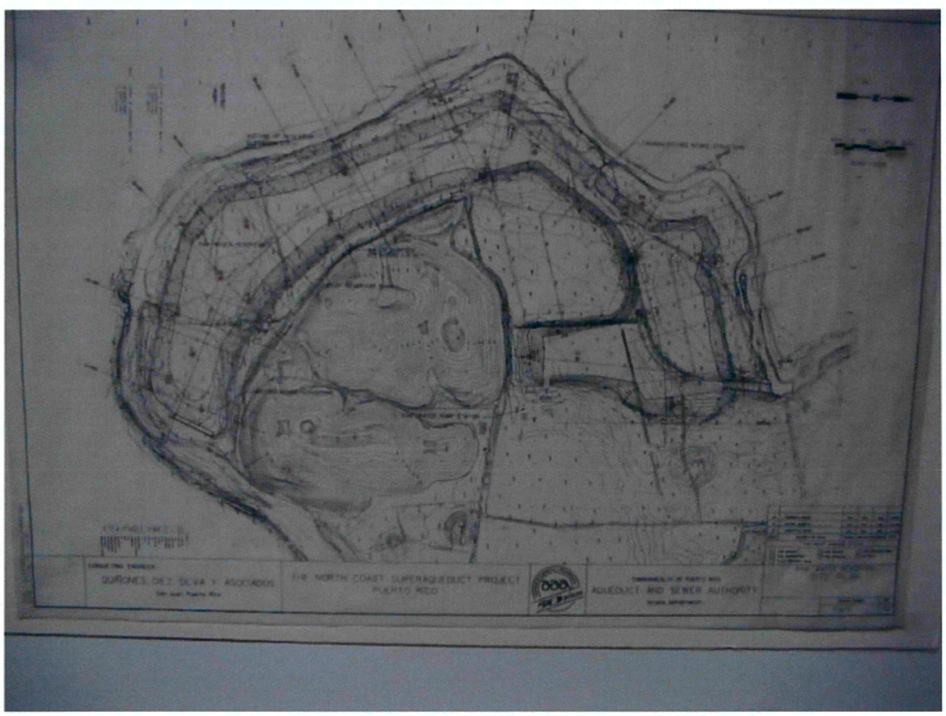

Figure 10. Plan view of the reservoir area or Retention Lagoon of the Super Aqueduct.

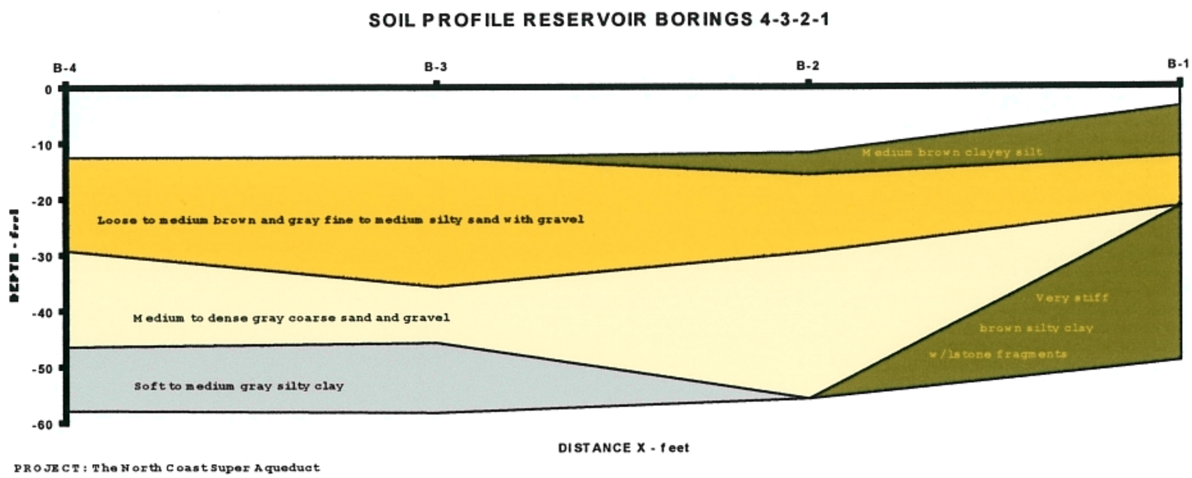

Figure 11. Soil Profile - Borings B-1, B-2, B-3 and B-4

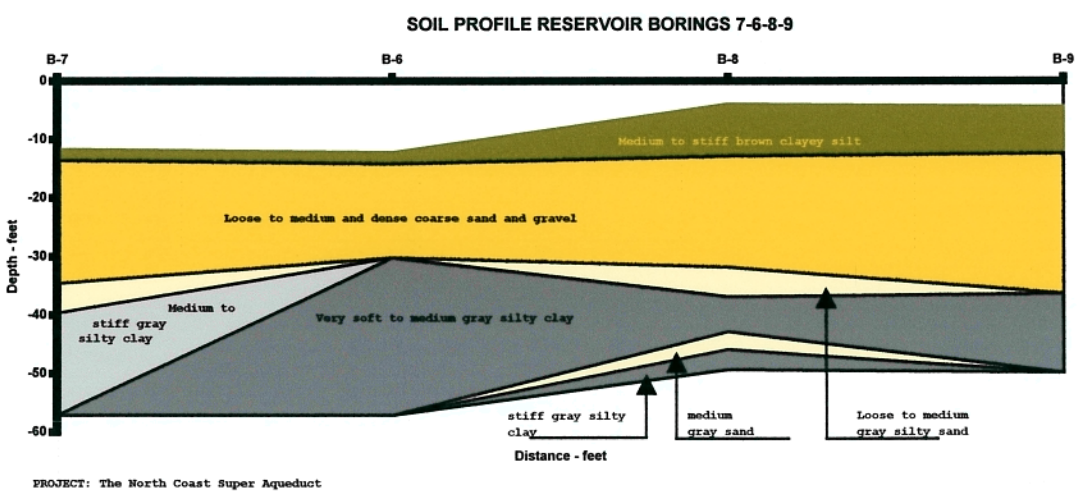

Figure 12. Soil Profile - Borings B-6, B-7, B-8 and B-9

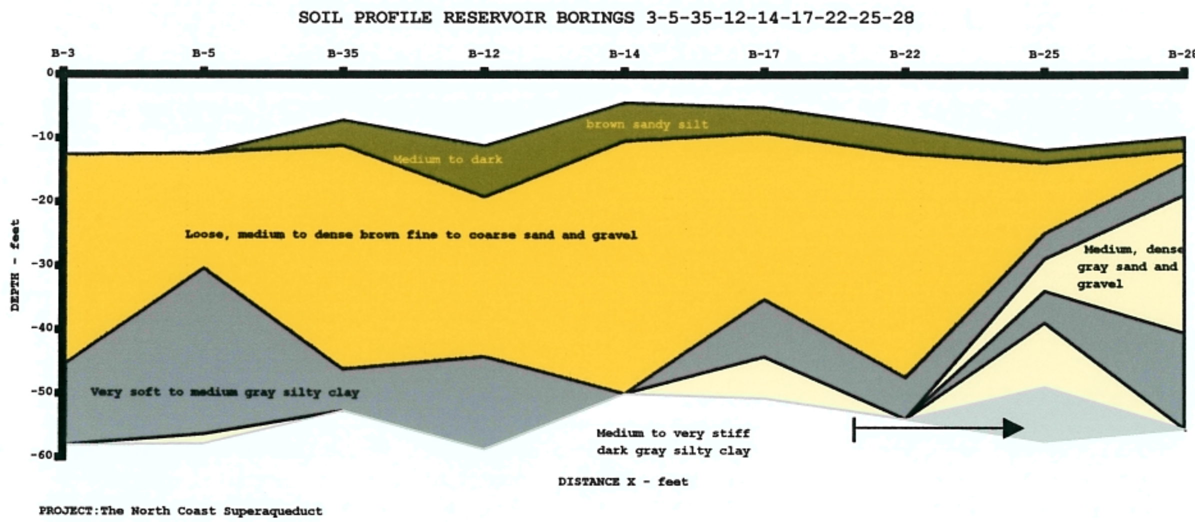

Figure 13. Soil Profile - Borings B-3, B-5, B-35, B-12, B-14, B-17, B-22, B-25 and B-28

Since the Reservoir or Retention Lagoon represents a large open excavation to store water to be drained by gravity to the Pump Station located on the northeast side, slope stability analyses were made to determine the factor of safety of the cut slopes against a shear failure. The soils vulnerable to shear failure are the loose to medium sands and gravels as well as soft bluish gray silty clays found intermediate between fine sands and sand and gravel layers. The analysis used was the Morgenstern & Price Method. A state of the art program, SLOPE/W developed by Dr. D. O. Fredlund from GEOSLOPE International, Calgary, Alberta, Canada was used together with STABL. 5M, a program developed by Purdue University in the mid 1970's and updated by them as recently as 1987. A total of 61 slope stability investigations were conducted for he site, for different boundary conditions, water elevations and earthquake accelerations ($\mathbf{C_h}$ = 0.0, 0.13, 0.20 and 0.32).

The results of the stability analyses indicated that the factor of safety, F_s, against a shear failure for water table elevations of 6.0 and 7.988 meters and horizontal coefficient of acceleration, $\mathbf{C_h}$ = 0.20 and 0.32 was below 1.15.

An alternate to the low factor of safety obtained in the stability analyses was the relocation of the Reservoir to the North East as the easiest way to steer clear of the high water and dynamic instabilities found. The factors of safety were found to be low because the sands and gravels ranged in N values from 1 to 61 and an effective angle of shearing resistance from 34^0 to 38^0. These values precluded the use of the deep cuts proposed by the designer. Although the recommendations made by Dr. Pedro Jimenez Quiñones to relocate the reservoir to northeast side of the project, the design firm represented by Mr. Mel Greene did not accept the recommendations and the reservoir was constructed at the site analyzed.

Due to the great floods of the Rio Grande de Arecibo which occurred as a result of hurricane Georges in 1998, the slopes of the Reservoir were eroded completely, **El**

Nuevo Día, 1998. Although the Reservoir was reconstructed, to date it is still vulnerable to high floods and most likely to earthquakes close to the site.

4. Construction of the Manati Bridge of PR-22 Express Way Over The Manati River

The Manati Bridge consists of 48 piers and two abutments. The writer was in charge of the program of driving 1760 steel H 24 x 73 piles. The average length of the piles driven was 150 feet. Piles with a length of 223 feet were also driven. This is the first bridge where the PDA – pile driving analyzer was used for the first time in the driving of piles in Puerto Rico. Figure 14 shows the location of the bridge.

Soil borings drilled at the site of the Manati river bridge piers and abuments, clearly indicate that the subsoil on the majority consists of soft to medium silty clays. In the next page are shown three typical soil borings and a photograph of the bridge during construction.

It is important to point out that research and observations during earthquakes in this type of soft clay soils indicate that seismic waves are amplified 4 to 6 times.

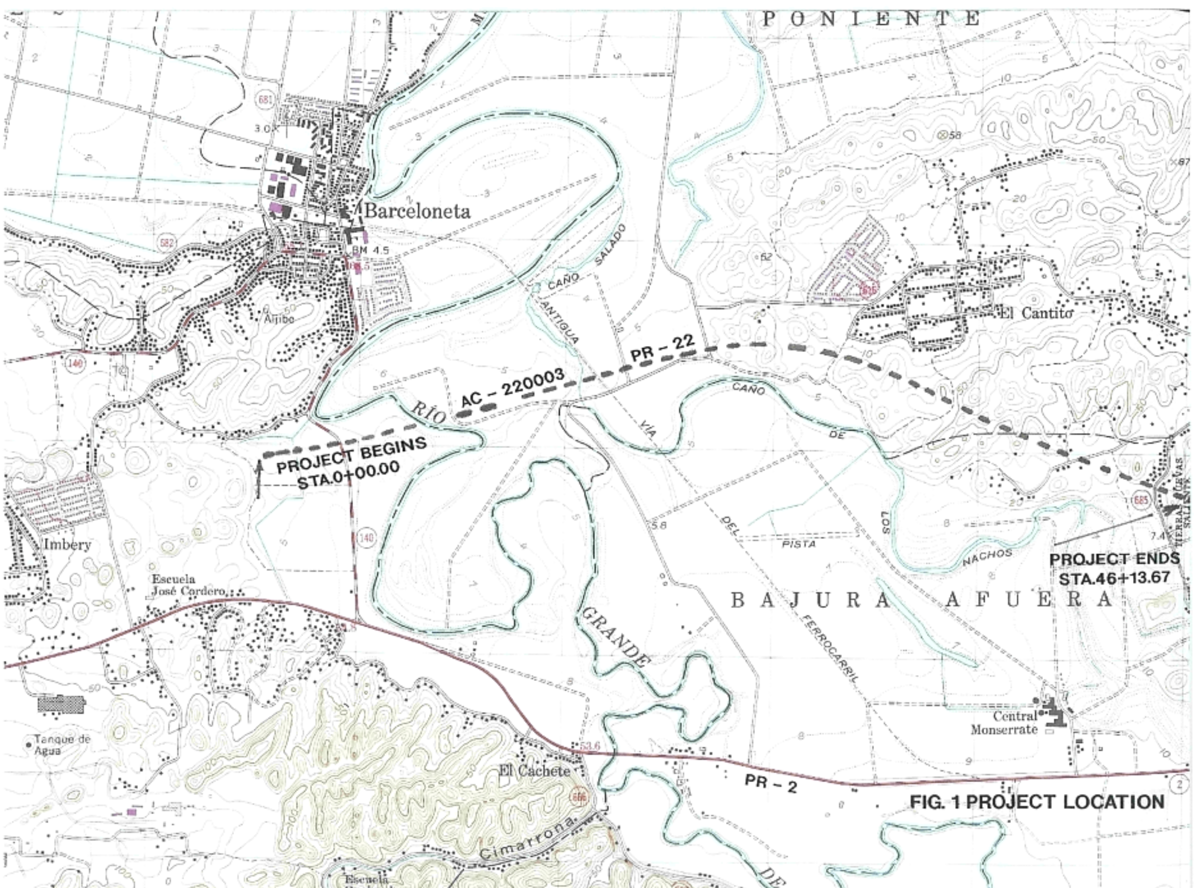

Figure 14. Location of Manati river Bridge, AC-220003

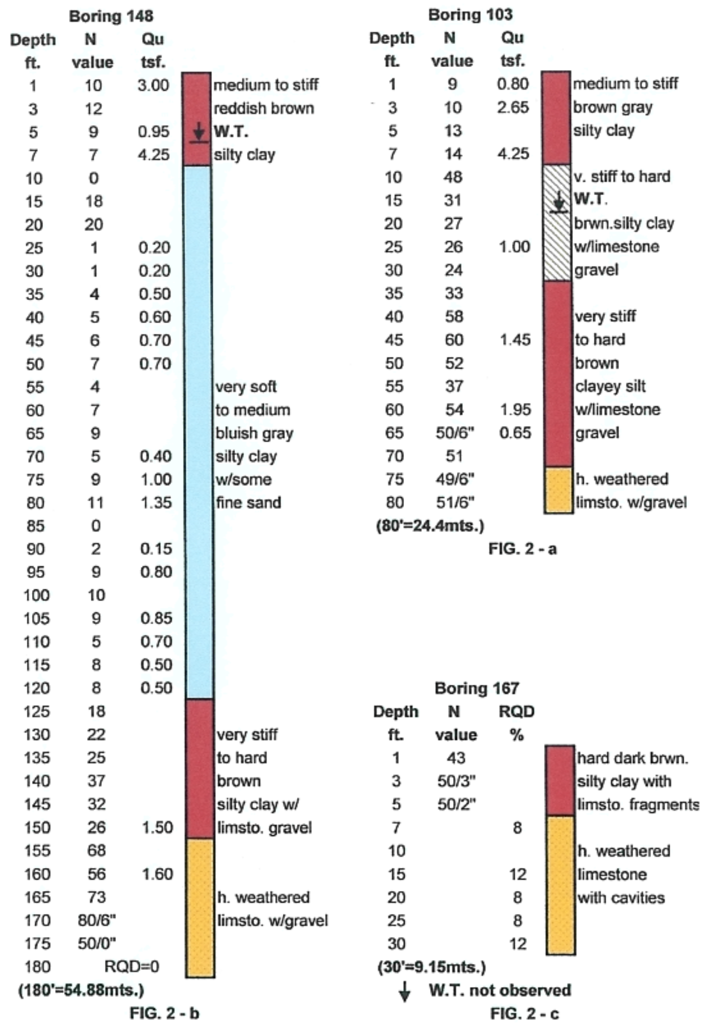

Figure 2. Soil Profiles for Borings 103, 148 and 167

Figure 15. Typical Soil Borings – Very soft to medium bluish gray clay

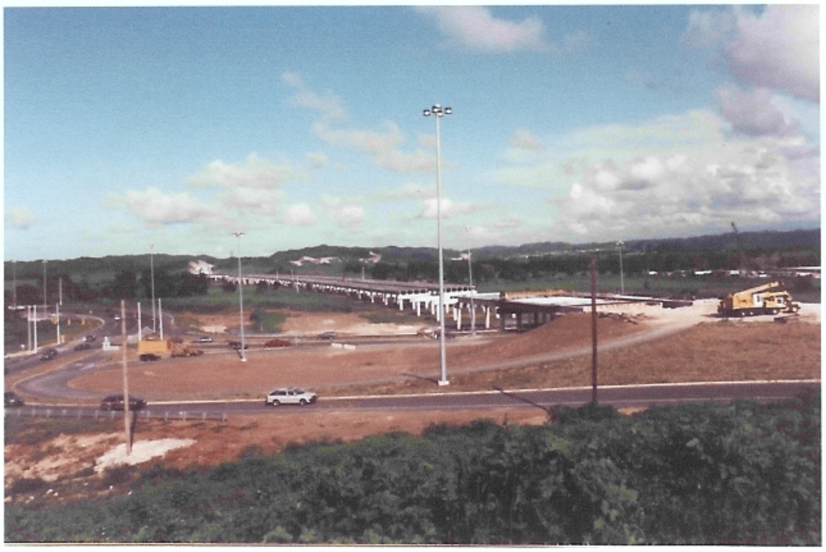

Figure 16. View of the Manati river bridge during construction

5. Natural Gas Line "Gasoducto" Project

5.1 Documents of the Preliminary Ambient Impact Declaration – DIA – P

- Twenty four Topographic Maps with each segment of route shown.

Each one of the topographic maps from Peñuelas, Adjuntas, Utuado, Arecibo, Barceloneta, Manati, Vega Baja, Vega Alta, Dorado, Toa Baja, Cataño, Bayamon and Guaynabo were digitized and inserted as an image in AutoCad coupled with MrCAD Dvp tools. Each one of the maps was clipped and assembled with its neighbor above in the case of the route from Peñuelas in the South to Arecibo in the North. The scale of 1:20,000 certified in each map was found to be incorrect. When compared with a certified USGS geologic map and a graphic scale of 1:20,000, it was found that the real scale of the maps of the DIA-P was about 1:7,200 to 1:7,400. Also, from Arecibo in the North to Guaynabo in the East, each one of the maps was clipped and assembled with its neighbor to the right.

The finished assembled map titled "Mapas Unidos.pdf shows the complete route in Plan view. With the aid of special tools named 3D-poly and Profiles from MrCAD, each one of the segments of the route was picked at different contours of known elevation and a 3D-poly line was obtained. With the Profiles tool a profile was drawn for each segment. These profiles are shown as Perfil 1 Ruta 1.pdf to Ruta 14.pdf. All these files found in the included CD can be opened with either Adobe Reader or the PDF Converter Professional program. After you open a file you should rotate it counterclockwise. With the Slope tool from MrCAD slopes between any two points along the profile could be easily determined. Although the profiles along the route were drawn at H:V of 1:10,000 and 1:1:1,000 some of the profiles were also drawn at a natural scale. The topography for both cases is very irregular for the construction of the gas line. ***The total distance of the route is indeed the sum total of the inclined distances and not the sum total of the horizontal distances. With this established, it is very unsound to realize how the robot or pig will travel and examine the gas line pipes with slopes varying from 18 to 38 degrees and higher.*** Furthermore the change in slope (negative to positive) for gas line pipes will produce a "***dip***" where natural gas contaminants will accumulate and produce on a long term internal corrosion of the steel pipes[3]. Also special and numerous welds will be required in the *pig sections* during construction which in turn change the steel section to brittle creating a potential vulnerability which with time provoke leakage of gas[4]. According to Professors Bea, the explosion of the gas line in San Bruno on September 9, 2010 showed that high resolution photographs of the pipe taken after the accident indicated that the pipe fractured without stretching, known in engineering terms as "*tensile necking*". It points to the possibility that the metal had become "*brittle*" with age. Professor Allouche said there were so many welds in such a short area, may be the pipe was rigid.

Table-2 shown below gives a summary of the horizontal distance for each segment of profile as well as the real or inclined distance expressed in meters.

Profile	Horizontal distance, mts	Inclined distance, mts.	Difference mts.
1	6407.075	6407.900	0.825
2	3638.73	3717.146	78.416
3	7093.392	7237.255	143.863
4	6650.511	6888.322	237.811
5	8535.582	8790.127	254.545
6	2650.182	2711.485	61.303
7	10634.208	10896.645	262.437
8	3521.881	3612.261	90.380
9	4961.382	5159.903	198.521
10	27797.254	27875.296	78.042
11	12276.981	12277.013	0.032
12	16493.193	16563.488	70.295
13	9042.467	9053.703	11.236
14	13652.655	13688.835	36.180
15	12145.2	12145.302	0.102
Total	145,500.693 mts	147,024.681 mts.	1523.988 mts.
Total	87.300 miles	88.215 miles	0.914 miles

[3] NTSF/PAR-0301 Pipe Line Accident Report, Natural Gas Pipeline Rupture and Fire Near Carlsbad, New Mexico, August 19, 2000.
[4] Bea, R., Professor of UC Berkely, Allouche, Erez, Professor of Civil Engineering, Lousiana Tech University, Research Director for the school's center for trenchless pipeline technology, Los Angeles Times, 2010/10/07.

Each segment of the route for each 3-D polyline was joined together and the whole route was pasted to the Map of Puerto Rico opened in the program of Google Earth. This was possible with the special tool ***PublishDWGtoGE32-64*** from AutoCad. The map of Puerto Rico can be rotated to a horizontal position as well as clockwise to the right and counterclockwise to the left as desired. The observer can see the route in 3–dimensional terrain. It is very interesting to view the very steep slopes and cross-sectional slopes along the route. All crossings of the route through rivers like the Rio Tallaboa, Río Grande de Arecibo, Río Grande de Manati, Río el Indio, Río Cibuco and etc. can also be observed. One of the critical river crossings is that close to the Reservoir of the Super Aqueduct In Arecibo where the loose sands susceptible to liquefaction during an earthquake are present. To the writer, the use of the technique of horizontal drilling, HDD, with bentonite is very doubtful and will not solve the stability problem of the 24" gas line steel pipes, particularly in the loose sands and soft clays of the alluvial environments of the Río Grande de Arecibo and Manati. It is a well known fact that bentonite is expansive and works adequately only in limited vertical holes and excavations. Indeed the 24" gas line has to designed and constructed safely under hurricane and earthquake conditions

Study of the terrain slopes in the profiles obtained along the route varied in the order of 18, 21, 24, 29, 33 and 38 degrees and higher. These slopes are very critical for the construction of the trench and the layout of the steel pipes. The change of slopes will be between pipe sections and constitute critical "dips" where contaminants of the natural gas will deposit. Furthermore, we do not realize how the alleged robot will traverse along these critical "dips" and inspect adequately the gas lines. Undoubtedly, construction costs will increase very much above the AEE estimate of 447 million dollars. With such terrain conditions construction equipment will be difficult to operate and change orders will be the "order of the day".

- Overview Of The Geology of The Proposed Via Verde Natural Gas Pipeline, Peñuelas to San Juan

The geology overview presented by geologist Alejandro Soto is very general. It uses a two-day trip as indicated in the report and geologic maps to give his overview. To the writer this is not a sound geology report and with no significance for the proposed project for construction.

First of all, the complete route of the proposed Via Verde Natural Gas pipeline should have been established in the field using surveying equipment, locating Bench Marks and taking transverse sections at least every 20 meters and longitudinal profiles and the location of the 150 feet right of way. Also location of nearby structures should be established together with photographs.

With the established field layout of the Gas pipeline, then a geotechnical subsoil study should have been performed. Borings with a minimum depth of 20 feet should have been drilled. Soil samples every 2 feet and up to 10 feet should have been taken, followed by samples at 15 and 20 feet and deeper whenever necessary. Soil samples are then identified and taken to the Soils Laboratory for soil classification and routine as well as special tests when necessary.

The geologist is then ready to perform a complementary field geological survey along the route to establish faults, structure and classification of rocks, previous colluvial landslides areas and critical weathered layers in a soil profile. Furthermore the geologist can examine the soil samples to complement his findings. After this study the geologist is in position to write a complete Report on the geology along the route.

A color geologic map of Puerto Rico[5] and adjacent islands prepared by Briggs and Akers is included as a very preliminary reference for the route of the gas line project. An examination of the rock and soil deposits crossed by the route is enormous, variable and very critical. This fact, together with the non uniform and critical longitudinal as well as transverse slopes make ***the construction of the project very high in cost, impractical and nonsense.*** From the study of all documents available in the DIA-P and DIA-F no engineering design plans and specifications were found for analyses and bidding purposes. Also the project lacks a field and laboratory sound geotechnical investigation.

- Types and Characteristics of Soils

The types and characteristics of soils presented in article 3.3 was obtained from the Department of Agriculture Soil Conservation Service. This type of classification is for agricultural purposes and is not recommended for engineering projects. The soil classification presented is a series of types of soils as for example Constancia silty clay, Ct. To the writer this type of soil classification has no engineering significance.

From the engineering point of view, it is recommended to perform soil borings, establish the water table after a 24 hour period, obtain soil samples, perform classification tests and classify the soil samples according to the AASHTO Soil Classification System.

5.2 Conclusions and Recommendations

1. The “Gasoducto” or VIA VERDE project as presented without a complete set of engineering construction plans and specifications is not sound from the engineering point of view and acceptable for bidding and construction purposes.
2. The excavation of a 5 feet depth trench in an irregular and variable longitudinal profile is improper and incorrect.
3. The scale of 1:20,000 certified in each of the submitted topographic maps of the DIA-P is incorrect.
4. The elevation of the terrain along the route varies from 1 to 1010 meters.

[5] R. P. Briggs and J.P. Akers, 1965, Hydrogeologic Map of Puerto Rico and Adjacent Islands, U.S. Geological Survey,1965

5. Surface slopes found in the longitudinal profiles developed with MrCAD are in the order of 18.34 and 37.88 degrees and higher. Other profiles show similar or higher slopes. These slopes will impede the flow of construction equipment particularly in clayey residual soils. Furthermore, heavy trucks loaded with fill material during rainfall seasons will not travel in these slopes. This will increase construction costs.
6. The real distance of the gas line project is the sum total of the inclined distances which indeed is very different to total sum of the horizontal distances as indicated by the PRAEE engineers.
7. The construction of a public work as it is presented without designed construction plans and specifications and in a highly erratic and variable topography will be 2 or 3 times the budget of 447 millions planned.
8. The excavation for the gas line will be done in a great variety of soils like expansive soils, silts, loose sands and soft to very soft clays, sound and decomposed rocks as well as residual soils susceptible to sliding. During the rainy season, residual silts and clays are subject to sliding and not apt for construction equipment. It is a well known fact that a perched water table is developed during the rainy season in residual slopes. This reduces the shearing strength and lowers the factor of safety against sliding. In this case the factor of safety against sliding is well below 1.5. This confirms why continued slope failures occur after every rainy season.
9. The excavation in PR-10 from Utuado to Arecibo will primarily be in the expansive clay of the San Sebastian Formation which underlies the Lares limestone. The San Sebastian expansive clay will be very dangerous for the gas line pipes due to the high swelling pressures of 1,000 to 10,000 lbs per sq foot and above normally exerted. At the site large sinkholes exit at the site where rainfall water rises to 10 and 20 feet and feed the expansive clay. At present continuous movements are occurring north of the Caguanitas river bridge in PR-10. The Department of Transportation and Public Works has not been able to control and stabilize the movements. A section of 495 feet was reported to be stabilized again in spite of a 5 millions dollar investment with that purpose in 1997, reference: **El Nuevo Día, 9 de febrero de 1998.** According to the article the sliding mass was moving at a rate of 3/16 inches per week and at that time was not considered critical from the point of view of the Secretary of Transportation. Inspection of the site by the writer clearly revealed that the San Sebastian Formation is present at the site.
10. The so called HDD horizontal drilling technique in the Karst environment of limestone mogotes and sinkholes will undoubtedly contaminate with drilling mud the ground water of the region. Please recall that the limestone rocks like the Lares, Aymamon and Aguada are very permeable and are present along the proposed route of the Gasoducto.
11. The crossing of the gas line pipe across the Rio Grande of Arecibo will be across loose and medium sands. These sands liquefies and loose their shearing strength under earthquake conditions. This condition was

confirmed by pseudo-static slope stability analyses performed in the study of the Retention Lagoon of the Super aqueduct project. In an earthquake, horizontal ground shaking will displace and disrupt the pipes. Slopes failure in the Retention Lagoon will stop the daily supply of water of the Super aqueduct.

12. In the case of liquefaction of the loose and medium sands under earthquake conditions occurring in the Rio Grande of Arecibo the gas line pipes will disrupt. Therefore, the water of the river will be contaminated with the gasified natural gas, particularly with the contaminants H_2O, CO_2, H_2S and O_2, it contain.
13. Gas line pipes constructed under the so called HDD horizontal drilling technique in the numerous crossing of rivers as indicated in the Google map of Puerto Rico will be subjected to scour and great horizontal pressures and even more during flooding conditions. The gas line pipes will be located both in granular soils as well as alluvial clays with low shearing resistances.
14. The types of Soil Classification presented in Section 3.3 "Tipos y Características de los Suelos" of Chapter III and in section 3.2 "Mapas de Clasificación de Suelos" of the DIA-P are not relevant for a construction project of the magnitude of the "Gasoducto de Puerto Rico". In geotechnical investigation soil samples are taken at different depths, classification tests as grain size, Atterberg Limits and compression tests are performed on the samples. The samples are described and classified according to the AASHTO or the Unified Soil Classification systems.
15. The report "Overview of the Geology of the Proposed VIA VERDE Natural Gas Pipeline Peñuelas to San Juan, Puerto Rico" presented by geologist Alejandro E. Soto consists of a general description and discussion of the geology according to geologic maps. The actual geology of a site like the "Gasoducto" being very variable along its route should be studied carefully in the field and complementing the geotechnical investigation performed with borings every 20 to 25 meters along the route. The report is not as rigorous as it should be for a 447 million dollars project.
16. The "Gasoducto" or VIA VERDE project does not have a complete set of engineering drawings and specifications necessary for a bidding process.
17. The "Gasoducto" or VIA VERDE project does not have a Geotechnical Investigation Report with specific recommendations of cut and fill operations, classification of soils, rock core drilling, excavation in sound and weathered rocks, slope stability analyses, compaction of soils, identification of soil samples, laboratory tests and properties of expansive soils of the San Sebastian Formation, depth of the water table, artesian and subartesian ground water conditions and ground water seepage from sinkholes, and etc.
18. The construction of the gas line project, undoubtedly, will include cuts in sound rocks where dynamite operations will be needed. Cuts in weathered residual soils will be subjected to sliding during rainy seasons. Cuts in the expansive clay of the San Sebastian Formation require

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