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Puerto Rico Energy Center Study

prepared for

COMMONWEALTH OF PUERTO RICO

in cooperation with the

United States Atomic Energy Commission

and

United States Department of the Interior

JULY 1970

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PUERTO RICO ENERGY CENTER STUDY

SITE SELECTION SUPPLEMENT

**PREPARED FOR
COMMONWEALTH OF PUERTO RICO
IN COOPERATION
WITH THE
UNITED STATES ATOMIC ENERGY COMMISSION
AND
UNITED STATES DEPARTMENT OF THE INTERIOR**

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1.0 SUMMARY AND SELECTION

1.1 SUMMARY

At the outset of this investigation to select a site for the Puerto Rico Nuplex^a, a series of meetings were held with Government Agencies to obtain information and guidance. One of these meetings was with the Planning Board who advised that consideration could be given to Guayanilla in the southwest region, Bay of Jobos (Aguirre) in the southeast region and the area east of Arecibo in the north central region. The sites were inspected by project management. Preliminary site requirements were compiled and tentative layouts were prepared. Further meetings were held with Federal and Puerto Rican Agencies to discuss the sites and obtain additional information. A team of engineers and agronomists visited each site. The site requirements were updated in keeping with developments in the industrial and agricultural studies. Site layouts were made. Descriptions of each site were prepared covering geology, seismology, hydrology, agronomy, demography, meteorology, transport, finance and socio-economics. Estimates of the relative capital cost of the sites were prepared including cost of acquiring the land and buildings, levees for flood protection, land filling and compaction, pump stations where required, harbor dredging, electrical transmission lines, power plant foundations and circulating water system. Operating costs were capitalized for pumping stations and for the cost of industrial water. The total relative estimated costs for capital and capitalized operating costs indicated the Aguirre area was lower in cost than Guayanilla and the Arecibo site exceeded both by a wide margin.

On the basis of the general undesirability as well as costs, Arecibo was dropped from further consideration. Qualitative factors were compared for Guayanilla and Aguirre including land availability, meteorological safety, conservation aspects and agronomical considerations.

A draft report was submitted to the Energy Center Committee recommending that the Nuplex be located at Aguirre.

a. In this supplement the terms Nuplex and Energy Center are used synonymously.

This recommendation was accepted by the Committee with the request that a further comparison be made of the industrial area located west of Aguirre as described in the original draft and alternately with it located east of Aguirre i.e., between Aguirre and the Phillips plant. For both cases the nuclear plant would be located as originally proposed just west of Aguirre.

A draft of a supplement to the Site Selection Report was submitted to the Committee. The Committee reviewed the draft and requested that further consideration be given to the matter with the East Aguirre Site modified to drop the western portion in the areas of San Felipe and Chun Chin and to substitute an equivalent area north of Highway 3 opposite the Central Guamani Area (East Aguirre Site A).

For the East Aguirre sites alternative locations of the harbor were considered, one being in the Bay of Jobos just east of the dock at Central Aguirre. The other harbor location was at Las Mareas based on expanding the existing harbor which currently serves the Phillips Plant. The relative dredging cost for the harbor and channel at Las Mareas is lower than the harbor and channel for the Bay of Jobos and it was therefore decided that for both East Aguirre sites the harbor would be at Las Mareas.

Preliminary plant layouts were made of the West and the East Aguirre sites. Relative cost estimates for the three sites indicated that the procurement and development costs of the West Aguirre site is about 15.8 million dollars lower than East Aguirre Site A and 17.1 million dollars lower than East Aguirre Site B. The cost difference between the West and both East Aguirre sites is primarily due to the need to run the steam supply from Aguirre, where rock is available to support the nuclear power plant, to the Jobos area where the industrial steam loads are located.

1.2 RECOMMENDATIONS

1.2.1 Choice of Region

It is recommended that the Aguirre area in the southeast region be used to develop the Nuplex.

This area is recommended on the basis of the following:

- A. Availability of the amount of land needed in a desirable configuration that is nicely sloped that will afford a good plant layout at a minimum cost.
- B. Indicated acceptability of the site from a nuclear safety standpoint by virtue of a good rock foundation for the reactors that has been geologically investigated, adequate exclusion radius and low density population zones around the power plant. Public hearings have been held and Planning Board approval of this site for a nuclear power plant has been given.
- C. Lowest cost to acquire and develop the land.
- D. Good highways to serve the area which will help to diffuse the socio-economic impact of the Nuplex over a large area of Puerto Rico and supply labor needed for construction and operation.
- E. Good possibilities for developing a harbor.
- F. Capable of being protected from flooding from the sea and with minimal danger of flooding from the landside.
- G. Availability of arable, level land to serve as a demonstration farm.
- H. Relative stability of ecological factors.

1.2.2

Choice of West Aguirre Versus East Aguirre Site

It is recommended that the Nuplex be located at the West Aguirre site. The advantages of the West Aguirre site that form the basis for this recommendation are as follows:

- A. Use of a dual purpose nuclear power plant as opposed to a dual purpose fossil power plant results in an annual savings of about 6 million dollars. Use of the West Aguirre site permits this savings to be realized, whereas use of the East Aguirre sites results in a large fraction of this savings being lost due to the cost of utility lines connecting the power plant to the industrial area. The superior economics of the West Aguirre site increase the chances of success of the Nuplex which in turn enhances the prospect of achieving Puerto Rico's social objective of creating jobs for men with good rates of pay and long term stability.
- B. The site has a desirable configuration, is nicely sloped and permits flexibility in plant layout. Present and future areas are separate and contiguous within themselves to allow efficient use of the land both for the present and the future.
- C. Minimal danger of flooding from the land side.
- D. Availability of arable, level land within the plot limits to serve as a demonstration farm.

1.2.3

Site Selection

The Energy Center Committee selected the West Aguirre site to serve as the reference design basis for the further study of the Nuplex.

2.0

INTRODUCTION AND APPROACH TO WORK

2.1

INTRODUCTION

The Puerto Rico Water Resources Authority (PRWRA) has contracted with the United States Atomic Energy Commission to study the application of an Energy Center in Puerto Rico. The Authority in turn has retained Burns and Roe, Inc. as a subcontractor and The Dow Chemical Company as a major subcontractor to carry out this study.

The Scope of Work of the contract calls for the following items related to site selection:

- A. Organize, process, and analyze data and other information on the resources and requirements of the southwestern, southeastern, and north-central coastal regions of Puerto Rico. Particular attention shall be given to water, raw materials, power, labor, and other factors, including planning projections for economic development of Puerto Rico as they relate to the specific areas to be considered.
- B. Make market analyses of products and technical assessments of industrial processes offering potential beneficial conjunctive use with a nuclear desalting installation (e.g. energy center) for application in Puerto Rico.
- C. Give particular attention to the role of desalting including its conjunctive use for municipal and industrial utilization, and its potential application to agriculture of the region.
- D. Comparison of alternative sites. This will draw on the information and data previously developed, and specific sites for energy center complexes will be evaluated. Recommendation for detailed analyses of specific complexes will be made.

At the outset of this investigation a series of meetings was held with agencies of the Government of Puerto Rico including Water Resources Authority (PRWRA), Economic Development Administration, Planning Board, Department of Agriculture, Ports Authority, and Land Authority for the purpose of obtaining information and guidance.

The meeting with the Planning Board was of special importance to insure that the sites to be considered for the Nuplex would conform to their plans for the development of Puerto Rico. The Planning Board was advised as to the nature of the Nuplex and its general requirements. After discussion and consideration of a number of sites, the Planning Board rendered their decision that the study could consider for the northcentral region, the area east of Arecibo up to the Manati River; for the southeast region, the Bay of Jobos area (referred to in this report as Aguirre); and for the southwest region, the Guayanilla area. Use of sites in the southwest corner of Puerto Rico which were of possible interest were specifically not allowed on the basis that those areas were reserved for the development of tourism.

Preliminary visits were made to these sites by project management.

The preliminary requirements for the site were compiled and possible arrangements for the Nuplex on the sites were prepared.

A second series of meetings was held with PRWRA, Land Administration, U.S. Geological Survey, U.S. Corps of Engineers, U.S. Weather Bureau, Aqueduct and Sewer Authority (PRASA) and Bureau of Master Planning to obtain further information and guidance relative to the sites being considered.

A team of engineers and agronomists visited each of the sites.

Time and funds did not permit additional borings to be taken that would have permitted estimates of the cost of site preparation, foundations and harbors to be made with

greater certainty but the existing body of data was used and they are believed to be adequate for the purpose of site selection.

A draft report was submitted to the Energy Center Committee recommending that the Nuplex be located at Aguirre. This recommendation was accepted by the Committee with the request that a further comparison be made of the industrial area located at West Aguirre as described in the original draft and alternately with it located east of Aguirre, i.e. between Aguirre and the Phillips Plant. This site is referred to in the report as East Aguirre Site B. For both cases the nuclear plant would be located as originally proposed just west of Aguirre.

A draft supplement to the report was submitted to the Committee. After reviewing the matter, the Committee requested that further consideration, in greater detail, be given to the comparison so that the impact of the site choice on the economics of the Nuplex could be more fully assessed. For this further comparison, the East Aguirre site was modified by dropping the portion in the area of San Felipe and Chun Chin and adding an equivalent area north of Highway 3 opposite Central Guamani. This site is referred to in the report as East Aguirre Site A.

The final site requirements (as compiled for the purpose of the site selection) are given in Section 3.0 of this report. The sites are described in Section 4.0 and a comparison of the sites is given in Section 5.0 of the report.

References noted in the text are listed at the end of each section of the report.

The site selection study reported herein was performed early in the study so that certain of the criteria used in selecting the site may not agree exactly with the values later developed in the study as reported in the main body of the report.

3.0 SITE REQUIREMENTS

3.1 GENERAL

This section of the report gives the site requirements for the Nuplex. It must be borne in mind that the industrial, agricultural, sea water desalting and power segments were still under study while the site selection was being made so that the site requirements as herein listed may differ somewhat from the final requirements. The fact that these requirements differ is not believed to invalidate the data put forth herein as a basis for selection of the preferred site.

The requirements are grouped according to the segments of the study; namely, industrial, agricultural, sea water desalting and nuclear power.

3.2 INDUSTRIAL

3.2.1 Land

Approximately 1000 acres of land is needed for the integrated industrial complex with the assurance that an additional 1000 acres of adjacent land will be available for future expansion of the basic production facilities and for the location of satellite industrial and "second-generation" product manufacture. The stated area requirement includes the areas needed for office buildings, shops and service buildings, tank farms, raw material stock piles and storage yards, but excludes that required for port facilities, any water reservoirs, and storm and flood protection structures. Ideally, the area should approximate a rectangular shape, with an important provision being that the minimum width be 2000 feet.

The site should be protected against flooding from storm tides or inundation from the land side drainage.

Surface topography should be reasonably level to minimize site preparation costs.

Bearing capacities of soils greater than 2000 lbs. per sq.ft. are desirable; otherwise, foundations of structures must generally be piled, increasing total plant cost by approximately 2 to 4%.

3.2.2 Transportation

3.2.2.1 Ship

3.2.2.1.1 Annual Tonnage Movements (Design Values) Inbound

60,000 bbl/day Crude Oil from North Africa

Nominal size ship	100,000 dwt. ^a	150,000 dwt.
Number of ships required	3	2
Approx. frequency of arrival	each 10 days	each 15 days
Annual ship trips	36	24
Days unloading per trip	1 day	1.5 days
Annual days @ Puerto Rico dock	36 days/yr	36 days/yr
Vessel Particulars:		
Draft	48 ft.	55 ft.
Depth of water	55 ft.	65 ft.
Length Overall	830 ft.	990 ft.
Breadth	130 ft.	155 ft.
Estimated ship freight rate	\$2.94/st ^b	\$2.47/st

a dwt. - dead weight tons

b st - short ton

250,000 stpa Alumina from Jamaica

Nominal capacity of barge	10,750 st
Number of barges required	1
Approx. frequency of arrival	each 15 days
Annual barge trips	24
Unloading & cleaning days/trip @ P.R.	3
Annual days at Puerto Rico Dock	72 days/yr
Vessel Particulars:	
Draft	20 ft.
Depth of water	22 ft.
Length overall	300 ft.
Breadth	80 ft.

3.2.2.1.2 Annual Tonnage Movements (Design Value) Outbound

500,000 stpa Ethyl Benzene to U.S. Gulf
401,000 stpa Cumene to U.S. Gulf
212,500 stpa Ethylene Dichloride to U.S. Gulf

Nominal capacity of multi-product tanker	40,000 st
Number of ships required	1
Approx. frequency of arrival @ dock	each 13 days
Annual ship trips	28
Time at plant dock per trip	1.25 days
Annual days @ Puerto Rico dock	35 days/yr.
Vessel Particulars:	
Draft	36 ft.
Depth of water	40 ft.
Length overall	680 ft.
Breadth	90 ft.

362,500 stpa Ethylene Glycol to New York Area
150,000 stpa Polyethylene to New York Area

Nominal capacity of multi-product tanker	40,000 st
Number of ships required	1
Assume 3 days diversion each trip to fill up	
Annual ship trips required	27
Approx. frequency of arrival @ P.R. dock	each 13.5 days
Time at plant dock per trip	1.25 days
Annual days @ P.R. dock	34 days/yr.
Vessel Particulars:	
Draft	36 ft.
Depth of water	40 ft.
Length overall	680 ft.
Breadth	90 ft.

211,000 stpa Propylene Oxide to U.S. Gulf

Nominal size of L.P.G. pressure barge	11,000 st
Number of barges required	1
Approx. frequency of arrival @ P.R. dock	each 19 days
Annual barge trips	19
Time at plant dock per trip	1 day
Annual days @ P.R. dock	19 days/yr.
Vessel Particulars:	
Draft	20 ft.
Depth of water	22 ft.
Length overall	350 ft.
Breadth	75 ft.

130,000 stpa Aluminum to U.S. Gulf

Nominal size of deep sea dry cargo barge	8,000 st
Number of barges required	1
Approx. frequency of arrival @ P.R. dock	each 21 days
Annual barge trips	17
Time in port per trip	2 days
Time @ dock in P.R.	34 days/yr.
Vessel Particular:	
Draft	19 ft.
Depth of water	21 ft.
Length overall	260 ft.
Breadth	60 ft.

153,000 stpa Caustic Solution to Jamaica

Nominal size of barge - part load	10,750 st Alum.
No. of trips/yr same as inbound Alumina	24
Extra days @ P.R. dock to load Caustic/trip	1
Total extra days @ P.R. dock	24 days/yr.
Dimensions same as inbound Alumina barge	

3.2.2.1.3 Harbor

Based on the inbound and outbound shipping requirements as given in the previous section, three types of vessels with three classes of draft, length, and breadth must be accommodated by the harbor as follows:

A. Inbound Crude via large ships

	<u>100,000 dwt</u>	or	<u>150,000 dwt</u>
Draft	48'		55'
Depth of water	55'		65'
Length overall	830'		990'
Breadth	130'		150'
Annual days @ the dock	36 days/yr.		36 days/yr.
Est. ship freight	\$2.94/st		\$2.47/st
Est. annual tons	3,380,000		3,380,000

B. Multi-product chemical tankers

	<u>40,000 st cap.</u>
Draft	36'
Depth of water	40'
Length overall	680'
Breadth	90'
Annual days @ the dock	69 days/yr.

C. Inbound and Outbound barges

	<u>8-11,000 st cap.</u>
Draft	20'
Depth of water	22'
Length overall	350'
Breadth	80'
Annual days @ the dock	149 days/yr.

The dock utilization should not exceed 55% of the time. The combined dock time of the above three sets of vessels is 254 days or 70% of the year so that a combination docking facilities must be provided to reduce this to meet the 55% criteria. Uses of the dock facilities other than for the needs of the Nuplex would have to be taken into account in meeting the criteria.

No requirement for general cargo ships is envisioned as part of the Nuplex except for incidental shipments which could be made through other ports if necessary. However, the ability to handle general cargo ships will be desirable during construction.

3.2.2.2 Road

Road access from the public highway system to both the port area and the industrial complex should be via paved, heavy-duty road, designed to accommodate gross vehicle loads of 70,000 pounds, and should preferably be four lane. The port area should communicate, via such roads, directly with the public highway system, in addition to its off-highway road connection with the industrial area.

3.2.2.3 Air

Convenient access and close proximity to an airport having scheduled service is an advantage in the emergency delivery of spare parts, mail, and for the convenience of personnel, but it is not a necessity. None of the industrial products contemplated can be moved economically by air.

3.2.2.4 Pipeline

The following pipelines will be needed for material transfer between the Nuplex Industrial Area and the Port Area:

Liquid Transfer via Steel Pipe

8 in.	-	Salt Slurry
10 in.	-	Ethylbenzene
10 in.	-	Cumene
10 in.	-	Ethylene Dichloride
10 in.	-	Propylene Oxide
10 in.	-	Ethylene Glycol
16 in.	-	50% NaOH - Insulated and Traced
6 in.	-	Diethylene Glycol
2-18 in.	-	Crude Oil
6 in.	-	Triethylene Glycol
8 in.	-	Propylene Dichloride
3-10 in.	-	Provisions for Future

Solid Transfer via Pipe

Alumina-Pneumatic
Polyethylene-Pneumatic

Solid Transfer via Truck

Aluminum Pig
Polyethylene

The following pipelines will be needed for utilities transfer between the Nuplex Industrial Area and the Nuclear Power Plant Area:

3 - 36" 150 psig Steam Lines
1 - 24" 400 psig Steam Line
1 - 36" 40 psig Steam Line
1 - 36" Desalted Water Line
1 - 12" Brine Line

3.2.3

Utilities

A. Electric Power

568,000 kw total demand

B. Steam and Condensate

400 psig @ 50-100°F superheat-400,000 lbs/hr.
Condensate Return - 70%

150 psig @ 50-100°F superheat-3,000,000 lbs/hr.
Condensate Return - 70%

40 psig @ Saturated - 1,200,000 lbs/hr.
Condensate Return - 95%

C. Cooling Water (Salt)

450,000 gpm @ 65 psig

D. Fresh Water

17,000 gpm

E. Potable Water

600 gpm

F. Compressed Air and Nitrogen

Air: 21,000 scfm

Nitrogen: 44,000 scfh

The scope of work of the contract gives the following as one of the parameters to be considered in the agricultural studies:

"Explore the potential for a demonstration and for commercial irrigated agriculture of up to 10,000 acres, based upon information to be provided by Puerto Rico."

The interpretation that has been placed on this requirement insofar as it bears on this site selection report, is that the commercial irrigated agriculture of up to 10,000 acres would be carried on by the farmers of the general area on lands they presently hold and using the methods that this study will hopefully show to be economically attractive. If the study makes a positive recommendation in regard to agriculture, it may be necessary to demonstrate the proposed techniques in order to show that they work, that they have the economics that are projected and to convince the local farmers of their validity so that they will be sufficiently interested to use the method. The site selection effort has therefore concerned itself with the availability of land in the vicinity of the Nuplex site that could serve as a demonstration farm.

It is estimated that 500 acres of good, arable, flat land, contoured for irrigation is required. The estimate is based on the need for a minimum of two acres per plot to make the results significant to farmers. Each plot treatment or practice will need to be replicated several times for proper significant statistical analysis. Based on a maximum of ten crops, the 500 acres will allow for six variations and four replications.

3.4 SEA WATER DESALTING

3.4.1 Land

The area requirement for the sea water desalting plant is approximately 4 acres per 10 mgd capacity. It is assumed that the plant will be owned by PRASA or PRWRA. As such, it is believed that the sea water desalting plant could be located within the nuclear power plant exclusion radius on the basis that this plant could by virtue of the cooperative attitude of its ownership and the nature of the process, be safely shut down and the plant evacuated within 30 minutes in the event of a nuclear incident.

3.4.2 Products

3.4.2.1 Desalted Water

The size of the sea water desalting plant is assumed to be in the range of 20 mgd to provide water for industrial needs. It is assumed that this plant will be operated conjunctively with existing systems using natural water sheds and reservoirs which will provide storage for the combined system.

3.4.2.2 Brine

Up to 10 mgd of brine at 3 times natural concentration to be transferred to industrial area for salt recovery. Alternately, this brine must be wasted to the sea by dilution with the cooling water if no salt recovery plant is installed.

3.4.3 Utilities

- A. Sea Water Makeup - 30 mgd
- B. Sea Water for Cooling - 80 mgd
- C. Steam at 40 Psia - 620,000 pounds per hr.

3.5 NUCLEAR POWER

3.5.1 General

The location of the nuclear power installation is to be based upon safety and economic considerations normally used for siting this type of plant.

3.5.2 Safety

3.5.2.1 Distance Factors

The site must insure a low risk of public exposure in the unlikely event of a serious accident. This is accomplished by selecting a site that has:

- A. An exclusion area within which there are normally no permanent residents. A tentative radius of 0.38 mile (2000 feet), which requires an area of approximately 315 acres will be used.
- B. A low population zone within which the total population and density are such that safety measures can be taken on their behalf. The outer radius of this zone varies from 1.5 to 4 miles depending on reactor type and extent of iodine removal.
- C. A distance to the nearest population center (over 25,000 residents) which is 1-1/3 times the distance to the outer boundary of the low population zone. The distance varies from 2 to 5-1/2 miles.

3.5.2.2 Foundations

The reactor building, all other Class I structures, and Class I equipment are to have foundations bearing directly on rock, if at all possible.

3.5.2.3 Flooding

The site is to be capable of being protected from high water levels from the ocean due to hurricanes and tsunamis and from the land side due to heavy rains and ground water rise.

3.5.2.4 Back Up Power

In addition to the auxiliary power of approximately 20 mva supplied directly from the turbine-generator, an independent source of auxiliary power equal to approximately 20 mva will be required for back up. A second independent source of auxiliary power is required for shut-down of the reactor. This independent power source requirement will be approximately 6 mva and will also be suitable for station startup. In case of a maximum credible accident and all of the above sources of power are lost, two diesel generator sets are required for safe shut-down of the reactor. Each diesel generator set, its switchgear and reactor shut-down equipment must be completely redundant from the second diesel generator set, its switchgear and reactor shutdown equipment. Both systems must be physically and electrically isolated.

3.5.3 Energy Transport

3.5.3.1 Electrical Power

For the purpose of this site selection, the Nuplex will be assumed to include two light water reactors rated at 2500 mwt. This size was selected on the basis of the estimated power and steam loads in the Nuplex and the ability of the PRWRA system to contain a unit with an electrical power capacity of 570 mwe. The firm power loads in the industrial area will be backed up by the PRWRA system at 115 or 230 KV as applicable and a capacity of 500 mva is assumed to be needed.

3.5.3.2 Steam

The steam load is estimated to be as follows:

- A. 400 psig @ 50-100°F superheat-440,000 lbs/hr.
Condensate Return 70%

- B. 150 psig @ 50-100°F superheat-3,000,000 lb/hr.
Condensate Return 70%
- C. 40 psig - saturated - 1,200,000 lb/hr.
Condensate Return 95%
- D. 25 psig saturated - 600,000 lbs/hr.
Condensate Return 95%

Economic consideration makes it desirable for the industrial steam users to be located close to the steam plant but outside the exclusion radius with the exception of the desalting plant.

3.5.4 Sea Water Cooling

Sea water cooling flow of 1,000,000 gpm will be required for the power plant condensers and the industrial cooling requirements. Discharged hot water must be prevented from recirculating to the water intake.

3.5.5 Accessibility

Port facilities should be reasonably accessible to the site for the off-loading of construction materials during construction. Extra heavy loads such as the reactor vessel will probably be transferred by barge and moved on shore using special rigging techniques.

The reactor power plant should be accessible by highway for transfer of equipment, supplies and personnel both during construction and operation. Spent fuel caskets are assumed to be transferred by ship to the continental United States for reprocessing.

4.0 DESCRIPTION OF SITES

4.1 GENERAL

This section of the report describes the five sites being considered for the Nuplex. Following a general statement given below intended to orient the reader as to the location of the sites within Puerto Rico, each of the sites is described in general plan. The detailed considerations of geology, seismology, hydrology, demography, meteorology, transport, finance, and socio-economics are then discussed.

The island of Puerto Rico is 110 miles long by 40 miles wide having a total area of 3435 square miles. The interior of Puerto Rico is mountainous with peaks up to 4389 feet. Puerto Rico is ringed with a coastal plain of varying width up to 5 miles. A highway map of Puerto Rico is shown in Exhibit 4.1-1. For administrative purposes Puerto Rico is divided into Regions, Sub-Regions and Municipalities as shown in Exhibit 4.1-2.

The locations for the three areas being considered for the Nuplex are shown in Exhibit 4.1-2; Guayanilla in the southwest, Aguirre in the southeast and Arecibo in the north-central region.

GUAYANILLA

SCALE
0 10
MILES

LEGEND —
—— REGION
--- SUB-REGION
--- MUNICIPALITY

BURNS AND ROE, INC. HEMPSTEAD, NEW YORK	THE DOW CHEMICAL CO. MIDLAND, MICHIGAN
MAP OF PUERTO RICO SHOWING ENERGY CENTER SITES	
PUERTO RICO ENERGY CENTER STUDY PUERTO RICO WATER RESOURCES AUTHORITY

KEY

PRIMARY HIGHWAY	1 to 99	
SECONDARY HIGHWAY	100 to 299	
MUNICIPAL HIGHWAY	300 to 9999	
FUTURE CONSTRUCTION		
HIGHWAY IN CONSTRUCTION

**OFFICE OF PLANS
HIGHWAY MAP**

AS OF 1 JANUARY 1969

APPROVED FOR:
Elbert J. J. J.
ELBERT J. J. J.
DIRECTOR EJECUTIVO

SCALE

0 5 10
KILOMETERS

0 5 10
MILES

4.2 ENERGY CENTER LAYOUTS

4.2.1 Guayanilla

The Nuplex site at Guayanilla is shown in Exhibit 4.2.1. The site is located in the Ponce Region, Ponce Sub-Region and Municipality of Guayanilla. The site lies on the west side of Guayanilla Harbor, the only major land parcel left undeveloped in this port. The areas to the east and northeast of the main channel into the port have been and are being developed for petro-chemical industries and are the sites of plants owned by CORCO, Union Carbide, PPG, Air Reduction, and others. In addition, PRWRA has their large South Coast Power Station located at the north end of this harbor.

The plant site utilizes the lands of the coastal plain on the west side of the harbor which are presently used for growing sugar cane. This land is privately owned. The lands utilized correspond closely to those requested by Fomento to be set aside by the Planning Board for industrial development. The area available is 1890 acres, which is slightly below the industrial area requirement. Additional land is not easily obtained. Punta Verraco, which has 520 acres, is owned by the Texaco Co. and may be developed as an oil refinery. The areas to the west and northwest are blocked by a combination of population areas, hill formations and forest preserves. An exception to this is the lands immediately around Central San Francisco where an additional 200 to 300 acres are available. Central San Francisco is still operating and the land in its immediate environs is good agriculture land. For these reasons plus the fact that Fomento did not include this land as part of its request for industrial zoning this land was excluded from the site plan.

At the northwest corner of the site there are some additional lands around Central Rufina. Central Rufina is shut down at present. These lands were not included in the industrial zoning request made by Fomento and they were therefore excluded.

The area at the north end of the site is blocked by the Playa and the start of industrial lands that have already been committed.

BURNS AND ROE, INC. HEMPSTEAD, NEW YORK	THE DOW CHEMICAL CO. MIDLAND, MICHIGAN
GUAYANILLA ENERGY CENTER LAYOUT	
PUERTO RICO ENERGY CENTER STUDY PUERTO RICO WATER RESOURCES AUTHORITY

CONTOUR INTERVAL 10 METERS
 DASHED LINES REPRESENT 5-METER CONTOURS
 DOTTED LINES REPRESENT 1-METER CONTOURS
 DATUM IS MEAN SEA LEVEL
 DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
 SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
 THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.3 METERS

The nuclear power plant has been located at the south end of the site at Punta Ventana to take advantage of rock foundations. It will be necessary to blast the rock to achieve a level area that can be used to locate the Class I structures that must be able to withstand an earthquake. This location has the advantage that about half of the exclusion area to the south and east is water. To the west (i.e., the downwind direction) is a large forest preserve, a most desirable condition from a meteorological standpoint. The power lines which must go northward around the entire site to tie in to the switchyard at the PRWRA South Coast Plant, can skirt the site generally following the high ground.

The petro-chemical plant and the expansion area for petro-chemicals could be located in the south end of the site in proximity to the steam source at the power plant, and to the Texaco property which may later accord opportunities for across the fence transfers.

The electro-metallurgical processes, such as aluminum, could be located at the north end of the site placing them in close proximity to the harbor for the handling of dry cargo. The caustic-chlorine plants could be centrally located in proximity to the dock for receipt of salt, shipment of liquid caustic solution and transfer of chlorine to the petro-chemical area.

4.2.2 Aguirre

At Aguirre three Nuplex sites were considered, one with the industrial area west of Aguirre as shown in Exhibit 4.2-2 and referred to as the West Aguirre Site. The other two have the industrial area located east of Aguirre as shown in Exhibit 4.2-3 and will be referred to as East Aguirre Site A and B, respectively. For all Aguirre sites the power plant is located just west of Central Aguirre. All of these sites are located in the Ponce Region and the Guayama Sub-Region.

4.2.2.1 West Aguirre

The Nuplex site at West Aguirre is shown in Exhibit 4.2-2. The site is in the Municipality of Salinas. The site lies to the west of Central Aguirre, north of the Lugo Vina mangrove area, and south of Route 3. The land is privately owned including the Lugo Vina mangrove area, a portion of

which is used for the Nuplex. The land is currently used for raising sugar cane. The land in the southeast corner to be used for the nuclear power station is a parcel that is currently under option to PRWRA and has been planned as a nuclear power plant site for some time. Public hearings have been held regarding the use of this area for a nuclear power plant and Planning Board approval has been given. PRWRA is proceeding with two 450 mw fossil units at this site.

The nuclear power plant has been located in the southeast corner of the site because there is rock available at this point on which it can be built. This is the only rock in the general area that is also in proximity to the sea water for cooling. It was for these reasons that PRWRA earlier optioned this site and has had studies of it made as a potential nuclear power plant site (Ref. 4.2-1,-2). The earlier studies considered the site adequate for four nuclear power units. The cooling water required for the power plant will be taken out of the Bay of Jobos, and the effluent discharge line run southeast to a point in Lugo Vina to prevent recirculation of hot water to the intake.

The power lines will run north from the power plant to the connection point with the 230 kv lines that run east and west, north of Route 3. One of the 230 kv lines would go north through the transmission right of way and then turn west to serve the industrial area.

The sea water desalting plant will be located within the exclusion radius of the power plant to place it in close proximity to the low pressure exhaust steam supply and cooling water.

It is proposed to relocate the people in Las Mareas on the basis that a settlement in such close proximity on the downwind side of the industrial development is undesirable. A few other habitations scattered throughout the plot would also be moved.

The industrial area of the Nuplex comprises a total of 2398 acres. The land contour lines of the industrial area run generally east and west so that the most economical development of the site would be achieved by terraces stepping down toward the sea.

The harbor is shown in Mar Negro and this was the basis of the initial cost comparisons with Guayanilla and Arecibo but later studies indicated the desirability of locating the dock facilities offshore to minimize dredging and endangerment of the underground aquifer that underlies this site.

4.2.2.2 East Aguirre Site A

East Aguirre Nuplex Site A uses the same location as the West Aguirre site for the power and water desalting plants. The bulk of the industrial area lies south of Route 3 between Chun Chin and the Phillips Plant. An additional industrial plot lies north of Route 3 opposite Central Guamani. As such, the power plant is in the municipality of Salinas and the industrial area and the harbor are in the Municipality of Guayama.

The industrial area of the Nuplex comprises a total of 2392 acres. The land for the most part is privately held with the exception of mangrove areas at the east end of the Bay of Jobos which belong to the Commonwealth. The existing port area at Las Mareas is owned by the Port Authority. Those portions of the site other than the mangrove and inhabited areas are used principally for raising sugar cane. Central Guamani shown in the exhibit no longer exists.

It is proposed to relocate the people living in Puerto de Jobos in order to eliminate their need for access across the site and their close proximity downwind of the industrial area. It is proposed to relocate the people of Jobos living south of Route 707, to widen the industrial plot at this point and give more freedom for plant layout.

Electrical power would reach the industrial area by a transmission line from the 230 kv lines running north of Route 3.

A right-of-way for the steam and other pipe lines through Central Aguirre would have to be acquired.

A connecting road from Route 3 to the harbor at Las Mareas has been constructed. This road must be maintained through the industrial property to give public access to the port as well as to Punta Pozuelo.

4.2.2.3 East Aguirre Site B

The Nuplex site at East Aguirre uses the same location as the West Aguirre site for the power and water desalting plants but the industrial area lies south of Route 3 between Route 705 at Aguirre and the Phillips Plant. As such, the power plant and a portion of the industrial area are in the Municipality of Salinas. The remainder of the industrial area and the harbor are in the Municipality of Guayama.

The industrial area of the Nuplex comprises a total of 2300 acres. The land for the most part is privately held with the exception of mangrove areas northeast of Central Aguirre and at the east end of the Bay of Jobos which belong to the Commonwealth. The existing port area at Las Mareas is owned by the Ports Authority. Those portions of the site other than the mangrove and inhabited areas are used principally for raising sugar cane. Central Guamani shown on the Exhibit no longer exists.

It is proposed to relocate Escuela Luce and the people living in San Felipe and Chun Chin in order to get the minimum 2000 acres needed. It is proposed to relocate the people living in Puerto de Jobos in order to eliminate their need for access across the site and their close proximity downwind of the industrial area. It is proposed to relocate the people of Jobos living south of Route 707, to widen the industrial plot at this point and give more freedom for plant layout.

4.2.3 Arecibo

The Nuplex site at Arecibo is shown in Exhibit 4.2-4. The site is in the lowlands just east and south of the City and Port of Arecibo. This land belongs to the Puerto Rico Land Authority. The land was reclaimed to be used as agricultural land by the installation of a pump house at Jarealito to pump the water from Cano Tiburones into the sea. A series of drainage canals exist throughout the length of the valley up to the Manati River to the east. The land is currently used for raising sugar cane.

There is adequate acreage in this valley for the

A T L A N T I C O C E A N

present and future needs of the Nuplex. Additional acreage is available to the east but it is a long narrow strip squeezed between the barrier reef ridge to the north and the higher ground to the south. For this reason, the area toward the western end of the valley was chosen.

The nuclear reactor has been located as shown because of the availability of a small island of rock at this spot and the present mangrove area around it which can be part of the exclusion area. A disadvantage of this reactor location is the long circulation water lines to supply and return the cooling water to the sea. No satisfactory location along the coast was evident from the preliminary investigation.

The dock facilities have been developed as an extension of the present harbor. It has been brought south of Route 681 to obtain adequate area to develop the turning basin and dock. A draw bridge would be constructed over the ship channel to permit vehicular traffic to flow normally.

The petro-chemical plants could be located in the northeast area to place them in proximity to the steam plant. The electro-metallurgical plants could be in the southeast quadrant as an intermediate location.

The surface rocks of most of the mountainous interior of Puerto Rico comprise of series of igneous, pyroclastic and sedimentary rocks of Cretaceous age. These rocks are highly folded and intruded by igneous dikes and sills. They formed the source material for, and the basement platform on which Tertiary and later materials which form the coastal plains of Puerto Rico, were deposited.

The Tertiary rocks lie unconformably on the Cretaceous rocks and lie in strips along both the north and south coasts. The north shore of Tertiary outcrops are the larger, extending as much as 100 miles eastward from the west coast with a width of as much as 50 miles. On the south coast, the Tertiary deposits are limited to the southwestern portion of Puerto Rico. The maximum width on the south is almost as wide as in the north, although the average is somewhat smaller. The basal portion of the Tertiary deposits is made up of clastic sediments with the remainder of the deposits largely limestone. These are marine deposits ranging from middle Oligocene to lower Miocene in age.

On the southeastern coast, the Tertiary deposits are discontinuous with the Cretaceous volcanics coming close to the shore.

The Tertiary deposits, and locally the Cretaceous beds, are unconformably overlain by sands, sandstones, sandy limestones, silts and clays of Pleistocene and Recent Age. These are to a large extent mantling deposits resulting from reworking of the older rocks with limited transport. In the main, they are unconsolidated.

The general geology of Puerto Rico is the consequence of the geologic history of the area which will be described briefly below as an aid to understanding the mechanisms by which the deposits of interest came into being and which determine their character.

During Cretaceous time (100,000,000⁺ years ago), the area now occupied by Puerto Rico was a shallow sea surrounded by islands built up by volcanic deposits from a series

of active volcanoes. Mud flows and erosion placed many feet of sediments on the shallow sea floor. With continuing subsidence of the sea floor, many thousands of feet of sediments accumulated.

Coral reefs fringed the volcanic islands and at times spread widely over the floor of the shallow sea.

During late Cretaceous and early Tertiary times the volcanic activity diminished, the old sea floor was raised above the sea and the sediments were intruded by basic igneous magmas. As the old sea bottom was elevated the sediments were subjected to folding and faulting.

Through the remainder of Tertiary time, the emergent island was subjected to erosion and thick sequences of limestones and associated deposits were exposed along the shores.

In the following Pleistocene Epoch, and extending into recent times, fluctuations in sea level resulted in erosion followed by deposition in valleys extending into the coastal areas.

Appendix A of this report gives excerpts taken from a report (Ref. 4.3-1) prepared for the Port Authority by Dr. Ta Liang, consultant. It gives geological data marked on Topographic maps of the harbors which may prove helpful in following the detail discussions of the site geology that follows.

4.3.1 Guayanilla

In the vicinity of Guayanilla two large valleys have been cut into the Tertiary limestones and filled with unconsolidated Pleistocene materials. The village of Guayanilla lies in the eastern valley and the Yauco River in the western. The two streams have combined to deposit a broad plain north of Puerto de Guayanilla.

An outlier of Tertiary limestones forms the peninsula extending out to Punta Verraco which protects the port on the south. The bedrock in the area is the Ponce limestone which is made up of two members. The lower member is chalky

and contains interbedded shales and occasionally sandstone. The upper member is a crystalline limestone, cavernous in most areas.

From the engineering point of view both members represent foundation rocks requiring careful investigation and possibly treatment for use as a reactor foundation.

It is planned to place the reactor on limestone just west of Punta Verraco. Examination of excavations in the vicinity indicate that the limestone is highly weathered. At the reactor site, however, forty to fifty feet of rock will be removed to establish plant grade. At this level, unweathered rock can be anticipated.

Little data is available on the character of the unconsolidated Pleistocene deposits underlying the proposed industrial area. However, on-site observations indicate that these soils, where covered by rock fill to raise the grade, can support roadways and light structures. Major loads will probably require piling in off-rock locations.

4.3.2 Aguirre

At Aguirre an outlier of Eocene sediments, sandstone, silt stone and sandstone breccia, is found surrounded by alluvial fan materials of Pleistocene Age. This "hill" mass has been eroded around its edges and some younger unconsolidated sediments deposited. In relatively recent times swampy areas have developed along the margins of Bahia de Jobos.

The bedrock "hill" has been well explored and its engineering character is well known. The area can be evaluated by reference to the existing studies to a better degree than can the alternate sites.

The West Aguirre industrial area consists of upland soils, quite variable in texture. However, the boring data available indicates that they can safely support light to moderate loads. Major equipment may require pile support.

No boring data were obtained for the East Aguirre industrial area but it is probably similar to equivalent areas of the West Aguirre site.

The north shore of Puerto Rico between Arecibo and Palmas Altas represents the late stages of typical marginal lagoon development. The barrier beach has been reworked by winds to form dunes, in part cemented. The lagoon has been filled by swamp deposits, largely peats and mucks.

Within the lagoon are outliers of Tertiary limestones which were formerly islands in the lagoon and are now islands in a sea of mud.

The bedrock exposed in the lagoon islands is the Camuy limestone, the upper formation in the Tertiary section. It is quite variable in character, ranging from pure calcium carbonate limestone to clayey limestone. Interbeds of chalk and marl occur with rare beds of quartz sandstone.

From the point of view of the engineering geologist, the Camuy limestone requires careful investigation and may require treatment for utilization under heavy foundation loads.

At this site the upper, peaty, deposits underlying the proposed industrial area will require special handling if fill is to be placed to create a reasonable plant grade. These deposits lie at very low levels. Extensive canal works and constant pumping is required to keep the area above water.

The peat soils may require removal and replacement to depths of as much as nine feet, or, if it is unusually firm peat a controlled fill may be used. The rate of placement must be controlled to limit pore pressure buildup. To hasten consolidation of the surface soils, the fills should be placed some five feet above the finish grade as a surcharge. The rate of fill placement, time of surcharge and other details of the development of the industrial area will require a detailed soil mechanics study. Piling will be required under any important structures.

Puerto Rico must be regarded as a moderately active seismic zone. While relatively few seismic events have epicenters on the island itself, the island is bounded on the east, north and west by zones of continuous seismic activity.

Shallow focus earthquakes associated with the Anegada Fault Trough occur to the east and southeast of Puerto Rico, while shallow focus earthquakes associated with the south wall of the Puerto Rico Trench occur to the northeast, north and northwest of Puerto Rico. The Mona Passage immediately northwest of the island is probably a southerly extension of the Puerto Rico Trench and has been the center of some of the most damaging quakes that have been experienced in Puerto Rico. West of Puerto Rico, in the eastern portions of the island of Haiti an active area of shallow and intermediate events is found.

The seismic history of Puerto Rico including tsunamis has been reviewed in detail on at least two occasions by Weston Geophysical Research, Inc. (Ref. 4.2-2 and 4.4-1) and will not be repeated here. However, the conclusions made and recommendations presented in the Weston Reviews is consistent with the conclusions that Puerto Rico lies in an area in which special consideration of seismic effects must be given in the selection of sites for nuclear reactors. This view is substantiated by the language contained in the Atomic Energy Commission - Tentative Regulatory Criteria - Seismic and Geologic Siting Criteria for Nuclear Power Plants, dated March 19, 1969 in which Puerto Rico is grouped with the continental United States west of the Rocky Mountain front, Alaska, and Hawaii insofar as special consideration of surface faulting is concerned.

From a review of the literature and consideration of the foregoing it is concluded that seismic effects are a significant factor in the design of important facilities in Puerto Rico and make it virtually mandatory to locate nuclear reactors on bedrock.

4.4.1 Guayanilla

The Guayanilla site is located near the center of the southern coast of Puerto Rico. The nature of seismic events most likely to be significant at this site are:

(a) medium focus earthquakes associated with the island structure, (b) shallow focus earthquakes associated with the Anegada Fault Trough or, (c) a major event on the Mona Passage. The distance and focal depth effect not only the probable base acceleration to be used in design but more importantly the frequency of the base shear input.

For Guayanilla it is expected that the design basis ground acceleration would be not less than 0.20 g at the bedrock surface.

4.4.2 Aguirre

The critical seismic event felt in the Aguirre area would probably originate in the Mona Passage, along the south wall of the Puerto Rico Trench or along the Anegada Fault Trough. Based on the historic record, the maximum intensities from events known to have originated along these trends is a Modified Mercalli VI. However, if the maximum events along the trends are assumed at the point nearest the site, the Anegada Fault Trough structure could produce a base acceleration in the bedrock as high as 0.20 g.

4.4.3 Arecibo

For a site in the Arecibo area the most probable source of seismic inputs appears to be the south wall of the Puerto Rico Trench to the north, or from the Mona Passage to the west. For Tortuguero, to the east, Weston Geophysical recommend a site ground acceleration of 0.25 g. The Arecibo site lies somewhat closer to the Mona Passage than Tortuguero. The value of 0.25 g appears to be reasonable for Arecibo; however a detailed investigation of the seismicity of the site may indicate need for modification.

4.5.1 Water Availability

If the island of Puerto Rico is considered in its entirety, there is adequate water available to supply the present and future needs. The problem, however, is one of collection and distribution. The average annual rainfall in Puerto Rico is approximately 69 inches, but this varies from 60 inches along the northern coastal region to 100 inches at the Cordillera Central (the island divide which determines whether the drainage flows to the north or south) and down to about 35 inches along the south coastal plain. Thus in terms of current and future needs there is a surplus of water in the northern region and a shortage in the south. Most of the better impoundable areas and underground aquifers in the south have already been developed and the major step presently being taken to solve the water supply problem is the Toa Vaca project in which water from the north will be diverted to the south. The Toa Vaca project (Ref. 4.5-1) is scheduled to be completed in five phases and produce water as follows:

<u>Phase</u>	<u>Scheduled for Completion</u>	<u>Expected Yield million/gals/day</u>
1	10/71	23
2	6/75	20
3	6/77	60
4	6/80	25
5	1/89	100

Phase 1 of Toa Vaca, which is presently under construction, will dam up the Toa Vaca River and improve control of the water flowing into Guayabal Dam, a portion of which is currently wasted due to siltation of the Guayabal reservoir. Phases 2, 3, 4 and 5 of the project, collect and divert water from the north of the Cordillera Central to the Toa Vaca Dam for distribution on the south coast. Funds have been appropriated to initiate studies on Phases 2 and 3 of the project. Water is distributed to the Ponce Sub-Region in which the Guayanilla site is located starting in 1971. Water is scheduled to be distributed in the Guayama Sub-Region in which Aguirre

is located starting in mid 1977.

Buck, Seifort and Jost, consultants to the Aqueduct and Sewer Authority, have studied (Ref. 4.5.2) the water demands on the south coast with regard to the yields from the Toa Vaca project superimposed on the water supplies currently available on the south coast. Their estimate of the anticipated supplies in relation to the projected future demands for the southern region has led them to the conclusion that if the Toa Vaca project proceeds as planned the future municipal and industrial water requirements of the Ponce Sub-Region in which the Guayanilla site is located, can be met (without the Nuplex present). If the Nuplex with its demand of 27 mgd were superimposed on the Ponce Sub-Region it is not clear that the demand could be met without the addition of a desalting plant to meet at least a portion of the Nuplex demand.

This study has considered the water needs of the Nuplex in relation to the Guayama Sub-Region in which the Aguirre sites are located and has concluded that a desalting plant is needed to meet the demands of the Nuplex in the time period 1975 to 1990 if it is located at Aguirre.

In summary then, water at Arecibo would be obtained from wells. Water at Guayanilla and Aguirre would be obtained in whole or in part from a desalting plant with the remainder coming from wells and Toa Vaca.

4.5.2 Flooding

4.5.2.1 General

Assurance that the investment in the Nuplex will be safe from floods is an economic necessity. The possibility of flooding of these coastal plain sites comes from both the sea and land sides during major storms. Storm tide protection levees will be required at all three sites and some form of protection from stream flooding will be necessary at all sites but particularly at Guayanilla and Arecibo. The levees estimated to be required for each site are shown in the Nuplex Layouts.

The height of tidal surges have been correlated with the central barometric pressure recorded in the eye of 24 hurricanes (Ref. 4.5-3) visiting the Gulf Coast of the United States.

States since 1893. Mr. R. J. Calvesbert, Commonwealth Climatologist of the U.S. Weather Bureau in San Juan, believes that this correlation applies to Puerto Rico. The minimum pressure recorded during Hurricane San Felipe which visited Puerto Rico in 1928 corresponds to a tidal surge of 15 above mean sea level. Mr. Calvesbert further advised that to design for a tidal surge of 15 feet elevation is the accepted practice of the industry recently located on the south coast of Puerto Rico. Mr. Calvesbert believes that a slightly lower tide height could be expected for the north coast.

In addition, some freeboard above the tidal surge is required to take care of wave action and 3 feet has been selected for the purpose of this site selection report, giving a crown height of 18 feet above mean sea level. Storm protection levees would have a crown width of 30 feet and side slopes of 1 on 5 on this configuration was assumed in estimating the costs of levees.

4.5.2.2 Guayanilla

At Guayanilla additional protection is required from the possibility of flooding due to surface runoff down the Yauco and Guayanilla valleys. The Yauco River traverses the site with a main branch flowing on the north side of the valley and a minor branch flowing on the south side. Levees would be required on either side of the main branch and across the back of the site to guard against the river overflowing its banks further up the valley. It has been assumed that the minor branch can be cut off further up the valley so that it would not be necessary to dike this stream as it cuts across the property.

Flooding in the flood plain of the Guayanilla River has been documented by the Corps of Engineers (Ref.4.5-4) Large floods occurred in 1899, 1925, 1928 and 1954. It is estimated by the Corps of Engineers that during the worst of these, the 1899 flood, an area approximately 1 mile wide was flooded parallel to the river with most of the flooded area lying to the southeast of the river and reaching beyond Central Rufina. To protect against flooding from this direction, a levee would be run along the westerly side of the Guayanilla River over past Central Rufina until high ground is reached to the west. This leaves a small tract of about 100 acres unprotected on the north end of the plot. This solution would pro-

tect the Nuplex but would create additional problem for the upstream area near the town of Guayanilla and the Playa by virtue of having restricted the effluent channel of the flood water. The proposed diking could only be used if it was compatible with a comprehensive flood plan for the entire area and this would be very expensive.

4.5.2.3 Aguirre

The West Aguirre site is not traversed by rivers and creeks so that no significant flooding from the land side is expected.

The East Aguirre site is traversed by several rivers and creeks; however, flood flow data for these is not available. The USGS advises that in the 1961 flood water levels at various points north of Route 3, such as in Coqui and in Jobos reached a depth of about one foot.

4.5.2.3 Arecibo

At Arecibo the site is endangered by flooding from the land side from two different sources. The first source of water is the natural drainage that continuously flows in the area from underground springs fed via the limestone from the hills to the south. This water is continuously drained from the site by the drainage system, flows via the Cano Tiburones to the pump house where it is pumped into the sea. The water level at the Cano Tiburones side of the pump house is normally maintained at 4 feet below mean sea level. Rain in the hills to the south increases the flow into the valley in a matter of hours. If the pumps stop, as has happened on at least one occasion (even though three of them are diesel engine driven), the valley will flood in a matter of hours. To utilize this site, it would be necessary to provide a levee to the east, a new pump house to supplement the existing unit for safety and a well-defined system of ground drainage.

The second source of flood danger at Arecibo is from the Arecibo River (Ref. 4.5-5). The flood of 1899 was the worst that has occurred. The 1928 flood was the second greatest from 1899 to 1966. The 1954 flood was the greatest from 1929 to 1966. During the 1920 flood almost all of the site presently being considered was inundated. In 1954 the

Arecibo River overflowed again but a levee inside of the proposed property line to the west held the water with only small break-through of undetermined extent.

The 500 acre demonstration farm, will be needed for a relatively short time, perhaps five years, in order to serve its purpose. As such, the land set aside for future expansion of the industrial area can be used for this purpose, if it has the proper agronomical characteristics. In addition, land adjacent to the Nuplex sites at Guayanilla and Aguirre was investigated.

The agronomical characteristics of the Arecibo site were not investigated because the abundance of natural rain-fall in this area does not make it suitable for the development of the technique of irrigated agriculture.

There are no climatic restrictions as to minimum nor maximum temperatures or available sunlight in either the Aguirre or Guayanilla areas to restrict development of crops normally grown in Puerto Rico such as tomatoes, taniers, plantains, peppers, citrus, mangoes, and avocados.

There are no major agronomic obstacles preventing the use of either the Aguirre or Guayanilla area for agriculture. Nor is there any major agronomic factor giving preference of either area over the other.

Within the areas, agricultural sites can be selected in preference to soil texture, drainage, and crop range. All sites considered have good access roads, and irrigation water. All sites considered are sufficiently level for irrigation by furrow or overhead methods. All sites considered are sufficiently level or require minimum land leveling for agricultural mechanization from planting to harvesting.

The Guayanilla sites are light to medium textured soils easier to work and with a bit higher fertility than the Aguirre sites. The Aguirre soils run to the heavier textured clay soils in certain sites. However, sites 4 and 5, as described below, give a good range of soil texture.

4.6.1 Guayanilla

The agricultural soils in the Guayanilla area are some of the best soils in Puerto Rico. These soils are pre-

dominately light to medium textured, sandy loams to silty clay loams, well drained and fertile. They are presently in sugarcane receiving irrigation from deep wells, rivers, and government irrigation systems.

Three sites were chosen in the Guayanilla area as the only suitable agricultural sites in this area with acreages of about 500 acres each. Site G-1 lies up the Barinas or Yauco valley. Site G-2 lies south of the Yauco River partly in industrial site as well as in the lands around Central San Francisco. Site G-3 lies north of the Yauco River and includes the Central Rufina lands. The soils of the sites are given below with a rough approximation of the areas occupied by the leading textural classes.

<u>Site</u>	<u>Soil</u>	<u>Soil</u>
G1	San Anton loam San Anton fine sand loam San Anton clay loam San Anton silty clay loam	San Anton clay River wash 95%
G2	San Anton loam San Anton silt loam San Anton silty clay	Vayas silt loam Vayas silty clay loam 50%
G3	San Anton silt loam San Anton clay loam San Anton silty clay loam Santa Isabel silty clay loam Vayas silt loam Vayas silty clay loam	Vayas clay Cintrona clay 80%

Site G1, located in the Barinas valley, is one of the most fertile agricultural areas in Puerto Rico being suitable for vegetables, fruits, and root crops. These alluvial soils are level, suitable for mechanization, and there is irrigation water available.

Site G2 has a small operative sugarcane factory, in Francisco, in its midst. The soils are level, deep, and well drained. Its upper border can be used for tree fruit

crops.

Site G3 comprises lands belonging to a non-operating sugarcane factory, Rufina, located on its north-central border. The soils are level, mostly medium textured, with some clays.

Sites G2 and G3 have coastal borders which have slight to moderate salinity problems. Irrigation water is less available for these two sites than G1.

4.6.2 Aguirre Area

The agricultural lands in the Aguirre area are level and fertile. The land is predominately in sugarcane under the control of Central Aguirre. There is irrigation water now available from deep wells and government irrigation canals.

4.6.2.1 West Aguirre

In West Aguirre six potential 500 acre sites have been chosen, because of the large area of agricultural land available at the Aguirre area. These six sites allow a more diverse selection depending on the industrial site needs. Sites A1, A2 and A3 lie along the coastline south of Route 3 between Central Aguirre and Salinas. Sites A1 and A2 lie in the area being considered for the industrial site. Site A3 lies closer to Salinas. These three sites have some salts in the soil, but the salinity is slight to moderate giving no serious problem. Sites A4, A5, and A6, which lie parallel to A1, A2 and A3 but north of Route 3, have a higher elevation and more slope than the A1-3 sites, but the former are still gentle enough for furrow irrigation.

The soils of the six sites are given below with a rough approximation of area occupied by various textural classes.

<u>Site</u>	<u>Soil</u>		<u>Soil</u>
A1	Aguirre clay	50%	San Anton loam
	Teresa clay		Santa Isabel silty
	Guanica clay		clay loam
	Serrano clay		

<u>Site</u>	<u>Soil</u>		<u>Soil</u>
A2	Santa Isabel clay	40%	San Anton silt loam
	San Anton loam	30%	Altura loam
			Vayas silt loam
A3	Aguirre clay	35%	San Anton loam
	Guanica clay	35%	San Anton silt loam
			San Anton silty clay loam
A4	Altura loam	75%	San Anton loam
			San Anton silt loam
A5	Santa Isabel clay	60%	Altura loam
	Altura silt loam	30%	San Anton loam
			San Anton silt loam
A6	Santa Isabel clay	100%	

Site A4 has the lightest textured soils in greatest quantity. It is quite suitable for vegetable, root crops, and tree fruits. Site A5 has less area in light soils, but sufficient for testing crops under various soil textures from loams to clays.

The Aguirre, Guanica, and Santa Isabel clay soils are productive soils when adequately drained. Sites A1, A2, A3 along the coastline might present problems of salts and high water table for fruit trees such as citrus and mango. However, the upper portions of A1 and A2 close to highway No.3 would possibly be suitable for such tree crops. Sites A4, A5, A6 are more suitable for tree crops.

4.6.2.2 East Aguirre

The East Aguirre sites contain arable land but do not contain a single 500 acre plot within the industrial property limits that could be used for the demonstration farm. Various areas within the East Aguirre sites and just outside of them are discussed below.

Hacienda Reunion: From Route 3 south to the railroad but still north of Phillips Plant, there are about 250 acres of good agricultural land now in sugarcane. About half

of this is under option to Phillips for industrial expansion.

Central Guamani: From Route 3 south to Route 707 and the bay, there are about 500 acres of land but not all of this is suitable for agriculture. There are approximately 300-400 acres of usable agriculture land. The rest of the acreage has severe salinity problems due to proximity of the bay and mangrove swamps.

Melania: This area north of Route 3 directly opposite from the Reunion area and west of Fibers International has about 100 acres of usable land. Expansion to the north is not possible since the land becomes steeper and unusable for irrigation.

San Felipe: South of Route 3 from Escuela Luce to San Felipe, there are about 100 acres of agricultural land but it is heavy clay with drainage problems.

Jobos: North of Route 3 from Jobos west to San Felipe, there are about 300-400 acres, but the major part of this land lies further north and is not adjacent to Route 3. The major portion of the land adjacent to Route 3 is in salt grass and scrub due to salts and poor drainage. This land may be recoverable, but it would be rather expensive.

Machete: South of Route 3 running east of Route 710 there are about 500 acres of good agricultural land.

Exhibit 4.7-1 shows the projected population of Puerto Rico from 1970 to 1990 by municipalities. The population data is further broken down into urban and rural classifications. There may be more than one concentration included in the urban population of a municipality. Nevertheless, the urban figures are an indication of whether a population center (population greater than 25,000) exists in the context of the USAEC site criteria.

POPULATION PROJECTIONS BY MUNICIPALITY ^a

REGION	SUB-REGION	MUNICIPALITY	<u>1970</u>		<u>1980</u>		<u>1990</u>	
			URBAN	RURAL	URBAN	RURAL	URBAN	RURAL
San Juan	San Juan	San Juan Metropolitan ^b	783,900	85,900	1,191,000	70,600	1,867,900	45,200
		Loiza	12,000	20,500	20,400	16,800	29,500	13,500
		Rio Grande	11,700	12,500	23,200	10,800	37,700	9,300
		Comerio	7,700	12,300	10,500	11,500	13,500	10,500
		Corozal	8,400	16,600	12,900	13,300	17,000	10,800
		Dorado	5,300	11,900	9,500	12,500	15,200	13,300
		Naranjito	5,300	13,500	7,500	12,500	10,300	11,500
		Toa Alta	5,500	12,500	9,800	10,700	14,100	9,300
		Toa Baja	8,000	19,000	18,200	19,600	30,900	20,100
		Vega Alta	7,500	12,500	11,800	10,800	16,300	9,400
		Orocovis	5,800	15,000	7,900	13,000	10,100	11,000
		Barraquitas	7,600	12,900	10,600	11,500	13,500	10,400
		TOTAL	868,700	245,100	1,333,300	213,800	2,076,000	174,300
	Fajardo	Fajardo	15,200	6,000	19,000	6,000	23,000	6,000
		Ceiba	2,900	7,300	4,200	7,100	5,800	6,900
		Luquillo	3,500	7,100	5,700	7,600	8,500	8,300
		Naguabo	7,800	10,500	11,400	8,000	14,300	6,200
		Culebra	000	700	000	900	000	1,100
		Vieques	3,600	3,900	4,500	3,300	5,500	2,700
		TOTAL	33,000	35,500	44,800	32,900	57,100	31,200

a. (Ref. 4.7-1)

b. The San Juan Metropolitan Area includes the municipalities of Bayamon, Carolina, Guaynabo, San Juan and Trujillo Alto.

REGION	SUB-REGION	MUNICIPALITY	<u>1970</u>		<u>1980</u>		<u>1990</u>	
			URBAN	RURAL	URBAN	RURAL	URBAN	RURAL
San Juan (Con't)	Caguas	Caguas	72,300	30,000	133,500	26,500	226,500	23,500
		Aguas Buenas	5,300	14,200	8,300	14,000	11,600	13,900
		Gurabo	8,400	11,500	13,400	10,400	18,800	9,500
		Juncos	10,600	13,400	14,700	11,800	19,200	10,300
		San Lorenzo	8,500	21,000	11,500	19,500	14,500	18,300
		TOTAL	104,800	90,100	181,400	82,200	290,600	75,500
	Cayey	Cayey	26,000	16,000	32,100	13,900	38,000	12,000
		Aibonito	7,300	13,200	9,100	13,700	10,900	14,100
		Cidra	6,300	17,000	9,300	15,700	12,500	14,300
		TOTAL	39,600	46,200	50,500	43,300	61,400	40,400
	Humaco	Humaco	13,600	24,000	19,300	22,800	26,500	21,500
		Las Piedras	5,100	13,100	7,100	12,400	9,100	11,700
		Yabucoa	7,600	24,400	11,200	22,800	14,800	21,200
		TOTAL	26,300	61,500	37,600	58,000	50,400	54,400
	Manati	Barceloneta	7,200	13,200	12,000	9,500	15,700	6,800
		Manati	13,600	19,400	17,900	19,100	22,000	19,000
		Vega Baja	10,300	23,200	16,800	20,200	23,200	17,800
		Ciales	5,300	13,200	7,200	11,700	8,700	10,400
		Morovis	4,700	13,800	7,000	11,900	9,200	10,200
		TOTAL	41,100	82,800	60,900	72,400	78,800	64,200

REGION	SUP-REGION	MUNICIPALITY	URBAN	<u>1970</u>	RURAL	URBAN	<u>1980</u>	RURAL	URBAN	<u>1990</u>	RURAL
San Juan (Con't)	Arecibo	Arecibo	48,000		36,000	68,000		32,000	92,000		28,000
		Utuaado	17,200		23,800	23,900		18,000	28,200		14,000
		Hatillo	6,400		15,600	10,100		13,900	13,700		12,300
		Camuy	5,600		14,500	8,900		12,000	11,000		10,000
		Quebradillas	5,000		9,200	7,800		7,600	10,100		6,400
		Lares	7,000		19,000	9,100		16,200	11,000		13,800
		TOTAL	89,200		118,100	127,800		99,700	166,000		84,500
	Total			1,880,000			2,430,000			3,300,000	
Mayaguez	Mayaguez	Mayaguez	77,900		27,100	105,100		25,800	145,600		24,400
		Anasco	4,800		13,500	7,200		12,300	9,000		11,700
		Hormigueros	3,000		5,200	4,500		4,900	5,600		5,200
		Cabo Rojo	5,070		24,930	12,670		23,730	22,000		18,400
		Las Marias	1,500		8,000	3,000		6,800	5,400		4,700
		Lajas	4,000		13,100	9,000		10,000	11,000		10,000
		Maricao	2,500		4,900	3,800		4,000	4,250		3,950
		Sabana Grande	6,000		10,800	9,000		8,600	11,000		7,400
		San German	11,900		17,200	16,000		15,000	20,000		13,000
		TOTAL	116,670		124,730	170,270		111,130	233,850		98,750
	Aguadilla	Aguadilla	25,600		26,400	35,100		21,900	44,800		18,200
		Aguada	7,300		17,600	10,300		15,900	13,600		14,300
		Isabela	12,200		18,800	17,700		16,100	23,000		14,000
		Moca	4,000		18,900	7,000		16,500	9,200		15,300
		Rincon	2,500		6,700	4,200		5,600	5,700		4,600
		San Sebastian	6,400		26,500	10,200		21,800	16,300		15,500
		TOTAL	58,000		114,900	84,500		97,800	112,690		81,900
	Total			410,000			460,000			510,000	

REGION	SUB REGION	MUNICIPALITY	1970		1980		1990	
			URBAN	RURAL	URBAN	RURAL	URBAN	RURAL
Ponce	Ponce	Ponce	164,200	30,800	229,900	30,100	315,200	29,800
		Guanica	6,700	10,100	11,000	9,100	18,000	6,200
		Guayanilla	5,300	14,700	9,200	13,300	15,700	9,800
		Penuelas	7,000	10,400	13,000	7,300	17,800	6,800
		Yauco	17,200	20,800	24,200	16,800	31,500	13,500
		Adjuntas	7,000	12,500	9,500	9,600	10,500	8,400
		Jayuya	4,000	11,100	7,000	8,700	9,000	7,200
		Coamo	18,700	11,800	25,200	9,800	32,800	8,200
		Juana Diaz	9,200	24,300	23,000	14,800	29,000	13,000
		Santa Isabel	6,400	10,500	8,600	10,900	11,700	11,100
		Villalba	3,000	13,500	7,000	9,900	9,000	8,100
		TOTAL	248,700	170,400	367,600	140,300	499,400	122,100
	Guayama	Guayama	25,000	27,000	66,000	14,000	95,000	28,000
		Salinas	5,000	21,000	13,000	16,000	17,000	16,000
		Arroyo	4,500	10,500	11,000	6,000	13,000	6,000
		Patillas	2,500	15,500	8,500	10,100	11,800	7,500
		Maunabo	1,500	9,400	4,400	6,600	5,600	5,400
		TOTAL	38,500	83,400	102,900	52,700	142,400	62,900
	Total			540,000		666,000		830,000
Total	-	-		2,830,000		3,550,000		4,640,000

FOOTNOTES:

1. Based on "Regional Domestic Water Demand Estimates, 1970-1990," Puerto Rico Aqueduct and Sewer Authority, February 1969.
2. The San Juan Metropolitan Area includes the municipalities of Bayamon, Carolina, Catano, Guaynabo, San Juan and Trujillo Alto.

4.8 METEOROLOGICAL

4.8.1 Climatology

4.8.1.1 Wind

Puerto Rico is a tropical hilly island which lies directly in the path of the easterly trade winds throughout the year. These winds are steady and blow without exception from an easterly direction, i.e. between north-northeast and south-southeast. More specific wind data is presented below in the evaluation of the specific sites.

4.8.1.2 Precipitation

Rainfall in Puerto Rico varies markedly from place to place over relatively short distances. The majority of all Puerto Rico's rainfall is orographic in nature. Moisture-laden air from the ocean is carried by the trade winds inland and forced to ascend over the mountains. It is then cooled, causing condensation in the form of rainfall. The majority of these orographic showers are rather brief. Abundant sunshine prevails throughout the year, even during the so called rainy seasons. The lowest annual precipitation averages are along the southern coast from Aguirre westward. A rainfall map of Puerto Rico is shown in Exhibit 4.8-1. Exhibit 4.8-2 shows total precipitation during the ten year period 1951-1960 for each of the three sites under consideration.

4.8.1.3 Temperature

Mean temperatures in Puerto Rico have a very small range between the warmest and coldest months. The smallest range is generally found in areas near the coast, with only 4.7°F at Patillas. In the interior a slightly larger range is observed with 7.3°F at Utuado the largest. These small annual temperature ranges are due in part to the fact that Puerto Rico is an island surrounded by waters whose temperature changes but little from the warmest to coolest season (82.5°F in September to 77.9°F in February and March). Over practically the entire island the lowest mean maximum temperatures occur in January. The warmest daytime temperatures are recorded in the northern section of Puerto Rico. Freezing temperatures are unknown in Puerto Rico, even at the higher

BURNS AND ROE, INC.
HEMPSTEAD, NEW YORK

THE DOW CHEMICAL CO.
MIDLAND, MICHIGAN

RAINFALL MAP OF PUERTO RICO

PUERTO RICO ENERGY CENTER STUDY
PUERTO RICO WATER RESOURCES AUTHORITY

AVERAGE TOTAL PRECIPITATION AT ENERGY CENTER SITES (INCHES)Normal - 10 year period

	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL
Ponce*	.86	1.07	.61	2.28	4.49	3.51	2.74	4.69	5.93	5.31	3.70	1.34	36.53
Aguirre	1.07	1.29	.76	2.37	4.94	4.73	4.17	5.28	5.93	5.77	4.36	2.10	42.77
Arecibo	4.25	3.27	2.57	3.77	7.40	4.24	4.14	4.96	4.98	5.58	5.58	4.79	55.53

*Guayanilla

elevations. The coolest ever recorded is 40°F at Aibonito in March 1911. Exhibit 4.8-3 gives a mean temperature for the 1951-1960 period. In addition highest and lowest temperature tables are presented for the sites under consideration.

4.8.1.4 Storms

Hurricanes and tropical storms are an important feature of Puerto Rico climate during summer and early autumn. The tropical cyclone season in the North Atlantic region extends from June through November. The Puerto Rico area, however is outside the main paths of these most severe tropical atmospheric disturbances, except from August through the first half of October. The storms which severely affect Puerto Rico develop over the waters of the southern North Atlantic. The paths of the storms are usually between west and northwest and they may pass either to the south or to the north or directly over the island. Additional "near misses" of intense hurricanes or tropical storms, which produce little wind damage, may cause extensive rain (flooding) and/or tidal damage.

Areas of Puerto Rico most susceptible to flooding include the flatlands in the vicinity of the rivers. The annual average is about one serious local flood together with one or more lesser floods.

4.8.2 Factors Affecting Dispersion

4.8.2.1 Land-Sea Circulation

In addition to the trade winds already described, the most important factor to consider in studying surface winds over the coastal areas of Puerto Rico is the sea breeze circulation. Because of the orientation of the coasts in Puerto Rico, the land-sea circulation produces in the afternoon a north component along the north coast; a south component along the south coast; a west component in the west coast; and an east component over the east coast. Over the north coast the component is nearly perpendicular to the prevailing trades and the sea breeze is characterized by a difference between northeast winds in the afternoon and southeast winds at night and in the early morning. Over the south coast the difference is between southeast winds in the afternoon and the northeast winds at other periods of the day.

AIR TEMPERATURES AT ENERGY CENTER SITESMEAN TEMPERATURE (°F)

	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL
Ponce*	76.1	75.8	76.6	78.2	79.7	80.9	81.5	81.6	81.4	80.7	79.4	77.6	79.1
Aguirre	77.0	76.8	77.6	78.9	80.4	81.6	82.2	82.5	82.2	81.7	80.4	78.5	80.0
Arecibo	73.9	73.6	74.6	76.0	78.1	79.4	79.9	80.2	80.2	79.5	77.7	75.6	77.4

HIGHEST TEMPERATURE (°F)

	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL
Ponce*	97	95	94	94	96	98	98	100	98	98	98	96	100
Aguirre	92	92	93	92	95	94	97	98	98	96	95	93	98
Arecibo	92	92	93	95	94	96	95	96	94	94	93	90	96

LOWEST TEMPERATURE (°F)

	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL
Ponce*	56	54	56	58	61	58	58	61	65	61	60	55	54
Aguirre	60	59	60	62	62	68	67	69	67	62	64	62	59
Arecibo	59	56	57	59	62	60	66	66	64	65	62	60	56

*Guayanilla

Over Puerto Rico the wind speed is minimum around 2 to 4 a.m.; it increases rapidly after sunrise to a maximum around 2 p.m., and decreases gradually from 3 to 8 p.m. Over the north coast on an annual average the afternoon maximum is 15-16 mph, the minimum at night is 7-8 mph. In Ponce, the afternoon maximum is around 12 mph, the night time minimum is 3-4 mph.

The wind conditions at any specific locality in the coastal sections of Puerto Rico need to be interpreted within the framework of the two main factors mentioned so far: the prevailing trade winds and the land-sea circulation. The wind at a particular locality would also be influenced by the terrain in the vicinity. Such factors as physical obstruction provided by buildings and trees, significant water bodies, hills and valleys, etc., would introduce noticeable effects. For localities away from the coast, in the interior, the terrain would be the main factor to consider. There are no records of the penetration inland of the land-sea circulation. A good guess is that it is probably felt inland to about 10-15 miles, or to such distance where the effects of the mountains would dominate. Aside from the variability and highly unpredictable effects introduced by friction and obstacles, one effect noticed frequently in mountainous territory is the mountain and valley breeze. In the daytime, air near a mountain slope increases its temperature more rapidly than the air at the same pressure away from the mountain, it ascends and an upslope flow develops. At night, cooling near the mountain proceeds more rapidly and a downslope motion is introduced.

4.8.2.2 Inversions

Night-time radiation inversions at the surface are frequently observed in winter at San Juan; they are less frequent in summer. In the winter these inversions would start about midnight and hold until about 8 or 9 a.m. and then lift. An inversion never persists during the day. The inversions on the south coast are weaker and shorter than those on the north coast.

4.8.3 Meteorological Evaluation of Sites

4.8.3.1 Guayanilla

The towns of Guayanilla, Yauco and Guanica are 3,

6 and 8 miles respectively from the Guayanilla site. Even allowing for the projected three-fold growth of Guayanilla by 1990, its population will only be 15,700. By 1980, the urban population of Yauco will be 24,200 and by 1990 it will be 31,500. Guanica's population is expected to increase from 6,700 in 1970 to 18,000 in 1990. Thus, in the foreseeable future only Yauco will have a population which is sufficiently large for it to be classed as a population center (over 25,000) in terms of the USAEC site criteria. Use of standard calculational models for accident analyses would not preclude the siting of a light water cooled power reactor at the site.

Consideration of site wind data would probably give better results for the accident analyses than the standard model. This site, does not have any wind data available. Since wind structure along the Puerto Rican coastline is controlled by the trade winds plus superimposed land-sea circulation, one can use with reasonable confidence wind data of a neighboring coastal location. The Ponce site which is approximately 12 miles east of Guayanilla on the southern coast line has extensive (over a three year period) wind data. This data shown in Exhibit 4.8-4 has been used as the wind structure of the Guayanilla site.

Examination of the data indicate that the wind blows from the site to Guayanilla, the closest town, less than one per cent of the time. Although the wind direction frequencies for the directions of Yauco and Guanica are higher than desirable, they are no worse than in the standard calculational model. The average velocities tend to improve dispersion and make the site more acceptable from a nuclear reactor licensing standpoint.

On the basis of the discussion above, it is concluded that this site is acceptable for the location of a power reactor.

4.8.3.2 Aguirre

Salinas, Coqui and Central Aguirre are situated in the general vicinity of the reactor site. They all are part of the municipality of Salinas for which the projected population in 1990 will be 17,000. Thus none of these towns is sufficiently large to be classed as a population center (over 25,000) in accordance with the USAEC site criteria.

PONCE, P.R.
SURFACE WIND DATA

ANNUAL
(April 1941 thru July 1944)

PERCENTAGE FREQUENCY TABULATION OF SURFACE WINDS

<u>DIRECTION</u>	<u>VELOCITY (mph)</u>				<u>% of Total</u>	<u>Average Velocity</u>
	<u>1-3</u>	<u>4-12</u>	<u>13-24</u>	<u>25-31</u>		
N	4.18	6.69	.18		11.1	4.6
NNE	2.21	3.53	.25		6.0	5.1
NE	4.65	12.00	1.35		18.0	6.1
ENE	1.33	6.21	1.24		8.8	7.6
E	1.46	6.92	1.91	.01	10.3	8.4
ESE	.23	4.43	4.25		8.9	12.2
SE	.29	6.13	10.30	.04	16.6	13.6
SSE	.09	1.87	.84		2.8	10.9
S	.17	1.04	.12		1.3	8.2
SSW	.04	.35	.06		.5	8.8
SW	.05	.29	.04		.4	7.7
WSW	0	.05	0		.1	7.3
W	.12	.08	0		.2	3.6
WNW	.08	.11	0		.2	4.3
NW	1.01	1.44	.01		2.5	4.6
NNW	2.33	5.80	.08		8.2	5.2
TOTAL %	<u>18.24</u>	<u>56.95</u>	<u>20.63</u>	<u>.05</u>		
CALM	4.13%					

Guayama, situated about 8 miles to the east of the site is expected to have a population approaching 95,000 in 1990. It must, therefore, be considered as a population center. The distance between the site and Guayama is sufficient to permit siting of light water reactors at Aguirre.

The proximity of the town of Central Aguirre to the site boundary is worthy of consideration. There is an available exclusion radius ranging from 1580 feet to 2280 feet for each of the proposed reactors at this site boundary. Due to the elevated release from a boiling water reactor, there is no difficulty in siting such a reactor. Consideration must be given to iodine removal in siting a pressurized water reactor. For the range of exclusion radii, iodine removal factors must range from 2.3 to 3.4 in order to just meet siting requirements. A construction permit has recently been issued to Maine Yankee on the basis of an iodine removal factor of 4.5. Therefore, exclusion radius considerations would not preclude locating a pressurized water reactor at this site.

Use of on-site meteorological data would probably have a significant influence in the matter of selecting a site so close to Central Aguirre.

This site has fragmentary (5 months) wind data available. It has been spot-checked for the reported months with the extensive Ponce data and for these months shows an overall similarity of wind structure and of frequency of wind directions so that the annual Ponce wind data can be used with confidence for this site also. Ponce is approximately 26 miles west of Aguirre. The Ponce wind data is given in Exhibit 4.8-4.

As can be seen from the Ponce data, the wind blows from the site towards Central Aguirre only 0.2 percent of the time. This is such a low frequency that a strong case can be made to obtain credit for actual site meteorological data in the safety analyses needed for reactor licensing.

Proving that this site is an acceptable location for a power reactor will require careful presentation and use of on-site meteorological data in a license application. However, this should not present any serious difficulty, and it must be concluded that Aguirre is an acceptable site for a power reactor.

4.8.3.3 Arecibo

The urban population of the municipality of Arecibo is projected as 48,000 for 1970 and 92,000 for 1990. While some of these people will be in outlying communities, the majority will reside in the city of Arecibo. Thus, Arecibo must be considered as a population center in terms of interpreting the distance factors in the USAEC site criteria. The Arecibo city limits are located about 2.1 miles from the proposed reactor site. The required low population zone radius for this site is $2.1/1.33 = 1.6$ miles. Using standard calculational models for accident analyses, the site would be marginal for a pressurized water reactor and unacceptable for a boiling water reactor.

The conservatism of standard calculational models can be avoided by using models based on meteorological data obtained at the site. In the present case, detailed wind data over a 9 month period does exist for this site. Comparison with extensive San Juan data (over 8 year period) is not possible in all cases mainly due to the differences in wind ranges and calm-interval specification. In addition San Juan is approximately 44 miles east of Arecibo. In spite of these considerations, comparison of the overall features of the two sets of data give a high degree of confidence in the limited Arecibo wind data. This data is summarized in Exhibit 4.8-5.

Examination of this data indicates that the wind blows from the reactor site towards the city of Arecibo a high percentage of the time. The only favorable feature of the wind data is the high frequency of high wind speeds. Thus the probability of improving the licensability of this site by using on-site meteorological data is small.

On the basis of combined consideration of population, distance and wind direction frequencies, this site is not presently recommended from the standpoint of nuclear safety.

ARECIBO, P.R.
SURFACE WIND DATA

ANNUAL
(9 Month Period)

PERCENTAGE FREQUENCY TABULATION OF SURFACE WINDS

<u>DIRECTION</u>	<u>VELOCITY (mph)</u>				<u>% of Total</u>	<u>Average Velocity</u>
	<u>1-3</u>	<u>4-12</u>	<u>13-24</u>	<u>25-31</u>		
N	.66	1.70	.07		2.4	6.2
NNE	.53	2.66	.83		4.0	8.7
NE	.70	5.70	1.17		7.6	8.5
ENE	.60	7.05	18.70	.53	26.9	15.1
E	.76	6.62	11.10	.03	18.5	13.4
ESE	.43	6.90	4.55	.13	12.0	11.4
SE	.73	3.66	.46		4.9	7.3
SSE	.73	1.47	.13		2.3	5.5
S	.73	.70	.03		1.5	4.7
SSW	1.37	1.47	.16		3.0	4.7
SW	2.44	1.80			4.2	3.8
WSW	1.43	1.26	.03		2.7	4.1
W	.30	.12			.4	2.9
WNW	.23	.16			.4	4.0
NW	.20	.46			.7	5.6
NNW	.27	2.20			2.5	7.8
TOTAL %	12.10	43.90	37.30	.70		
CALM	6.0%					

4.9

TRANSPORTATION

4.9.1

Ship

The cargos shipped into or out of the Nuplex will for the most part be shipped to or from locations at considerable distances outside of Puerto Rico. As such, the location of the Nuplex site on the relatively small island of Puerto Rico will not have a major impact on shipping costs. Additionally, there will tend to be compensating effects in that a shorter import haul may be offset by a longer export haul or vice versa. As such, no relative advantage is seen from the standpoint of shipping between the three sites on the basis of location as such.

Consideration was given to the following alternatives for ship unloading and loading at each of the site locations:

- A. Use of existing harbors for dry cargo and bulk solids.
- B. Enlarging existing harbors to accommodate dry cargo, bulk solids and berthing "super tankers" of 200,000 dead weight tons.
- C. Construction of a new harbor, adjacent to the Nuplex, with conventional dockside berthing of 200,000 dead weight ton tankers as well as dry cargo vessels and bulk-solids carriers.
- D. Construction of a new, adjacently-located harbor for the dockside handling of dry cargo, bulk solids and chemical products, plus an off-shore mooring facility for off-loading crude oil from a 200,000 dead weight ton tanker.

4.9.1.1

Guayanilla

A land-cut harbor dredged from the cove on the west shore of Guayanilla Bay as shown in Exhibit 4.2-1 would give a port facility centrally located with respect to the plant. Some rock would be unavoidable in channel dredging.

An alternate harbor site would be further north on the site in the area recommended by Dr. Ta Liang (see Appendix 4.9-1. While this might warrant further investigation, it would have the disadvantage of not being as centrally located in the Nuplex.

An alternate harbor location at Punta Ventana would probably require rock blasting and dredging and would be poorly located with respect to the bulk solid handling plants.

The submarine trench located south of Punta Ventana is too narrow at the required depth for an off-shore mooring facility.

4.9.1.2 Aguirre

4.9.1.2.1 West Aguirre

For West Aguirre a harbor dredged from Mar Negro was considered and used in the preliminary cost comparison between sites. However, later investigation of the underground aquifers indicate that this location would probably violate the silty seal between the aquifer and the sea, resulting in considerable loss of fresh water and increasing the possibility of salt water intrusion during periods of heavy pumping or drought. Accordingly, the harbor was located to the southwest to take advantage of the naturally existing depth and yet keeping it within the barrier reef islands to afford protection against swells and heavy seas. A trestle that carries pipe lines, conveyors and roadway is provided to reach the wharf area which consists of a filled core dock to afford protection against the sea. Barge docking will be on the west, or lee side of dock where a natural depth of 22 feet exists that is adequate for the barges. For the chemical tankers, the turning basin, dock and channel area have been dredged from the natural depth of about 30 feet to the required depth of 40 feet. The dock for the chemical tankers has been arranged in an east-west direction to orient it into the prevailing wind and the general direction of the swells, which will be westerly except to the extent they are refracted by the presence of the land.

The large crude oil tankers will be unloaded off-shore at a depth of 65 feet. This unloading facility will consist of a mooring platform with dolphins. The crude oil will

be unloaded via a submerged pipe line, 7,000 feet in length, that rises at the dock.

It cannot be stated unequivocally that the dredging of this harbor will not have an effect on the aquifer underlying the West Aguirre site. However, moving the dredging operation southward and limiting it to 10 feet beyond the existing depth should minimize any effects and reduce them to acceptable levels.

4.9.1.2.2 East Aguirre

The existing harbor at Las Mareas has a present depth of 38 feet alongside the dock and 40 feet in the turning basin. This harbor can be expanded along the lines presently envisioned by the Ports Authority to provide an additional dock for chemical tankers and a wharf for barges, while keeping its general depth at about 40 feet. The channel width must be increased to 350 feet.

The large crude oil tankers will be unloaded in 65 feet of water at an offshore facility similar to that proposed for West Aguirre. This facility requires 5,000 feet of submerged pipeline.

The change to the harbor may result in some further loss of water from the aquifer, but it should be small compared to the loss that occurred due to the construction of the original harbor.

The Ports Authority proposes to have a general cargo handling area in Las Mareas for use of industry in the region.

An alternate harbor location for the East Aguirre site to be located just east of the dock at Central Aguirre was considered. This harbor would have a channel following the existing 27 foot channel and reaching the sea through Boca del Infierno. The cost of this harbor exceeded the cost of development of the Las Mareas Harbor, so that the Bay of Jobos Harbor was dropped from further consideration.

4.9.1.3 Arecibo

This location has by far the highest estimated dredging costs of the three locations, resulting from the expected massive limestone nature of the bottom through which the channel must be cut. The expected cost of a land-cut harbor is far greater here than at either Guayanilla or Aguirre. During the last three months of the year rough seas and ground swells can occur that would probably necessitate a greater bottom width for the channel and might result in some shipping delays.

Although the distance to 80 feet water depth at Arecibo (about 1 mile) is less than at either Guayanilla or Aguirre, this advantage for an off-shore mooring facility is partially offset by the rough seas, possibly necessitating a breakwater.

4.9.2 Highways

The availability of a modern high-speed highway system is an important consideration to the Nuplex, particularly during the construction period when it will be necessary to draw on a wide labor market, as well as during operations when the existence of the system will permit workers to commute substantial distances. Thus the highway system is the single most important element in the diffusion of the economic impact of the Nuplex to benefit a greater portion of the island and reduce the need for intensive development of infrastructure in the environs of the site.

Most of the industrial imports and exports to the Nuplex will be by ship from outside Puerto Rico but there will, of course, be need for highway trucking in connection with miscellaneous supplies for operation and maintenance.

Agricultural products to be marketed in Puerto Rico will benefit from good highways connecting with the San Juan area, the major center of population.

The Puerto Rico Highway Authority has underway a highway improvement program covering the period 1969 to 1973. This program calls for the construction of modern four-lane divided highways around the coastal perimeter of the island,

as well as across the mountainous interior, to connect the north and south shores. This primary highway program is estimated to cost \$156,000,000. In addition, improvement programs for secondary roads costing \$44,000,000 and for urban roads costing \$124,000,000 are under way. The completion of these programs will give good highway access to all the sites.

At Guayanilla, the new highway from Ponce to Guayanilla has been completed. This highway passes the northern end of the property being considered for the Nuplex. The completion of this road to Mayaguez on the west coast of the island is scheduled for 1972. This road will facilitate access to the new international airport to be built in the Lajas Valley. The road to the east of Ponce along the south shore to Salinas and across the mountains to San Juan is scheduled to be completed by 1972. A secondary road into the site from Route 2 to the Texaco property on Punta Verraco has been partially completed and is scheduled to be completed by Texaco and the Highway Authority.

At Aguirre, the junction point between the new highway connecting Ponce to San Juan and the branch going to the east toward Yabucoa is almost directly north of the Nuplex site, a distance of 2 or 3 miles. A direct connecting road from this point to the Nuplex would give excellent highway communication with San Juan, Ponce and the areas to the east in the direction of Yabucoa. The latter stretch of highway is scheduled to be completed in 1973. In addition, the existing Route 3, which is scheduled for improvement, will give good local access to Salinas and Guayama.

At Arecibo, the new highway to San Juan is presently under construction and is scheduled to be completed after 1972. The new highway to the Aguadilla area on the west coast is scheduled for completion in 1973. Route 10 going south to Utuado is scheduled for completion in 1971.

4.9.3 Railroads

In general, railroads are not a major means of transportation in Puerto Rico, as they are in the continental United States. The systems that do exist are narrow gauge roads used primarily for hauling sugarcane and are generally not interconnected so as to form a system covering the island.

At Guayanilla there was a small system serving Central Rufina but it is apparently no longer in use since the Central is shut down.

At Aguirre, the proposed sites are traversed by the Ponce-Guayama Railroad which, as its name implies, runs from Ponce to Guayama. This narrow gauge system is owned by the Aguirre Co. and is operational at the present time. They have 18 small diesel engines, 800 pieces of rolling stock and a round house located at Central Aguirre. Most of the rolling stock is cane cars but some solid bulk handling and tank cars are available. This railroad might be worked into the development of a Nuplex at this site with a view to providing a second means of transferring cargo between the Nuplex and secondary industries in the area, as well as facilitating use of the port facilities by industries in the area served by the railroad.

At Arecibo there is a railroad system that traverses the site and serves Central Cambalache and Central Plazuela. The condition of this system is not known.

4.9.4 Air

Air transport is of interest to the Nuplex in connection with executive travel, receipt of replacement parts in maintenance emergencies and the shipment of high value perishable products, such as fruits. The latter consideration, namely the shipment of perishable agricultural products, would probably have to be done by jumbo jets if it is to be economic. The other considerations, for executive travel and parts shipment, can be handled by the jet planes normally used in international travel at the present time.

At present the San Juan International Airport is the only airport in Puerto Rico capable of handling jumbo jets. However, steps have already been taken to acquire land in the Lajas Valley in the southwest corner of the island for the construction of a second international airport, which is scheduled for operation by 1974. This airport, which is being constructed mainly in connection with plans to develop the southwest corner for tourism, will be well located to serve the Guayanilla site.

The Aguirre site can use both the Lajas Valley

Airport or the San Juan Airport. It is the opinion of the Ports Authority that the Lajas Valley Airport would probably be used more often because the driving time along the coastal road is estimated to 80% of the time to San Juan, which is nearer but over the mountains.

In addition the Aguirre site can also use the Salinas Airport which is directly north of the site, across Route 3. This airport is currently capable of handling light commercial aircraft but is scheduled to be upgraded to a 5,500 ft runway capable of handling DC-9 jets.

The Arecibo site would use the San Juan Airport. There is a small airfield at Arecibo that presently handles light commercial aircraft. The Ports Authority indicates they have no plans for upgrading this field but it could be upgraded to a 5,500 ft runway if the load projections warranted.

4.9.5 Electrical Power Transmission

The PRWRA power generating and transmission system is shown in Exhibit 4.9-1. At present power is delivered at 38 and 115 kv and will be transmitted along the south coast on 230 kv lines by 1973. The 500 mva of capacity needed to back up the outage of a Nuplex power unit will be transmitted on the 115 or 230 kv system.

4.9.5.1 Guayanilla

The tie-in point for power at Guayanilla will be the 230 kv lines at the switchyard of the South Coast Plant. It is understood, based on discussion with PRWRA, that the system will have sufficient capacity both in transmission and interrupting ratings at this point to permit tie-in without major modification of the transmission system.

The station startup and auxiliary backup power will be obtained from a tie-in to the 38 kv and the 115 kv line in this same switchyard.

The transmission distance from the Nuplex switchyard to the South Coast Plant switchyard is about 7 miles.

4.9.5.2 Aguirre

The tie-in point for power at Aguirre will be the east-west 230 kv line. It is understood, based on discussions with PRWRA, that the system will have sufficient transmission capacity and interrupting capacity at this point to permit tie-in without major modification to the system. For West Aguirre the industrial area would be fed directly from the Aguirre Station switchyard, whereas the industrial area of the East Aguirre site would be a transmission line tying into the east-west 230 kv transmission line.

The station auxiliary power will be obtained from a tie-in to the 38 kv and the 115 kv line in the substation north of the Phillips Plant. The transmission distance from the Nuplex power plant switchyard to the 230 kv tie-in point is about 4 miles and to the 38 kv and 115 kv tie-in point is about 6 miles.

4.9.5.3 Arecibo

The 230 kv system does not presently exist in the vicinity of Arecibo and no plans exist for constructing 230 kv transmission by 1975. Power transmission for this site would therefore presumably be at 115 kv. The 115 kv system would have to be reinforced to supply the required capacity. No detailed study has been made of the modifications needed. For the purpose of this site selection study, it is assumed that a tie to Aguadilla, a distance of 30 miles, would be needed. A tie to the Dos Bocos Hydroelectric plant, a distance of about 10 miles, would also be needed. An additional tie somewhere in the San Juan area would be needed that might be 30 miles in length. This would be a major undertaking and this would require a total of about 70 miles of transmission lines. However, a short circuit analysis of the system would have to be made to determine if the proposed transmission line terminating and tap substations will have sufficient interrupting capacity when the generating station is energized.

The backup power would presumably tie-in to the 38 kv line but the independence of two 38 kv circuits would have to be investigated.

- LEGEND**
- STEAM PLANTS
 - HYDRO PLANTS
 - ▲ SUBSTATIONS
 - AREA MAIN OFFICE
 - 38 KV TRANSMISSION LINE
 - 115 KV TRANSMISSION LINE
 - - - 115 KV TRANSMISSION LINE UNDER CONSTRUCTION
 - - - AUTHORIZED BUT NOT UNDER CONSTR.
 - BONUS NUCLEAR POWER PLANT
 - - - MUNICIPALITY LIMITS
 - - - AREA LIMITS
 - () DATE CONNECTED
 - * INCREASE CAPACITY
 - △ FUTURE SUBSTATION
 - △ " THROW - OVERS
 - △ " 115 KV SWITCH YARD or EXTENSION
 - △ " 38 KV " " " "
 - - - 38 KV LINE

BURNS AND ROE, INC. HEMPSTEAD, NEW YORK	THE DOW CHEMICAL CO. MIDLAND, MICHIGAN
38, 115 AND 230 KV TRANSMISSION LINES SYSTEM	
PUERTO RICO ENERGY CENTER STUDY PUERTO RICO WATER RESOURCES AUTHORITY	

The Government of Puerto Rico offers as an inducement for industry to come to Puerto Rico a period of time in which no business tax need be paid or alternately a longer period in which tax is paid on only a percentage of profits. The length of this period differs at various locations on the island, being greatest in those areas that the Government of Puerto Rico wants to be developed.

At Guayanilla, the period is 17 years and at Aguirre and Arecibo, the period is 15 years.

Other than as discussed above, there is no other known significant financial distinction between the three sites.

The Socio-Economics data considered covered the municipalities of Guayanilla, Penuelas and Yauco for the Guayanilla site and the municipalities of Guayama and Salinas for the Aguirre site. These communities are those which are most likely to be involved and affected by the complex if built at Guayanilla or Aguirre.

At the present time the Guayanilla area has a larger population, more school rooms, more houses, more employment and is farther along the development process than the Aguirre site. This is probably due to the earlier start of CORCO, but the Phillips Project in Guayama is expected to furnish the push which will remove most of these differences by 1975.

The Planning Board's 1968 Economic Report to the Governor points out that 59% of the employees of CORCO live in Ponce. Phillips is reported to be bussing employees from as far away as Caguas. Penuelas has not developed enough infrastructure over the years to attract a majority of the community dependent upon CORCO.

These factors raise some questions about the future developments of infrastructure being in the immediate vicinity of the site selected. If it is possible to develop the community close to the plant there would appear to be little choice between the sites based on socio-economic factors. On the other hand, if Ponce continues to provide most of the infrastructure for the Guayanilla area, the socio-economic impact would be less than at Aguirre.

REFERENCES

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- 4.2-2 Weston Geophysical Research, Inc., "Geological and Geophysical Investigations of the Proposed Aguirre Nuclear Power Station, December 15, 1967.
- 4.3-1 Dr. Ta Lian, "An Investigation of On-Shore and Off-Shore Physical Features of Potential Port Sites" December 1960.
- 4.4-1 Weston Geophysical Research, Inc., "Geological and Geophysical Investigation of the Proposed Tortuguero Nuclear Power Plant Station", December 16, 1966.
- 4.5-1 PRWRA, "Feasibility Report Toa Vaca Dam", 1967.
- 4.5-2 Buck, Seifort and Jost "Report on the Best Method of Supplying Water for Municipal and Industrial Use from the Toa Vaca Multi-Purpose Water Supply Project", May 7, 1969.
- 4.5-3 Monthly Weather review, May 1957, p. 171.
- 4.5-4 Corps of Engineers, Jacksonville, Florida District, "Flood Plain Information - Guayanilla River" October 1967.
- 4.5-5 Hickenlooper, I.J. "Floods at Arecibo-Hydrological Investigations Atlas AA-271" 1968.
- 4.7-1 "Regional Domestic Water Demand Estimates" 1970-1990", Puerto Rico Aquaduct and Sewer Authority, February 1969.

5.0 COMPARISON OF SITES

5.1 GENERAL

This section of the report compares the sites and discusses various aspects of the site selection.

The sites were compared on a general basis including site development costs and the choice was narrowed down to the Aguirre area. The sites at Aguirre were then compared in greater detail before making the final choice of the West Aguirre Site.

There are many considerations that enter into the site selection. Some of these considerations can be quantified and reduced to dollars. Others can only be stated in qualitative terms but may, nevertheless, constitute important factors that must be weighed in making the final judgment. Those considerations that can readily be reduced to cost will be discussed first followed by the qualitative considerations.

All sites were considered acceptable from the standpoint of general conformance with the Planning Board's program for promoting industrialization of Puerto Rico. The Nuplex industries as finally selected did not utilize native raw materials and as such all sites were equal from this standpoint. The cargos shipped into and out of the Nuplex will, for the most part, be shipped to and from locations at long distances compared to the size of Puerto Rico, so that all three Nuplex sites were considered equal from the standpoint of shipping. Therefore, the selection of the site was made largely on the basis of comparing the physical aspects of the sites and the cost of development.

Exhibit 5.2-1 compares the relative cost of the five Nuplex sites, both for capital cost and for capitalized operating costs. It should be emphasized that these are relative, not absolute costs, and take into account only those items that vary from site to site. They do not take into account the cost of running utility lines between the power plant and the industrial area, which can have considerable bearing on the problem as will be shown later. The cost estimating sheets are given in Appendix 5.4-1.

5.2.1 Capital Cost

It can be seen from Exhibit 5.2-1 that the East Aguirre Site A has the lowest cost and is about \$2,597,000 below West Aguirre, about \$5,276,000 below East Aguirre Site B, about \$6,937,000 below Guayanilla, and about \$45,273,000 below Arecibo. All of the Aguirre sites are below Guayanilla and far below Arecibo.

5.2.1.1 Land

The average value of the land at Guayanilla was taken at \$6,000 per acre, at Aguirre at \$4,000 per acre and at Arecibo at \$2,000 per acre. The Guayanilla price was set higher than the Aguirre price on the basis of the greater industrialization presently existing in the area and the diminishing availability of industrial land at Guayanilla. The Guayanilla and Aguirre land costs were established based on discussion with Fomento and the Land Administration. The Arecibo land belongs to the Commonwealth so that the value assigned was chosen on the basis of lower value agricultural land.

The estimated cost of the land at Guayanilla is based on 1890 acres of industrial land which is 110 acres below the minimum amount desired. The additional 110 acres would increase the Guayanilla estimate by \$660,000, should this land be required.

5.2.1.2 Houses

The cost of expropriating houses that would have to be removed was based on the number of houses shown on the

RELATIVE COST COMPARISON OF ENERGY CENTER SITES
(In Thousands of Dollars)

	<u>Guayanilla</u>	<u>Aguirre</u>			<u>Arecibo</u>
		<u>West</u>	<u>East A</u>	<u>East B</u>	
1. <u>CAPITAL COSTS</u>					
a. Cost of Land	\$12,000	\$10,600	\$10,700	\$10,400	\$ 4,800
b. Cost of Expropriated Houses	534	1,392	1,816	4,954	480
c. Site Preparation					
(1) Levees & Flood Protection	2,300	1,392	1,844	3,553	1,500
(2) Land Filling & Compaction	1,290	965	723	1,452	34,700
(3) Drainage Pump Station	0	0	0	0	505
d. Harbor & Channels ^c	20,500	19,415	16,134	16,134	31,200
e. Power Plant					
(1) Foundations	900	900	900	900	100
(2) Circulating Water System	1,660	338	338	338	2,405
(3) Electrical Transmission	546	388	388	388	2,376
	<u>\$39,730</u>	<u>\$35,390</u>	<u>\$32,793</u>	<u>\$38,119</u>	<u>\$78,066</u>
2. <u>CAPITALIZED OPERATING COST</u>					
a. Pumping Station Operation	0	0	0	0	227
b. Water - Alternate A ^a	<u>21,500</u>	<u>21,500</u>	<u>21,500</u>	<u>21,500</u>	<u>2,300</u>
3. TOTAL COST (Alternate A)	\$61,230	\$56,890	\$54,293	\$59,619	\$80,593
2. b. Water - Alternate B ^b	<u>38,200</u>	<u>38,200</u>	<u>38,200</u>	<u>38,200</u>	<u>2,300</u>
3. TOTAL COST (Alternate B)	\$77,930	\$73,590	\$70,993	\$76,319	\$80,593

NOTES:

- a. Alternate A - Industrial water at Guayanilla and Aguirre supplied by PRASA at an assumed rate of 28¢/10³ gallons. Water at Arecibo obtained from wells at 3¢/10³ gallons.
- b. Alternate B - Industrial water at Guayanilla and Aguirre supplied by desalting plant at 50¢/10³ gallons. Water at Arecibo obtained from wells at 3¢/10³ gallons.
- c. Comparison is based on harbors capable of handling vessels up to 1100' in length and requiring 65' of water with entrance channels to harbor 400' minimum width.

USGS topographic maps, with an allowance to compensate for the increase since the maps were printed in 1960. An average of \$1,000 per house was assumed, plus an additional allowance of \$5,000 per structure for relocating the people. The Arecibo and Guayanilla sites have an advantage in this regard since there are fewer people that must be moved out of their homes and relocated. The East Aguirre Site B requires relocation of many more people than East Aguirre Site A or the West Aguirre site and places a heavy cost penalty against the East Aguirre Site B.

5.2.1.3 Site Preparation

Levees and Flood Protection: The cost allowance for levees was based on the length of levees shown in the exhibits and the volume of fill required based on a levee crown height of 18 ft. above mean sea level and the existing grade level of the land. The crown width was taken as 30 ft. with the sides sloped 1 on 5.

For the East Aguirre sites there are several small rivers and creeks that cut across the sites and money was allowed for conducting this water across the site in buried closed concrete pipe or else diverted around the site in open trenches.

Land Fill: Land filling and compaction costs were based on the amount of marshy or mangrove type land that would have to be reclaimed for use as industrial land. At Guayanilla this was taken as 200 acres, at West Aguirre 162 acres, at East Aguirre Site A as 112 acres, and at East Aguirre Site B as 225 acres, each of which was assumed to require 2 feet of compact backfill at \$2 a cubic yard. At Arecibo the entire site, with the exception of parts of the reactor site were assumed to require 5 ft. of compacted backfill because of the peaty nature of the soil. This represents a severe cost penalty against Arecibo and while more detailed investigation might develop schemes to reduce this cost, the generally poor character of the soil and the drainage problems in the area will likely result in a major cost penalty under any scheme.

Drainage Pumping Station: At Arecibo it has been assumed that the existing Cano Tiburones pump house would have to be supplemented with a modern installation to achieve the reliability that should be available to insure safety and to

protect a major capital investment against the constant flow of water into this site. The fact that this pump station needs high reliability is a detrimental consideration for this site. All sites will be protected by levees so that they will all require some form of catch basins and pump stations to take care of rain water during heavy storms but this is only for the water that falls on the site and its immediate environs. These pumping facilities have been assumed equal for all sites and have not been included.

5.2.1.4 Harbors

For the initial cost comparison it was assumed that the harbors would all be excavated to permit the large crude oil tankers to come into the harbor. The cost of the harbors at Aguirre are less than at Guayanilla and greatly less than Arecibo, which requires rock excavation. The modifications to the East Aguirre harbor at Las Mareas are about \$3,575,000 less than a new harbor at West Aguirre.

5.2.1.5 Power Plant

The cost of the power plant foundations at Guayanilla is about the same as those at Aguirre after credit is taken for the value of the rock that will be blasted out.

The circulating water system costs are highest at Arecibo because of the long distance from the sea. At Guayanilla they are higher than Aguirre because of the deep intake structure, which is brought out to water 35 feet deep.

The cost of the electrical transmission at the Guayanilla site is higher than Aguirre because of the slightly longer run to the tie-in point. At Arecibo the tie-in runs are much longer.

5.2.2 Capitalized Operating Costs

5.2.2.1 Pumping Station Operation

The pumping station at Arecibo must be operated continuously and the estimated cost of power and labor for this has been capitalized. The site at Guayanilla and Aguirre not have a comparable cost.

5.2.2.2 Water

The cost of the 19,000 gpm of fresh water for the industrial processes and demonstration farm has been capitalized in Alternate A based on PRASA supplying water at Guayanilla and Aguirre at an assumed rate of 28¢ per thousand gallons. This assumption is based on Toa Vaca water being available when required

In Alternate B the water at Guayanilla and Aguirre is assumed to be obtained from a desalting plant at 50¢ per thousand gallons. In both alternates, water at Arecibo is assumed to be obtained from wells at 3¢ per thousand gallons.

The annual charge for the water was capitalized using a fixed charge rate of 13%. This fixed charge rate was based on an average industrial plant economic life of 15 years and 10% interest on money, which are the factors an industrialist might use in deciding the capital investment that could be justified to reduced water consumption.

It can be seen that the low cost of water at Arecibo does not overcome the other capital cost penalties associated with this site. If a desalting plant was needed at Aguirre but not at Guayanilla, then the total capitalized cost of these two sites is then in favor of Guayanilla. On the other hand, the Toa Vaca Project brings water to Guayanilla before it does to Aguirre. If at Guayanilla, PRASA provided 50% of the Nuplex water from outside sources at 28¢ per thousand gallons and the other 50% was obtained from a desalting plant, the capitalized cost of Guayanilla would be about equal to that of Aguirre with an all-desalted water supply.

5.3 QUALITATIVE SITE CONSIDERATION

5.3.1 General

The Arecibo site has several major detrimental qualitative considerations including the poor prospect of being licensed from a nuclear safety standpoint, the need for continuous pumping of water to prevent flooding and the problems associated with harbor development and use in winter. These factors, taken in conjunction with the high development cost for this site, lead to a decision to drop Arecibo from further consideration and concentrate further comparison between Guayanilla and the Aguirre sites. The remainder of this section compares these two areas only. The conclusion drawn was that the Aguirre sites are preferable to the Guayanilla site.

5.3.2 Meteorology

The site at Guayanilla with the forest preserve occupying most of the downwind area is preferred to Aguirre from a nuclear safety standpoint.

5.3.3 Land Availability

The land availability at Guayanilla is marginal in terms of the space needed for future expansion. The area requirements, and especially the future area requirements, are not that well known at this time but there is no question that this factor is more restrictive at Guayanilla than at Aguirre.

The addition of Punta Verraca to the Guayanilla Nuplex would help but the uncertainty of Texaco's plans make any assumption regarding the availability of this land a poor basis on which to proceed. Furthermore, this is rocky, hilly land and would be costly to develop for the purposes of the Nuplex.

Additional land could be acquired if some additional agricultural lands of Central San Francisco or Central Rufina were taken into the site.

The Nuplex layout at West Aguirre is on a roughly rectangular plot which gives considerable freedom in plant layout. Other than for the Ponce-Guayama Railroad which could be moved, the site is not fragmented by natural obstacles. The site is gently graded toward the sea which will facilitate the installation of sanitary and storm sewers. The highway gives good access to the site and harbor. The present and future areas can be clearly separated so that only the present areas need be developed at the outset. When the future areas are developed they will also have good access to the highway and the harbor.

The East Aguirre Site A is irregularly shaped and is fragmented by two public roads, the combined effect of which is to reduce flexibility of plant layout and the efficiency of use of the plot. The present and future areas may have to be fragmented and interspersed in order that future expansion units can be grouped with present generation plants. The nearest part of the plot is 3.3 miles from the power plant and the furthest part is 6.2 miles, which will involve extra cost for the steam, condensate and water lines. The plot is traversed by the Ponce-Guayama Railroad, which could be moved. The site is crossed by several creeks and rivers and, even though money has been allowed to conduct the water through or around the site, the use of the land is inhibited to a degree. The main highway gives good access to the entire site. The harbor is well located with respect to about half of the plot, with the other half being between 2 and 3 miles distant. The Ports Authority envisions expansion of the Las Mareas Harbor for general cargo.

The East Aguirre Site B is on a long narrow plot. The plot is separated from the power plant site by a distance of 0.6 of a mile, which will involve extra costs for steam, condensate and desalted water, but less than East Aguirre Site A. The plot is traversed by the Ponce-Guayama Railroad, which presents problems because the track runs through the long dimension of the plot and through the narrowest part, giving less freedom to work around it. The site is generally lower than the other Aguirre sites. The site is crossed by several more creeks and rivers than the East Aguirre Site A and, ev

though money has been allowed for use of buried conduits to conduct the water through the site, they inhibit the use of the land to a degree. The main highway gives good access to the entire site. The present and future areas may have to be fragmented and interspersed in order that future expansion units can be grouped with present generation plants. This may mean that much of the site may have to be developed at the outset with respect to roads, sewers, power wiring and utilities distribution systems. The harbor at Las Mareas is well located with respect to about half of the plot with the other half being between 1.5 to 5 miles distant.

The Nuplex layout at Guayanilla is on a long narrow curving plot which is fragmented by the Yauco and Guayanilla Rivers and their levees, as well as the existing highway into the Texaco property. The site is generally lower and flatter than the Aguirre sites, which will make sewer installation more difficult. The main highway is at one end of the site, making travel more difficult. The present and future areas may have to be fragmented and interspersed in order that future expansion units can be grouped with the present generation of plants. This may mean that much of the site may have to be developed at the outset with respect to roads, sewers, power wiring and utility distribution systems. The harbor does not lend itself as readily to future expansion without encroaching on industrial land as the Aguirre layouts. As such, its potential for development into a public industrial harbor is limited.

In short, the West Aguirre site is felt to be superior to the East Aguirre sites, which in turn are superior to the Guayanilla site from a layout standpoint. Further site study would probably support the belief that it would cost many additional millions of dollars to use these less desirable sites. Since the cost comparisons that were made indicated the superiority of the Aguirre sites, these additional considerations could be expected to only reinforce the conclusion that the Aguirre sites are superior to Guayanilla.

5.3.5 Demonstration Farm

From the standpoint of a demonstration farm the Guayanilla and West Aguirre sites are about equal and the East Aguirre sites are inferior to both. The Guayanilla land is a little better farm land than West Aguirre, but this is not

necessarily an advantage for a demonstration farm since better yields due to the quality of the soil would have to be discounted in projecting results that could be obtained by the farmer in applying the method to his land. The Aguirre lands are probably more representative of the average farm land of the south coast.

At Guayanilla and East Aguirre a demonstration farm might have to be broken into several parcels if the future industrial expansion land is to be used, but this is not necessarily a disadvantage.

The possible effect of industrial air pollution on crop data would have to be taken into account in selecting land for the demonstration farm. In the case of Guayanilla the prevailing wind is across the narrow dimension of the plot so that air pollution might be expected to have the least effect in this case. Of course, the entire Guayanilla plot is downwind of the petro-chemical plants at Penuelas and the PRWRA fossil-fired South Coast Power Plant. The West Aguirre site has the land available for the demonstration farm downwind of most of the industrial plants and will also be downwind of the PRWRA fossil-fired power plants at Aguirre. The East Aguirre Site B has three areas that could be used for the demonstration farm, of which the one north of Route 3 would probably be least subject to industrial air pollution, the others south of Route 3 being subject to air pollution either from the Nuplex or from Phillips.

For East Aguirre Site B it may be necessary to lease lands outside of the plot to get sufficient arable land.

5.3.6 South Coast Balance

Placing the Nuplex at Guayanilla would practically double the capital investment in this area, resulting in an unbalanced condition on the South Coast. Placing the investment in Aguirre would roughly balance the two areas.

The presence of the forest preserve downwind of a major industrial installation at Guayanilla could conceivably have an effect on the forest. Furthermore, the location at Guayanilla is close to the phosphorescent bay at Parguera and this could be another source of concern to conservationists.

5.4

FURTHER COMPARISON OF THE AGUIRRE SITES

5.4.1

General

The site comparison presented in the previous section established the basis of narrowing the choice down to one of the Aguirre sites. In order to make a final choice of one of these three sites it was necessary to go into more detail concerning the plant layout, harbor design, cost of utility line between power plant and the industrial area, cost of pipe lines to the harbors, as well as additional qualitative factors concerning the relation of the site selection to social objections of the Government of Puerto Rico. This section of the report develops this more detailed comparison. The conclusion reached is that the interests of the Nuplex favor the choice of West Aguirre, whereas many of the social objections tend to favor the East Aguirre sites. The West Aguirre site was recommended and accepted by the Energy Center Committee as the basis for the further study of the Nuplex Energy Center concept in Puerto Rico.

5.4.2.1

Plant Layouts for West and East Aguirre

The cost comparison as summarized in Exhibit 5.2-1 did not include all of the additional costs associated with the layout problems that were previously discussed. To reduce some of these costs to quantitative terms, preliminary layouts of the West and East Aguirre Site A were prepared as shown in Exhibits 5.4-1 and 5.4-2, respectively. A layout for East Aguirre Site B was not prepared but the costs were developed based on assumptions relative to the cost of East Aguirre Site A. It must be borne in mind that the layouts are only for the purpose of developing relative costs and are not necessarily optimum arrangements in either case.

5.4.2.1

West Aguirre Layout

The plant layout for West Aguirre that provided the basis of the cost comparison is shown in Exhibit 5.4-1. The present generation of plants occupy the southeast half of the site with the northwest half available for the demonstration farm and future industrial growth. The aluminum plant battery limits contain within them an allowance for expansion of this unit. Public roads would be run down the west

BURNS AND ROE, INC. HEMPSTEAD, NEW YORK	THE DOW CHEMICAL CO. MIDLAND, MICHIGAN
EAST AGUIRRE SITE A ENERGY CENTER LAYOUT	
PUERTO RICO ENERGY CENTER STUDY PUERTO RICO WATER RESOURCES AUTHORITY	

and east sides of the plot to give good access to the entire industrial area and harbor without the public roads traversing the site so as to limit flexibility of use. These public roads would also give access to Lugo Vina, which may be necessary since current plans do not call for the purchase of this mangrove area as part of the Nuplex. The Ponce-Guayama Railroad is proposed to be relocated just south of Route 3 to minimize interference with the use of the land. However, this need not be done until the future plant areas are to be used, some time in the 1980's, at which time this railroad might be out of business if Central Aguirre is closed in the interim.

The industrial site has been graded in a series of terraces that curve to follow the existing contours. The width of the terraces have been set to conform to standard plot widths that will suit most of the plants.

The harbor has been located in deeper water to reduce excavating costs and reduce any damage to the aquifer underlying the site. A trestle to carry pipe lines, conveyors and truck roadway is provided to the barge and chemical tanker unloading area. The large crude oil tankers will be unloaded offshore at a depth of 65 feet by means of a submerged pipe line, 7,000 feet in length that rises at the dock.

The plant layout has taken into account three inter-relationships for each plant, namely, (1) with other plants, (2) with the power plant and (3) with the harbor. Those plants with the larger steam demands such as salt and chlorine have been placed in close proximity to the steam plant. The polyethylene plant, which is a large user of steam, has been placed further away to put it in better proximity to the dock since its product is a solid and must be conveyed to dock for bulk shipments. The aluminum plant which uses little or no steam has been located in the southwest corner where it has good access to the dock for the receipt of alumina and shipment of aluminum.

5.4.2.2 East Aguirre Site A Layout

The plant layout for East Aguirre Site A which provided the basis of the cost comparison, is shown in Exhibit 5-2. The present generation of plants has been divided into two groupings, those in the southwest portion near the harbor that have a solids-handling problem and the petro-chemical

plants located in Central Guamani tract that have interrelations with the steam plant and the harbor. The future expansion area has been broken into three areas with some in good proximity to the harbor, with some in good proximity to the petro-chemical plants and steam supply and with the remainder north of Route 3. This break up is more or less dictated by the shape of the plot and the fact that it is cut by Route 3 and the road leading from Route 3 to the harbor at Las Mareas. An alternate possibility would be to relocate Route 3 around the northern perimeter of the plot and to relocate the road to harbor to the east and parallel to the Phillips' property line. This would give greater freedom in plant layout; however, it has not been allowed for in the current differential cost estimates.

The Ponce-Guayama Railroad would be relocated to follow Route 3 to eliminate its interference with plant layout and operation. The portion through the Central Guamani tract would be relocated at the outset. The portion from Jobos to east of the Phillips' optioned property could be relocated at a future date and would have to be coordinated with Phillips' plans.

The industrial site has been graded in a series of terraces conforming to the general lay of the land and the dimensional needs of the plants.

As mentioned previously, the existing harbor at Las Mareas will be enlarged to handle chemical tanker and barges and the channel will be widened. The large crude oil tankers are unloaded offshore in 65 ft. of water by means of a submerged pipe line, 5,000 ft. in length that goes directly to the tank storage area.

The plant layout has taken into account the same interrelationships as mentioned for the West Aguirre site.

A pipeline right-of-way is provided between the power plant and the industrial area. This right-of-way is a minimum of 75 ft. wide to provide space for the following:

- 3 - 48" 150 psig steam lines
- 1 - 30" 400 psig steam line
- 1 - 36" Water Line
- 1 - 6" Salt Bitterns Line
- 1 - 6" Salt Solution Line
- 1 - Truck Service Road

The right-of-way runs north out of the steam plant to get around Central Aguirre, it then more or less follows the Ponce-Guayama Railroad to the site.

As a safety precaution, the entire length of the pipe line right-of-way would be fenced. In spite of this, there is an element of danger that must be acknowledged in such a long steam line traversing areas that are accessible to the public and crossing railroads and public highways. The danger exists both from the standpoint of the lines failing and endangering the public as well as the public endangering the lines. These lines are vulnerable to sabotage, which must be considered in view of the recent activities of proponents of independence for Puerto Rico.

Additional failure of these long steam lines even if no one is hurt, represents increased maintenance and operating costs for the plants.

The salt recovery plant must stay in proximity to the power plant since it utilizes 40 psig steam which cannot be piped economically more than about 1/2 mile. The salt recovery plant could be located within the power plant exclusion radius along with the desalting plant or alternately it could be located in a small separate enclave abutting the PRWRA property. The salt, after being crystallized and washed, is put back into solution and shipped via pipeline to the caustic-chlorine plant. The bitterns from the salt recovery plant are transferred via pipeline to the industrial area for recovery of brome, KCl , and $MgCl_2$, should these plants prove to be economic.

5.4.3 East Aguirre Site B Layout

As previously mentioned, no specific industrial plant layout was made for East Aguirre Site B but it was assumed that the petro-chemical plants and the chlorine-caustic plant would be located at the western end of the site to re-

duce the cost of the utility lines to the power plant. The savings is partly offset by the longer pipeline to the harbor at Las Mareas. The aluminum plant was assumed to stay near the harbor at Las Mareas.

5.4.3 Additional Capital Costs for West and East Aguirre Sites

The additional relative capital costs for the West and East Aguirre sites, based on the layouts shown in Exhibits 5.4-1 and 5.4-2 and as described in the preceding section are summarized in Exhibit 5.4-3. Backup details of these estimates can be found in Appendix 5.4-1. It can be seen from Exhibit 5.4-3 that the major cost item against the East Aguirre Site A is the pipelines connecting the power plant to the industrial area which cost 17.6 million dollars more than West Aguirre. Other than for this, most of the cost items are about the same or in favor of East Aguirre Site A. East Aguirre Site B costs \$11,187,000 more than West Aguirre, saving money on the utility lines to the power plant but losing part of the savings on the transfer lines within the complex.

The existing harbor at Las Mareas was built by Phillips, who were reimbursed by the Port Authority, who now own the harbor and charge fees for its use designed to recover for the Port Authority the full cost of the harbor. Therefore, in order to put the capital cost of the Las Mareas Harbor on an equal footing with the West Aguirre Harbor some portion of the capital cost of the existing part of the Las Mareas Harbor must be added to the capital cost of the modifications to the harbors. The original cost was about \$6,000,000 and based on the size of the Nuplex relative to the Phillips plant, 2/3 of this cost was assigned to the Nuplex.

The fact that a harbor already exists at Las Mareas that is capable of expansion at reasonable cost is an important consideration with regard to the initial hurdles to be overcome in bringing the Nuplex into existence. It reduces the interdependence of the triangle of the harbor, petro-chemical units and the aluminum plant in coming to a mutual agreement before the Nuplex can proceed. With relatively minor changes to the existing harbor, bulk unloading facilities for alumina could be added. Initial operations of the petro-chemical plant could be started using the chemical

ADDITIONAL RELATIVE CAPITAL COSTS FOR COMPARISON

OF

WEST AND EAST AGUIRRE SITES

(In Thousands of Dollars)

	<u>West</u>	<u>East A</u>	<u>East B</u>
1. Site Development (Grading-Roads-R.R.-Fencing)	\$ 7,147	\$ 4,657	\$ 4,734
2. Services-Nuclear Station to Industrial Load Center (R-O-W, Land, Fencing, Piping & Service Road)	3,500	21,100	12,750
3. Raw Material and Product Transfer within Complex (Outside Manufacturing Area Battery Limits)	9,350	9,340	13,700
4. General Plant Services (Based on Item 3 Comparison)	Same	Same	Same
5. Raw Material and Product Transfer Between Harbor and Plant Storage	3,145	2,720	2,720
6. Port Facilities (Harbor-Docking-Crude Oil Unloading)	6,010	2,435	2,435
7. Pro-Rated Share of Existing Harbor Cost	---	4,000	4,000
	<hr/>	<hr/>	<hr/>
Total Additional Capital Costs	\$29,152	\$44,252	\$40,339

tanker docks, pending future addition to the offshore facility needed for the more economical operation associated with large oil tankers. As such; the aluminum and petro-chemical areas are relatively independent of one another and need not mutually agree in order that the harbor costs will not be overburdensome as they might be if independent actions were taken.

Sharing use of the harbor with Phillips will reduce the fee schedule for all users.

Exhibit 5.4-4 combines the cost data from Exhibits 5.4-1 and 5.4-3 and shows that the total relative cost of West Aguirre is about 16 million dollars lower than East Aguirre Site A and 17 million dollars lower than East Aguirre Site B.

If rock existed at East Aguirre adequate to found the nuclear reactor, the East site would be preferable to the West site on the basis of cost by about 1.5 million dollars. It must be understood that there is not an absolute prohibition against placing the nuclear power plant on a non-rock foundation. Technically this can be done with safety by designing for increased earthquake accelerations that result from the alluvial geology of this area. This would result in designs that would consume part or possibly all of the savings that would result from eliminating the steam lines. But even if it cost as much as the steam line, it would have the advantage of eliminating the uncertainty in reliability of the steam line. However, another aspect of the problem of building on a non-rock foundation and perhaps the crucial one is the problem of licensing the power plant with the AEC. Most attempts that have been made to license nuclear power plants on non-rock foundations in earthquake areas of the continental U.S. have cost the applicants considerable time and money and have been unsuccessful. It is this uncertainty that leads us to recommend that for a nuclear power plant in Puerto Rico only a rock foundation be considered at this time.

Fossil fired power plants do not have the same licensing problems as nuclear power plants. A dual purpose fossil plant could be built at Jobos that would eliminate the steam line. In this regard a comparison was made of the cost of generating the power and steam required for the Nuplex

TOTAL RELATIVE CAPITAL COST COMPARISON

OF

WEST AGUIRRE VERSUS EAST AGUIRRE

(In Thousands of Dollars)

	<u>West</u>	<u>East A</u>	<u>East B</u>
Capital Costs Exhibit 3.1-2	\$35,390	\$32,793	\$38,119
Less Harbors and Channels	<u>-19,415</u>	<u>-16,134</u>	<u>-16,134</u>
Net Capital Cost	\$15,975	\$16,659	\$21,985
Additional Capital Costs Exhibit 3.1-3	<u>29,152</u>	<u>44,252</u>	<u>40,339</u>
CAPITAL COST TOTAL	\$45,127	\$60,911	\$62,324

with dual purpose nuclear plants versus a dual purpose fossil fired plant. The annual cost savings for a dual purpose nuclear plant was about \$3,000,000 and these then are the savings that can be realized by application of the nuclear energy center concept as it applies to the West Aguirre site. When the industrial site is moved away from the nuclear power plant as it is in the case of the East Aguirre sites, substantial fractions of the potential savings are lost due to the cost of the steam lines.

In addition to the economic effect of the long steam line to East Aguirre, there is concern for the reliability of these lines.

The Dow Chemical Company has experienced failures of large steam lines due to slugs of condensate rupturing the pipe walls. Nevertheless, The Dow Chemical Company is planning on installing two 48"-150 psig, and one 24"-400 psig steam lines from the Consumers Power Plant to The Dow Midland Plant, a distance of 1 to 2 miles. However, when the question arose of increasing the separation up to 3 to 4 miles in the interest of safety, Dow advised the AEC that the project would be dropped because of their concern with the reliability of the steam supply and safety consideration.

Burns and Roe, Inc. and The Dow Chemical Company are unaware of any other installation in the world with so many large steam lines of such great length as would be needed in the East Aguirre sites. The New York Steam Company operates steam lines ranging up to 24 inch in the 200 psig range with a few degrees of superheat that are 6 to 7 miles in length. These lines run under the streets of New York City. Expansion is taken care of by loops, bellows, expansion joints and slip joints. New York Steam Company has been in business since 1885 and report no unusual difficulties.

5.4.5 Other Factors In Comparing the Aguirre Sites

The East Aguirre sites have an advantage from the viewpoint of the Government of Puerto Rico in regard to the conservation of insular lands.

It is the policy of the Government of Puerto Rico to conserve agricultural land for agricultural use. When a

choice must be made between areas such as West and East Aguirre, the policy would call for industry to use the plot that is least desirable from an agricultural standpoint. In this instance the East Aguirre plots are less desirable from an agricultural standpoint.

An estimate of the financial impact of agriculture on the choice between the two sites has been made. During the first 10 years of the Nuplex project, i.e. 1972 to 1982, the industrial complex would require about 1250 acres of land. Based on the layouts the use of this industrial land would remove about 1000 acres of land presently in sugar cane on the West Aguirre Site and 500 acres for the East Aguirre Sites or a net difference of 500 acres. Based on a gross income of \$500/acre for cane, this would reduce the gross income for agriculture by about \$250,000/year.

For the second 10 year period, i.e. 1982 to 1992, the remaining industrial land of 1000 acres would be used which would displace about 250 acres more of cane at the West site as compared to the East site. This increases the loss in gross income for agriculture to \$375,000/year.

East Aguirre sites are also less desirable from a residential standpoint since they are downwind of the Phillips Plant.

Use of the East Aguirre Site B would afford an opportunity to eliminate considerable substandard housing and permit these people to be relocated in other more desirable areas.

Use of either East Aguirre site would result in a single industrial development zone consisting of the Phillips Plant and The Energy Center, rather than two industrial developments separated five miles apart.

Use of the Las Mareas Harbor eliminates the existence of two harbors in the area that would be competing for available construction and maintenance funds. If there is hope of getting Federal aid to construct and maintain these harbors, the chances may be diminished by the existence of two harbors.

Excavating harbors endangers to some extent the underground fresh water aquifers and use of Las Mareas would restrict this to a single aquifer and only change the degree of the problem which already exists.

5.4.6 Final Choice of Site

The West Aguirre Site involves lower capital and annual operating costs than the East Aguirre Sites. The superior economics of the West Aguirre Site increases the chances of success of the Nuplex, which in turn enhances the prospect of achieving Puerto Rico's social objectives of creating jobs for men with good rates of pay and long term stability. These considerations were felt to outweigh the more intangible benefits to be achieved through use of the East Aguirre Sites and the West Aguirre Site was recommended to the Energy Center Committee, who accepted the recommendation as the basis for completing the remainder of the study.

This appendix gives information excerpted from a report by Dr. Ta Liang, Consultant of Ithaca, New York, entitled "An Investigation of On-Shore and Off-Shore Physical Features of Potential Port Sites" prepared in December of 1960 for the Puerto Rico Ports Authority. The excerpts which continue to carry the designations and page numbers used in the original report, cover the following:

- 3. Jobos and Aguirre
- 5. Guayanilla
- 11. Arecibo

The excerpts are of interest since the author gives his opinion on the potential of these harbors as ports as well as his opinion regarding on-shore and off-shore geological conditions.

3. Jobos and Aguirre

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:20,000 scale hydrographic chart; field reconnaissance, and communications from Cahagan Overseas Dredging Company.

The on-shore area consists of fan and flood plain soils with extensive swamps, salt flats and some beach sands along the coast. There is an igneous rock hill situated directly west of the town of Central Aguirre.

Off-shore, the area is well protected from waves by coral islands. Conditions of sediments are variable; the sediments are generally deep and poor.

The Jobos Bay is very shallow, filled with fine-textured sediments. Most of the Bay is surrounded by low, swampy land except at Point Pozuelo area where extensive beach sand developed. Because of its sandy soil and favorable approach from sea, Point Pozuelo area itself might provide a good possibility for development and is so indicated in the accompanying map.

In Central Aguirre, the on-shore topography varies from rolling to hilly; the harbor is muddy but becomes more sandy toward the sea. Between the harbor and the sea, there is a chain of coral islands with patches of sand on top of them.

West of central Aguirre, there is an extensive area of swamps and salt flats, although a narrow band of beach sand developed along the coast. Mud and some rock are expected directly off-shore. A relatively deep sandy channel is reported between these mud areas and the coral chain toward the sea. Development along the coastal area at Mar Negro and vicinity is a possibility. If such a development is contemplated, a limited probing to ascertain bay bottom conditions directly adjacent to shore would be desirable. This area is also indicated in the accompanying map.

In summary, the overall physical condition of this general area is not favorable because of the swampy low land on-shore and the deep mud bottom off-shore. However, if because of economic reasons, serious consideration for port development is required in this location, then the Point Pozuelo and Mar Negro areas should be further explored and a limited probing program executed. Detailed information is shown in the accompanying map, Plate IV, which also indicates potential port and probing locations.

Plate IV Jobos and Aguirre

Condensed Legend*

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
I Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
II Talus, Alluvial Cone and Fan			
Ilo Talus	Easy	Good	Poor
Ila Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Ilb Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Ilc Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
III Flood Plain			
IIIa Silts and well-drained Soils	Easy	Good	Good to Fair
IIIa* IIIa over granular Soils	Easy	Good	Good
IIIb Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
IV Sand			
IVa Beach Sand	Easy	Good	Good
IVb Ridge Sand	Easy	Good	Good
IVc River Sand	Easy	Good	Good to Fair
IVc* Shallow silt over granular Soils	Easy	Good	Good to Fair
V Tidal Area			
Va Low land	Easy to Medium	Fair to Poor	Poor
Vb Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

- A Coral
- B Coral or Rock
- C Silts and Clays primarily
- D Sands primarily
- W Water depth greater than thirty feet

Recommendations

- P Potential Area for Port Development
- X General Location for Limited Probing Program

* Note: 1. For a more detailed description see Part I of this report.
 2. Compound symbols: A/B indicates A overlying B at relatively shallow.

TO LINES CONSULTANT ENGINEERING INTERPRETATION OF AERIAL PHOTOGRAPHY ITACA, NEW YORK	PUERTO RICO PORTS AUTHORITY, SAN JUAN, P.R.	
	PORT SITES INVESTIGATION	
	3 JOBOS AND AGUIRRE	
	SCALE 1:50,000 DEC 1950 PLATE 18 OF 18 DATE MAP U.S.S. TOPOGRAPHIC SERIES	

5. Guayanilla

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:10,000 scale hydrographic chart; field reconnaissance, communications from Gahagan Overseas Dredging Company.

The on-shore area consists of limestone hills, well-drained fans and flood plains and coastal swamps. At the east wing, Punta Guayanilla, there is a prominent development of sandy beach ridges along the coast.

The off-shore conditions are variable. In the middle portion of the harbor, where the waves are active, there is a sandy bottom. At Puerto de Guayanilla, the western bay, there is an accumulation of deep fine-textured sediments. In both the west and east outlying areas of shallow and relatively quiet waters, there are fine-textured soils overlying rock. Many coral reefs and islands scattered throughout the off-shore regions of the coast. However, navigation would not be difficult.

In summary, the area is a natural, well-protected harbor. Furthermore, both on-shore and off-shore features are generally favorable for development in the vicinity of Playa de Guayanilla and in Punta Guayanilla area; a special point for consideration is the coral and mud deposit at certain locations off-shore. A limited probing program should be undertaken in the off-shore locations immediately adjacent to the above mentioned land areas prior to detailed planning. Detailed information and the potential development areas are shown in the accompanying map, Plate VI.

Plate VI Guayanilla

Condensed Legend*

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
I Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
II Talus, Alluvial Cone and Fan			
Ilo Talus	Easy	Good	Poor
Ila Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Ilb Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Ilc Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
III Flood Plain			
IIIa Silts and well-drained Soils	Easy	Good	Good to Fair
IIIb Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
IV Sand			
IVa Beach Sand	Easy	Good	Good
IVa**I Va, primarily corals and shells	Easy	Good	Fair
IVb Ridge Sand	Easy	Good	Good
IVc River Sand	Easy	Good	Good to Fair
V Tidal Area			
Va Low land	Easy to Medium	Fair to Poor	Poor
Vb Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

- A Coral
- B Coral or Rock
- C Silts and Clays primarily
- D Sands primarily
- W Water depth greater than thirty feet

Recommendations

- P Potential Area for Port Development
- x General Location for Limited Probing Program

* Note: 1. For a more detailed description see Part I of this report.
 2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

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ENGINEERING INTERPRETATION
OF AERIAL PHOTOGRAPHY
THACA NEW YORK

PUERTO RICO PORTS AUTHORITY SAN JUAN P.R.
PORT SITES INVESTIGATION
5 GUAYANILLA
SCALE 1:20000 DEC 1960 PLATE 91 of 221
BASE MAP U.S.G.S TOPOGRAPHIC SERIES

11. Arecibo

Sources of Information: Topographic map, agricultural soil map, geological map. 1:15,000 scale and 1:4,800 scale airphotos, 1:20,000 hydrographic chart; field investigation, and communications from Mr. A. Dauway, Puerto Rico Ports Authority.

The on-shore area consists of sedimentary rock hills, flood plains, beach sands and some swamps. There is also some land filled with dredged material. The on-shore soil condition is generally satisfactory for engineering purpose, although the areal extent of land is relatively limited.

Off-shore, the harbor bottom material is primarily sandy; rocks are found at shallow depths in scattered locations, particularly when close to the rock headland. A relatively small part of the harbor has been dredged to a depth of twenty-five feet. This small area is now protected by breakwater and is suitable for small crafts. The remaining major portion of the harbor, southwest of the dredged area, is composed of deep sand. The wave action there is exceedingly strong; some substantial protective structure would be required for the development of this area.

In summary, the overall condition of this area is not favorable because of the strong wave action affecting the major portion of the harbor. The already developed area is satisfactorily protected by the breakwater, but there, both on-shore and off-shore spaces are limited. Detailed information is indicated in the accompanying map, Plate XII.

Plate XII Arecibo

Condensed Legend*

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
I Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
II Talus, Alluvial Cone and Fan			
Ilo Talus	Easy	Good	Poor
Ila Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Ilb Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Ilc Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
III Flood Plain			
IIla Silts and well-drained Soils	Easy	Good	Good to Fair
IIlb Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
IV Sand			
IVa Beach Sand	Easy	Good	Good
IVb Ridge Sand	Easy	Good	Good
IVc River Sand	Easy	Good	Good to Fair
V Tidal Area			
Va Low land	Easy to Medium	Fair to Poor	Poor
Vh Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

- A Coral
- B Coral or Rock
- C Silts and Clays primarily
- D Sands primarily
- W Water depth greater than thirty feet

* Note: 1. For a more detailed description see Part I of this report.
 2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

W* Water depth twenty-five feet; dredged area

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OF AERIAL PHOTOGRAPHY
ITHACA, NEW YORK

PUERTO RICO PORTS AUTHORITY, SAN JUAN, P.R.

PORT SITES INVESTIGATION

II. ARECIBO

SCALE 1:20000 DEC 1960 PLATE XII of XII

BASE MAP U. S. G. S. TOPOGRAPHIC SERIES

6.2

APPENDIX 5.4-1

COST ESTIMATION DATA SITE SELECTION SUPPLEMENT

FOR PUERTO RICO ENERGY CENTER

W. O. NO. 2720-01BURNS AND ROE, INC.
NEW YORK, N. Y.DATE: 4/4/70

DRAWING NO. _____

BY: AVTITLE: PUERTO RICO ENERGY CENTER - EXH. 5.2-1SHEET 1 OF 40COST OF LANDGUAYANILLAINDUSTRIAL
REACTOR FACILITY
HARBOR

1890 ACRES

100

- RETAINED LAND ±

1990 ACRES X \$6000/ACRE = \$12,000,000AGUIRREWESTINDUSTRIAL
REACTOR FACILITY
HARBOR

2400 ACRES ±

250 "

- NIL ±

2650 ACRES X \$4000/ACRE = \$10,600,000EAST SITE AINDUSTRIAL
REACTOR FACILITY
RIGHT OF WAY
HARBOR

2400 ACRES ±

250 "

28 "

- NIL ±

2678 ACRES X \$4000/ACRE = \$10,700,000EAST SITE BINDUSTRIAL
REACTOR FACILITY
RIGHT OF WAY
HARBOR

2,300 ACRES

250 "

43 "

NIL

2,593 ACRES X \$4000/ACRE = \$10,400,000ARECIBOINDUSTRIAL
REACTOR FACILITY
HARBOR

2000 ACRES

315 "

100 "

2415 ACRES X \$2,000/ACRE = \$4,800,000

W.O. NO. 2701-01BURNS AND ROE, INC.
NEW YORK, N. Y.DATE: 4/4/70

DRAWING NO. _____

BY: AV/SFGTITLE: PUERTO RICO ENERGY CENTER EXH. 52-1SHEET 2 OF 40COST OF EXPANDMENT HOUSES

VALUE OF HOUSES AVERAGED AS \$1,000 EA. + \$5,000 FOR RELOCATION
NUMBER OF HOUSES IS BASED ON INSPECTION OF AREAS.

GUAYANILLA

$$89 \text{ HOUSES} \times \$6,000 = \underline{\underline{\$534,000}}$$

AGUIRREWEST

$$232 \text{ HOUSES} \times \$6,000 = \underline{\underline{\$1,392,000}}$$

EAST SITE A

MovE ESCUELA LUCE		\$100,000
JOBOS - So. OF ROUTE 707	42 @ \$6,000	252,000
PUERTO de JOBOS	194 @ \$6,000	1,164,000
CENTRAL GUAMANI	30 @ \$6,000	180,000
JOBOS No. OF HWY 3	20 @ \$6,000	120,000
		<u>\$1,816,000</u>

EAST SITE B

MovE ESCUELA LUCE		\$100,000
JOBOS - SOUTH OF ROUTE 707	42 @ \$6,000	252,000
PUERTO de JOBOS	194 @ \$6,000	1,164,000
CENTRAL GUAMANI	30 @ \$6,000	180,000
SAN FELIPE & CHIN CHIN	543 @ \$6,000	3,258,000
		<u>\$4,954,000</u>

ARECIBO

$$80 \text{ HOUSES} @ \$6,000 \text{ ea} = \underline{\underline{\$480,000}}$$

W.O. NO. 2720-01 BURNS AND ROE, INC.DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: PEM/JERTITLE: PUERTO RICO ENERGY CENTER EXH. 5.2-1SHEET 3 OF 40LEVEES - GUAYANILLA

CROWN ELEVATION ; +18.0 FT ABOVE MEAN SEA LEVEL

CROWN WIDTH: 30 FEET

SIDE SLOPES ; 1 ON 5

COMPLETE SECTION, BASED ON ELEV 0.0 MSL = 80 CU YD $\pm$ /ft.GUAYANILLA

COMMENCING WITH "PUNTA VENTANA" PROMONTORY,
 PROCEEDING AROUND ALTERNATE HARBOR SITE,
 THENCE NORTHWARD AROUND GUAYANILLA BAY,
 LASTLY BOTH BANKS OF RIO YAUCO.

<u>LINEAR YARDS</u>	<u>RMS LEVEE HEIGHT (FT)</u>	<u>CUBIC YARDS PER FOOT</u>	<u>TOTAL CUBIC YARDS</u>
550	12	40	66,000
2690	18	80	693,600
880	18	80	221,200
880	18	80	221,200
680	18	80	163,200
1100	18	80	264,000
550	18	80	132,000
1300	18	80	312,000
1650	15	58	287,100
2880	13	45	390,000
1930	15	58	336,000
<u>15,290 LIN YDS</u>			<u>3,066,000 CUBIC YARDS</u>

LENGTH OF LEVEE SYSTEM = 8.7 MILES

ESTIMATED COST = $3,066,000 \times 0.75/\text{CU YD} = \underline{\$2,299,500}$

W.O. NO. 2720-01BURNS AND ROE, INC.
NEW YORK, N. Y.DATE: 4/4/70

DRAWING NO. _____

BY: AVTITLE: PUERTO RICO ENERGY CENTER EXH. 5.2-1SHEET 4 OF 40LEVEES - AGUIRRE

<u>WEST</u> L-FT	x D-FT	x AVG W-FT	= C.U. FT
2000	10	80	1,600,000
7000	17	115	13,685,000
2600	18	120	5,616,000
2200	17	115	4,301,000
1600	20*	130	4,160,000
1600	20	130	4,160,000
6400	20	130	16,640,000
<u>23400</u>			<u>50,142,000</u>

$$\frac{50,142,000}{27} = 1,856,000 \text{ cy}$$

$$1,856,000 \text{ cy} @ 0.75 = \underline{\underline{1,392,000}}$$

EAST AGUIRRE SITE A

1800	8	70	1,008,000
5000	15	105	7,875,000
16000	20*	130	41,600,000
1000	20	130	2,600,000
1200	8	70	672,000
<u>250,000</u>			<u>53,755,000</u>

$$\frac{53,755,000}{27} = 2,180,000 \text{ cy}$$

$$2,180,000 \text{ cy} @ 0.75 = \underline{\underline{1,630,000}}$$

ROUTING OF DRAINAGE FROM
NORTH OF HWY 3
(SEE SHEET 5)

$$\frac{214,000}{1,844,000}$$

* WHERE LEVEES CROSS MANGROVES, A HEIGHT OF 20 FT WAS USED TO ALLOW FOR 2 FT SETTLEMENT.

W.O. NO. 2720-01BURNS AND ROE, INC.
NEW YORK, N. Y.DATE: 4/4/70

DRAWING NO. _____

BY: ASTITLE: PUERTO RICO ENERGY CENTER EXH. 5.2-1 SHEET 5 OF 40FLOOD CONTROLROUTING OF DRAINAGE FROM NO. OF HWY 3EAST AGUIRRE SITE ARICO SECO QUANTITY UNIT MATERIAL UNIT TOTAL LABOR UNIT TOTAL

TRENCHING	12000	cy	1.00	12000	-	-
60 RCP 36" NO	450	LF	32.00	14400	-	-
EXCAV	1500	cy	0.40	1050	0.40	600
BACKFILL	1200	cy	0.50	600	0.30	360
CONC.	36	cy	16-	576	5-	180
FORMS	1800	SF	0.40	720	1-	1800
REINF	3000	lbs	0.07	210	0.07	210

RIO MELANIA

TRENCHING	4800	cy	1.00	4800	-	-
48" RCP	3000	LF	23-	69000	-	-
EXCAV	2100	cy	0.40	1470	0.40	840
BACKFILL	1800	cy	0.30	900	0.30	540
CONC.	20	cy	16-	320	5-	100
FORMS	1000	SF	0.40	400	1-	1000
REINF	1600	lbs	0.07	112	0.07	112

CREEK EAST OF RIO SECO

36" RCP	3500	LF	15-	52500	-	-
EXCAV.	1200	cy	0.40	840	0.40	480
BACKFILL	800	cy	0.30	400	0.30	240
RC CROSSING	1	ea	-	1000	-	-
BASINS	2	ea	-	2000	-	-

163,344 6,462 169,806

OH & P 15/10

44,150
\$ 213,956
\$ 214,000

Say

W.O. NO. 2720-01 **BURNS AND ROE, INC.**
 DRAWING NO. _____ **HEMPSTEAD, N.Y.**
 TITLE: PUERTO RICO ENERGY CENTER EXH 5.2-1

DATE: 4/4/70
 BY: VJB-VLK.
 SHEET 6 OF 40

LEVEES - AGUIRRE (CONT'D)

EAST AGUIRRE SITE B

<u>L-FT</u>	<u>x D FT</u>	<u>x Aver W-FT</u>	<u>= CU. FT.</u>
2400	45	3	324,000
3600	85	11	3,366,000
4800	130	20 *	12,480,000
3200	130	20	8,320,000
5000	130	20	13,000,000
7000	130	20	18,200,000
1800	120	18	3,888,000
2800	130	20	7,280,000
3400	120	18	7,344,000
3400	75	9	2,295,000
			<u>74,497,000 $\cong$ 2,833,200 c.y.</u>

$$2,833,200 \text{ c.y. @ } \$0.75 = \$2,124,900$$

$$\text{Flood Control/Conduits} = \underline{1,428,000}$$

$$(\text{see Sheets 5 \& 6}) \quad \$3,552,900$$

* where levee ran across mangrove a height of 20 ft was USED TO ALLOW 2 FT. FOR SETTLEMENT.

BURNS AND ROE, INC.
ESTIMATED CONSTRUCTION COST

NO. 2720-01
 JOB Puerto Rico ENERGY CENTER
 BUILDING EXHIBIT 5.2-1
 CONTRACTOR _____

SUBJECT East Aguirre Site B
 CHANGE ORDER _____
 SHEET 7 OF 40
 BY 2/3 DATE 4/4/70

NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL		LABOR		TOTAL
				UNIT	TOTAL	UNIT	TOTAL	

BURNS AND ROE, INC.
ESTIMATED CONSTRUCTION COST

NO. 2720-01
JOB Puerto Rico ENERGY CENTER
BUILDING EXHIBIT 52-1
CONTRACTOR _____

SUBJECT East Aguirre Site - B
CHANGE ORDER _____
SHEET 8 OF 50
BY UFR DATE 4/4/70

NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL		LABOR		TOTAL
				UNIT	TOTAL	UNIT	TOTAL	
	<u>Flood Control</u>							
	<u>Quebrada Aguas Verdes</u>							
	Excav.	11100	CY	1 ⁰⁰	11100	0 ⁴⁰	2300	
	Fine Grade	10000	SF	X	X	0 ⁰⁵	500	
	Backfill	10000	CF	1 ⁰⁰	10000	0 ⁵⁰	5000	
	24" R.C. Pipe	5000	LF	4 ⁷⁰	23500	3-	15000	
					44600		24900	
	<u>Quebrada Amoroso</u>							
	Excav.	7800	CY	1 ⁰⁰	7800	0 ⁴⁰	3120	
	Fine Grade	7000	SF	X	X	0 ⁰⁵	350	
	Backfill	7000	CY	1 ⁰⁰	7000	0 ⁵⁰	3500	
	24" R.C. Pipe	3500	LF	4 ⁷⁰	16450	3-	10500	
					31250		17470	
	<u>Rio Seco</u>							
	Excav.	60000	CY	1 ⁰⁰	60000	0 ⁴⁰	24000	
	Fine Grade	12000	SF	X	X	0 ⁰⁵	600	
	Backfill	34800	CY	1 ⁰⁰	34800	0 ⁵⁰	17400	
	60" R.C. Pipe	24000	LF	23 ⁵⁰	564000	8-	192000	
					658800		234000	
	<u>Rio Melanes</u>							
	Excav.	7400	CY	1 ⁰⁰	7400	0 ⁴⁰	2960	
	Fine Grade	6000	SF	X	X	0 ⁰⁵	300	
	Backfill	6000	CY	1 ⁰⁰	6000	0 ⁵⁰	3000	
	36" R.C. Pipe	3000	LF	9 ⁷⁰	27600	4-	12000	
					41000		18260	

W.O. NO. 2720-01 **BURNS AND ROE, INC.**

DATE: 4/4/70

DRAWING NO. _____ **HEMPSTEAD, N.Y.**

BY: PEM/JER

TITLE: PUERTO RICO ENERGY CENTER EXH 5.2-1

SHEET 9 OF 40

LEVEES - ARECIBO

SAME LEVEE CRITERIA AS FOR GUAYANILLA

ARECIBO

ALONG COAST: 3800 LIN YDS x 4 FT AVERAGE HEIGHT
= 3800 x 22 = 84,000 CU YDS

AT EASTERN BOUNDARY: 5100 LIN YDS x 15 FT AVERAGE HEIGHT
= 5100 x 52x3 = 888,000 CU YDS

AT WESTERN BOUNDARY: 5300 LIN YDS x 16 FT AVERAGE HEIGHT
= 5300 x 65x3 = 1,032,000 CU YDS

84,000
888,000
1,032,000
2,004,000 CU YDS x 0.75/CUYD = 1,500,000

W.O. NO. 2720-01

BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____

HEMPSTEAD, N.Y.

BY: NJB/NER

TITLE: PUERTO RICO ENERGY CENTER EXH. 5.2-1 SHEET 10 OF 40

LAND FILLING AND COMPACTION

OBTAIN, PLACE AND COMPACT FILL

1 FOOT FILL PER ACRE = 43,560 CUBIC FEET = 1613 CUBIC YARDS

GUAYANILLA

2 FEET OF FILL = 3226 CUBIC YARDS/ACRE

COST PER ACRE = 3226 CY x \$2.00/CY = \$6452/ACRE

ACREAGE 200 ACRES x \$6452 = \$1,290,000

AGUIRRE

2 FEET OF FILL = 3226 CUBIC YARDS/ACRE

COST PER ACRE 3226 CY x \$2.00/CY = \$6452/ACRE

WEST AGUIRRE - 162 ACRES @ \$6452 = \$ 965,224

EAST AGUIRRE SITE A - 112 ACRES @ \$6452 = \$ 722,624

EAST AGUIRRE SITE B - 225 ACRES @ \$6452 = \$ 1,451,700

ARECIBO

5 FEET OF FILL = 8065 CUBIC YARDS/ACRE

COST PER ACRE = 8065 CY x \$2.00/CY = \$16,130

ACREAGE INDUSTRIAL 2000 ACRES

REACTOR 150

2150 ACRES x \$16,130/ACRE = \$34,700,000

W.O. NO. 2720-01 BURNS AND ROE, INC.

DRAWING NO. _____ HEMPSTEAD, N.Y.

TITLE: PUERTO RICO ENERGY CENTER EXHIBIT 5.2-1

DATE: 4/4/79

BY: RTR/1118/1ER

SHEET 11 OF 40

DRAINAGE PUMP STATION

SUPPLEMENT EXISTING STRUCTURES AND PUMPS USED FOR
AREA DRAINAGE AT JAREALITO.

PUMPS 4 FT HEAD, \$60,000 EACH

3- 80,000 GPM DIESEL DRIVEN PUMPS 3 x \$60,000 = \$180,000
1- 80,000 GPM ELECTRICALLY DRIVEN PUMP 1 x \$60,000 = \$60,000
\$240,000

PUMP HOUSE \$3.00/CUBIC FOOT OR VOLUME

VOL = 50 FT x 50 FT x 30 FT HEIGHT = 75,000 CUBIC FEET

COST: 75,000 CF x \$3.00/CF = \$225,000

GATES 4 x \$10,000 40,000
\$505,000

W.O. NO. 2720-01 BURNS AND ROE, INC.
DRAWING NO. _____ HEMPSTEAD, N.Y.
TITLE: PUERTO RICO ENERGY CENTER EXH 5.2-1

DATE: 4/4/70
BY: PEH/JJB/JER
SHEET 12 OF 40

HARBOR AND APPROACH CHANNEL - GUAYANILLA

HARBOR DEPTH OF 65 FEET, CHANNEL DEPTH OF 65 FEET
AND BOTTOM WIDTH OF 400 FEET TO ACCOMMODATE
DEEP DRAFT TANKERS APPROXIMATELY 1100 FEET IN LENGTH

GUAYANILLA

1. HARBOR DREDGING

3400 FT X 1200 FT AVERAGE WIDTH X 59 FEET DEEP
PLUS VOLUME REMOVED FOR SLOPING BOTTOM
(EXISTING BOTTOM ASSUMED AS -6.0 FT AVERAGE ELEVATION)

$$= 1133 \text{ YDS} \times 400 \text{ YDS} \times 19.7 \text{ YDS} + 1133 \text{ YDS} \times 98 \text{ YDS} \times 19.7 \text{ YDS}$$
$$= 1133 \times 498 \times 19.7 = \underline{\underline{11,115,000 \text{ CUBIC YARDS}}}$$

2. CHANNEL DREDGING

2480 LINEAR YARDS TO DEEPEN RMS AVERAGE OF 38 FEET
1100 LINEAR YARDS TO DEEPEN RMS AVERAGE OF 3.6 FEET
EST'D. 300,000 CUBIC YARDS OF ROCK TO BE BLASTED

$$= 2480 \times 197 \times 12.7 \text{ YDS} + 1100 \times 135 \times 1.2$$
$$= 6,200,000 \text{ CU YDS} + 178,000 \text{ CU YDS} = \underline{\underline{6,378,000 \text{ CU YDS}}}$$

3. TOTAL DREDGING AND BLASTING

HARBOR 11,115,000
CHANNEL 6,378,000
17,493,000 CU YARDS

$$\text{DREDGING COST AT } \$0.75/\text{CU YD} = \underline{\underline{\$13.1 \text{ MILLION}}}$$
$$\text{DREDGING COST AT } \$1.00/\text{CU YD} = \underline{\underline{\$17.5 \text{ MILLION}}}$$

$$\text{ROCK AT } \$8.00/\text{CU YD} = \underline{\underline{\$2.4 \text{ MILLION}}}$$
$$\text{ROCK AT } \$10.00/\text{CU YD} = \underline{\underline{\$3.0 \text{ MILLION}}}$$

$$\text{MINIMUM} = 13.1 + 2.5 = \underline{\underline{\$15.6 \text{ MILLION}}}$$

$$\text{MAXIMUM} = 17.5 + 3.0 = \underline{\underline{\$20.5 \text{ MILLION}}}$$

W.O. NO. 2720-01 **BURNS AND ROE, INC.**

DATE: 4/4/70

DRAWING NO. _____ **HEMPSTEAD, N.Y.**

BY: PEN/JER

TITLE: PUERTO RICO ENERGY CENTER - EXHIBIT 5.2-1

SHEET 13 OF 40

HARBOR AND APPROACH CHANNEL - ARECIBO

HARBOR DEPTH OF 65 FEET, CHANNEL DEPTH OF 65 FEET
AND BOTTOM WIDTH OF 400 FEET TO ACCOMMODATE
DEEP DRAFT TANKERS APPROXIMATELY 1100 FEET IN LENGTH

ARECIBO

1. HARBOR DREDGING

SAME DREDGING QUANTITIES AND COST AS AT AGUIARE
= 12,015,000 CU YDS

2. CHANNEL DREDGING

410 LIN YDS IN ALLUVIUM (SURFACE ELEV = 0.0)
= 2,200,000 CU YDS

1430 LIN YDS BLASTING AND DREDGING (25 FT AVERAGE
INCR IN DEPTH) = 1,700,000 CU YDS

3. TOTAL DREDGING AND BLASTING

HARBOR

DREDGING COST AT \$0.75/CU YD = \$9.0 MILLION

DREDGING COST AT \$1.00/CU YD = \$12.0 MILLION

CHANNEL

EXCAVATION COST AT \$1.00/CU YD = \$2.2 MILLION

ROCK AT \$8.00/CU YD \$13.6 MILLION

ROCK AT \$10.00/CU YD \$17.0 MILLION

MINIMUM $9.0 + 2.2 + 13.6 =$ \$24.8 MILLION

MAXIMUM $12.0 + 2.2 + 17.0 =$ \$31.2 MILLION

W.O. NO. 2720-01 BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: PEM/ICR

TITLE: PUERTO RICO ENERGY CENTER EXHIBIT 5.2-1 SHEET 1A OF 40

ALTERNATE HARBOR AND APPROACH CHANNEL - GUAYANILLA

GUAYANILLA ALTERNATE

1. HARBOR DREDGING

3400 FT X 1200 FT X 69 FT (EXISTING GRADE = +4' MSL)

+ 3400 FT X 345 FT X 69 FT

$$= 1133 \text{ YDS} \times 515 \text{ YDS} \times 23 \text{ YDS} = \underline{\underline{13,400,000 \text{ CY YDS}}}$$

2. CHANNEL DREDGING

ASSUMED MASSIVE LIMESTONE BOTTOM

960 LINEAR YARDS TO BE DEEPENED RUNS AVERAGE OF 40 FEET

$$= 960 \times 147 \times 13.3 = \underline{\underline{1,870,000 \text{ CU YARDS}}}$$

3. TOTAL DREDGING AND BLASTING

HARBOR

DREDGING COST AT \$0.75/CU YD = \$10.0 MILLION

DREDGING COST AT \$1.00/CU YD = \$13.4 MILLION

CHANNEL

ROCK AT \$8.00/CU YD = \$15.0 MILLION

ROCK AT \$10.00/CU YD = \$18.7 MILLION

$$\underline{\underline{\text{MINIMUM}}} = 10.0 + 15.0 = \underline{\underline{25.0 \text{ MILLION}}}$$

$$\underline{\underline{\text{MAXIMUM}}} = 13.4 + 18.7 = \underline{\underline{32.1 \text{ MILLION}}}$$

W.O. NO. 2720-01 BURNS AND ROE, INC.

DRAWING NO. _____ HEMPSTEAD, N.Y.

TITLE: PUERTO RICO ENERGY CENTER EXH. 5.2-1

DATE: 4/4/70

BY: av

SHEET 15 OF 40

HARBORS CONTD

AGUIRRE - WEST

CHANNEL $12000 \text{ LF} \times 32' \text{ AVG. D} \times 520' \text{ AVG. W} = 199,680,000 \text{ CF}$
 $7,396,000 \text{ CY}$

HARBOR $12,019,000 \text{ CY}$
CHANNEL $7,396,000 \text{ CY}$
TOTAL $19,415,000 \text{ CY} @ 0.75 = 14,561,300$
" $\text{CY} @ 1.00 = 19,415,000$

(ALTERNATE) CENTRAL AGUIRRE

HARBOR = $10,436,700 \text{ CY}$
CHANNEL = $17,031,600 \text{ CY}$
TOTAL $27,468,300 \text{ CY} @ 0.75 = 20,612,500$
" $\text{CY} @ 1.00 = 27,468,300$

AGUIRRE - EAST (LAS MAREAS)

HARBOR $10,526,000 \text{ CY}$
CHANNEL $5,608,000 \text{ CY}$
TOTAL $16,134,000 \text{ CY} @ 0.75 = 12,100,500$
" $\text{CY} @ 1.00 = 16,134,000$

W.O. NO. 2720-01

BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____

HEMPSTEAD, N.Y.

BY: VK/JLB/JERTITLE: PURTO RICO ENERGY CENTER EXH. 5.2-1SHEET 16 OF 40POWER PLANT FOUNDATIONS

ALL CLASS I STRUCTURES TO BE PLACED ON ROCK.

ALL ROCK EXCAVATION FOR PRESENT AND FUTURE STRUCTURES
WILL BE PERFORMED AT THE SAME TIME.

ASSUME LEVEL AREA 500' x 600'; EXCAVATION AT \$3.00/CY

GUAYANILLA FOUNDATIONS TO BEAR ON ELEVATION +5.0 FT

$$VOLUME = \frac{500' \times 600' \times 27'}{27} \text{ AVERAGE DEPTH} = 300,000 \text{ CY}$$

$$COST = 300,000 \text{ CY} \times \$3.00/\text{CY} = \underline{\underline{\$900,000}}$$

AGUIRAE FOUNDATIONS TO BEAR ON ELEVATION +5.0 FT.

$$VOLUME = \frac{500' \times 600' \times 27'}{27} \text{ AVERAGE DEPTH} = 300,000 \text{ CY}$$

$$COST = 300,000 \text{ CY} \times \$3.00/\text{CY} = \underline{\underline{\$900,000}}$$

ARECIBO FOUNDATIONS TO BEAR ON ELEVATION -5.0 FEET ±

MINIMAL REMOVAL OF WEATHERED ROCK, SAY 3'

$$VOLUME = \frac{500' \times 600' \times 3'}{27} = 33,333 \text{ CY}$$

$$COST = 33,333 \text{ CY} \times \$3.00/\text{CY} = \underline{\underline{\$100,000}}$$

W.O. NO. 2720-01

BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____

HEMPSTEAD, N.Y.

BY: RTR/JJB/JERTITLE: PUERTO RICO ENERGY CENTER EXH. 5.2-1SHEET 17 OF 40CIRCULATING WATER DIFFERENTIAL COSTSAVERAGE COSTS

a. SUBMERGED PIPE INTAKE

\$650 / LINEAR FOOT

b. CANAL, LOW LEVEL

150 / LIN FT

c. CANAL, DEEP AND THROUGH ROCK

600 / LIN FT

1. GUAYANILLA

a. INTAKE CRIB AT INLET TO INTAKE PIPING

= \$100,000

b. INTAKE PIPING 2400 FT x \$650 / LIN FT

= 1,560,000

\$1,660,0002. AGUIRAE

a. DISCHARGE CANAL 2250 FT x \$150 / LIN FT

= \$338,0003. ARECIBO

a. INTAKE CRIB AT INLET TO INTAKE PIPING

= \$100,000

b. INTAKE PIPING 1700 FT x \$650 / LIN FT

= \$1,105,000

c. CANAL, DEEP 2000 FT x \$600 / LIN FT

= 1,200,000

\$2,405,000

W.O. NO. 2720-01 BURNS AND ROE, INC.

DRAWING NO. _____ HEMPSTEAD, N.Y.

TITLE: PUERTO RICO ENERGY CENTER - EXHIBIT 5-2-1

DATE: 4/4/70

BY: 4HD/LIA/JLR

SHEET 18 OF 40

ELECTRICAL TRANSMISSION COSTS

GUAYANILLA

500 MVA POWER AT 230 KV: 7 MILES $\times$ \$40,000/MILE = \$280,000
20 MVA POWER AT 115 KV: 7 MILES $\times$ \$23,000/MILE = 161,000
6 MVA POWER AT 38 KV: 7 MILES $\times$ \$15,000/MILE = 105,000
\$546,000

AGUIARE

500 MVA POWER AT 230 KV: 4 MILES $\times$ \$40,000/MILE = \$160,000
20 MVA POWER AT 115 KV: 6 MILES $\times$ \$23,000/MILE = 138,000
6 MVA POWER AT 38 KV: 6 MILES $\times$ \$15,000/MILE = 90,000
\$388,000

ARECIBO

500 MVA POWER AT 115 KV: 70 MILES $\times$ \$30,000/MILE = \$2,100,000
20 MVA POWER AT 38 KV: 6 MILES $\times$ \$23,000/MILE = 138,000
8 MVA POWER AT 38 KV: 6 MILES $\times$ \$23,000/MILE = 138,000
\$2,376,000

W.O. NO. 2720-01 BURNS AND ROE, INC.

DRAWING NO. _____ HEMPSTEAD, N.Y.

TITLE: PURTO RICO ENERGY CENTER EXH. 5.2-1

DATE: 4/4/70

BY: JJB/JER

SHEET 19 OF 40

PUMPING STATION OPERATION - ARGCMO

1. POWER

ASSUME 150 HP

$$150 \text{ HP} \times 0.75 \text{ KW / HP} \times 8000 \text{ HR / YR} \times 0.005 \text{ / KWHR} \\ = \underline{\$4,500 / \text{YR}}$$

2 LABOR

ASSUME 5 PERSONNEL FOR OPERATION AND MAINTENANCE

$$5 \times \$5000 / \text{YR AVERAGE} = \underline{\$25,000}$$

$$\text{TOTAL: } \$4,500 + 25,000 = \$29,500$$

FIXED CHARGE RATE AT 10% FOR 15 YEARS = 0.13

CAPITALIZED VALUE OF PUMPING STATION OPERATION:

$$= \frac{29,500}{0.13} = \underline{\underline{\$227,000}}$$

W.O. NO. 2720-01 BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: VJR

TITLE: Puerto Rico ENERGY CENTER EXH 5.2-1

SHEET 20 OF 40

CAPITALIZED COST OF FRESH WATER

Water Requirement = 19,000 gpm

WATER COSTS = Arecibo 3¢/1000 gallons

" " = Guayanilla 28¢/1000 gallons

" " = Aguirre ALT A 28¢/1000 gal.
ALT B 50¢/1000 gal.

Fixed Charge RATE For 10% Money - 15 yrs
= 0.13/yr.

Arecibo

$$19,000 \frac{\text{gal}}{\text{min.}} \times \frac{\$0.03}{10^3 \text{ gal}} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{days}}{\text{yr.}} = \$300,000/\text{yr}$$

$$\frac{\$300,000/\text{yr}}{0.13/\text{yr}} = \$2,300,000$$

Guayanilla & Aguirre

Alt note A (Water From PRASA @ 28¢/10³ gal)
 $19,000 \times \frac{0.28}{10^3} \times 1440 \times 365 = 2,800,000$

$$\frac{2,800,000}{0.13} = \$21,500,000$$

Alt B. For 50¢/10³ gal = \$38,200,000

W.O. NO. 2720-01 **BURNS AND ROE, INC.**

DATE: 4/4/70

DRAWING NO. _____ **HEMPSTEAD, N.Y.**

BY: PEM/JER

TITLE: PUERTO RICO ENERGY CENTER AGUIRRE HARBOR SHEET 21 OF 40

COMPARISON OF COST AND CAPITAL DIFFERENCES BETWEEN:

- A. BUILD AND UTILIZE NEW HARBOR AND PORT FACILITY
AT MAR NEGRO ADJACENT TO CHEMICAL COMPLEX
AT AGUIRRE
- B. EXPAND EXISTING HARBOR AND PORT "LAS MAREAS"
7 1/2 MILES DISTANT; TRANSFER ALL MATERIALS
BETWEEN CHEMICAL COMPLEX AND "LAS MAREAS."

BASES AND ASSUMPTIONS

- 1. TYPE OF FINANCING (I.E., LEASE VS. OWN VS. WHARF FEES)
NOT CONSIDERED.
- 2. DISTANCE OF 40,000 FEET BETWEEN CHEMICAL
COMPLEX AND "LAS MAREAS."
- 3. DEPTH OF 65 FEET REQUIRED AT EACH LOCATION.
- 4. CASE 2 TONNAGES (EXPANDED FACILITIES)

A. NEW FACILITIES

1. CAPITAL

a. DREDGING.

1. HARBOR AND CHANNEL MINIMUM \$15.2 MILLION
MAXIMUM \$20.3 MILLION

2. ANNUAL COST \$0

B. EXPAND AND USE EXISTING "LAS MAREAS" FACILITY

1. CAPITAL

a. ENLARGE EXISTING CHANNEL TO 65 FT X 400 FT
= 3.2 MILLION CU YDS

W.O. NO. 2720-01 BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: PEM/JER

TITLE: PUERTO RICO ENERGY CENTER AGUIRRE HARBOR SHEET 22 OF 40

B.1 CAPITAL (CONT'D)

- b. ENLARGE EXISTING HARBOR TO 65' DEPTH TO
ACCOMMODATE 1100 FT² SHIPS
= 8.0 MILLION CU YDS.

TOTAL DREDGING - LAS MARERAS EXPANSION

$$= 3.2 \times 10^6 + 8.0 \times 10^6 = \underline{11,200,000 \text{ CU YDS}}$$

$$\begin{array}{ll} \text{COST} & \text{MINIMUM} \quad 11,200,000 \text{ CU YDS} \times \$0.75/\text{CU YD} = \underline{\$8.4 \text{ MILLION}} \\ & \text{MAXIMUM} \quad 11,200,000 \text{ CU YDS} \times \$1.00/\text{CU YD} = \underline{\underline{\$11.2 \text{ MILLION}}} \end{array}$$

c. CONSTRUCT ADDITIONAL SHORE TANKAGE

1. CRUDE OIL TANK CAPACITY (ADDITIONAL)

$$1,000,000 \text{ BBL} \times 2.00/\text{BBL} =$$

\$2.0 MILLION

- 2 TOTAL TANKAGE FOR ALL LIQUID PRODUCTS

(50% CAUSTIC, EO, EDC, ETBENZENE, CUMENE)

$$500,000 \text{ BBL} \times \$2.20/\text{BBL} =$$

\$1.1 MILLION

- *3 STGE. PILES FOR ALUMINA AND SALT

$$800,000 \text{ CU FT} \times \$0.50/\text{FT}^3 =$$

\$0.4 MILLION

TOTAL ADDITIONAL STORAGE (C.1+C.2+C.3)

\$3.5 MILLION

* ACTUALLY LOCATED IN PLANT AS ADDITIONAL STORAGE CAPACITY REQ'D.

d. INSTALL TRANSFER PIPELINES BETWEEN PLANT
AND HARBOR FOR ALL LIQUID MATERIALS

1. 12 INCH CRUDE - 1 REQ'D

6 INCH ETHYL BENZENE - 1 REQ'D

4 INCH (P.D., EDC, CUMENE) - 4 REQ'D.

$$34 \times 40,000 \times \$1.00 = \underline{\underline{\$1.4 \text{ MILLION}}}$$

W.O. NO. _____ BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: PEM/JER

TITLE: PUERTO RICO ENERGY CENTER AGUIRRE HARBOR SHEET 23 OF 40

B.1 CAPITAL (CONT'D)

2. 8 INCH ϕ TRACED CAUSTIC LINE 0.5 MILLION

TOTAL TRANSFER LINES (d.1 + d.2) \$1.9 MILLION

**C. PURCHASE TRACTOR-TRAILER UNITS TO TRUCK
ALL DRY MATERIALS**

1. BULK SALT

21 (18 + 3 SPARE) SELF UNLOADING TRACTOR-TRAILERS

21 x \$30,000 = \$0.63 MILLION

2. ALUMINA

16 (13 + 3 SPARE) PRESSURE DIFFERENTIAL TRACTOR-
TRAILERS

16 x \$30,000 = \$0.48 MILLION

3. ALUMINUM PIG

10 (8 + 2 SPARE) SELF UNLOADING TRACTOR TRAILERS

10 x \$22,000 = \$0.22 MILLION

TOTAL DRY SOLIDS TRANSFER EQUIPMENT
(C.1 + C.2 + C.3)

\$1.3 MILLION

TOTAL CAPITAL FOR ALTERNATE B MINIMUM \$15.1 MILLION

MAXIMUM \$17.9 MILLION

W.O. NO. 2720-01 BURNS AND ROE, INC.DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: DEM/JERTITLE: PUERTO RICO ENERGY CENTER AGUIRRE HARBOR SHEET 24 OF 40B. EXPAND AND USE EXISTING "LAS MAREAS" FACILITY (CONT'D)

2. ANNUAL COSTS

a. HAULING (8 HOURS/DAY, 7 DAYS/WEEK, 2920 HOURS/YEAR)

31 UNITS $\times$ 2920 $\times$ \$12.50/HR * \$1.13 MILLION8 UNITS $\times$ 2920 $\times$ \$10.00/HR * \$0.24 MILLION

ANNUAL COST OF HAULING PER YEAR \$1.37 MILLION

* UNIT OPG COST INCL. LABOR, WRITE-OFF, MAINT.

b ELECTRICAL ENERGY CONSUMED IN PUMPING FLUIDS
BETWEEN PLANT AND REMOTE LOCATION STORAGE

6 MILLION TONS/YEAR, 200 FT HEAD

6 MILL POWER 50% ENERGY EFF \$0.01 MILLION

TOTAL ANNUAL COST OF TRANSFER
OPERATIONS - ALTERNATE B = \$1.38 MILLION

FIXED CHARGE RATE AT 10% FOR 15 YEARS = 0.13

CAPITALIZED VALUE OF TRANSFER OPERATIONS

$$= \frac{1,380,000}{0.13} = \$10.6 \text{ MILLION}$$
SUMMARY

ALTERNATE A (MAXIMUM) CAPITAL + ANNUAL COSTS = \$20.3 MILLION A

ALTERNATE B (MAXIMUM) CAPITAL \$17.9 MILLION

ANNUAL COSTS \$10.6 MILLION

\$28.5

\$28.5 MILLION B

N.O. NO. 2720-01BURNS AND ROE, INC.
NEW YORK, N. Y.DATE: 4/4/70

DRAWING NO. _____

BY: AWTITLE: PUERTO RICO ENERGY CENTER EXH 5.4-3SHEET 25 OF 40SITE DEVELOPMENT - AGUIRRE WEST VS EAST SITES A+B

<u>WEST</u>	<u>QUAN</u>	<u>UNIT</u>	<u>MTL</u>		<u>LABOR</u>		<u>TOTAL</u>
			<u>UNIT</u>	<u>TOTAL</u>	<u>UNIT</u>	<u>TOTAL</u>	
* GRADING	5,221,000	cy	0 ³⁶	1879560	0 ²¹	1096410	
* PLANT ROADS 20'W	1,550,000	SF	0 ³⁰	474000	-	-	
PUBLIC ROADS	400,000	SF	0 ³⁰	120000	-	-	
R.R. REMOVAL	170,000	LF	3-	57000	-	-	
R.R. RELOCATE	150,000	LF	6-	90000	-	-	
P.L. FENCING	48,000	LF	4-	192000	-	-	
				2,806,560		1,096,410	3,902,970
							1,034,290
							\$ 4,957,260
							<u>TOTAL</u>

OH & P ¹⁵/₁₀EAST SITE A

* GRADING	2,780,000	cy	0 ³⁶	1,000,800	0 ²¹	583,800	
* PLANT RDS 20'W	1,430,000	SF	0 ³⁰	429000	-	-	
PUBLIC RDS.	-	-	-	-	-	-	
R.R. REMOVAL	19,000	LF	3-	57,000	-	-	
R.R. RELOCATE	16,000	LF	6-	96,000	-	-	
P.L. FENCING	84,000	LF	4-	336,000	-	-	
				1,918,800		583,800	2,502,600
							663,200
							\$ 3,165,800
							<u>TOTAL</u>

OH & P ¹⁵/₁₀

* QUANTITIES SHOWN ARE FOR APPROX. $\frac{2}{3}$ OF EACH SITE DEVELOPED AS SHOWN ON EXHIBITS 5.4-1 & 5.4-2. AN ALLOWANCE OF 50% IS PROVIDED FOR FULL FUTURE DEVELOPMENT ON A COMPARABLE BASIS AS FOLLOWS:

<u>WEST</u>	
\$ 1,879,560	
1,096,410	
474,000	
\$ 3,449,970	\$
<u>1,724,985</u>	

OH & P ¹⁵/₁₀ = 465,000Allowance = 2,189,9854,957,260ADJUSTED TOTAL \$ 7,147,245

<u>EAST SITE A</u>	
\$ 1,000,800	
583,800	
429,000	
\$ 2,013,600	\$
<u>1,006,800</u>	

OH & P ¹⁵/₁₀ = 480,000Allowance = 1,490,8003,165,800ADJUSTED TOTAL \$ 4,656,600

W.O. NO. 2220.01 **BURNS AND ROE, INC.**

DATE: 4/4/70

DRAWING NO. _____ **HEMPSTEAD, N.Y.**

BY: RG

TITLE: PUERTO RICO ENERGY CENTER - EXH 5.4-3

SHEET 26 OF 40

SITE DEVELOPMENT - AGUIRRE WEST VS EAST SITES A & B (CONT'D)

EAST SITE B

EAST AGUIRRE SITE B REQUIRES APPROXIMATELY
50% MORE FOR R.R. REMOVAL & RELOCATION. ALL
OTHER ITEMS REMAIN THE SAME

ADJUSTED TOTAL - EAST SITE A \$ 4,656,600

ADDITIONAL R.R. Removal & RELOCATION 77,000

EAST SITE B \$ 4,734,000

W.O. NO. 2720-01 **BURNS AND ROE, INC.**DRAWING NO. _____ **HEMPSTEAD, N.Y.**TITLE: PUERTO RICO ENERGY CENTER EXH. 5.4-3DATE: 4/4/70BY: AVSHEET 27 OF 40COST OF SERVICES VIA R.O.W. TO EAST AGUIRRE SITE A

<u>LOAD CENTER</u>			<u>MATERIAL</u>		<u>LABOR</u>		<u>TOTAL</u>
ROADWAY	240,000 SF	0 ³⁰	\$	72,000	-	-	
FENCING 6'H	30,000 LF	5 ⁵⁰		168,000	-	-	
PIPE & INSUL (SHT. 3)	LS	-		15,926,000	-	-	
EXCAV	9700 CY	0 ⁷⁰		6,790	0 ⁴⁰	3880	
BACKFILL	8000	0 ⁵⁰		4,000	0 ³⁰	2400	
CONCRETE	1600 CY	16-		25,600	5-	8000	
FORMS	97000 SF	0 ⁴⁰		38,800	1-	97000	
REINF	80000 #	0 ⁰⁵		6,400	0 ⁰⁷	5600	
STR. STL	355000 #	0 ²⁰		71,000	0 ²⁰	71000	
				16,318,600		16,7900	\$ 16,486,500
							4600000
OH & P 15/10							
					SAY \$		\$ 21,100,000

COST OF SERVICES VIA R.O.W TO EAST AGUIRRE SITE B

STEAM LOAD CENTER WILL BE APPROXIMATELY
2 MILES CLOSER TO STEAM PLANT.

$$\$ 21,100,000 \times \frac{10,560'}{26,500} = \$ 8,350,000$$

$$\begin{array}{r} \$ 21,100,000 \\ \text{Less} \quad 8,350,000 \\ \hline \end{array}$$

COST FOR EAST AGUIRRE SITE B - \$ 12,750,000

W.O. NO. 2720-01 **BURNS AND ROE, INC.**DATE: 4/4/70DRAWING NO. _____ **HEMPSTEAD, N.Y.**BY: ASTITLE: PUERTO RICO ENERGY CENTER EXH. 5.4-3SHEET 28 OF 40PIPE LINES NUCLEAR STA VIA R.O.W. TO EAST AGUIRRE

DISTANCE - NUCLEAR STA TO EXCL. RAD. 2,000 LF
 R.O.W. 16,000 LF
 SITE W.P.L. TO LOAD CNTR 8,500 LF

TOTAL DISTANCE 26,500 LF

FOR COLD LINES ASSUME 26,500 LF

FOR HOT LINES INCR 10% ±

FOR EXP LOOPS TO 29,000 LF

1-30"-400[±] STM x 29,000' x 15[±] \$/FT = 4,582,000[±]
 3-48"-150[±] " x 29,000' x 200[±] \$/FT = 17,400,000[±]
 1-8"-PITCH x 29,000' x 28.6[±] \$/FT = 840,940[±]
 1-36"-WATER x 26,500' x 177[±] \$/FT = 4,690,500[±]
 1-6"-BITTERNS x 26,500' x 19[±] \$/FT = 503,500[±]
28,016,940

PIPE COST = 28,016,940[±] @ 0.35/\$ = SAY 10,000,000

TRAPPING STATIONS

ASSUME 25Z @ 500 EQ = 126,000

INSULATION

30"x4" - 29,000 LF x 32/LF = 928,000[±]
 48"x4" - 87,000 LF x 50/LF = 4,350,000[±]
 8"x4" - 29,000 LF x 12/LF = 348,000[±]
5,626,000

STM. TRACING (8" PITCH)

8" Line 29,000 LF @ 6/LF 174,000

TOTAL PIPE COST

15,926,000

W.O. NO. 2720-01 BURNS AND ROE, INC.

DRAWING NO. _____ HEMPSTEAD, N.Y.

TITLE: PUERTO RICO ENERGY CENTER

DATE: 4/4/70

BY: JS

SHEET 29 OF 40

COST OF SERVICES FROM NUCLEAR STA TO WEST AGUIRRE
LOAD CENTER

DISTANCE - NUCLEAR STA TO EXCL RAD. 2000 LF

ROW TO WEST SITE

SITE E.P.L. TO LOAD CNTR . 4000 LF

TOTAL DIST. 6000 LF

ASSUME SAME LINES AS TO EAST COMPLEX (SHT. 3)

AND ASSUME PROPORTIONAL COST
BASED ON RELATIONSHIP OF DISTANCES TO
LOAD CENTERS FOR RESPECTIVE AREAS.

	<u>DISTANCE</u>	<u>COST</u>
EAST AGUIRRE	26,500 LF	\$ 15,926,000 (SHT 3)
WEST	6,000 LF	

$\frac{6}{26.5} \times 15,926 = US\$$ 3,500,000

(No Fence or Rd To)
Consider

W.O. NO. 2720-01

BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____

HEMPSTEAD, N.Y.

BY: awTITLE: PUERTO RICO ENERGY CENTER EXH 5.4-3SHEET 30 OF 40

CAPITAL COST COMPARISON OF AGUIRRE SITES WEST VS EAST
FOR RAW MATERIAL & FINISHED PRODUCT HANDLING
BETWEEN BATTERY LIMITS OF PRODUCTION UNITS AND STORAGE
WITHIN INDUSTRIAL COMPLEX.

	\$10 ⁶		\$10 ⁶
RAW MATERIAL HANDLING & STORAGE	WEST		EAST SITE A
CRUDE OIL 2-18" ϕ x 6500' cu	0.84	Same	0.84
ALUMINA PNEU ALLOW	0.42	ALLOW	0.42
MECH. 3000'	0.60	SAME	0.60
BENZENE TO EB & CU 6" ϕ T & I x 3500'	0.35	1000'	0.07
ETHYLENE TO EB, EDC, EO, PE 10" ϕ x 4000'	0.09	4000'	0.09
PROPYLENE FROM ETHYLENE TO PO & CU 8" ϕ x 1200'	0.02	6000'	0.11
CHLORINE TO PO & EDC 8" ϕ x 3000'	0.15	2000'	0.10
NaOH TO PO 4" ϕ I & T x 3000'	0.12	500'	0.02
ETHYL CHLORIDE FOR PO & CU			
UNLOAD 4" ϕ x 2000'	0.03	1500'	0.02
DISTRIB 3" ϕ x 4000'	0.04	8000'	0.08
STORAGE 50,000 GAL ALLOW	0.07	ALLOW	0.07
HYDROGEN FROM CELL PLANT TO REF. ALLOW	0.10	ALLOW	0.10
MISC MINOR RAW MATERIALS ALLOW	0.50	ALLOW	0.50
TOTALS	<u>3.33</u>		<u>3.02</u>
FINISHED PRODUCT STG. & HANDLING			
ETHYLENE 4 GAL STL. STG.	0.31	SAME	0.31
8500' LOADING 10" STL.	0.18	11000'	0.23
CUMENE 3 GAL STL. STG.	0.27	SAME	0.27
5500' LOADING 10" STL	0.12	10,000'	0.21
ETHYL DICHLORIDE 1.5 M GAL STL. STG.	0.21	SAME	0.21
7200' LOADING 8" STL	0.13	8,000'	0.14
ETHYLENE GLYCOL 3 M GAL STL. STG.	0.27	SAME	0.27
7300' LOADING 10" STL	0.16	7500'	0.16
50% NaOH 2-3 M GAL. EA I & H	0.78	SAME	0.78
8000' LOADING 16" STL T & I	0.80	9000'	0.90
DIETHYLENE GLYCOL 500 M GAL. STG.	0.11	SAME	0.11
7300' LOADING 6" STL.	0.11	10,000'	0.15
TRIETHYLENE GLYCOL 200 M GAL STG.	0.07	SAME	0.07
7300' LOADING 6" STL.	0.09	10,000'	0.12
FUTURE ALLOWANCES	1.54	SAME	1.54
TOTALS	<u>5.25</u>		<u>5.47</u>

W.O. NO. 2720-01 **BURNS AND ROE, INC.**DATE: 4/4/70DRAWING NO. _____ **HEMPSTEAD, N.Y.**BY: GRTITLE: PUERTO RICO ENERGY CENTER EXHIBIT 5-4-3SHEET 31 OF 40CAPITAL COST COMPARISON OF AGUIRRE SITES CONTD.

		\$10 ⁶	
<u>BY PRODUCT STORAGE & HANDLING</u>		<u>WEST</u>	<u>EAST SITE A</u>
C-4s	200 M GAL STG	0.13	SAME 0.13
	8000' LOADING 8" STL	0.15	10,000' 0.19
<u>PROPYLENE DICHLORIDE</u>			
	200 M GAL STG.	0.08	SAME 0.08
	8000' LOADING 8" STL	0.15	10,000' 0.19
OTHER	ALLOW	0.26	ALLOW 0.26
		<u>0.77</u>	<u>0.85</u>
RAW MTL & PRODUCT HANDLING & STG		\$ <u>9.35</u>	\$ <u>9.34</u>
GRAND TOTAL			

EAST AGUIRRE SITE B

COST OF LINES TO HARBOR - SITE A
 ADDITIONAL COST OF LINES TO HARBOR - SITE B

\$10⁶
 \$ 9.34

RAW MTL IN

CRUDE OIL

\$10⁶
 \$.46

FINISHED PRODUCT OUT

ETHYLENE	.30
CUMENE	.22
ETHYL DICHLORIDE	.18
ETHYLENE GLYCOL	.23
50% NaOH	1.06
DIETHYLENE GLYCOL	.16
TRIETHYLENE GLYCOL	.13
FUTURE ALLOWANCE	1.62
	<u>\$ 3.90</u>

4.36

RAW MTL & PRODUCT HANDLING & STG -
 GRAND TOTAL

\$ 13.70

W.O. NO. 2720-01BURNS AND ROE, INC.
NEW YORK, N. Y.DATE: 4/4/70

DRAWING NO. _____

BY: QVTITLE: PUERTO RICO ENERGY CENTER EXHIBIT-5.4-3 SHEET 32 OF 40PRODUCT / OR RAW MTL. TRANSFER BETWEEN HARBOR
UNLOADING FACILITIES & STORAGE IN INDUSTRIAL COMPLEXFINISH PRODUCTAGUIRE WEST AGUIRE EAST
SITE ALIQUID LINES - MTL. & LENGTH

		8000 L.F.	7000 L.F.
ETHYLBENZENE	10" STEEL PIPE		
CUMENE	10" " "	"	"
ETHYLENE DICHLORIDE	8" " "	"	"
PROPYLENE OXIDE	10" " "	"	"
ETHYL GLYCOL	10" " "	"	"
50% NaOH	16" " " I&T	"	"
DIETHYLENE GLYCOL	6" " "	"	"
TRIETHYLENE GLYCOL	6" " "	"	"
CRUDE OIL	2-18" " "	"	"
SPACE ALLOWANCE FUTURE	3-10" " "	"	"
PROPYLENE DICHLORIDE	8" " "	"	"
SALT SLURRY	8" " "	"	"

SOLIDS TRANSFER

ALUMINA - PNEUMATIC CONV.	8" STL.	5500 L.F.	3000 L.F.
ALUMINUM - TRUCK			

SUPPORTS - TYPE & LENGTH

8000 L.F.	2000 L.F.	O.H.
WEST	6000 L.F.	SLEEPERS

5500 L.F.	2000' O.H.
WEST	3500' SLEEPERS

7000 L.F.	3500' O.H.
EAST	3500' SLEEPERS

3000 L.F.	1500' O.H.
EAST	1500' SLEEPERS

PUERTO RICO ENERGY CENTER

W.O. NO. 2720-01 BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: H. J. S.

TITLE: PIPING - WEST AGUIRRE

SHEET 33 OF 40

HARBOR TO STORAGE EXHIBIT 5.4-3

WEST AG.

$$16000 \text{ L.F. } 6" \phi @ 18.97^*/\text{L.F.} = 304,000^*$$

$$24000 \text{ L.F. } 8" \phi @ 28.55^*/\text{L.F.} = 685,200^*$$

$$32000 \text{ L.F. } 10" \phi @ 40.48^*/\text{L.F.} = 1,295,500^*$$

$$8000 \text{ L.F. } 16" \phi @ 82.77^*/\text{L.F.} = 662,200^*$$

$$16000 \text{ L.F. } 18" \phi @ 104.75^*/\text{L.F.} = 1,676,000^*$$

$$4,622,900^*$$

$$4,622,900^* @ 40/\text{LB} = \$1,849,160$$

INSULATION

$$8000 \text{ L.F. } 16" \times 4" \#20/\text{L.F.} = 160,000$$

TRACING

$$8000 \text{ L.F. } 16" @ \$10/\text{L.F.} =$$

SUB TOTAL

$$\begin{array}{r} 80,000 \\ \hline \$2,089,160 \end{array}$$

PUERTO RICO ENERGY CENTER

W.O. NO. 2720-01 BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. HEMPSTEAD, N.Y.

BY: H.J.S.

TITLE: PIPING - WEST AGUIRRE

SHEET 34 OF 40

HARBOR TO STORAGE - EXHIBIT 5.4-2

BROUGHT FORWARD. - \$2,089,160

5500 L.F. 8" ϕ SCHED 40 495,000

TYP. 304 S/S PNEUM.

LINE @ \$90 / FT.

SUB-TOTAL. \$2,584,160

SAY \$2,585,000

Pipe Racks (Sht. 12) ^{FROM} \$560,000

GRAND TOTAL \$3,145,000

PUERTO RICO ENERGY CENTER

W.O. NO. 2720-01 **BURNS AND ROE, INC.**

DRAWING NO. _____ **HEMPSTEAD, N.Y.**

TITLE: PIPING - EAST AGUIRRE

HARBOR TO STORAGE - EXHIBIT 5.4-3

DATE: 4/4/70

BY: H.T.S.

SHEET 35 OF 40

EAST Aguirre

$$14000 \text{ L.F. } 6" \phi @ 18.97^*/\text{L.F.} = 266,000^*$$

$$21000 \text{ L.F. } 8" \phi @ 28.55^*/\text{L.F.} = 599,600^*$$

$$28000 \text{ L.F. } 10" \phi @ 40.48^*/\text{L.F.} = 1,133,400^*$$

$$7000 \text{ L.F. } 16" \phi @ 82.77^*/\text{L.F.} = 579,400^*$$

$$14000 \text{ L.F. } 18" \phi @ 104.75^*/\text{L.F.} = 1,466,500^*$$

4,044,900*

$$4,044,900^* @ .40/\text{LB.} = \$1,617,960$$

INSULATION

$$7000 \text{ L.F. } 16" \times 4" @ 20/\text{L.F.} = 140,000$$

TRACING

$$7000 \text{ L.F. } 16" @ 10/\text{L.F.} = 70,000$$

} 1,827,960
SUB TOTAL

28-155

PUERTO RICO ENERGY CENTER

W.O. NO. 2720-01 **BURNS AND ROE, INC.**

DATE: 12-2-69

DRAWING NO. _____ **HEMPSTEAD, N.Y.**

BY: H. J. S.

TITLE: PIPING - EAST AGUIRRE

SHEET 36 OF 40

HARBOR TO STORAGE EXHIBIT 5.4-2

BROUGHT FORWARD - \$1,827,960

3000 L.F 8" ϕ SCHED 40
TYP. 304 S/S, PNEUM.
LINE @ \$90/Ft

270,000

SUB - TOTAL \$2,097,960

SAY \$2,100,000

Pipe Racks (Sht. 12) \$620,000

GRAND TOTAL \$2,720,000

PUERTO RICO ENERGY CENTER

W.O. NO. 2720.01

BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____

HEMPSTEAD, N.Y.

BY: YK

TITLE: PIPE RACKS - AGUIRRE WEST & EAST

SHEET 37 OF 40

WEST AGUIRRE

PIPE RACKS ON PIER - 6000 LF

$$621,000^{\circ} \times 0^{\circ}50 = \$310,500^{\circ} / 6,000' = \$51.75/LF$$

OVERHEAD 2000 LF

$$5000^{\circ} \times 0^{\circ}50 \times 100 = \$250,000^{\circ} / 2,000 = \$125^{\circ}/LF$$

TOTAL \$560,500

EAST AGUIRRE

$$\text{PIPE RACKS ON PIER } \$51.75 \times 3500 = \$181,125^{\circ}$$

$$\text{OVERHEAD } \$125 \times 3500 = \underline{437,500^{\circ}}$$

TOTAL \$618,625^{\circ}

BURNS AND ROE, INC.
ESTIMATED CONSTRUCTION COST

W.O. 2720-01
IOB PUERTO RICO ENERGY CENTER
BUILDING PORT FACILITIES
CONTRACTOR 1

SUBJECT West Aguirre
CHANGE ORDER _____
SHEET 38 OF 40
BY DJK DATE 4/4/50

NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL		LABOR		TOTAL
				UNIT	TOTAL	UNIT	TOTAL	
<u>SUMMARY</u>								
	Dredging				165,000			
	Trestle				4,800,000			
	24"φ Pipe Line 7000'				470,000			
	Off Shore Mooring				575,000			
					<u>\$ 6,910,000</u>			
<u>DETAIL</u>								
	6000 LF x 40'w Trestle	240,000	SF	20	4,800,000			
	Dredging	220,000	cy	0.75	165,000			

FORM BR4803

BURNS AND ROE, INC.
ESTIMATED CONSTRUCTION COST

W.O. 2720-01
JOB PUERTO RICO ENERGY CENTER
BUILDING PORT FACILITIES
CONTRACTOR _____

SUBJECT East Aguirre
CHANGE ORDER _____
SHEET 39 OF 40
BY VJR DATE 4, 1, 70

NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL		LABOR		TOTAL
				UNIT	TOTAL	UNIT	TOTAL	
		SUMMARY						
	Dredging				750000			
	Bulkhead				450000			
	Core Dock (32000 SF @ 10')				320000			
	24" Pipe Line 5000'				340000			
	off Shore Mooring				575000			
		TOTAL COST				2435000		
	Dredging	1,000,000	cy	0.75	750,000		x	
	Core Dock 40' x 800'	32000	SF	10	320,000			
	Bulkhead							
	EXCAV	800	cy		x	0.50	400	
	Fill	500	cy		x	0.50	250	
	Conc	360	cy	18	6480	12	4320	
	Forms	9600	SF	0.50	4800	1	9600	
	Reinf	36000	#	0.08	2880	0.05	2880	
	Tie Rods etc	80	ea	250	20000	250	20000	
	Misc Steel	100,000	#	0.20	20000	0.20	20000	
	Steel Sheet Piling	1,100,000	#	0.08	88000	0.05	88000	
	Painting	64000	SF	0.50	32000	-	x	
					174160		145450	
	Ins. On L 20%				x		29090	
					17460		174540	348200
	OH&P 15/10							92416
					215E			50,000
	OIL TANKER MOORING							
	Conc Piles 110' Lg. x 103 pc	11400	LF	5	57000	3	34200	
	Conc. Caps	600	cy	70	42000	40	63000	
	Bridges 400 LF	ALLOW			20000		20000	
	Chain Anchors & Buoys	ALLOW			200,000		x	
					319,000		117200	
	Ins on L 20%				x		17580	
					319000		134780	153780
	OH&P 15/10							120256
	28-159					215E		575000

W.O. NO. 2720-01 BURNS AND ROE, INC.

DATE: 4/4/70

DRAWING NO. _____ HEMPSTEAD, N.Y.

BY: aw

TITLE: PUERTO RICO ENERGY CENTER EXH. 5-4-3 SHEET 40 OF 40

PRO-RATED SHARE OF EXISTING HARBOR COST
AT LAGOONA DE LAS MAREAS - AGUIRRE EAST

ASSUMED VALUE OF EXISTING FACILITIES ^{\$}6,000,000

PRESENT USAGE : 4 TO 5 SHIPS/WK

ASSUME $4.5 \times 52 = 234$ days/yr

NUPLEX EST. USAGE :

CRUDE OIL TANKERS (OFF SHORE UNLOADING 36 days/yr)

CHEMICAL TANKERS - 69 days/yr

BARGES - 149 "

TOTAL EST. USAGE = 218 "

THE ABOVE ANNUAL USAGE FIGURES APPEAR TO BE DISPROPORTIONAL TO THE POTENTIAL OF THE NUPLEX. THEREFORE FOR PURPOSES OF THIS ESTIMATE THE RATIO OF 1:2 IS BEING ASSUMED, WITH THE NUPLEX SHARE OF THE ESTIMATED VALUE PRO-RATED AT \$4,000,000