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FEASIBILITY STUDY

FOR

LAND RECLAMATION PROJECT

FOR THE

COMPLEMENTARY URBAN DEVELOPMENT

OF THE

CITY OF CORINTO

NICARAGUA

FINAL REPORT

PORT STUDIES

SUBMITTED TO

BOSWELL-AMMANN AND WHITNEY-LAMSA

JOINT VENTURE

CORINTO NICARAGUA

BY

OLKO ENGINEERING PORT PLANNERS

500 FIFTH AVENUE NEW YORK N. Y. 10036

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FEASIBILITY STUDY
FOR
LAND RECLAMATION PROJECT
FOR THE
COMPLEMENTARY URBAN DEVELOPMENT
OF THE
CITY OF CORINTO
NICARAGUA

SYNOPSIS
OF
FINAL REPORT OF PORT STUDIES

I. Introduction

The Final Report of Port Studies for Corinto, Nicaragua is presented as a section of the overall feasibility study for land reclamation. The evaluation relates to Port development only, and is based on estimates of export and import cargo tonnages up to the year 2000. The overall conclusion is that the Port of Corinto will expand beyond the presently planned program of constructing a new Container Wharf and Liquid Cargo Pier, with the basic recommendation that three additional berths be provided, scheduled for years 1985, 1991 and 1997, to accommodate the future tonnage projections.

II. Objective of Port Studies

Based on the assumption that the new Container Wharf and new Liquid Cargo Pier, presently under construction at Corinto, will be completed within the next three to four years; the objective of this Port Study is to determine the extent, location and costs of reclaiming land at Corinto for port use only, after the present construction, has been completed and the requirements in the future grow. Figure H-15 shows the recommended three future berths, extending up to year 1997.

III. Existing Port Facilities

The existing port facilities at Corinto are generally shown on H-4 and consist of: a Banana Pier, a General Cargo Wharf for two berths, an Old Timber Deck Pier, and Miscellaneous Small Facilities for handling Liquid Cargo and shrimp boats, located adjacent to the existing tank farm.

IV. Immediate Proposed Port Expansion

The construction work in progress is also shown on Figure H-4, but consists of dredging a main channel to a depth of eleven meters, demolishing the Old Timber Deck Pier, and constructing a new 240-meter long Container Wharf and, finally constructing a new Liquid Cargo Pier, along with administration building, stevedores building, etc. All of this work is

to be completed in about three years, and of the two million cubic meters of material to be dredged, it is estimated that about 1.5 million cubic meters will be available as fill.

V. Cargo Projections and Berth Requirements

In 1974, Corinto exported 568,300 revenue tons and imported 556,700 revenue tons. Exports primarily are agricultural products, such as cotton, bananas, coffee, sugar, etc.; whereas, imports consist primarily of fertilizer, chemical products, vehicles, iron and steel, wheat, and petroleum products.

High, medium, and low projections of combined export-import tonnages, passing through Corinto, are shown on Figures H-5, H-6, and H-7. The "medium" projections are used in this study.

It has been estimated that in the year 1995, the existing and present facilities under construction, would be able to handle 1,950,000 RT of combined exports and imports per year. However, 550,000 RT consist of bananas and liquid cargo. Consequently, the remaining 1,400,000 RT capable of being handled in 1995, consist primarily of general cargo and container products. In comparison, in 1995 it is projected that 2,233,000 RT of container and general cargo will be shipped through Corinto. Consequently, the deficiency of 833,000 RT

(2,233,000 minus 1,400,000 = 833,000 RT) must be accommodated by new berths. This will require two new berths, taking into account yearly fluctuations, and concentrations of exports-imports, with a third berth for future planning; all as shown schematically on Figure H-15, with the berths scheduled for construction in 1985, 1991 and 1997, as derived from the expected general cargo and container exports-imports shown on Figure H-8.

VI. Containers

The present Container Wharf, under construction, requires additional land for backup, and it is understood another row of city blocks will be demolished, and that surplus area will be made available from adjacent reclaimed swampland. Discussions already have been held with private container lines and it, therefore, appears that in some measure Corinto, in the future, will develop into a container port possibly serving to some extent, as a regional container port. Studies made by others have forecast for Corinto in year 1990, the need to handle about 53,000 containers representing about 800,000 metric tons of cargo.

This Study, per se, does not take into account Corinto becoming a major regional container port for the Pacific Coast of Central America. However, the container traffic forecast can be accommodated within the present Container Wharf, under

construction, and the proposed two and three berths, recommended for the future. Should container traffic develop more rapidly than assumed, it will mean that the schedule of berth construction will have to be correspondingly modified.

VII. Natural Site Conditions

In general, natural conditions at Corinto, with respect to winds, waves, tides, currents, soils, etc., are not particularly difficult or imposing.

Rainfall is seasonable, with very little occurring from December to April. However, during hurricanes, the rainfall intensity could be as severe as 10 centimeters in one hour. For purposes of drainage design, about 6.5 centimeters maximum hourly rainfall can be assumed.

Winds at Corinto are seasonable. The winter winds blowing from the southerly quadrant from May to August; whereas, the summer winds blowing from the northeast to the west from October to March. These create corresponding wave conditions. However, the winds within themselves are not considered a particularly serious problem at Corinto, in terms of ship berthings.

The waves generally corresponding to the winds, are most severe during the winter June to August, when the southwest

swell develops, and are the main cause of littoral drift. In any event, the average wave conditions are not so serious as to interfere with normal approach and departure of ships into Corinto harbor.

The mean tide range at Corinto is 2.27 meters with an extreme range of 3.11 meters.

The currents in the estuary at Corinto, caused by tides, vary from two to three knots maximum on an ebb tide, diminishing to one knot at the offshore channel. These currents line up with the natural channels of the estuary. Currents have been diminished, to some extent, in the Estuary El Realejo as a result of the silting up and closing off, of the Paso Caballos near the railroad bridge. This will have to be evaluated in more detail in the future as to whether or not the closing of this tidal passageway diminishes currents, to such an extent in the estuary, that self-scouring action no longer occurs.

The net littoral drift offshore at Corinto is 100,000 cubic meters per year, travelling northward. This represents a "stabilized" balance between the northerly drift, during summar storms and the southerly drift, during the winter. The offshore channel leading to Corinto will have to be periodically dredged.

The water depths in the estuary and at the Port of Corinto have remained stable for many years, with little siltation. The only major siltation estimated, for the immediate future, is with respect to the offshore main channel approach, subjected to the northerly littoral drift. However, in the future as the estuary is further dredged, widened and deepened, it is quite possible that the entire tidal prism may change, to such an extent as to cause more siltation in the estuary. Model testing would be required to evaluate these effects but it is judged, from an overall viewpoint, that such siltation would not be a serious problem and the amount that would occur, could be removed by periodic maintenance dredging, consistent with the value of the new expanded Port.

The general topography in the Corinto area is low-level, consisting basically of mangrove swamp on the east side of the Island, where the port expansion would occur, with two small tidal inlets, entering into the swamp.

The general soil conditions consist of one or two meters of organic silt in the swamp, overlying fine to medium sands and then encountering hard pan or bedrock below. The sand material in the river is suitable as hydraulic fill, with possibly some undercutting to mix with the overlying organic silt. It appears that the organic silt

can be stabilized sufficiently, simply by placing and surcharging hydraulic fill on top. Only in isolated areas for specific structures would the organic silt layer have to be removed.

Earthquakes are a design consideration at Corinto, in terms of the history of destruction in the past. However, very little can be done about the situation in that the port is already established; and the purpose of this Study is to expand the existing port and not locate a new port in a new area. Consequently, the designs will have to take into account earthquake problems dealing with surface faulting, movements, liquefaction, and tsunami hazards. From a practical viewpoint, nothing can really be done, with respect to surface faulting and tsunamies. However, the structures can be designed for horizontal and vertical movements, using standard earthquake analysis; and the liquefaction of subsoils is not deemed serious, since it is intended to found the major structures on the hard pan or bedrock, which is located within reasonable distance from the surface.

VIII. Alternative Locations-Expansion

Eleven alternative sites were considered for the expansion of the Port of Corinto, to provide three additional general cargo wharves, plus room for a potential fourth berth. The sites are shown on Figure H-14, and include six areas on

the Island of Corinto, plus three potential areas for expansion, on the east side of the Estero El Realejo, opposite Corinto.

Numerous factors were taken into account, in evaluating the relative merits of one site versus another; such as cargo handling, dredging of channels, soil and rock conditions, infrastructure, costs, etc. All of the sites have particular advantages and disadvantages. But from an overall long-range consideration, it was concluded that Site C, immediately north of the Liquid Cargo Pier presently under construction, would be the most favorable site, for the various reasons enumerated.

Expanding over the east side of the estuary is an attractive alternative but unfortunately, because of the lack of infrastructure, the costs would be very high and such expansion must be deferred to the future, when larger scale projects are contemplated, which would compensate for the high infrastructure costs.

IX. Recommended Expansion

The recommended expansion of Port facilities at Site C, as indicated on Figure H-15, were based on assumptions regarding completion of the present facilities under construction, the tonnages projected in the future, the fact that an additional city block will be demolished and made available for

Port use, and the assumption that the existing tank farm and shrimp boat facilities can be relocated.

The three-berth expansion up to year 1997, assumes that each berth would accommodate a 25,000 DWT container ship and, therefore, each berth length is 260-meters long, extending back 400 meters, with a dredge depth of 13.33 meters, mean sea level.

The turning basins are dredged in stages, in front of the berths, as the construction proceeds for years 1985, 1991 and 1997. The turning basin is assumed at 400-meters width, and in addition, it is recommended that the 90 meter existing channel, extending out to open waters, be widened to 150 meters for future two-way ship traffic; and that the turning basin of 310-meters width, in front of the Container Wharf presently under construction, be increased to 400-meters width.

The dredging of the turning basins and channels provides sufficient fill for Port expansion, with a surplus available for use in land reclamation to develop areas for housing, commercial and industrial uses. The ecological effect is beyond the scope of this Report, but it does appear to be minimal from an overall viewpoint, when considering the low-grade mangrove swamp to be covered with fill.

An evaluation was made as to whether or not future dredging should be accomplished, by outside contractors bidding

competitively, or should the Port Authority purchase and operate its own dredge. In general, it is assumed that the Port Authority would enter the dredging business, when the unit price would be about 2/3 that of competitive bids; thus allowing for the added overhead, risks, and other factors accruing to the Port Authority. On this basis, the analysis showed that the Port Authority should not, at this time, purchase and operate its own dredge, primarily because the volume of dredging projected in the immediate future is insufficient to result in low price operations for the Port Authority. The capital costs, maintenance, and operating costs of dredging would be excessive; compared to competitive bids for the relatively small quantities projected in the next few years. It is recommended, however, that this decision should be reviewed in the early 1980's when the first phase of dredging for the expansion of the Port of Corinto will take place and when, quite possibly, the harbor and port activities contemplated in Nicaragua expand to such an extent that larger volumes of dredging are required. At that point, with fixed capital costs and other factors, the unit price of dredging would then diminish to a sufficiently low base to justify purchase and operation of a dredge, by the Port Authority.

The inherent advantages of the Port Authority, having its own dredge, are acknowledged in terms of greater flexibility

in contracting procedures and maintenance of channelways. However, these intangibles must be equated with costs and also, the practical realization that all dredging could not be accomplished by the Port Authority with a single dredge. Some of the channelways are exposed to swells and currents, wherein the pipeline cutterhead type dredge contemplated would not operate economically and/or efficiently. Also, as port activities expand in Nicaragua, it is quite possible that dredging may be required simultaneously at two ports. In any event, it is apparent that the Government will still have to subcontract some of the dredging, even if a dredge were purchased.

Consideration was given to the infrastructure requirements and these were divided into two phases. The first, for basic infrastructure to simply develop the wharf area; and then later followed by a more sophisticated infrastructure to meet the specific port needs of the future with the type of cargo, equipment, etc., to be employed.

Estimates were made of the personnel requirements of the future and it is anticipated that about 340 additional personnel would reside in Corinto, during construction of the future additional marginal wharves, consisting of 300 Nicaraguans plus 40 foreigners. Accordingly, housing and other accommodations would have to be provided. Whereas

the future operations of the Port, up to year 1995, anticipate that the port staff would increase from its present size of 300 to about 450 people; and the stevedores would double from 1,200 to about 2,000.

Preliminary layout schematic designs were made, based on design criteria with respect to size of ship, water depths, live load, earthquake forces, etc. On this basis, four alternative designs were seriously considered:

1. Steel sheet pile cells - Drawing H-19.

2. Reinforced concrete caissons - Drawing H-20.

3. Steel pipe piles - Drawing H-21.

4. Prestressed concrete piles - Drawing H-22.

All of these designs are based on deriving positive support on the underlying hard pan or bedrock. It was concluded, however, that the prestressed concrete pile design would be the most appropriate for more detailed study, in view of its overall economies, maximum use of local materials, and relatively lightweight structure for earthquake loading. Consequently, subsequent analysis proceeded on the basis of the prestressed concrete design, and the construction methods were analyzed in terms of the contractor setting up a plant for the prestressed piles, and the stages in which the work

would be accomplished, within a construction period of three years, as shown on the construction schedule bar chart.

On this basis, construction costs were estimated assuming January 1976 prices, without escalation. The details are shown in the Appendix for the various stages of construction, but are summarized below:

Port Expansion

Cost Estimate Summary

	1985 Berth No. 1	1991 Berth No.2	1997 Berth No.3
Dredging, Wharf & Engineering	131,476,900	55,481,900	110,440,400
Relocate Tanks & Shrimp Boats	62,425,000		
Complete Facilities & Engineering	68,529,000	108,629,000	54,813,500
Total - Cordobas	262,430,900	164,110,900	165,253,900
Total - USA Dollars	37,490,000	23,444,000	23,607,000

Port Expansion

1985 Berth No. 1

	Local Capital	Foreign Capital	Total Capital
Dredging, Wharf & Engineering	45,725,380	85,751,520	131,476,900
Relocate Tanks & Shrimp Boats	44,425,000	18,000,000	62,425,000
Complete Facilities & Engineering	20,443,300	48,085,700	68,529,000
Total - Cordobas	110,593,680	151,837,220	262,430,900
Total - USA Dollars	15,800,000	21,690,000	37,490,000

It is estimated, based on past experience, that the construction costs would escalate approximately 6 percent per year for the marine construction. Accordingly, for Berth No. 1 projected to be completed in year 1985, it would mean that the construction costs would be about 60 percent higher; than those estimated in January 1976. In financing the project, these escalation factors must be taken into account in setting up any sinking fund or bond issues.

The estimates also separate into two parts, namely, the initial basic structures and infrastructure required; plus the future enlargement of facilities with additional infrastructure, warehousing, paving, etc. In short, the basic costs of developing the raw land are compared to a completed, final facility.

In the cost estimates, it was assumed that dredging of the channels, turning basins,was primarily for the Port and, therefore, a port use. Those wishing to reclaim land for other uses, such as commercial, housing and industrial development, would then have to pay to the dredger a premium in order to have the surplus dredge material deposited in the swamp, in those areas to be developed.

Consideration was given to lead time purchases for scarce materials, but this is difficult to predict so many years in advance. Nevertheless, it can be assumed that the

steel products and specialty items would still be scarce, and lead time purchase is required.

Analysis was made of the maintenance costs and basically, for the dredging it was assumed that about 200,000 cubic meters per year would have to be dredged as a result of siltation. This presumes some change in the tidal prism, as a result of the widening of channels and turning basins, thus causing additional deposition of silt. However, it is not anticipated that such deposition would be excessive, simply because the silt load emptying into the Estuary is relatively restrictive; whereas, the main maintenance dredging would be outside the harbor area, in the seaward channels where the littoral drift travelling northward up the coast would be entrapped and maintenance dredging required.

The structures themselves would require maintenance, which must be funded and this is based on a sliding scale, over the 40-year minimum life of the structures, varying from 0.5 percent of the capital costs for the first 5 years to as high as 3.0 percent after 20 years. The maintenance would be accomplished by a staff of about 15 people, added on to the present maintenance staff.

Outline specifications are presented for the prestressed concrete pile wharf design. These specifications do not detail the dredging aspects to any large extent, as this would be

covered in reports, prepared by the soils and civil engineers.

X. Conclusions

It is concluded that to meet the future demands, general cargo and container berths will be required at the Port of Corinto in the years 1985, 1991 and 1997. These three berths are in addition to the present Container and general cargo wharf, and Liquid Cargo Pier, presently under construction.

Alternative sites were studied and it was concluded that expansion should proceed northward from the Liquid Cargo Pier and this entails demolishing another row of city blocks, as well as relocating the tank farm and the shrimp boat facilities.

Based on January 1976 prices, it is estimated that the costs for the three future berths are: 193,901,900; 55,481,900; and 110,440,400 cordobas. In comparison, the complete facilities, with all infrastructure and transit sheds, etc., would cost a total of: 262,430,900; 164,110,900; and 165,253,900 cordobas. It is anticipated that escalation would increase these prices at the rate of six percent per year.

It is anticipated that in the future, as the Port develops, the east side of the estuary will be the site for wharf construction and segregated piers. The basic infrastructure would have to be installed with connections to the

mainland, as well as a bridge connecting the Island of Corinto to the east side of the estuary.

Analysis was made of the desirability of the Port Authority purchasing and operating its own dredge. It was concluded that for the dredging projected for the immediate future, it would not be economical for the Port to enter into this operation. The major dredging in Nicaragua is now taking place at Corinto, by an outside contractor, and it will be some years before large volumes of dredging are required. Accordingly, this recommendation should be reviewed in the early 1980's when the first expanded berth will be constructed and when, quite possibly, other ports in Nicaragua may be developed.

FEASIBILITY STUDY
FOR
LAND RECLAMATION PROJECT
FOR THE
COMPLEMENTARY URBAN DEVELOPMENT
OF THE
CITY OF CORINTO NICARAGUA

FINAL REPORT OF PORT STUDIES

I. Introduction

The purpose of this Final Report of Port Studies, representing a section of the overall Feasibility Study for Land Reclamation at Corinto, Nicaragua, is to present an evaluation of the land reclamation project as it relates to port development only. This evaluation is based on approximate estimates of future export and import cargo tonnages, extending up to the year 2 000, as provided by the Consulting Economist. Based on these cargo projections and the natural site conditions, an assessment is made of the technical feasibility of port expansion and development, along with approximate capital costs and maintenance percentages.

Considering the natural sheltered deep waters of the Port of Corinto, the inevitable growth of exports and imports as population and industries grow, the necessity to provide spacious land areas for modern port facilities, the trends toward larger vessels, the present full capacity operations at the port and the trends toward designing specialized berths, all point to the conclusion that the Port of Corinto will expand beyond the presently planned program of constructing a new Container Wharf and Liquid Cargo Pier. The practical necessities of the future require more land area and more berths for the port.

II. Objective of Port Study

The objective of this Port Study is to determine the extent, location and costs of reclaiming land at Corinto for port use only. In this connection a land use, which generates employment, is of first priority and quite obviously, port operations are the prime activity at the City of Corinto from which activities related to other industries develop, such as commerce, public and residential uses. However, development of the Port must meet the needs of the port from an overall national interest. The Port cannot progress by itself, without coordination with the activities and development of all of Nicaragua.

The extent of land required (hectares) is determined by

the projected growth in cargo handling at Corinto, within 20 years (year 1995). This study also considers the probable use of the facilities for specialized use, as this determines the water depths, loads on the wharf and costs, all related to phased construction to meet future increased cargo handling demands.

This Port Study will provide some of the basic data necessary to support a loan application to an international lending agency. However, this Port Study in itself will be incomplete, without the input of the Urban Planners and Economist.

The estimated capital cost developed by this Port Study are only for port land reclamation and development. Specifically, the costs will include dredging, bulkheading, filling, utilities, roads and railroad. It will not include such items as fendering, wharf fittings, paving, transit sheds, buildings and material handling equipment. In short, the cost of developing the raw land for port use will be established, without regard as to how that land will be specifically used.

However, for the purpose of guiding the Autoridad Portuaria de Corinto in future planning, separate cost estimates will be provided to complete the facilities with paving, buildings and equipment.

This Port Study assumes that the present program of ex-

pansion will be accomplished within the next 3 to 4 years, consisting of a new Container Wharf, a New Liquid Cargo Pier and dredging of about 2 million cubic meters, resulting in about 1.5 million cubic meters of fill placed on land. Consequently, this study assumes these new facilities already exist, constructed in accordance with the existing contract plans and specifications, as prepared by Frederic R. Harris Eng. Corp., Cisneros y Conrado Co. Ltda, Santos y Helemann.

III. Existing Port Facilities

Detailed descriptions of the existing Port facilities at the City of Corinto will be presented by the Urban Planners. However, for reference, the following summarizes the existing port facilities.

The Port of Corinto, located on the North Pacific Coast, is the prime port of Nicaragua, handling the largest tonnage of cargo. The relative location of Corinto to other ports, is shown on Figure H-1 and the overall arrangement of the city and port with respect to surrounding areas is shown in more detail on Figure H-2 and Figure H-3. The existing wharves are located at the southeast end of a long, narrow island sheltered by an offshore island (Isla del Cardon) and peninsula extension (Castanones).

Corinto is located in the prime agricultural section of the country. However, the vast majority of port related in-

dustry is located in Chinandega, located immediately northeast of Corinto. Because of the presence of a natural harbor, an infrastructure has developed, connecting the port by railroad and highway to Chinandega, Leon, Managua and other areas, thus expediting exports-imports throughout the country. Consequently, the sheltered, relatively deep draft harbor and integrated transportation network serve the expanding economy of Nicaragua.

Unfortunately, useable land area on the long, narrow Island is limited. The eastern part is a swamp. The only useable land, at present, is a very narrow strip of higher land extending along the west side of the Island, down to the City of Corinto at the south tip.

The Autoridad Portuaria de Corinto, mindful of the natural growth of the port, coupled with the shortage of useable land, has developed the concept of reclaiming a portion of the 350 hectares of swampland on the island for the orderly expansion of the Port and the City of Corinto. The technical feasibility of reclaiming swamplands for port use is the basis for this Port Study.

Starting at the south end of the Island and extending around a portion of the east side, on the east bank of the Estero El Realejo, are the following port facilities, shown on Figure H-4.

1. A Banana Pier, constructed around 1972, consisting of a conveyor system from shore, with ship loader conveyors, extending out from breasting and mooring dolphins. It is designed to handle 16,000 boxes (400 tons) of banana per hour, or other boxed bagged cargo.

2. A General Cargo Wharf for 2 berths, 370 meters long, with 2 transit sheds each 50x117 meters in area, with 10,000 square meters of open storage, plus railroad service and 10 meters water depth (MLWST) alongside the wharf.

3. Old Timber Deck Pier, primarily for liquid cargo, built in early 1900's, having a length of 160 meters, width of 12 meters, and 7 meters of water depth (MLWST) alongside. This pier is used for general cargo and for liquid cargo products pumped through pipe lines on the deck.

4. Miscellaneous small facilities for POL, a marine RR, Shrimp Boat Pier, etc., all located adjacent to the existing tank farm.

5. The port owns a 1,100 HP tug and one pilot boat. In addition the port owns numerous fork lift trucks and 1-1/2 and 5 ton cranes.

The Banana Pier and the General Cargo Wharf, with its two transit sheds, are all in good condition. In contrast, the Old Timber Deck Pier and miscellaneous small facilities are in poor condition.

IV. Immediate Proposed Port Expansion

It is understood that in the immediate future the following construction will start, to expand the Port of Corinto.

1. Dredge a main channel to a depth of 11.0 meters (MLWST).

2. Demolish the Old Timber Deck Pier and construct in its place a 240 meter long wharf for containers. The new Container Wharf would be a straight extension of the existing 2 berth wharf. The intervening area to shore would be filled to create 20,500 square meters of open storage. The water depth alongside would be 12 meters (MLWST). A crane and straddle lift carrier would be provided, of sufficient capacity to handle 40 foot containers. Railroad service would be installed.

3. Construct a new Liquid Cargo Pier consisting primarily of a trestle structure with a central loading platform and mooring and breasting dolphins. It would be constructed immediately north of the

new 240 meter long Container Wharf, in front of some of the miscellaneous small facilities and storage tanks. The water depth alongside would be 12 meters (MLWST).

4. Construct a new Administrative Building, Stevedores Building and relocate a workshop, warehouse and gasoline filling station.

All of the above work is to be completed within about 3 years. The dredging will start very early in 1976. Accordingly, plans must now be developed for the land to be reclaimed so as to effectively utilize the dredge spoil, filling the areas of first priority. At present, the contract plans indicate using dredge material to fill in stages, beginning at the extreme south end of the swamp near Isla del Amor and advancing northward. This general schedule is consistent with the anticipated development of the Port and City of Corinto since about two million cubic meters of material are to be dredged, but considering washout and transportation losses, only about 1.5 million cubic meters of material will be available as fill. Supposedly, the dredged soil will consist primarily of fine sand, compacted by the puddling action of the hydraulic placement of the fill. This should create a satisfactory fill material.

It is understood that closing of the "Canal de Boca

Falsa," between Isla de El Cardon and Peninsula Castanones will not be accomplished. Also, a breakwater will not be constructed off the southeast end of Corinto, across Banco Sawyer, to divert tidal flows into the main entrance channel so as to cause scouring and self-maintenance of channel depths. It is important to state that this construction will not be accomplished (but has been discussed in the past) in order to ascertain the future conditions at Corinto. Consequently, in determining the cost of maintenance dredging, it can be assumed that the present rate of siltation will continue, since no provisions will be made to reduce the effect of littoral drift migration into the main channel.

Although some consideration was recently given to moving the Liquid Cargo Pier further north, or interchanging the new Container Wharf with the new Liquid Cargo Pier; it is understood that the work is proceeding as originally planned, and as generally shown on Figure H-4. Consequently, this Final Report presumes that the new Container and General Cargo Wharf, as well as the new Liquid Cargo Pier, "exist" and in effect have been constructed. Future expansion proceeds on the basis that these two facilities, along with the channel dredging, represent an "existing condition."

V. Cargo Projections and Berth Requirements

The Port of Corinto and Port Samoza are both located

on the Pacific Coast of Nicaragua and account for over 80 to 85 percent of the gross marine cargo tonnage of the nation. Although the East Coast ports will develop in the future, it is expected that their development will not greatly detract from expansion of the Port of Corinto and Port Samoza, as both have their local base of operations and products, and close proximity to Managua and the other main cities along the Pacific Coast, thus precluding any "major competition" from East Coast ports.

Furthermore, in the future, as the nation expands its economy, it will naturally develop that manufacturing at Port Corinto and Port Samoza will tend to exceed the Port itself in terms of employment and total income. However, such operations as manufacturing are essentially an outcome of the fact that the Port itself exists.

The product mix is distinctly different at Port Samoza and Port Corinto. For example, Port Samoza has a limited water depth of about 4 meters, handling primarily crude oil via submarine pipeline. This product is pumped to a refinery at Managua. In addition, Port Samoza handles a modest tonnage of general cargo serviced by lighters.

In contrast the Port of Corinto has a wide product mix, excluding crude oil. Most general cargo and other dry bulk cargo and agricultural products use Corinto. Attached are

tabulations of export and imports handled in 1974, through the Port of Corinto. The shipments consisted of 568,300 revenue tons of exports and 556,700 revenue tons of imports. They are in close balance, but this is meaningless, from a material handling viewpoint, without an analysis of individual commodities.

Considering the very limited area at the existing wharves, it is fortunate in some respects that the large bulk items, such as cotton, banana, sugar, etc., are all exported since the entire City of Corinto and its hinterland, with individual small warehouses, can be used as staging areas for ship loading. The operation is remarkably efficient due to close coordination and considerable deployment of manpower. Nevertheless, further economies and faster ship turnaround would result if additional land areas were located immediately adjacent to the wharves themselves. At present both the existing and the planned facilities have insufficient adjacent land area.

The Port of Corinto handled 1,125,000 revenue tons of cargo in 1974. As best as can be determined, the breakdown of commodities accommodated over each of the individual facilities were as follows:

FACILITY	REVENUE TONS
Banana Pier.....	132,700
Marginal Wharf (2 berths.....	805,000
Old Timber Deck Pier.....	100,000
Miscellaneous Small Facilities..	87,300
TOTAL	1,125,000 RT

In general, the Banana Pier handles boxed bananas and refrigerated beef packages. Supposedly, the conveyor system is designed for a loading rate of 16,000 boxes per hour, which is equivalent to a design rate of 400 MT per hour. Considering a two shift production of 14 hours per day, a 300 day year (straight time pay) the present utilization rate for 132,700 RT export per year is obviously only 12 to 13 percent, for an assumed average loading rate of 250 MT per hour. Therefore, taking into account ship bunching and turnaround, to approach a usual utilization rate of about 50 percent, about four times more product can be exported than is presently exported or say about 550,000 RT per year over the Banana Pier.

However, it is doubtful that 550,000 RT of bananas and packaged beef would be exported over this pier, within the 20 year (year 1995) limit of this study. Indications from banana growers point towards an export of about 200,000 RT per year in the future and in all probability, beef would be shipped

in refrigerated containers. Consequently, in evaluating future throughput to determine additional berth requirements, it has been assumed at this time that the existing Banana Pier will handle 150,000 RT in 1975, generally increasing in 25,000 RT increments every 5 years, to a total of 250,000 RT export in year 1995. This is conservative and consistent with the expectations of exporters.

The existing Marginal Wharf, with its two berths, handled 805,000 RT of cargo in 1974. The operations required offsite staging areas and use of private warehouses because of the limited land and open storage area at the port. The operations would probably optimize at a lower tonnage, but considering the increased efficiencies of future equipment and the flexibility of alternative scheduling with the new Container Wharf, it seems logical to assign a continued berth capacity of 800,000 RT per year to the existing two berth wharf.

The existing Old Timber Deck Pier handles primarily 100,000 RT per year of liquid cargo. Once this pier is demolished to provide space for the proposed new Container Wharf, all products will be transferred to the new Liquid Cargo Pier. For this report it is anticipated that the quantities of liquid cargo will increase in the future, particularly aviation gasoline, asphalt, and molasses. On this basis, it has been assumed that the new Liquid Cargo Pier will handle increasing tonnages consisting of 150,000 RT

in 1980, increasing in increments of 50,000 RT each 5 years to a total of 300,000 RT in year 1995.

The existing Miscellaneous Small Facilities located north of the existing Old Timber Deck Pier (adjacent to the tank farm) handled 87,300 RT of cargo in 1974. Since some of these facilities will be blocked by construction of the new Liquid Cargo Pier, increased useage in the future is questionable. However, it is assumed that the use of these facilities remain at a constant 100,000 RT per year. Should this not be possible in terms of interference with the new Liquid Cargo Pier or possibly even future demolition of these Miscellaneous Small Facilities for normal expansion of the Port, then this 100,000 RT could easily be handled at the future wharf, (built after 1980) thus increasing its throughput but within normal, realistic limits.

The presently planned Container Wharf will be constructed within the next few years. The tonnage to be handled over this berth is difficult to estimate, as it depends on whether or not containers will play a dominant role. It is appreciated that general container useage increases every year and this increase represents a definite trend. However, many of the import and export items at Corinto do not necessarily lend themselves to containerization. On the other hand, depending on arrangements with other nations in Central America and with shipping companies, Corinto could become a major container port, servicing and transshipping products throughout

Central America.

It is realized that various meat packers in Nicaragua have expressed great interest in refrigerated container service. However, the extent to which containers are used for meat export depends to a large extent on the charges the Port will make to the shippers. Considering the unidirectional flow of containers, coupled with the high capital costs of constructing new wharf facilities, it is problematical whether the interest expressed today in containerizing meat products will necessarily materialize in the future, as a large scale container operation, once the handling charges are established. It is, therefore, essential to establish such charges and negotiate them at an early date, as this in turn will determine to some extent the volume of refrigerated meat to be shipped out of Corinto in containers.

A modest growth in tonnage is anticipated over the planned Container Wharf. A mixture of both containers and bulk cargo being handled initially at the rate of 200,000 RT in 1978 and then increasing and remaining constant at 500,000 RT in 1980 through year 1995. This throughput of 500,000 RT could increase if appreciable containerization is utilized. Also, it could be increased to 600,000 RT if the Miscellaneous Small Facilities (adjacent to the tank farm) prove incapable of handling that volume because of interference with the new Liquid Cargo Pier or demolition of these Miscellaneous

facilities because of Port expansion to the north. A more detailed discussion of containerization follows in the next section.

The estimated throughput of both the existing facilities and the proposed planned new facilities, in 5 year increments, is summarized as follows:

FACILITY-CORINTO	EXPORTS + IMPORTS (1,000 RT)						
	1974	1975	1980	1985	1990	1995	2000
Banana Pier	132.7	150	175	200	225	250	275
Marginal Wharf (2 berths)	805.0	800	800	800	800	800	800
Old Timber Deck Pier	100.0	100	none	none	none	none	none
Misc. Small Facilities	87.3	100	100	100	100	100	100
New Liquid Cargo Pier	none	none	150	200	250	300	350
New Container Wharf	none	none	500	500	500	500	500
TOTAL (1,000 RT)	1,125	1,150	1,725	1,800	1,875	1,950	2,025
Total less Bananas & Liquid Cargo	892	900	1,400	1,400	1,400	1,400	1,400

It must be realized that the Banana Pier and the new Liquid Cargo Pier could handle larger tonnages, but it is doubtful that the need will arise. However, if the tonnages handled by these two specialized facilities should increase beyond the estimate, the increased tonnages would be independent of the container and general cargo needs which determine the number of additional berths required and the extent of land reclamation required for port use. The important point is that the

Port of Corinto with its existing two berth wharf, plus the Miscellaneous Facilities, plus the planned Container Wharf, will all together be able to handle 1,400,000 RT per year of container and mixed cargo. Consequently, any port traffic above 1,400,000 RT will require additional berths, excluding bananas and liquid cargo.

Using the preliminary port traffic projections and estimates of tonnages handled through both the existing and planned facilities, it is possible to determine the additional berths required in the future, based on the total projected tonnages for the entire Port of Corinto, less bananas and liquid cargo. The additional tonnage will require primarily general cargo type berths, with some containerization. These facilities would handle increased future exports of agricultural products such as cotton and sugar.

Also, increased imports could be expected with commodities such as wheat, fertilizer, autos, machinery, equipment, iron, steel, etc.

Preliminary projections of total exports and imports, through Corinto, to year 1995 have been prepared by the Economist.

Although individual commodity fluctuations are difficult to predict, the total tonnages can, however, be more reliably estimated as they are related to such matters as gross domestic

product, per capita income, population growth, etc. It is a basic expectation that 60 percent of the gross national product will be represented in exports plus imports. Consequently, using such parameters, the ultimate tonnages to be shipped through Corinto can be estimated by the Economist with some degree of accuracy, ignoring minor fluctuations caused by temporary external influences.

Figures H-5, H-6 and H-7 show the estimated exports, imports and combined tonnages, passing through Corinto, up to the year 2000. Three ranges of projection are given - high, medium and low projections and for the purposes of this Port Study, the "medium" projections have been used to determine future expansion of the Port of Corinto.

Figure H-8 shows the medium projection of combined exports and imports, but excluding those products which would use the Banana Pier and the planned Liquid Cargo traffic. It is assumed that the specialized Banana and Liquid Cargo Piers will be under-utilized, but not capable of handling general products. Accordingly, on Figure H-8 the present and planned capability of handling 1,400,000 RT of container and general cargo coincides with the year 1984. After 1984 additional container and general cargo wharves will be required to handle the total of 2,233,000 RT of container and general cargo by year 1995.

In order to determine the total number of additional

berths required in year 1995 to handle the deficiency of 833,000 RT (2,233,000-1,400,000 = 833,000 RT) estimates were prepared of the cargo capacity of a typical container general cargo berth. These estimates take into account the seasonal fluctuations and anticipated commodity mix.

Figures H-9, H-10 and H-11 show the monthly fluctuation in exports, imports and combined tonnages, basically reflecting changes due to the agricultural section of the economy and the predominance of agricultural related exports and imports through Corinto. Discussions of average yearly throughput are meaningless if there are several months when the throughput is above average. Unless such "peak" tonnages are considered, excessive delays and demurrage will result. Consequently, although it is uneconomical to design for maximum peak tonnages, consideration must be given to planning for peak periods. From a review of Figure H-11, about 20 percent throughput above the average seems to be a reasonable basis for design and is consistent with the experience of other ports. On an average handling 500,000 RT per year of container and general cargo over a new modern wharf, represents a favorable rate of throughput for Corinto and allows a "peak" throughput of 600,000 RT per year, if the increased rate was sustained the entire year. The rate could easily be assumed at 700,000 RT, again assuming that the Miscellaneous Small Facilities are not operating and the products are handled over the new general

cargo container wharf, built in 1985.

On this basis, for the 833,000 RT deficiency in year 1995, a total of 1.7 additional berths of 500,000 RT average capacities (or 600,000 RT without the Miscellaneous Small Facilities) will ultimately be required beyond the present existing and planned facilities. Obviously, a partial berth cannot be constructed and handling 833,000 RT per year through one berth would be excessive. Consequently, two additional berths will be required, thus providing less congested facilities and/or sufficient capacity to meet the demands up to year 1995. In any event, good design practice requires that in the planning of two required berths, space be provided for expansion for a third berth. Accordingly, layouts will proceed on the basis of three additional berths which will theoretically accommodate container and general cargo increases after the year 1997-2000. On this basis, even three berths do not seem excessive, considering the time lag in planning, design, appropriation of lands, construction, etc.

In conclusion, master planning should proceed with three (3) additional container general cargo berths (beyond the presently planned facility) with area set aside (zoned) for a potential fourth berth.

These requirements establish the land reclamation areas, the infrastructure and the land needed for port related industries. The additional berths, coupled with the soil invest-

igations, also establish the channel lengths and widths, turning basins and hence indirectly determine the availability of sufficient dredged material to fill the land areas.

VI. Containers

A detailed study of the potential container traffic at the Port of Corinto is beyond the scope of this Report. Nevertheless, the volume of cargo to be handled in containers is an important design factor, in terms of the type of facilities required and the land area necessary for backup. Efficient container operations require as much as 10 hectares of land per berth. The precise area is a function of the sizes of container handled, the mix of various sizes, the layout of the facilities, the need to reassemble and transship as well as requirements for refrigeration. Obviously, the subject is too complex to be detailed in this Report, other than to establish some parameters of tonnages and land area to be reclaimed.

The presently planned Container Wharf, under construction, has minimal area for efficient container operations, even assuming that additional land is obtained from the city by demolishing another city block, parallel to the wharf. However, since this new wharf will also handle general cargo and since there will be reclaimed land nearby, to which containers can be hauled and stored; the problem is not overly serious and as the port expands toward the north, more and more reclaimed

land will be readily available in close proximity to new wharves, thus alleviating congestion.

It is understood that discussions have already been held with private container lines which view Corinto as a potential regional container port. The needs of these private lines is beyond the scope of this Report, but as previously described, a great deal depends on the container sizes, the products to be carried, the reassembling, repairs and more specifically, the need for refrigeration. It is quite possible that minimal requirements would suffice (simply a storage area with fencing around it) and trailers used to move the containers to a reclaimed storage area, beyond the immediate limits of the wharf itself. However, the requirements may be more sophisticated, depending on the products handled.

High value commodities lend themselves best to containerization, particularly those that can be easily packed in a container unit. Other products of a bulk nature or general cargo, may not necessarily lend themselves to containerization. This then, determines the material handling equipment. A container crane does not have the "flexibility" for efficient general cargo handling; compared to a mobile whirly crane.

It appears that from discussions with shipping lines and others, Corinto will develop, in some measure, into a container port. This includes the possibility of not only

obtaining container traffic from Honduras, but serving to some extent as a regional container port. Studies that have been made by the World Bank indicate that in Central America in 1990, the portential container traffic would be over 3,000,000 metric tons. This, however, represents both the East and West Coasts of Central America; whereas, Corinto is best suited for container traffic to Japan and the West Coast of the USA, plus intercoastal service between the various Central American nations on the Pacific Coast. There is, of course, the possibility of diverting through the Panama Canal for Europe and the East Coast of the USA; but realistically, such traffic would be in competition with east coast ports.

On the basis of an average cargo load of 15 metric tons per a container, previous studies by others have indicated a forecast for Corinto in year 1990 of handling about 53,000 containers, representing about 800,000 metric tons. This would be a volume somewhat difficult to handle at one berth, without demurrage, etc. It is more likely a two-berth requirement. This takes into account that the number of containers handled by vessels, vary from wide ranges but a general acceptable figure, on an average, is about 600 containers per ship. This would mean 88 vessels a year; feasible for one berth but crowded at times with ship bunching. It therefore, appears that the existing contai ner wharf, presently under construction, could, with some straining, handle the container

traffic up to the year 1990.

The studies conducted for this Report with the projections by the Economist, do not consider Corinto as the regional container port; per se, but instead are related to other factors of national growth thereby, being independent of the container volume forecasts. The new Container Wharf is visualized as handling both containers and general cargo with a capacity of 500,000 to 600,000 RT annually. This is not overly inconsistent with the container traffic forecast for Corinto, which is about 350,000 metric tons in 1980, about 700,000 metric tons in 1985 and about 800,000 metric tons in 1990.

Since the basis for this Study is year 1995, with a total of 2,233,000 RT of container and general cargo, taking into account the present capacities of the wharves, the deficiency is 833,000 RT in 1995. This represents the additional 1.7 berths needed by 1995, beyond the present existing and facilities under construction. The projections are, therefore, not incompatible and in effect, take into partial account of the concept of Corinto becoming a regional container port.

All of the above emphasizes the need for flexibility in planning. Fortunately, such flexibility is easily obtained as development proceeds northward into the undeveloped

swamp areas, there is ample room for expansion and the filling is geared to the dredging. Consequently, as experience is gained the precise timing for additional berths can be evaluated in light of experience. It is not a situation of a completely developed port with intermediate land lying idle, on which capital investment and infrastructure has been expended. It is merely sufficient to indicate the broad parameters of expansion and the fact that by 1995, basically two new additional berths will be required.

VII. NATURAL SITE CONDITIONS

The natural site conditions determine to a large extent the relative merits of alternative locations, the layout of facilities, and the consequent land reclamation needs.

In general, the natural conditions at Corinto with respect to winds, waves, tides, currents, soils, etc. are not particularly difficult or imposing. The problems associated with the natural conditions are all solvable at a relatively reasonable cost, compared to other ports in the world where conditions are much worse. Consequently, it can be stated that land reclamation for port use is technically feasible. The economic aspects will, however, have to be studied in detail by the Economist.

The following discussion of the natural site conditions at Corinto focuses on the problems, their interdependence, and their effects on the land reclamation project as analyzed for port use only.

A. Rainfall

Rainfall data is of prime importance in terms of drainage requirements. The generally flat slopes over large extensive wharf areas and the limited height above sea level all contribute to a difficult drainage condition, plus the

fact that slopes cannot be too steep, because of the need to efficiently operate handling equipment, such as fork-lift trucks, etc. Furthermore, the crane rails and railroad tracks with their own restrictive slope requirements are a complicating factor in establishing an overall drainage layout.

In general, it is intended to drain the area by means of open ditches, at least around the perimeter, where there would be no interference with traffic. Open ditches are preferred from an economic viewpoint, and also because they enable the shaping of a ditch to accommodate any design interferences. The ditches can be of adequate width so as to handle the runoff, even though the ditch itself may be relatively shallow.

The rainfall at Corinto is seasonable, with very little rain from December to April. Reportedly, during the rainy season, from May to November, over 25 cm of rain has occurred in one day. However, the average monthly rainfall is closer to 21 cm per month.

In September 1974 during the hurricane Fifi, the rainfall intensity was severe with 10 cm occurring in one hour.

Serious flooding cannot be tolerated. The drainage system will have to be positive and adequate to accommodate

about 6.5 cm maximum hourly rainfall during the rainy season. This will mean designs consisting of catch basins, grating over ditches, and open ditches at the perimeter. Such facilities will be estimated in the basic construction costs.

B. Winds and Waves

Winds determine wave action, ship approach and departure. Considering the main channel approach to Corinto and the necessary turns to reach the berth, it is obvious that an ideal straight run against the wind is impossible. Also, conditions have to be individually evaluated fro a ship in light ballast, presenting a large sail area, compared to a loaded vessel, less affected by winds, but increasingly subjected to tidal currents forces.

The winter trade winds from May to August blow from the southerly quadrant and consequently develop waves from the south with relatively high wave energy. In contrast, the summer winds from October to March are from the northeast to the west and create waves from the westerly direction at Corinto. According to reports, the most severe wave action is during the winter at Corinto during the months of June to August, when the southwest swell develops. These winds may not be the strongest, but their steady persistent duration accounts for the severe wave action.

The frequency and direction of winds are as follows:

Direction	Frequency Per Cent
North	16.33
Northeast	12.65
East	10.04
Southeast	8.33
South	10.45
Southwest	9.63
West	4.65
Northwest	5.47
Calm	22.45
Total	100.00

Information gathered to date indicates that the strongest winds are in January and February, with the worst from the northwest. Reportedly, the strong winds do not create any significant wave surge, raising the water above normal tide elevations in the harbor of Corinto. Such a surge could be important in terms of elevating the wharf and land areas above flooding and also to protect utility trenches and vaults. Fortunately these westerly winds will not create waves on wharves located on the east side of Corinto and, therefore, in establishing safe wharf elevations, wave runup during severe storms is not a problem. However, other facilities, related to the land reclamation project and located on the west side of Corinto "island" must take into account wave runup, particularly at the north end where the offshore water tends to be deeper, not influenced by shallow deposits of littoral drift. In contrast, off the southwest end of Corinto, the shallow "Sawyer Bank" decreases

wave action and refraction changes the wave directions. Consequently, the experience of the City of Corinto at the south end of the island can not be extrapolated for areas located to the north, where wave conditions will be more severe.

Supposedly, the prevailing winds are from the east and northeast from November to March within the general range of 10 KM per hour and every 2 to 3 years a storm from this direction attains velocities up to 80 KM per hour. The prevailing winds are generally not severe but would tend to push a vessel, berthed on the east side of the island, against the wharf, particularly if future berths are aligned in a north-northwest direction, somewhat perpendicularly to the prevailing winds. Accordingly, on occasions tug or tidal current assistance may be required for a ship departing the berth.

From April to October, winds are generally from the southwest. Notwithstanding, studies made by others, indicate that offshore wave action is nota problem for ships approaching or departing Corinto. For example, it has been estimated that ships of 9 meter draft (30 feet) could enter the main channelway, 95 percent of the time, against the prevailing south to west waves during June to October and the prevailing offshore north to west waves during November to June. The approach would also have to consider the wind

and tidal currents at the time.

C. Tides and Currents

The tides control many aspects of design, including the elevations of facilities and ship maneuvering. In addition, maintenance dredging and "self scouring" action is dependent on tidal currents.

Figure H-12 shows tide ranges referenced to mean sea level (MSL). In summary, the mean tidal range at Corinto is 2.27 meters, with an extreme range of 3.11 meters, extending up to 1.61 meters above mean sea level.

Although this is not a very large range, it is sufficient to cause a 2 to 3 knot maximum ebb current at the existing wharves, diminishing to 1 knot at the offshore channel and also north up the Estero El Realejo. The flood tide currents are reportedly less severe.

Since these currents tend to align with the natural channels, the berths should also align with the channels. It is desirable for ships to parallel the currents, particularly to head into the tide when approaching or departing the berth. Turning broadside to a 3 knot current in a relatively narrow channelway would be dangerous. The ship would have to await slack tide. Accordingly, in the planning of wharf facilities for the land reclamation proj-

ect, internal basins projecting into the swamp are discouraged because of the need to maneuver perpendicular to tidal currents or, encounter delays waiting for safe tidal conditions.

The matter of detailed ship maneuvering is beyond the scope of this report. Specific situations would have to be studied with the Harbor Pilot. However, the problems are variable, considering if the ship is in light or heavy ballast, loading or unloading, requiring special cargo placement or handling facilities, etc. In short, each ship approaching or departing Corinto at a particular time has to evaluate the existing wind, wave and tidal conditions to make proper decisions regarding maneuvering.

One favorable aspect of the tidal conditions at Corinto is the fact that there seems to be a short time lag in tidal response between the main channel and the existing wharves. This simplifies the ship maneuvering.

The currents developed by tidal action play an important role in maintaining the existing channelways free of silt and minimizing maintenance dredging. In recent years, storms along the coast and the general progression of littoral drift have sealed off the north end of Paso Caballos near the railroad bridge. Consequently, with this sealing there tends to be a diminished flushing action in Estero

Paso Caballos and this may result in some added siltation. However, until now, the tidal currents have been sufficiently strong so as to flush out the fine grained material and maintain a natural deep channel at Corinto.

Dredging of widened channels and turning basins, therefore, becomes critical in terms of changing the tidal prism to such an extent as to diminish this self-flushing action. This matter will be discussed later in this report.

D. Littoral Drift

A net northerly littoral drift of 100,000 cubic meters per year has been reported traveling up the coast of Nicaragua, passing Corinto. Supposedly, the predominant southwest to west waves caused this net drift. In general, the direction is north in summer and south in winter. However, since the wave energies toward the south are about two thirds those driving the sand to the north, the net result is a movement of littoral drift toward the north.

The situation around Corinto is complicated by the isolated island of El Cardon which serves as an offshore breakwater, providing shelter and some measure of entrapment for littoral drift moving southward. It also causes refraction of waves, thereby forming the shallows of Sawyer Bank at the entrance to Corinto harbor.

In addition, the channel (Boca Falsa) between the off-

shore island and the peninsula to the south also tends to entrap some of the littoral drift which is later driven by wave action inside the harbor, causing siltation in the main channel turn, immediately south of the City of Corinto.

The consequence of the littoral drift process is the perpetual need for maintenance dredging of the main channel, which has been estimated at the rate of 125,000 cubic meters per year. Accordingly, the prudent dredging procedures would be to overdredge to some extent and then redredge every few years when navigation becomes impeded.

Although redredging is a maintenance expense, it also represents a source of fill for land reclamation. This develops a need for staged planning to determine where to place maintenance spoil as it becomes available. Presuming that the maintenance spoil is a granular material, suitable for filling, it can be used for land reclamation. The problem arises, however, during dredging maintenance to have a sufficient quantity of material to be removed, so as to make economical mobilization of dredging equipment. The ideal situation would be to defer maintenance dredging until that time when port expansion proceeds with new channel basins, channel widening, etc. so that large dredging contracts can be let at one time, with the economies of large scale dredging, as well as the ability of the dredger to schedule production, using different equipment during different periods

of the year, depending on the wind and wave conditions. In any event, littoral drift will require maintenance dredging of the main offshore channel - approximately everaging 125,000 cubic meters per year.

E. Water Depths

Reportedly, the water depths in the estuary are relatively stable. Apparently a balance between siltation and scour has established itself. This is somewhat contrary to the statements made regarding littoral drift depositions. However, siltation by littoral drift becomes a factor after deepening of the natural 7.5 meter deep offshore channel to about 11 meters (MLW) to accommodate 9 meter draft ships. Otherwise, the natural scouring action of the tidal currents tends to maintain an open channel way. In the final siting of wharves, detailed sounding will be used to establish specific alignments. The berth alongside the wharf would be dredged to about 12 meters at mean low water (MLW) capable of accommodating up to a 40,000 DWT (10.7 meter draft), taking advantage of high tide conditions to traverse the future 11 meter (MLWST) offshore channel.

A matter of concern is that dredging of new turning basins and thus changing the natural tidal prism affect the tidal velocities to such an extent that the historical self-scouring process may be diminished with consequent siltation occurring. It is a fact that historically the estuary was

deeper with the old port located at El Realejo, which has silted up in the interim.

However, in comparing hydrographic charts over the years, such as 1884, 1928 and 1968, little siltation has been observed, less than 100,000 cubic meters per year.

Besides the fact that the estuaries have established a stable condition with tidal velocity, self-scouring the channel ways, there is the fact that the freshwater discharges encounter salt water far upstream so that precipitation does not occur in the immediate vicinity of the existing berths. Also, this freshwater discharge, with its siltload, is seasonable in that there is little rainfall from December to April. Consequently, little siltation could occur from this source during this period.

The water depths, as affected by littoral drift into the main channel, are also stable primarily because with the net littoral drift traveling norhtward, there is a tendency for deposition to occur south of Isla del Cardon, namely in the natural channelway of Boca Falsa. Consequently, the littoral drift "traps" in this area, before proceeding further northward into the main channel extending out from Corinto, north of Isla del Cardon.

The matter of the tidal prism being changed to such an extent that siltation would occur, with consequent added maintenance dredging, can only be resolved by model-

testing on a movable bed model. This would indicate to what extent the currents are diminished, and siltation may occur. However, it is judged that extensive siltation will not be a factor, primarily considering the sheltering offered by Isla del Cardon and the Peninsula Castanones from littoral drift, and the fact that little silt discharge comes from overland, and that which does develop during the rainy season would tend to discharge up north, in the arms of the various estuaries, rather than at the main estuary. However, one problem that will have to be resolved in this matter of maintaining a free flushing action, along the existing marginal wharves and their expansion, is the need to possibly open the silted-up Paso Caballos, where the railroad bridge crosses onto Corinto Island. This silted opening diminishes tidal flow and flushing action to self-scour in front of the existing and extended wharves.

F. Land Topography

Cross-section profiles have been surveyed throughout the entire mangrove swamp area. The detailed results and the final topographical map are included in the comprehensive report of Engineering Investigations, prepared by others.

In general, the swamp topography is quite flat, varying from elevation zero MSL to a maximum height of about 1.0 meters. The most critical topographic elements in the en-

tire swamp area are the two small tidal estuaries that discharge at the southeastern side of the swamp, immediately north of the developed harbor area. The Rio el Espino and the Estero Palo Bonito drain the south half of the island, maintain fish and shell fish, and serve as a waterway for entry into the swamp and Isla del Amor. The dpeth of the water, at the entrances of both estuaries is about four meters below mean sea level, extending inland to shallows of very limited draft. From an ecological viewpoint, it would be desirable not to disturb these two swamp estuaries. However, the demands for land are so strong that preservation will not be possible; instead, these estuaries will have to be "shifted" and allowed to flow through culverts, still draining the central area of the island.

Maintaining these estuaries or at least the initial swamp areas, will serve as a buffer zone between the port and the remainder of the island.

It is questionable to what extent the swamp area will remain since the hydraulic filling operations will tend to spew material over the area, thus tending to fill up the swamp. Possibly, they may no longer remain as waterways but rather as semifilled areas, with typical swamp vegetation-type growth but little open water.

G. Soil and Rock Conditions

A detailed program of soil borings and laboratory

tests have been conducted over the entire mangrove swamp area, in the waterways and on the opposite shores, away from Corinto. The purpose of this program was to (1) determine the dpeth and extent of unsuitable soils for foundation support of reclaimed areas, (2) to locate sources of suitable borrow fill material and (3) to tentatively establish designs of probable wharf structures to determine the capital costs of construction for the economic cost benefit ratio analysis by the Economist.

A comprehensive report on the soil and rock conditions is contained in the "Engineering Investigations," prepared by others. Consequently, repetition will be avoided except to point out certain factors particularly significant with respect to this Port Study.

The subsoil exploration program disclosed three important facts that will influence port development:

1. Large quantities of good sand fill, close to the port area, are not readily available, particularly if the fill is also required for other than port use. Consequently, every attempt must be made to reduce the fill requirements.

2. The organic silt soil overlying the mangrove swamp area is relatively thin, averaging only about 1 to 2 meters. Consequently, no problems are anticipated

with subsoil settlement or stability as this unsuitable material can be treated by displacing, surcharging, or even excavating this stratum.

3. Rock and/or hard pan has been encountered at relatively high elevations at the east central portions of the swamp. See Figure H-13. Consequently, port development must be planned to eliminate or at best minimize costly rock dredging. This means that the deeper draft berths should be located toward the southerly end of Corinto Island, adjacent to the existing developed port. In addition, the wharf structures must be designed to take into account the close presence of rock, particularly as expansion proceeds to the north.

The matters of constructing over the existing swamp soils have been reviewed in detail, in the "Engineering Investigations" by others. But in general, the one-to-two meters of organic silt overlying the sand, hard pan and rock below are not extensive and it is only in the small swamp estuaries that the thickness of this stratum is greater than two meters. The organic silt is highly compressible, generally having a water content of about one hundred per cent and ranging up to as much as five hundred per cent. However, for the shallow thicknesses of organic silt, the

lineate the organic silt areas. Nevertheless, the borings cored into rock for example, Boring No. 91, disclosed that the rock is relatively hard, although in some areas fractured, but is basically a fine grained igneous rock, namely a basalt. It is an excellent foundation support for any structure, provided it is not necessary to core drill into it, which would be difficult because of the hardness of the rock and slow progress. From this viewpoint, it is desirable to have an overburden on the rock for fixity of any pile structure, or if a gravity structure is envisioned, to found it directly on the rock surface, or on a layer of gravel blanket, crushed stone overlying the rock.

H. Earthquakes

Mindful of the disastrous earthquake at Managua, and the tremors in the region of the Pacific Coast of Nicaragua, design against earthquake is of prime importance.

It is understood that the closest fault to Corinto is approximately 57 km away and studies, made by others, have indicated that with an epicenter about 200 km offshore, the earthquake severity at Corinto could be 8.5 on the Richter scale.

In terms of design for earthquake, there are basically four items to be considered, namely:

1. Surface faulting.
2. Horizontal and vertical movements.
3. Liquefaction of subsoils.
4. Tsunami hazard.

With respect to surface faulting, no particular design can be evolved, other than to avoid the fault zone itself. In order to establish the fault zones in Corinto, it would require an extensive testing and boring program. Even then, the ability to discover all faults is somewhat limited. However, from the viewpoint of the Port itself, and the type of facilities constructed, plus the past history of earthquakes at Corinto and the general knowledge as to where the probable fault zones lie in the area, it appears that no particular concern should be felt for a surface fault intersecting the port facilities. The fact is that if this did occur, the damages are not severe in terms of loss of life, as the port facilities are basically low-level structures with minimum habitation or work force. The hazards at Corinto are quite different and of a much lesser degree than having a fault zone pass through a populated city with skyscrapers. Consequently, since the Port of Corinto is where it is today, and any expansion would be an extension of the existing facility and no knowledge is available of any intersecting faults, consequently, all that can be done is to proceed with the construction. In effect, the potential possibility of a

fault zone will be ignored, but realizing that in designing for earthquake forces there will be an inherent strength built into the structures that to some extent will resist faulting, but obviously not at the structure itself. There is no intention to relocate the port or to embark on an extensive program of locating potential underground fault zones, within the harbor wharf area itself.

With respect to the movements, both horizontal and vertical, occurring during earthquakes, the structures must be designed for these forces, particularly the lateral loads. On this basis, the U.S.A. California Earthquake Code would be used as a criteria for Class V Earthquake loading. In final design, particular care will have to be paid to the details of connections of vertical and horizontal members where they interconnect. Also, it is desirable for the structures to be light in weight, rather than massive, so as to minimize the effects of lateral load thrust caused by earthquake motions. In short, all of the known factors in designing against earthquakes will have to be incorporated into the final designs.

Liquefaction is a phenomena that may occur in loose, fine-grained sands. The shaking action of the earthquake tends to compact the sand and in its attempt to compact, the sand particles try to settle in the voids, but since the

voids are full with water; in effect the load of the sand is temporarily carried on the pore water. Without grain-to-grain contact, there is a tendency for the entire loose sand mass to have an internal shear resistance approaching zero, and the material then flows out as a liquefied mass or slide. This has occurred in recent years at a number of areas subjected to earthquakes, where loose, fine-grained materials, throughly saturated in water, have liquefied. In this respect, the situation at Corinto is somewhat different in that the underlying sands, although not compact are in the lower range of medium compactness. Consequently, their ability to liquefy is questionable. Whereas, overlying the sands is the organic silt material and this will not liquefy, due to its inherent shear strength and cohesion, along with the fibrous root system in the material. Finally, on top, will be placed hydraulic sand which under normal circumstances would seem to be an an "ideal material" to liquefy, except that much of this fill will be above the permanent water table. In addition, the placement of hydraulic fill, with proper drainage, tends to compact such soils above their critical density. Lastly, it must be remembered that hard pan and/or bedrock is relatively close below, and that there are no extensive deep deposits of fine silty sands. Obviously. the hard pan or bedrock will not liquefy. On this basis, the matter of liquefaction at Corinto in terms of port development, as a major hazard, is somewhat academic. It is

visualized that all of the structures would be constructed, either as gravity or piled facilities bearing on the hard pan and/or bedrock. On this basis, the liquefaction would not occur beneath the foundation, but instead could occur in the backfill - as an added thrust or pressure on the structure. However, considering the normal safety factors and a knowledge that something of this nature may occur, it is possible to design those structures, within practical limits, to resist such temporary forces - particularly since the quantities and depths of soils susceptible to liquefaction are limited.

In conclusion then, with respect to earthquakes, the situation is that the Port of Corinto does exist and no provisions can be made to protect those facilities which already exist. Whereas, any expansion of the port can be designed using modern technology, taking into account earthquake forces and being aware of the possibilities of horizontal forces or liquefaction, the facilities can be designed to resist these forces.

In any event, should such a disaster occur, relatively speaking, the effects on the port facilities would be quite minimal. The port facilities are low-rise structures, basically isolated, not inhabited and consequently, loss of life and/or damage to property would be relatively minimal. In short, the best will be made of an unfortunate situation

wherein the entire Pacific Coast of Nicaragua is subjected to such forces and it is doubtful that any searching along the coast would locate an area more or less suitable than Corinto, from the viewpoint of earthquake safety. Such a program would, of course, be outside the scope of this report, since the purpose of this report is not to relocate the Port of Corinto, but rather to take advantage of the natural deep draft harbor and basic infrastructure to expand the existing port, with due recognition of the potential forces on new construction.

VIII. Alternative Locations - Expansion

In analyzing the alternative possibilities for expanding the existing and planned berths with three additional container/general cargo wharves, plus providing space for a potential fourth berth, a number of alternative locations were considered. The alternatives included sites along the entire perimeter of the Island of Corinto, basins dredged into the interior of the Island, plus sites on the opposite side of the main channelway, across from the City of Corinto.

Numerous factors were taken into account in evaluating the relative merits of one site versus another, such as:

1. Number of required additional berths.
2. Nature of cargo handled and storage needs.
3. Sizes of ships, tugs and auxiliaries.
4. Approach channels, turning basins and anchorages.
5. Hydraulic conditions in the estuary.
6. Soil, rock and siltation conditions.
7. Winds, waves and shelter.
8. Existing and planned infrastructure.
9. Ecology and preservation of natural conditions.
10. Property ownership, boundaries and zoning.
11. Existing and potential future industries.
12. Separation of Port activities into specialized zones.
13. Initial capital cost versus future maintenance costs.

Many locations can be rejected immediately for obvious reasons, without detailed analysis. However, for purposes of record and to illustrate the principles, the following discussion will cover even some of the obviously unsuitable sites.

The locations of the various alternative sites that have been considered for expansion of container/general cargo wharves, up to the year 1995-2000 are shown on Figure H-14. Each will be described in some detail, but briefly summarized in location and concept, they are as follows:

A. North West End of Corinto Island - a breakwater enclosed harbor to take advantage of a natural deep water approach for ships, with shallow swamp deposits on shore.

B. South End of Corinto Island - take advantage of open land areas on shore, shallow offshore depths, but close proximity to the main deep channel.

C. Extend Existing facilities at SE End - remove the tank farm complex and permit more orderly expansion of marginal wharves to the north.

D. Internal Basin North of Existing Facilities - take advantage of shelter and greater depths to rock.

E. Northeast End of Corinto - on the Estero El Realejo progressing with wharves toward the south, thereby separating the existing from the new facilties and decreasing the road congestion with direct outlet to the main road on Corinto.

F. Northeast Pilot Fill Area-taking advantage of the existence of an already filled area and ease of filling adjacent shallow swamp areas.

G. East Side of Estero El Realejo - on the east bank north of Estero Esparta, considering the close proximity to a future bridge connecting Corinto with the mainland.

H. Isla El Granadillo - relocate on the opposite side of the estuary to separate liquid cargo and dangerous cargoes and provide for ultimate expansion of port facilities, bypassing the Island of Corinto.

I. Isla Encantada-opposite the existing Port of Corinto on the east bank of Estero El Realejo, again separating the facilities with direct connection to the mainland without the congestion of traversing the Island of Corinto.

The studies of the various alternative sites lead to the recommendation that the area immediately north of the Liquid Cargo Pier, namely Site C, be developed for future expansion

of container and general cargo wharves. This means that the existing miscellaneous facilities and their tank farm will have to be demolished and moved. On this basis, comparison can be made with the recommended site as the various alternative locations are now discussed.

A. North West End of Corinto Island

An interesting possibility is to develop a completely new port facility at the north end of Corinto Island, on the west side. Since this is the exposed Pacific Ocean side, a new breakwater enclosed harbor would be required (Site A, Figure H-14).

Consideration of constructing a new harbor on this exposed side of the island developed because of the following reasons:

1. The 10 meter water depth contour is 3.5 Km offshore of the City of Corinto, but approaches to within only 1.5 Km at the north end of the Island. Since practically 2.0 Km of main channel will have to be dredged and maintained off Isla del Cardon, it is apparent that constructing a new harbor at the northwest end would place it in naturally deep water with no or very little maintenance dredging.

2. The ship approach to this new harbor would be easier and could be specifically designed to take

into account winds and waves, compared to the more difficult course for a ship entering the existing and planned channelways, contending with winds, waves, plus turns and tidal currents.

3. The shore line at the northwest end of the island is subject to wave erosion. Maintenance and repair will be needed but constructing a breakwater protected harbor would also protect the shore line.

4. The basic infrastructure already exists, with water, electric power, highway and railroad. It is reported that a new bridge will be required to handle the future 40 foot containers. This affords the opportunity to construct a new bridge to also support a railroad bypass, using the existing railroad bridge and line as a siding to service the new port. It would therefore not be necessary for the additional traffic to go into the City of Corinto, thus minimizing the potential for increased congestion.

5. The open mangrove swamp area at the north end is relatively high in elevation and contains only a one meter layer of organic silt. This land area could be easily developed for port related industries. Although the land borings showed rock rel-

atively close to the surface, it is believed that further offshore the rock would dip down thus eliminating or minimizing any rock dredging.

On the basis of the above, there appears to be some merit to constructing a new harbor at the extreme north west end of Corinto Island. The main disadvantage is that construction of a breakwater would be expensive and time consuming. Also, any future expansion, beyond the assumed four berths, would be costly, unless the original breakwater enclosure is sufficiently large to accommodate all reasonable eventualities. However, this becomes somewhat impractical for staged funding since even the first berth expansion can not be developed without first constructing the entire breakwater complex. The initial financial burden is disproportionate, although all subsequent berth construction would be relatively economical.

B. South End of Corinto Island

The extreme south end of Corinto Island, immediately west of the Banana Pier, offers possibilities for development of additional container and general cargo wharves for the following reasons (Site B, Figure H-14):

1. A considerable portion of the existing shore area is open and possibly available for storage.

2. Advantage could be taken of the shallow offshore waters to fill out and thus develop sufficient land area to properly sustain an efficient operation, combined with the existing open onshore storage areas.

3. The site is immediately adjacent to the natural deep water channel.

4. Spoil from the channel dredging could be readily pumped onto this area, without unduly interfering with other port operations. The distances from the channel dredging are relatively short.

5. Ship navigation would be simplified because of the easy approach and no interference with the existing wharf facilities.

The disadvantage of this site is that unless a closure were made at Boca Falsa, between Isla El Cardon and the peninsula, wave action on some occasions could be too severe at the new berths. In fact, a short breakwater spur at the west end of the new development, extending in a southerly direction, would probably be required for protection against waves refracting over Sawyer Bank. Another disadvantage is that a development at the south tip of the island would seriously add to the congestion in the city.

However, from the viewpoint of this port study, related to land reclamation of the mangrove swamp areas, this south location would not fulfull the requirements since no swamp reclamation would be involved. The study would necessarily deal with developing a new port expansion area.

C. Extend Existing Facilities at Southeast End

Expansion of container and general cargo wharves, at the sacrifice of existing facilities at the southeast end of Corinto Island, has already been discussed to some extent in "Section IV Immediate Proposed Port Expansion." However, ignoring details of berth alignments, etc., the important facts concerning expansion immediately north of the planned Liquid Cargo Pier are as follows (Site C, Figure H-14):

1. Expansion of wharf facilities cannot be achieved except at the expense of demolishing the existing miscellaneous waterfront facilities and moving the tank farm.

2. Some disruption to normal port traffic will occur as well as phasing of the infrastructure and expanded facilities.

3. Although expansion on the existing tank farm area

is not necessarily related to land reclamation of the mangrove swamp, the fact remains that reclamation will still be required for the tank farm to be relocated further westward towards Isla del Amor. Such demolition would occur around 1984-85 when the first phase of port expansion begins, after the new container pier presently under construction has fulfilled its use with respect to its capacity.

It is, however, from the viewpoint of long-range planning, highly desirable to continue expansion in an orderly, progressive, northward direction from the existing port facilities. Very little is gained in the long run by attempting to preserve the existing antiquated waterfront facilities and badly congested old warehouse facilities. However, this can only be done with the realization that the tank farm must be moved and that additional land must be taken from the City so as to develop an adequare hinterland for port development. It is understood that these changes are practical and possible. Consequently, the relocation to Site C is recommended.

Although consideration was given to relocating the tank farm facilities on the opposite side of the estuary at, say, Isla El Granadillo. However, the lack of infra-

structure and the scheduling of the expansion of the City and the Port itself are such that this becomes impracticable, particularly since the Liquid Cargo Pier is a fait accompli. Obviously, use must be made of the pier now under construction and since its use is directly related to the presence of a nearby tank farm, the planning is constrained.

D. Internal Basin North of Existing Facilities

An area for potential expansion of the Port is to construct berths leading into the interior of the mangrove swamp, immediately north of the tank farm and shrimp boat pier. This would avoid the high rock areas further to the north, where extensive rock dredging may be required. The general plan for an internal basin would be to dredge out the small tidal estuaries, having a west-northwest alignment, for ease of ship approach and departure from the main estuary, as shown as Site D on Figure H-14. The relative advantage of this arrangement would be as follows:

1. Less demand for fill since some swamp is converted into a waterway and the deeper sections in the beds of the two small tidal estuaries are not filled.

2. The rock is deeper in this area, about 14 to 15 meters below mean sea level, thereby economically accommodating deeper draft vessels.

3. Future maintenance dredging may be minimized. The main channel estuary would not have to be dredged further north. But this may be counterbalanced by the creation of a "dead pocket" berth, where silt laden waters would discharge sediment.

A disadvantage of this "internal basin" is that tug service would be required for all approaches and departures. Furthermore, it may not be possible to enter or leave the basin under all tidal current conditions for a broad side turn. It would be necessary to wait for tidal currents to slacken. It is appreciated that mid channel turns are now made north of the existing wharves under all tidal conditions, but if the ship drifts during the turn, no harm results. However, in the future, with long container ships attempting to approach a fixed basin with a broadside turn, this is a more difficult maneuver.

The over-riding disadvantage is that the intrusion of this basin into the interior of the swamp along with its filled areas, connecting roads, railroad, etc. effectively

cuts off the south end of Corinto Island from northward growth. In addition, drainage conditions would be difficult around the vicinity of Isla del Amor. Considering all of these factors, the "internal basin" is not an optimum scheme for land reclamation and expansion of port facilities.

E. Northeast End of Corinto

An obvious area for future port expansion is along the east side of Corinto Island on the estuary immediately north of the existing storage tank farm and shrimp boat pier. It is a natural expansion of the existing facilities (Site E of Figure H-14). At this location, the expansion would generally proceed from north toward the south, towards the existing port facilities. In effect, the two port areas, that which exists and the future, would be separated with their own infrastructure and main roads leading to the main highway at Corinto.

Some of the major advantages of this location are as follows:

1. Adequate hinterland can be developed for efficient port operations (transit sheds, warehouses and port related industries) simply by reclaiming the necessary swamp area.

2. New construction would not interfere with existing port operations.

3. Suitable fill for land reclamation is readily available from dredging the main channel adjacent to the proposed new port area.

4. The new wharves, having a north-south orientation, would be parallel to the tidal currents, thus simplifying ship approach and departure.

5. The natural channel in the adjacent estuary is supposedly relatively stable, oppposite the proposed expansion area. Maintenance dredging would be minimized. It must be realized, however, that dredging to a greater depth may change the tidal prism and cause increased siltation.

Accordingly, southward expansion of the Port along the estuary seems a logical extension. However, there are major disadvantages. The first is the separation of the Port into two distinct areas with basically two administrative areas, relatively poor liaison and the inability to efficiently utilize equipment along a straight continuous wharf.

The other disadvantage is that at this northerly location the rock increases in elevation and no doubt is even higher than disclosed by the few borings made in the area.

Consequently, it can be anticipated that some hard igneous, basalt rock dredging may be required. This would be expensive and would realistically limit ship size so as to minimize dredging requirements. Consequently development at this northerly end (Site E, Figure H-4) should be restricted to shallower draft vessels and facilities which should generally be isolated from the remainder of the Port. For example, an indepdent, self-sustained fertilizer plant, or relocation of the shrimp boat facilities would be a logical location for Site E.

F. North East Pilot Fill Area

Another alternative location for port expansion on the Island of Corinto is at the northeast side, somewhat east of the pilot fill. This area is of general interest as it bypasses both the thicker swamp deposits and the more developed areas of the Island. In addition, connecting highway and railroad alignments would be simplified. Unfortunately, this area has three natural disadvantages which interfere with its use for container and general cargo expansion (Site F, Figure H-14).

1. Rock rises to as high as 2 meters below mean sea level along the shore and 8 meters (MSL) in the estuary. Costly rock dredging would be required as area for expansion with sufficient water depth

becomes limited, as expansion proceeds eastward.

2. Judging from the relatively shallower depth of the estuary, there is a tendency to silt in this area, requiring more maintenance dredging.

3. The natural channelway is relatively narrow and widening would be necessary for ship turn around.

On the basis of the above, the areas adjacent to and east of the Pilot Fill present no particular net advantage. Development of this area is questionable as the existing pilot fill itself is too small to influence overall future port development.

The existing pilot fill area, as indicated on Figure H-14, is presently being used by the contractor constructing the new Container Wharf and the Liquid Cargo Pier. It is therefore not readily available. However, since construction of the first additional general cargo/container wharf is scheduled for around 1985, it is obvious that by that time this area would be abandoned by the present contractor and be available for development as a new wharf area. However, it is quite doubtful that in the interim period this pilot fill would not be developed for other uses, once the present contractor moves off the site. In any event, the three major disadvantages stated above preclude its use or consideration as a viable site for Port development, particularly since the overall masterplanning for the entire

City of Corinto and the surrounding areas envision a bridge connecting Corinto to the mainland, south of this pilot fill. Consequently, no further consideration should be given to the pilot fill area, as a viable location for development of any major Port facility.

G. East Side of Estero El Realejo - Sites G, H and I (Figure H-14)

The east side of the estuary, opposite the existing facilities at Corinto, offers interesting alternatives as it is envisioned that eventually Corinto Harbor will encompass both banks of the estuary, particularly when a connecting bridge is constructed onto the mainland, heading toward Puerto Esparta.

The advantage of developing the east bank is to minimize rock dredging, which seems to shallow towards the north, thereby accommodating larger vessels of deeper draft and utilizing both sides of a dredged and maintained channel.

A further advantage of developing the east side of the estuary is the relatively short distance to Puerto Esparta and the highway system to the east, without traversing the circumferential route through Chinandega. The congested Corinto Island would, in effect, be bypassed.

The disadvantages at this time are, however, somewhat

once the Port and City outgrow the narrow confines of the Island and a connecting bridge is constructed with the necessary infrastructure. It is premature to expect construction to proceed on the east bank at this time - but the area must be reserved for such future use.

IX. Recommended Expansion

Recommendations are given herein for the future expansion of container and general cargo wharves and other facilities at Corinto. The basic assumptions on which the recommendations are made are listed below:

A. Assumptions

The recommended layout for future expansion of the Port of Corinto is based on the following assumptions:

1. The presently planned container wharf at the site of the existing Old Timber Deck Pier, plus the new Liquid Cargo Pier will be constructed as planned (within the next three or four years). They will exist before the recommended additional facilities are constructed.

2. "Boca Falsa" will not be closed and a breakwater will not be constructed across Sawyer Bank to control littoral drift and tidal currents.

3. The existing Banana Pier and the planned Liquid Cargo Pier will be capable of handling all banana and liquid cargo exports-imports until the year 1995. Accordingly, only expansion of container and general cargo facilities is needed within the 20 year study period.

4. The existing and presently planned container and general cargo facilities will be capable of handling 1,400,000 RT per year, compared to a projected tonnage of 2,233,000 RT in year 1995. Accordingly, to accommodate the deficit of 833,000 RT at the average yearly rate of 500,000 to 600,000 RT per berth, two new berths will be required by the year 1995, with three berths needed after 1997, plus area set aside (zoned) for a future fourth berth. Planning for future expansion will, therefore, be based on a minimum of four additional container and general cargo berths.

5. The port will have first priority on land usage, even to the extent of forcing aside urban city development and its normal amenities. The "Port" comes first.

6. Obtaining land for Port use by demolishing adjacent city blocks can be accomplished from an economic, legal and social viewpoint to create new land for the Port.

7. The existing tank farm with its joint ownerships and rentals can be demolished and relocated.

8. The layer of organic silt in the swamp areas is relatively thin with bedrock generally rising to the north along Estero El Realejo, with sufficient sand available to reclaim land for Port use.

9. The work can proceed in an ecologically acceptable manner.

10. The master plan can be developed so that the Port has sufficient room for expansion even beyond the needs of 1995, with natural barriers between the Port and the remainder of the city and the ability, with new road systems, to bypass the congestion of the city and provide access for workmen servicing the the Port.

11. In the future, a connecting bridge will be constructed across the Estero El Realejo, connecting the Island of Corinto with the east bank of the river, with all of the necessary infrastructure and highway system, heading toward Porto Esparta and the mainland.

On the basis of the above, the Port Studies and recommendations can proceed.

B. Selected Site for Port Use

The recommended site for expansion and construction of additional container and general cargo wharves is on the east side of Corinto Island along the Estero El Realejo immediately north of the Liquid Cargo Pier, presently under construction The expansion would proceed in a northward direction removing and relocating the existing tank farm and the miscellaneous boat and shrimp pier facilities in front. This area is generally indicated as Site C on Figure H-14 and is shown in more detail on Figure H-15.

The relative advantages and disadvantages of the various alternative sites have been previously discussed. Consequently for the remainder of this Report, the overall expansion shown on Figure H-15 will be detailed.

On Drawing H-16 is shown the ultimate expansion contemplated, encompassing both sides of the Estuary. The specific details will vary in the future as the Port develops and also as additional detailed information such as borings, seismic surveys, etc., are obtained. In addition, depending on the type of industries locating on the east side of the Estuary, the connecting infrastructure to the mainland will, to a large extent, establish the details of the overall layout. In any event, it must be kept in mind

that ultimate expansion will proceed onto the east side of the Estuary and this area must be preserved for such development.

One important consideration of the large-scale ultimate development is the potential changes in the tidal prism of the harbor, caused by dredging of new turning basins, which may minimize the self-scouring tidal action and thus require more frequent and additional maintenance dredging. This is a study far beyond the scope of this Report. It would entail model testing and detailed field readings, etc. It is believed, however, that the siltation problem will not be serious for the reasons enumerated previously and if there is additional maintenance other means could be employed to check some of the silt load upstream, preventing it from discharging into the main estuary. Also, with increased harbor development, the relative costs of maintenance dredgeing at more frequent intervals would still be minimal in terms of overall economies.

C. Dimensions of a Typical Berth

The layout of the berths would be basically linear in a north-south direction along the estuary generally as shown on Drawing H-17. Each berth would be 260 meters long, which is a realistic length for a 25,000 DWT container ship, having a draft of about 10 meters and a length of about 220 meters.

On this basis, the layouts proceeded with 260-meter-long berths, having a depth of 13.33 meters alongside at MSL, allowing for 2 meters keel clearance at MLW. This depth corresponds to the depth presently planned for the 240-meter-long Container Wharf to be constructed at the site of the old Timber Deck Pier, immediately south of the new Liquid Cargo Pier.

The 260 meter length is highly desirable for ease of ship approach and departure, while adjacent berths are occupied. Also, the longer berth can safely accommodate the occasional longer container ships having approximately the same draft. For example, the very large container ship "Sealand Galloway" of 27,650 DWT has a length of 287 meters, a beam of 32 meters but a draft of only 10.4 meters. Even this ship could be accommodated on the assumption that adjacent berths were occupied with smaller vessels. The important point is that although container ships are becoming longer and broader, their draft is deliberately being maintained at around 10 meters so they can enter most harbors without restriction.

A longer berth is desirable in terms of ease of container and general cargo handling, and also for standby space and marshalling of equipment.

Furthermore, for Corinto where export and import tonnages practically balance, separate transit sheds will be

required for exports and imports. A longer berth with sheds side by side is a proper layout for this type of operation.

Accordingly, the typical future container and general cargo berth will be 260 meters long with a dredged depth of 13.33 meters MSL.

D. Phasing of Berth Construction

To handle the increased container and general cargo tonnages of the future, Figure H-8 shows the necessary phasing of berth construction, summarized as follows:

1st	Berth completed in year 1985
2nd	Berth completed in year 1991
3rd	Berth completed in year 1997
4th	Berth zoned for future needs after year 2000

Figure H-8 also shows that for an individual berth to be completed "on schedule," the design and construction must commence about 3 years earlier and obviously, the financial planning must commence even sooner. On this basis, it would seem that the "processing" for the first additional berth will have to start in about 5 years, only a couple of years after the presently planned container wharf is completed. Time will pass quickly. Temporary "setbacks" in economic growth or cargo tonnages should not be misinterpreted and allowed to delay construction.

Drawing H-17 shows the overall layout of the initial three berths (year 1997) and their phasing with particular emphasis on the fact that additional land is required north of an individual berth, during Phases I and II, to accommodate the curve in the railroad track.

E. Location of Phased Construction

The recommended location for phased construction, as previously described and enumerated, is a continuation northward from the existing Liquid Cargo Pier, presently under construction. This means that the tank farm and the Miscellaneous Small Facilities in front of the tank farm will all have to be relocated.

This northerly progression is considered to be a logical and realistic expandion of the Port, maintaining the same basic infrastructure, facilities, administration, etc., with the understanding that additional land will be obtained from the city by demolition of a row of city blocks as well as relocating the tank farm itself. Once these fundamental decisions are made, in the long run, the orderly expansion toward the north is best suited for reasons stated as well as resulting in minimum disruption to the hydraulics of the tidal prism in the estuary, interfering with its normal self-cleansingaction, scouring silt and sand and maintaining a natural channelway.

F. Required Land Area

A modern container berth requires a minimum of 8 hectares of land but preferably 12 hectares. With a large swamp area available for development, there is a temptation to use a greater area, but realistically it is anticipated that joint container/general cargo facilities will develop and, consequently, taking into account all factors, a compromise area of about 10 hectares per berth is recommended. Specifically, for a 260 meter-long wharf the hinterland should extend back about 400 meters, as shown on Figure H-15.

In addition, port-related industries will develop in the general berth area. This will include warehousing, marshalling yards, manufacturing, etc. It is difficult to predict the area needs for port-related industries, but it is reasonable to assume, based on the experience of other ports, that an area approximately equivalent to the berth area itself will be required. Consequently, the overall master plan for the development of the Island of Corinto takes into account such port-related industries and sets aside zones equivalent in area for port-related use. The specific layout and orientations can best be seen on plans proposed by the Urban Planner, in a separate report.

C. Required Water Areas

A balance will have to be developed between dredging and filling, taking into account such factors as:

1. Required filled land areas (hectares).

2. Phasing of filling operations, scheduled with future construction.

3. Needs for channels, turning basins, and anchorages.

The presently planned channel to be dredged around the south end of Corinto Island is to have a width of 90 meters. This is too narrow for two-way ship traffic, which will certainly develop when the future additional container and general cargo wharves are constructed. The straight-run channel widths will have to be increased to about 150 meters.

The presently planned turning basin of 310 meters width, in front of the Container Wharf to be constructed at the site of the existing Old Timber Deck Pier, is too narrow. It should be about 400 meters wide for safety of ship turn, unless two tugs are used for assistance. Otherwise, the ebb current is too strong to accommodate the turn and tidal drift of a large container ship.

The future expansion of container and general cargo wharves along the Estero El Realejo, as a continuation north of the Liquid Cargo Pier, will require staged dredging to correspond to development of the berths, as shown on Drawing H-17.

The future expansion consists of a series of 400 meter-wide turning basins, in front of the individual wharves. Berth No. 2 expansion in 1991 does not have the full 400 meter width, as for this northernmost berth it would be possible with tug assistance for the vessel to enter and depart without a full turning basin width. However, once Berth No. 3 expansion is constructed in 1997, the maneuvering becomes too complicated, and at that time the full 400 meter width is necessary.

The presently planned facilities, namely, the Container Wharf and Liquid Cargo Pier plus the future expansion along the Estuary means that more ships will be calling at Corinto. Paradoxically, although additional berths will exist, there will be a tendency for more vessels to "bunch," because the number of berths will be insufficient to handle peak throughput and random ship arrivals. Accordingly, some deep water areas will have to be reserved for ship anchorages, and this could best be accomplished southeast of the existing Corinto port.

The above minimum water area requirements have been coordinated with the soils and dredging studies. A sufficient quantity of acceptable sand fill material is available for the port construction, plus a surplus which could be utilized for swamp reclamation for housing, commercial use, etc.

H. Dredging and Filling

The soil borings and laboratory tests, discussed in the "Engineering Investigations" phase of the overall study, prepared by others, were performed to locate suitable sources of fill and to establish settlements and stability of the reclaimed area. The overall land reclamation project, including those aspects dealing with Urban Development, have been coordinated with respect to dredging and filling in terms of:

1. Locating sources of satisfactory fill materials meeting specified gradation criteria.

2. Sequence of filling operations considering:

   a. Material available from planned channel dredging and construction of the new Container Wharf and new Liquid Cargo Pier.

   b. Materials obtained from future maintenance dredging.

3. Minimize interference with existing facilities and operations. This includes protecting the city, its utilities, etc.

4. Coordinate filling with method(s) used for organic silt stabilization - such as displacement, surcharging and excavation removal. Although it has been concluded that filling and surcharging will be basically used, except for excavation at selected critical structures.

5. Establish priorities of areas to be filled first because the land must be available at an early date or the underlying compressible organic silt must be surcharged for a longer period of time.

6. Locate disposal areas for unsatisfactory materials, not suitable for fill. Although, the intent is to underdredge and mix any fine grained material with coarser sands.

It is obvious from the above that dredging and filling is a complicated planning procedure requiring careful coordination to gain maximum benefit.

In general, dredging in the calm waters can be done with a trailer-suction dredge, having a cutter head; whereas, the dredging of the main channelways, where wave action is more

severe, and pipelines cannot be utilized, a hopper dredge is required.

The dredging would generally proceed on a six-day, twenty hour per day schedule. The contractor would be responsible for constructing onshore, dikes, baffle boards, and then bulldoze additional dikes to retain the fill, and prevent fines from washing out into the Estuary. Stock-piles would be created for later distribution and/or surcharging.

In terms of the pumping rate, the availabe capacities and power of the dredges must be considered, but basically materials can be pumped about 1500 to 2000 meters before booster pumps are required.

In any evaluation of the use of dredge material for fill, the shrinkage factor must be considered and this has been established by the soils engineer at about twenty-five percent, taking into account not only washout but some settlement of the underlying silt.

Drainage provisions must be made for the hydraulic fill, not only to stabilize it, but to prevent inundation of the surrounding built-up city areas.

The mangrove growth must be removed, prior to the filling operations so as to obtain a uniform flow of fill

throughout the area, and a uniform surcharge without the interference of the mangroves. Cutting and stripping of the mangrove is an added expense.

Fill, for port development, will be obtained primarily from dredging the channel and turning basin in front of the berth to be constructed. Consequently, since this work will, to some extent, proceed simultaneously with the construction of the berth structure itself; there won't be a long "seasoning period" for settlement of the organic silt, wherever it is allowed to remain in place. On this basis, stockpiling of material would be accomplished for distribution and regrading, as settlements occur. If possible, the stockpile would be located at the site of future buildings or rigid pavements, so as to minimize future settlements. The final paving and/or construction of buildings would be accomplished last, after most settlement has occurred, since the primary consolidation is expected to occur within one year.

The ecological aspects of dredging and filling are discussed by the Ecologist in a separate report and coordinated with the extent and sequence of dredging and filling required for both Port use and land reclamation. The main problems will be disposal of unsuitable materials, changes in hydrology as a result of dredging, stirring up of silt and controlling hydraulic dredging outwash. The ecology will be

changed by dredging and filling of the mangrove swamp. However, the mangroves at Corinto are not of a type that should necessarily be preserved. They represent second-stage scrub growth. Careful control will minimize the ecological impact but obviously, the major impact of filling over a swamp cannot be avoided, once a decision is made to fill. It can only be stated that the total area to be filled is relatively small, compared to remaining swamplands along the Nicaraguan Coast. Land reclamation in the country has not advanced to a stage where the filling of the swamp at Corinto poses a serious threat to ecology. Other needs such as the development of the Port, the City, and jobs have a higher priority.

The effects of siltation in the estuary, as a result of the dredging operations, will be shortlived. The effects on sea life will be discussed by the Ecologist. However, it would be highly desirable to monitor the present dredging program for the new Container Wharf and Liquid Cargo Pier, to determine the effects and turbidity created. By this form of monitoring and study, recommendations can evolve for future work to minimize the ecological impact. It is believed however, that scum plumes and silt-laden water will generally follow the estuary channel currents and not spread out over the entire area. To some extent, the effects of siltation will thus be lessened.

I. Dredging - Force Account vs Competitive Bidding

An evaluation has been made of the relative merits of the Port Authority owning and operating its own dredge versus having the dredging accomplished by outside contractors on a competitive bid basis. It is concluded that the present volumes of dredging envisioned at the Port of Corinto, the time scheduling for new port expansion, and the dredging needs at other harbors in Nicaragua, are all not of sufficient magnitude to economically maintain and operate a dredge. Considering that a dredging program is presently underway at the Port of Corinto, it will not be until 1984 that additional dredging will be required for port development. It is, therefore, recommended that the Port Authority not purchase a dredge but review the entire matter, later in the early 1980's, when possibly other developments may arise, so that the volume of dredging is sufficient and sustained over a long period of time to justify the initial capital expenditures, maintenance and operating costs.

In analyzing the situation, the details of costs and volume production are contained in a separate Appendix, but the purchase of a dredge must be considered in terms of a viable loan application for either port development and/or land reclamation. In this connection, there are three alternatives possible:

1. Prepare plans and specifications and obtain competitive bids for dredging, as and when required.

2. Upon completion of the present dredging contract for the new marginal Container Wharf and Liquid Cargo Pier, purchase the present Dixie dredge and continue its use with Port Authority personnel.

3. Purchase a new dredge to be operated and maintained by Port Authority personnel for the development of new projects and maintenance dredging in Nicaragua.

The relative advantages of the Port Authority owning its own dredge are obvious and would result in flexibility in Port Authority operations, particularly if the dredge is assigned to and used for any and all port developments and port maintenance programs in Nicaragua. The dredge could not be economically assigned to a single port. Some of the advantages that would accrue are as follows:

1. The Government would not be subjected to problems of international emergencies which would raise the costs of dredging and in fact make dredges unavailable at times. For example, during the Korean and Viet Nam conflicts, dredges were not readily available on the international market.

2. Channels could be maintained as required, distributing the fill wherever desired, with the flexibility of not negotiating changes with an independent contractor.

3. The contingency factor in dredge bidding would be removed and consequently result in lower cost.

4. The profit factor would also be removed and correspondingly result in lower cost.

5. The concern about interfering with ship schedules would be iminized in that there would be no penalties accrued for delays in dredging to accommodate shipping.

6. The market fluctuations in dredge availability would be minimized and the dredge would be on hand to work when and where needed without the bureaucratic delays of obtaining bids and requiring all detailed technical information.

7. Mobilization costs would be reduced in that the dredge would at least be in Nicaraguan waters rather than having to be brought from overseas for a specific project.

All of the above advantages, however, infer that the dredge is operating full time, usually at two shifts a day, 20 hours, and 6 days a week. This is the competitive basis on which commercial dredges operate. If the dredge cannot operate over continuous, sustained periods with the crew gainfully occupied in production, rather than in standby and maintenance, the costs of dredging prorated over years of service for the quantities of material removed, would be very high.

The analysis contained in the Appendix shows that at present, with the dredging programs visualized in the immediate future, it is not economically feasible for the Government to enter into the dredging business. The situation is that all major dredging at Corinto will basically be completed under the present dredging contract now underway. No further dredging will be required for channel maintenance until, say, at least five years from now and certainly no dredging will be required for port expansion until about ten years from now. Consequently, the requirements at Corinto are limited. If it were intended, however, to continue with a land reclamation project, then the cost of filling the land make reclamation uneconomical, for the cost of dredging to obtain fill is too high. In short, the land reclamation project itself is economically viable only because "surplus" fill is obtained at a relatively low price, as a byproduct from

essential port development, such as dredging of channels and turning basins.

The dredging requirements at the other ports are relatively limited and also progress in stages with relatively long intervals between, when no dredging service is required. In fact, the quantities to be dredged at the other ports are relatively small in comparison to the overall projections for the enlargement and expansion of Corinto.

Another factor to be considered is that no one single type of dredge can efficiently operate at all ports under all conditions. Although the types of material to be removed are generally the same and the depth to which dredging is to proceed is deepest at Corinto, nevertheless, there are different degrees of exposure of the dredge to wind and wave action. Consequently, a cutterhead suction dredge can operate efficiently with its strung-out pipelines in the relatively calm and sheltered waters of the Port of Corinto. However, in the main channels beyond, where there is considerable wave action, such a dredge can no longer operate efficiently or safely. Consequently, a hooper dredge type is essential, and for this reason contractors from the outside would have to be brought in with their specialized equipment for the deep water, exposed dredging. Since this would control the use of the Port anyway it, therefore, becomes apparent that all of the advantages attributed to the Port Authority owning

its own dredge equipment do not prevail. Outside contractors with competitive bids and the normal delays, extras, etc., would still be a consideration with any expansion or maintenance program of any port in Nicaragua.

Since there are no large volumes of dredging to be accomplished at a steady work flow, it becomes uneconomical for the Government to purchase, operate and maintain its own dredge. It is somewhat unfortunate, but the dredging work load seems to consist of relatively medium to large quantities to be dredged at a specific time, consistent with the siltation of channels and/or expansion of an individual port. Purchasing the dredge now in operation at Corinto or a new dredge is, therefore, not recommended at this time. The situation should, however, be reviewed in the early 1980's to determine if the quantity and scheduling of dredging has changed to such an extent that purchase and operation of a dredge would be economically viable.

J. Infrastructure Requirements

In any port and/or land reclamation development, certain minimum infrastructure must be provided to bring the site into suitable condition for use. With respect to port use only, the following is considered the minimum infrastructure necessary, and is included as a part of the reclamation cost for port use only.

1. Dredging of channels, turning basins and anchorages.

2. Stabilizing and filling the port land to grade.

3. Constructing a bulkhead structure to retain the land and provide sufficient water depth for ships.

4. Drain the filled land, basically with open ditches, around the perimeter and catch basins, piping and grated ditches in the interior.

5. Provide transportation to the reclaimed land in the form of highways and railroad, including marshalling yards. In this connection, the regional plan of railroads and highways has been considered by the Urban Developer for coordination with port use.

6. Provide electric power assuming connection to the national grid, rather than a separate power station

7. Provide telephone service, including an extension of the present national system.

8. Provide fresh water for the port, both as portable water and fire. This is a problem in that now, when a ship takes on water at Corinto, the city is without water for two days. Supposedly,

the existing twelve-inch line will soon be supplemented by a ten-inch line, and much of this problem will be alleviated. However, the main trunk line along with the necessary elevated water towers, etc., are all required, as part of the Urban Planning infrastructure, outside of the limit of the port, but to which the port connects.

9. Provide sanitary sewage system - with the port again connecting to a new system, consisting basically of package treatment plants providing secondary treatment. The port is not responsible for the overall capacities of these plants, but rather for the connection outside the property limit.

10. Provide garbage disposal, basically intermingled with the City of Corinto, and supposedly disposed off the Island of Corinto as a land fill.

Other infrastructure, such as fendering, paving, transit sheds, area lighting, etc., are not considered a part of the land reclamation project and/or cost as related to port development only.

K. Personnel Required

Estimates are required of the personnel needed to operate and maintain the future container and general cargo berths. These estimates guide the Urban Planners in establishing housing and other infrastructure.

It is understood that the present facilities, namely, from the Banana Pier to the Old Timber Deck Pier, require about 300 port personnel; plus about 1200 stevedores, etc., or a total of 1500 people working directly at the wharves. This estimate does not include others, such as truck drivers who are also working at the wharves, but are not a part of the permanent scene.

Since the future expansion is located directly adjacent to and north of the existing facilities and the new Liquid Cargo Pier, some personnel could duplicate their efforts, thus not increasing the total employment proportional to the increase in berths.

During construction, it is anticipated that there would be an increase of about 300 people in Corinto; plus about 40 foreigners, making a total of 340 persons for whom housing and other accommodations must be found.

It is further estimated that for the ultimate three container and general cargo berths, the total port staff would

increase from 300 to about 450 people; whereas, the stevedores and others would double to 2000 persons, thus requiring a total of 2,450 people working at the wharves in year 1995. This takes into account and assumes that a considerable proportion of cargo will consist of container traffic, with its specialized requirements and transshipment activities.

L. Design of Facilities

Preliminary designs have been prepared of an approximate nature, to assist in developing cost estimates and to evaluate more realistically the conditions at Corinto, as the port and facilities expand northward of the Liquid Cargo Pier. The designs were based on the following:

1. The maximum "composite" ship will be 42,000 DWT or 60,000 MT displacement with a draft of 10.4 meters and a length of 290 meters. The ship will approach the wharf at a speed of 20 centimeters per second. Average ships will be smaller than this length, and easily accommodated within the 260 meter length individual berth.

2. The water depth will be 13.33 meters below mean sea level with the top of wharf at 2.5 meters above mean sea level.

3. The live load design will be 3.0 metric tons per square meter, plus concentrated wheel loads of cranes, forklift trucks, etc., and Coopers E-50 Railroad. The container crane would operate on its own, independent and supported system.

4. The lateral earthquake force will be in accordance with seismic Class V of the U.S.A. California Code. Additional attention will be paid to details to resist lateral loads, as well as potential problems of liquefaction of the soil, with all structures founded on hard pan or bedrock.

5. Soil pressure will be determined by using unit weights of 1.60 metric tons per cubic meter above water; 0.65 metric tons per cubic meter below water and a 30 degree angle of friction. This will be verified by laboratory tests.

6. Bollard pulls will be 100 metric tons.

Designs will proceed using normals standards and codes such as ACI, AISC, ASTM, etc.

A typical cross-section through the wharf and the upland area, along with a general type of container crane are all shown systematically on Drawing H-18. In detail, however, consideration has been given to a number of alternative types

of bulkheads, but based on experience and judgment, it was considered that four types are particularly applicable. These are as follows:

1. Steel sheet pile cells - Drawing H-19.

2. Reinforced concrete caissons - Drawing H-20.

3. Steel pipe piles - Drawing H-21.

4. Prestressed concrete piles - Drawing H-22.

The steel sheet pile cells, schematically shown on Drawing H-19, lend themselves to variations in the hard pan or rock level, and its relatively close proximity to the channel bottom. Basically, steel sheet pile cells of the circular type would be driven down to rock and filled with hydraulic sand to develop a gravity-type structure. There would be no difficulties in constructing such a bulkhead in the relatively quiet waters of the estuary, where the currents are strong but not unduly strong to prevent maintaining the template in place. The container crane rails would be independently supported on their own pile foundation. The front of the cells would be capped with a reinforced concrete coping beam, plus a rubber fendering system to resist ship impact. In many respects, the sheet pile cell scheme is a good solution to the problem for the site conditions; however, it was not selected for final cost estimating nor is it recommended

as the basic design, primarily because of the need to import extensive quantities of steel sheet piling and the fact that maintenance costs in painting the sheeting, along with cathodic protection would be a perpetual expense. Accordingly, Drawing H-19 is presented schematically as a potential solution, but not as one that is recommended from the overall viewpoint of capital costs and maintenance costs.

The reinforced concrete caissons shown schematically on Drawing H-20 are another gravity-type structure, taking advantage of the high-bearing capacity of the underlying hard pan and bedrock. These caissons would be reinforced concrete units cast at a central area, probably launched on a small shipway, towed into position and sunk over a leveling bed of gravel and crushed stone. In this instance, the container rail would be supported partially on the reinforced concrete caisson and partially on an independent pile foundation for the rear leg. In evaluating this scheme, however, with its advantage of permanency and minimal maintenance - its construction has not been recommended nor priced. The main reason is the relative difficulties in the tidal current of leveling off the bed to receive the caissons, and the fact that within the limits of Corinto, there are no areas readily available where the caissons could be built and launched in sufficiently deep water to be towed to the site. Launching partial caissons and then building up the height with slip

forms would be too expensive. Consequently, although this is a relatively straightforward design, the conditions in terms of currents and construction yard are not favorable for its use. It is, however, a viable scheme which should be considered.

Steel pipe piles supporting a relieving type platform, with a riprap slope beneath, is the third scheme studied, shown schematically on Drawing H-21. The pipe piles were selected for their relative lightweight handling and the ability to cut off and splice to accommodate variations in the hard pan and rock level. This structure is also lightweight so that earthquake forces would be minimized and in addition, there is direct support for the crane rail on the pile foundation. Since the cranes are usually supported by some form of pile foundation, this is merely an extension of such support. However, in comparison with another scheme later suggested, it is deemed that steel pipe piles should not be recommended, primarily because of the need for maintenance of the steel. An alternative possibility, however, is to drive the steel pipe piles as sacrificial forms - with reinforcement placed inside the steel pipe, and then tremie-pump grouted so as to create a cast-in-place concrete pile and thus allow the outer steel shell to corrode away. This is a potential alternative, but was not seriously considered because of the cost of importing the steel.

The fourth scheme is a prestressed concrete pile relieving-type platform shown schematically on Drawing H-22; and basically the same as the steel pipe pile with an underwater riprap slope and the crane rails supported directly on the platform. This scheme is recommended as an initial pricing for cost estimating purposes, since it is practical and can be constructed at Corinto and is a permanent facility with little maintenance. It is a relatively "light structure" so that the earthquake loadings would not be severe, but yet sufficiently rigid with the piles extending down to bedrock, and enough deadweight to prevent any uplift, so as to resist the lateral earthquake loads as well as berthing impacts and wind loads on the cranes. Consequently, for the three berth expansion, where it is deemed that there is sufficient overburden over the rock surface to gain fixity for the piles, particularly those along the offshore side, the prestressed concrete pile scheme is recommended as a means of pricing the land reclamation project for port use, schematically shown on Drawing H-22.

M. Construction Methods

The construction methods will be determined in detail by the design, the natural conditions, and the availability of a contractor's work yard in the future, when the various phases of port development progress.

The dredging aspects, including possible rental and/or purchase of a dredge have been previously discussed separately, and are an essential part of the overall construction procedure from the viewpoint of timing and coordination with the construction of the wharf structure itself.

It is presumed that the bulkhead structure would be constructed by an international firm of heavy-marine contractors basically using waterborne equipment. The existing wharf at Corinto would have to be used to accommodate the contractors' loading and unloading of materials and equipment. Unless such berth use is permitted, the costs would increase considerably.

It is also presumed that housing for contractors' personnel would be the sole responsibility of the contractor, and would not be provided by the Port Authority.

Beside the fact that the construction would proceed in schedule and sequence, it is visualized that the following would be representative of the methods to be employed for the prestressed concrete pile wharf scheme, shown on Drawing H-22:

1. The dredging contract would be an independent contract and presumably, would go into effect prior or during construction of the wharf's

structure; so as to dredge alongside the wharf the necessary slip for floatation of the contractors' equipment. Also, it would be necessary to dredge out the soils to stable slopes so that after pile driving, the slopes would not ravel. The dredge material would be placed onshore, properly diked, impounded, surcharged and stockpiled, for later use as backfill for the marginal wharf.

2. The contractor would set up a concrete plant and concrete casting yard for production of prestressed concrete piles, after detailed borings and soundings have been made throughout the entire wharf area, to establish in an accurate fashion the length of the piles, previous to their casting operations.

3. The contractor would obtain the necessary materials required - including reinforcing strands, reinforcing rods and cement and aggregate, along with necessary stockpiles, storage areas for a site selected by the Port of Corinto, presumably adjacent to the new construction, basically in the areas where the existing tank farms are now located. This means that previous to this construction

operation, the tank farms must be relocated to the west, on reclaimed land.

4. Work would then proceed in stages with water equipment, driving the verical and batter piles, all braced in place and supported against the movement of tidal currents and placement of riprap.

5. The riprap would then be placed between the piles and the slope trimmed as required, prior to setting of the concrete slab and deck.

6. The concrete deck would be placed on the piles, serving as a cap. Some of the elements could be precast for efficient operations, provided a heavy-duty crane is available for the lifting, with cast-in-place connections joining the precast elements.

7. Lastly would come the final placing of the fills, slabs, bollards, cleats, fendering system, etc.

Attached is a construction schedule, depicting the major elements of construction. This construction schedule is also superimposed on Figure H-8, allowing time for design and construction, indicating that about three years are required to

realize the construction from design to finish. On this basis, it is obvious that to meet the projected plans, the funding, design and construction must start well in advance of the year when the completed facility is required.

N. Construction Costs

All estimated construction costs are based on January 1976 prices without escalation for future phased construction. The detailed cost estimate tabulations are attached.

Since it will be years before the recommended wharf construction program is implemented, escalation will occur during the intervening periods. The degree of escalation is dependent on international factors, unpredictable and outside the scope of this Report. Nevertheless, it is judged, based on past experience, that the escalation would be of the order of four to eight percent per year for marine construction. On this basis, an average escalation of six percent could be used as a means of projecting the capital required in the future, when actual construction commences.

Assuming the first berth is completed in January 1985 and that the mid-point of major construction expenditures is January 1984, then there is a period of eight years, compounded at six percent per year, resulting in an increase of approximately 60 percent in the costs of January 1976, compounded to

January 1984. Consequently, any sinking fund account, loan or bond issue will have to take such escalation into account.

In addition to the capital costs, which include some contingency and engineering and construction inspection costs, the Port Authority will have to add legal and administrative costs to establish the overall funding of the project.

The estimates are divided, basically, into two parts. The first is to establish the unit cost per item of work, separated into three factors of labor, material and equipment. Then each of the three factors are, in turn, separated into local and foreign unit costs. The foreign cost represents foreign labor working on the project or foreign materials and equipment imported into Nicaragua.

The second stage of the cost estimate utilizes the unit costs (both local and foreign) related to the quantities in order to obtain a total estimated cost of construction, again separated into local and foreign costs.

The cost estimates then continue in detail for the three stages of construction, but each of these stages, in turn, is separated into the initial reclamation aspect, such as dredging, bulkhead construction and basic infrastructure with another stage for final construction, including fendering systems, transit sheds, etc. Attached is a tabulated summary of the cost estimates.

In making the estimates and analyzing the preliminary designs, attempts were made to minimize the foreign expenditures. For this reason, those designs requiring imported material, such as steel sheet piling, pipe piles, etc., are not recommended in favor of concrete type structures, where the import quantities are greatly reduced.

In analyzing the overall costs, the interrelationship with the land reclamation project, such as construction of housing, schools, etc., had to be closely coordinated. On this basis, since it is essential for port development to have channels, turning basins, anchorages, etc., it was assumed that all such dredging is chargeable to the Port. Consequently, the use of the dredge material as fill in the Port area itself is at a higher unit price than the use of surplus dredge material as fill for land reclamation for housing, schools, etc. It is presumed that the land reclamation project for housing, schools, etc., would pay a premium for the use of surplus dredge material so that the added cost of placing the fill would not be charged to the Port.

Consideration was given to lead time for purchase and procurement in evaluating the various alternative designs. It is extremely difficult to predict today the shortages of materials eight to ten years from now, when the first phase

of port development will be constructed. However, it does seem logical to presume that items such as steel, sheeting and pipes could and probably will be in short supply, requiring considerable lead time. Consequently, here again, the advantages of concrete construction become apparent beside the advantages of using primarily local materials and not imports. The lead time on concrete construction will obviously be much less than, say, for steel sheet piling. However, critical items such as prestressing strands, etc., will still have to be ordered well in advance. This, however, should not create any serious problems because the quantities are relatively small and consist of materials which can be purchased in odd lots and shipped to Nicaragua in small bulk. Consequently, the studies proceeded on this basis that the prestressed concrete pile relieving type platform is the first choice for construction.

The detailed cost estimates and their breakdown, with unit prices, are self-explanatory. The prices developed are based on the international competitive market for marine construction.

O. Maintenance Costs

After the facilities are constructed, maintenance costs will arise in terms of dredging of the deeper channels and turning basins as they tend to silt up, as well as maintenance

of the structures and facilities themselves.

The dredging maintenance costs can be based on the studies made by others which concluded that the main channel would silt at the average rate of about 150,000 cubic meters per year in the vicinity of Sawyer Bank and Boca Falsa. In addition, it is presumed that upon dredging of the estuary, there will be a tendency to entrap additional silt and, consequently, it would be prudent to add 50,000 cubic meters of dredging per year for the estuary. On this basis, the average rate of siltation can be assumed to be in the order of 200,000 cubic meters per year, to be dredged approximately, say, every three to five years. Unfortunately, this rate of dredging does not correspond to the construction program for future wharf facilities so that the maintenance dredging would have to be done under separate contracts. This is also necessary from the viewpoint that the type of dredge needed for the deep channel dredging in the exposed waterway is different from a hydraulic cutterhead with pipelines in the relatively sheltered waters inside the Port area. It appears, therefore, that maintenance dredging will have to be accomplished by outside contractors, bringing in a hopper dredge every, say, five years in order to maintain the main channel. The frequency of maintenance dredging can be reduced by overdredging, although this in turn tends to cause greater entrapment of silt. However, with overdredging, it appears that every five years

or so would be a realistic average time for a hopper dredge contract to be let for maintenance of the main channels. Consequently, in any funding for the Port, funds should be set aside for such maintenance dredging.

The wharf facilities and structures will also have to be maintained, consistent with the maintenance program now in effect for the existing facilities. It is assumed that the facilities themselves from a structural viewpoint will have a "forty-year minimum life." In structures of this type, the total yearly maintenance is generally considered to be at the rate of one percent for the first five years, increasing by 0.5 percent increments for every five-year interval, so that after 20 years, the yearly maintenance would be 3 percent of the capital cost for the remainder of the life of the structure. This schedule of maintenance is independent of dredging and presumes a complete final structure in good condition is turned over by the contractor upon completion of the construction. The schedule is as follows:

Age - Years	Percent Annual Maintenance
0 - 5	0.5
6 - 10	1.5
11 - 15	2.0
16 - 20	2.5
21 - 50	3.0

Based on the above, it can be appreciated that considerable maintenance expenses will accrue and that sizable staff will be occupied with such maintenance. Since the new extended facilities will be a part of the existing wharves and Liquid Cargo Pier, it is difficult to separate the personnel required for maintenance. It is visualized, however, that a permanent staff of about 15 people would be involved, consisting of a superintendent, assistant, skilled electrical, mechanical and common labor.

The maintenance program should be established on a permanent basis with specific items scheduled for inspection, painting and/or repair at specific times. Preventive maintenance will reduce the overall expenditures. Some items of maintenance will, however, have to be subcontracted where special skills and/or equipment are required.

P. Outline Specifications

Outline specifications are included in the Appendix, basically covering the construction of the prestressed concrete pile relieving platform scheme. The overall construction procedures and sequence are outlined.

The specifications for dredging and filling, along with all of the major controls thereof, are not a part of this Port Study Report, but instead have been prepared separately

by the soils and civil engineering group. Nevertheless, where there is a close interrelationship, some aspects of the dredging and filling are covered in the Port outline specifications.

X. Conclusions

Three general cargo/container berths will be required at the Port of Corinto, basically required in sequence in 1985, 1991 and 1997, to accommodate the future tonnage projections. These facilities are in addition to the Container and General Cargo Wharf now under construction and its adjacent Liquid Cargo Pier.

Alternative sites were studied and it was concluded that the long-range expansion of the Port is best satisfied by constructing these new berths as a northward extension of the existing facilities. On this basis, the berths will continue as a progression, commencing immediately north of the Liquid Cargo Pier presently under construction.

This expansion program necessitates demolition of one row of city blocks to provide additional hinterland for the facilities and it also requires relocation of the existing tank farm and the Miscellaneous Marine Facilities.

The dredging of channels and turning basins for the new construction provides sufficient fill for Port development,

plus a surplus which can be utilized (at an additional price) for land reclamation to accommodate future housing, schools, etc. The land reclamation aspect is, however, beyond the scope of this section of the Port Development Report.

It is estimated that at January 1976 prices, the basic Port development costs for the three future berths are: 193,901,900; 55,481,900; and 110,440,400 Cordobas. In comparison, the complete facilities with all infrastructure, transit sheds, etc., would correspondingly cost: 262,430,900; 164,110,900; and 165,253,900 Cordobas. These prices do not include the administrative expenses of the Port Authority or escalation. It is anticipated that escalation for marine construction would be at the overall rate of 6 percent per year. Consequently, in any funding or establishment of sinking funds, etc., such escalation will have to be considered.

In the future, it is visualized that the Port of Corinto will expand over to the east bank of the estuary. This will require an entirely new infrastructure, connecting to the mainland as well as a bridge over the estuary, joining the Island of Corinto to the east bank of the estuary and onward to the general area of Puerto Esparta. Consequently, care should be exercised to "zone" the east bank so as to control this expansion. In particular, it is visualized that separate facilities, possibly those of dangerous cargo, or facilities

which are relatively independent of the Port could best be established on the east bank.

Studies were also made of maintenance dredging and the desirability of the Port purchasing and operating its own dredge, servicing Corinto and other ports in Nicaragua. It is concluded that at this time, with the present dredging at the Port of Corinto under separate contract, there is not in the immediate future, a sufficient quantity of dredging to be accomplished, to justify purchase of such equipment. The dredging volumes are not sufficient and much of the maintenance dredging would have to be done in open waters where a specialized hopper type of dredge is required, rather than a cutterhead suction dredge with pipelines. Accordingly, it is recommended that no further consideration be given at this time to purchasing a dredge. This matter can and should, however, be reviewed in the early 1980's when extensions will be required to the Port of Corinto, and quite possibly, additional dredging may be required elsewhere, thus justifying the expense. Only if a dredge could be operated full time, can its capital and maintenance costs be prorated at a reasonable unit price per quantity of material dredged. The inherent advantages of the Port owning its own dredge, are overbalanced by the expenses of purchasing and operating a dredge for the relatively small volumes of dredging required, at nonuniform intervals.

1974 EXPORTS

(In thousands of Revenue Tons).

TOTAL EXPORTS	568.3
DRY CARGO	538.5
Cotton	141.7
Cotton Seed	33.6
Cotton Seed Oil	6.2
Cotton Seed Cake	53.7
Cotton Linters	17.2
Bananas	132.7
Coffee	29.4
Sugar	46.8
Sesame	4.8
Meat	3.4
Lumber	55.7
Cargo, n.e.c	13.3
Agriculture a_/	0.7
Other b/	12.6
LIQUID CARGO	
Molasses	30.3

a_/ Includes: Beans, Tobacco, Peanuts, Corn and Leather.

b_/ Includes: P.V.C. compound, in transit cargo and cargo specified as "other bulk products".

1974 IMPORTS

(In thousands of Revenue Tons.)

TOTAL IMPORTS	556.7
DRY CARGO	449.7
Fertilizers and Insecticides (bulk)	40.5
Fertilizers in Packages	36.7
Chemical Products	48.7
Machinery, Spare Parts and Tools	29.7
Vehicles	59.4
Iron and Steel Products	96.8
Glass Products	7.6
Paper Products	16.9
Lubricants and Oils, and Other Petroleum Products, n.e.c.	8.8
Explosives	0.6
Wheat	32.3
Barley and Other grains	13.3
Jute in Bails	13.5
Other Dry Cargo a_/	94.9
LIQUID CARGO	57.0
Aviation Gasoline	25.5
Asphalt	0.3
Solvents	18.1
Diesel	7.3
Tallow	5.8
Other products by Pipe	

Includes: Mail, in transit cargo and general merchandise.

COSTO ESTIMADO TOTAL EN CORDOBAS - MUELLE FUTURO DE CARGA GENERAL/CONTENEDORES
TOTAL ESTIMATED COST IN CORDOBAS - FUTURE PIER FOR GENERAL CARGO/CONTAINERS

BASIC STRUCTURE	LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
DRAGADO Y RELLENO	4,565,000	11,942,000	16,507,000	3,570,000	5,467,000	9,037,000	8,626,500	24,579,000	33,205,500
DREDGING AND FILL									
ESTRUCTURA DEL MUELLE	23,432,380	30,767,520	54,199,900	11,267,000	15,092,900	26,359,900	17,254,000	22,690,900	39,944,900
WHARF STRUCTURE									
INFRAESTRUCTURA BASICA	7,598,000	16,872,000	24,470,000	2,991,000	3,094,000	6,085,000	3,730,000	3,460,000	7,190,000
BASIC INFRASTRUCTURE									
MOVILIZACION Y DESMOVILIZACION	2,500,000	7,500,000	10,000,000	1,000,000	3,000,000	4,000,000	2,000,000	6,000,000	8,000,000
MOBILIZATION & DEMOBILIZATION									
SUBTOTAL	38,095,380	67,081,520	105,176,900	18,828,000	26,653,900	45,481,900	31,610,500	56,729,900	88,340,400
SUBTOTAL									
DISEÑO Y SUPERVISION	2,100,000	8,400,000	10,500,000	600,000	2,600,000	3,200,000	1,800,000	7,000,000	8,800,000
DESIGN & SUPERVISION									
CONTINGENCIAS	5,530,000	10,270,000	15,800,000	2,700,000	4,100,000	6,800,000	4,700,000	8,600,000	13,300,000
CONTINGENCIES									
TOTAL	45,725,380	85,751,520	131,476,900	22,128,000	33,353,900	55,481,900	38,110,500	72,329,900	110,440,400
TOTAL									
REUBICACION DE INSTALACIONES EXISTENTES RELOCATION OF EXISTING FACILITIES									
PATIO DE TANQUES	24,630,000	10,000,000	34,630,000	----	-----	----	-----	-----	-----
TANK FARM									
INSTALACIONES CAMARONERAS	18,955,000	8,000,000	26,955,000	----	-----	----	-----	-----	-----
SHRIMP FACILITIES									
ESTRUCTURAS MISCELANEAS	840,000		840,000	----	-----	----	-----	-----	-----
MISCELLANEOUS STRUCTURES									
SUBTOTAL	90,150,380	103,751,520	193,901.900	22,128,000	33,353,900	55,481,900	38,110,500	72,329,900	110,440,400
SUBTOTAL									

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COSTO ESTIMADO TOTAL EN CORDOBAS - MUELLE FUTURO DE CARGA GENERAL/CONTENEDORES
TOTAL ESTIMATED COST IN CORDOBAS - FUTURE PIER FOR GENERAL CARGO/CONTAINERS

INSTALACIONES INTERIORES TERMINADAS COMPLETED INTERIOR FACILITIES	ATRACADERO No.1 - 1985 - SUD			ATRACADERO No.2 - 1991 - CENTRO			ATRACADERO No.3 - 1997 - NORTE		
	LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
SUBTOTAL	90,150,380	103,751,520	193,901,900	22,128,000	33,353,900	55,481,900	38,110,500	72,329,900	110,440,400
SUBTOTAL									
EQUIPO DE MUELLE	548,800	1,274,700	1,823,500	271,200	634,800	906,000	407,200	945,300	1,352,500
WHARF FITTINGS									
PAVIMENTACION	14,140,000	5,880,000	20,020,000	6,868,000	2,856,000	9,724,000	10,504,000	4,368,000	14,872,000
PAVING									
EDIFICIOS	790,000	520,000	1,310,000	22,000,000	11,500,000	33,500,000	20,000	10,000	30,000
BUILDINGS									
EQUIPO	----	24,596,000	24,596,000	---	34,189,000	34,189,000	---	23,619,000	23,619,000
EQUIPMENT									
INFRAESTRUCTURA QUE PERMANECE	314,500	3,065,000	3,379,500	305,000	2,405,000	2,710,000	---	840,000	840,000
REMAINING INFRASTRUCTURE									
MOVILIZACION Y DESMOVILIZACION	1,250,000	3,750,000	5,000,000	2,000,000	6,000,000	8,000,000	1,000,000	3,000,000	4,000,000
MOBILIZATION & DEMOBILIZATION									
SUBTOTAL	107,193,680	142,837,220	250,030,900	53,572,200	90,938,700	144,510,900	50,041,700	105,112,200	155,153,900
SUBTOTAL									
DISEÑO Y SUPERVISION	800,000	3,200,000	4,000,000	1,240,000	4,960,000	6,200,000	640,000	2,560,000	3,200,000
DESIGN & SUPERVISION									
CONTINGENCIAS	2,600,000	5,800,000	8,400,000	4,700,000	8,700,000	13,400,000	1,900,000	5,000,000	6,900,000
CONTINGENCIES									
TOTAL COSTOS ESTIMADOS	110,593,680	151,837,280	262,430,900	59,512,200	104,598,700	164,110,900	52,581,700	112,672,200	165,253,900
TOTAL ESTIMATED COSTS									

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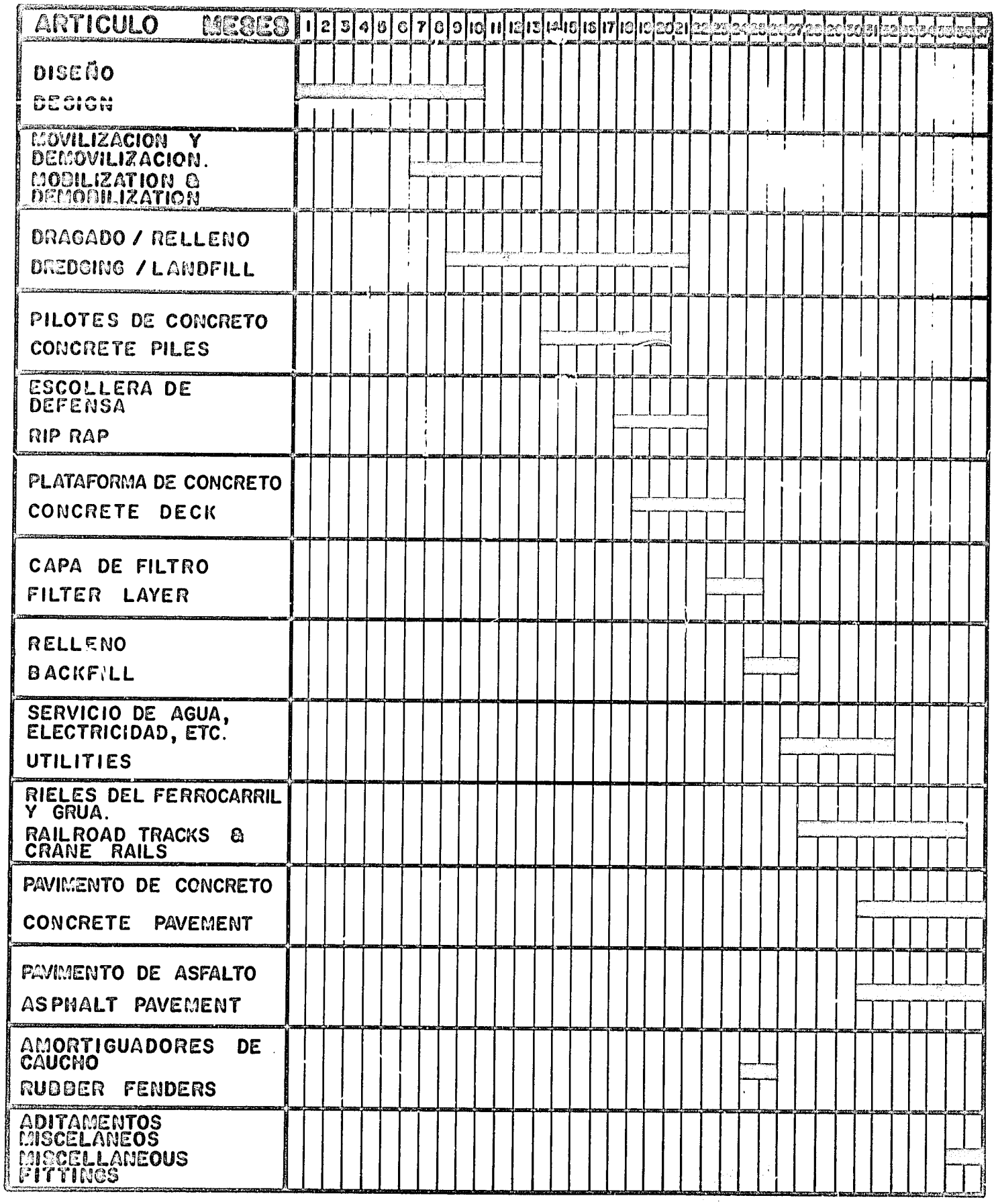
ATRAGADERO Nº 1-1985 PLAN DE CONSTRUCCION
BERTH Nº 1 - 1985 — CONSTRUCTION SCHEDULE



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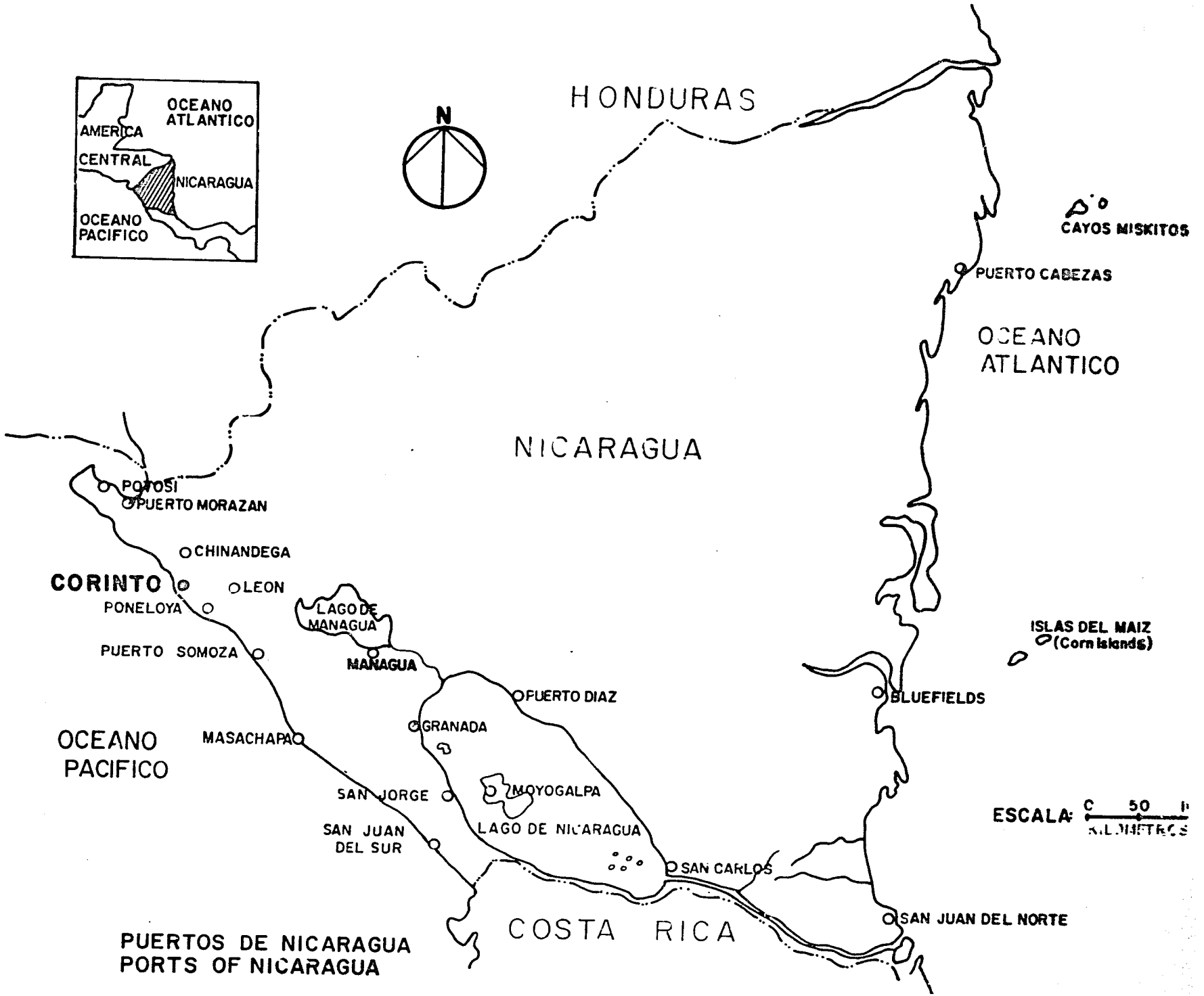
NEW YORK, N.Y. DIC. 1978 PUERTO DE CORINTO



PUERTOS DE NICARAGUA
PORTS OF NICARAGUA

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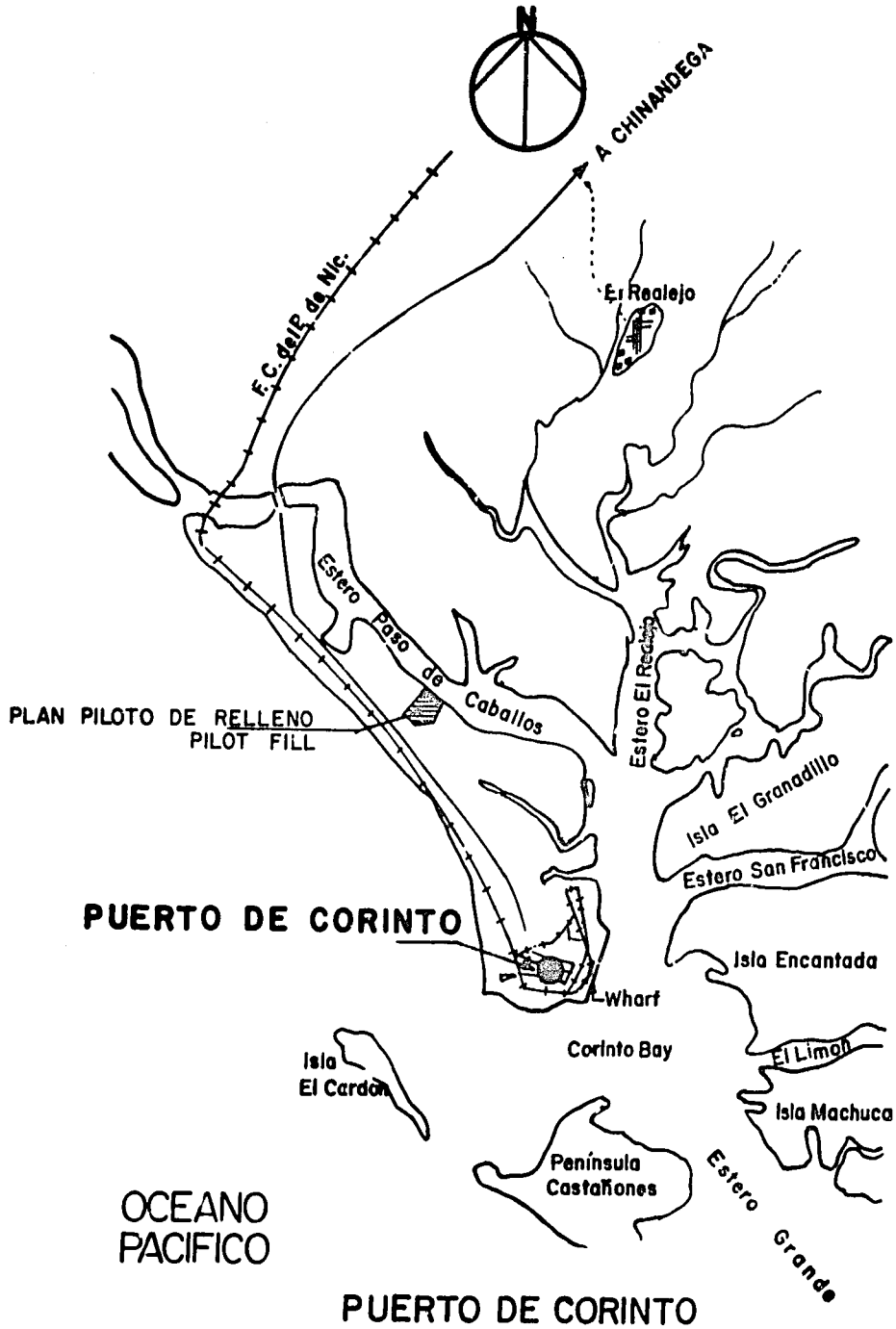
PUERTO DE CORINTO
FIGURE A.1



PUERTO DE CORINTO

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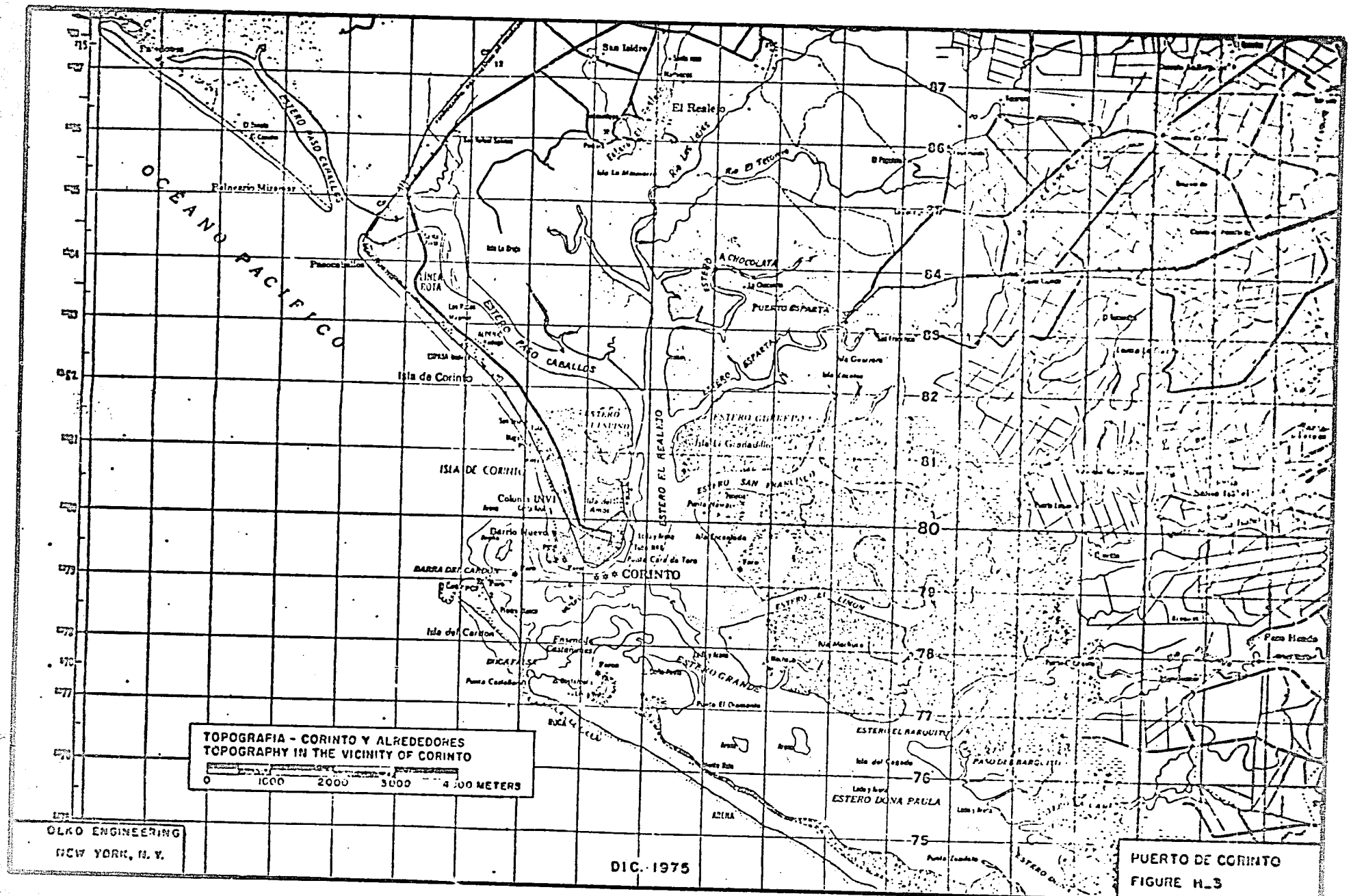
PUERTO DE CORINTO
FIGURE H-2



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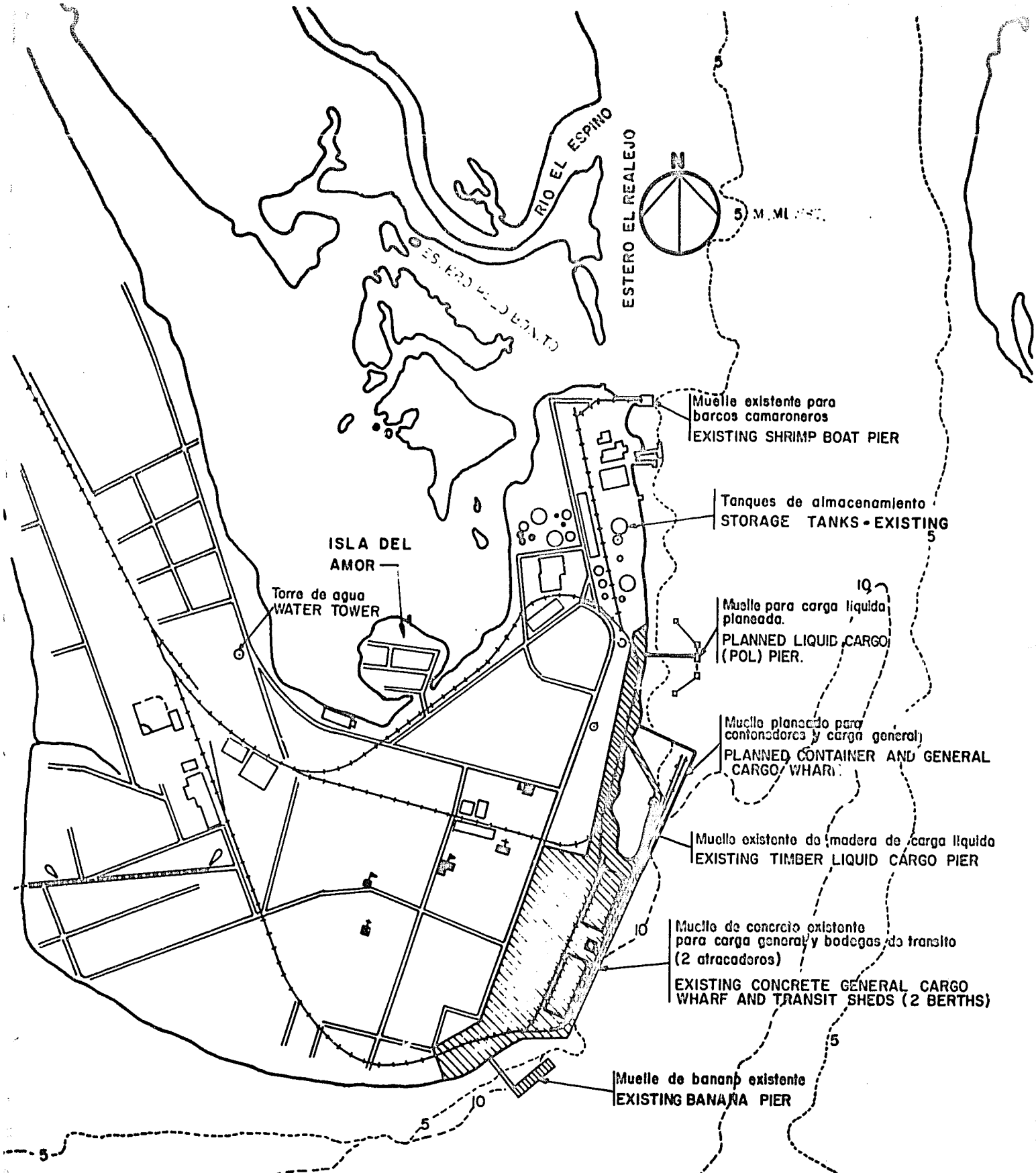

FACILIDADES EXISTENTES Y EXPANSION PLANEDA PRESENTE

EXISTING FACILITIES AND PRESENTLY PLANNED EXPANSION

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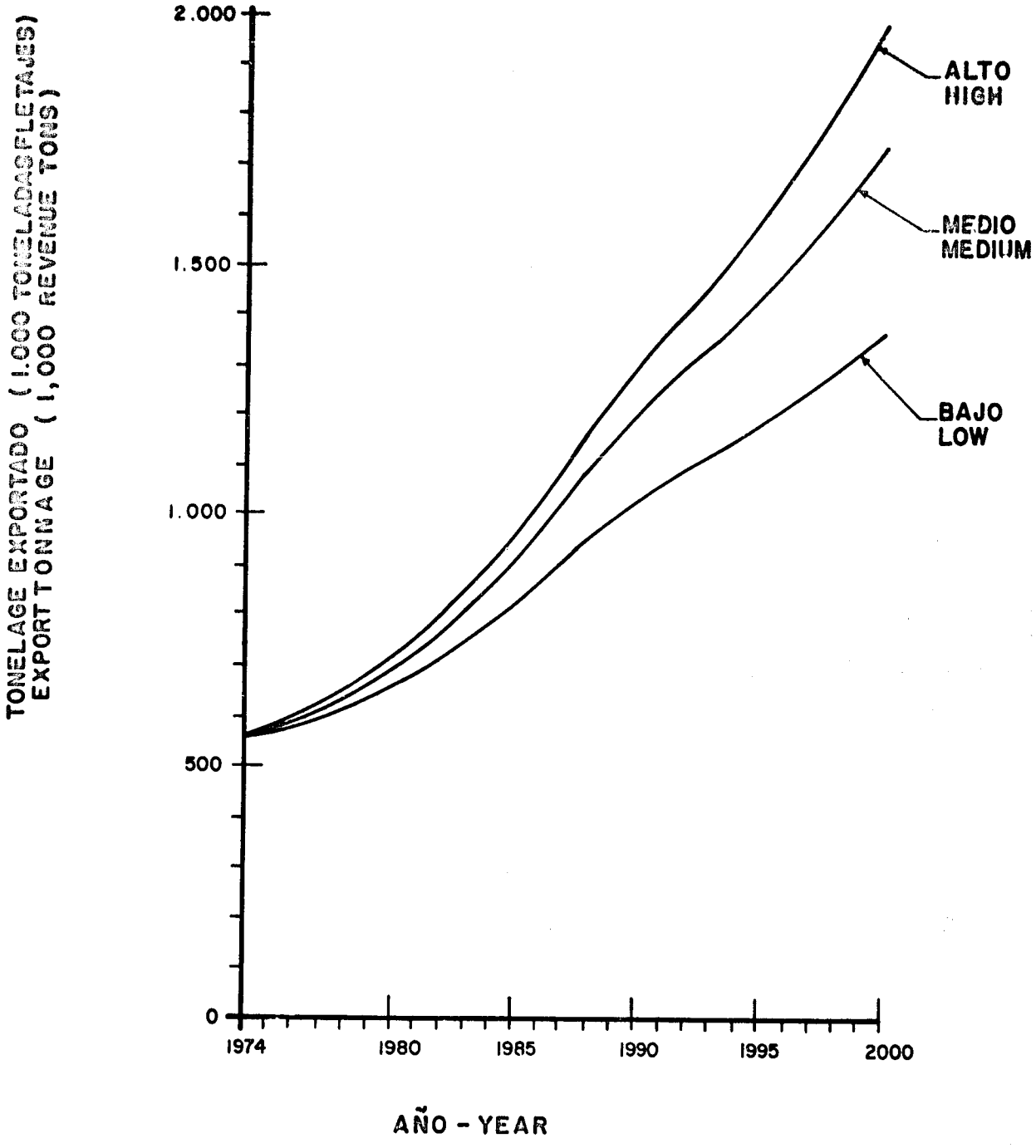
PUERTO DE CORINTO
FIGURE N.4



EXPORTACIONES ESTIMADAS
ESTIMATED EXPORTS

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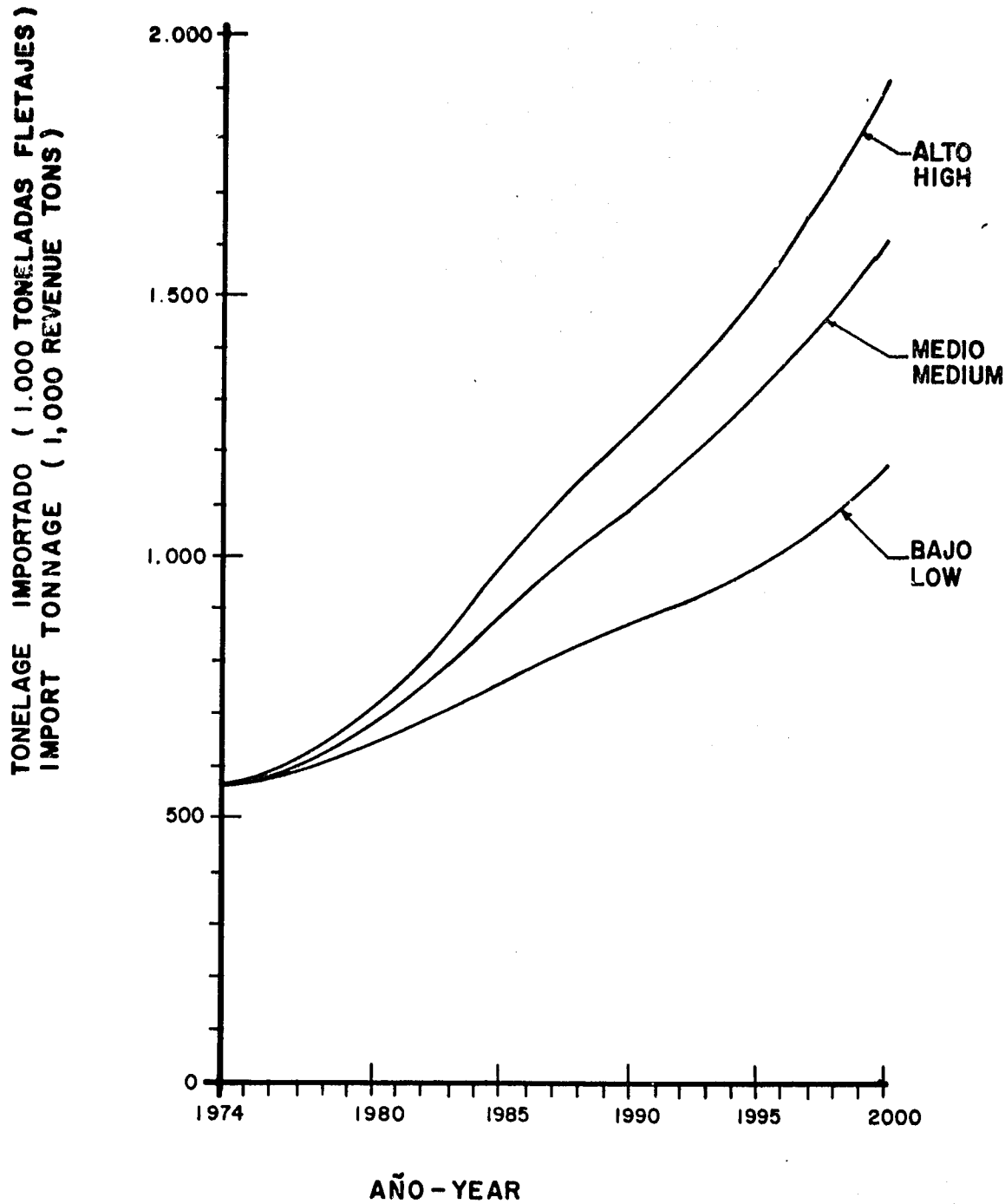
PUERTO DE CORINTO
FIGURE M-6

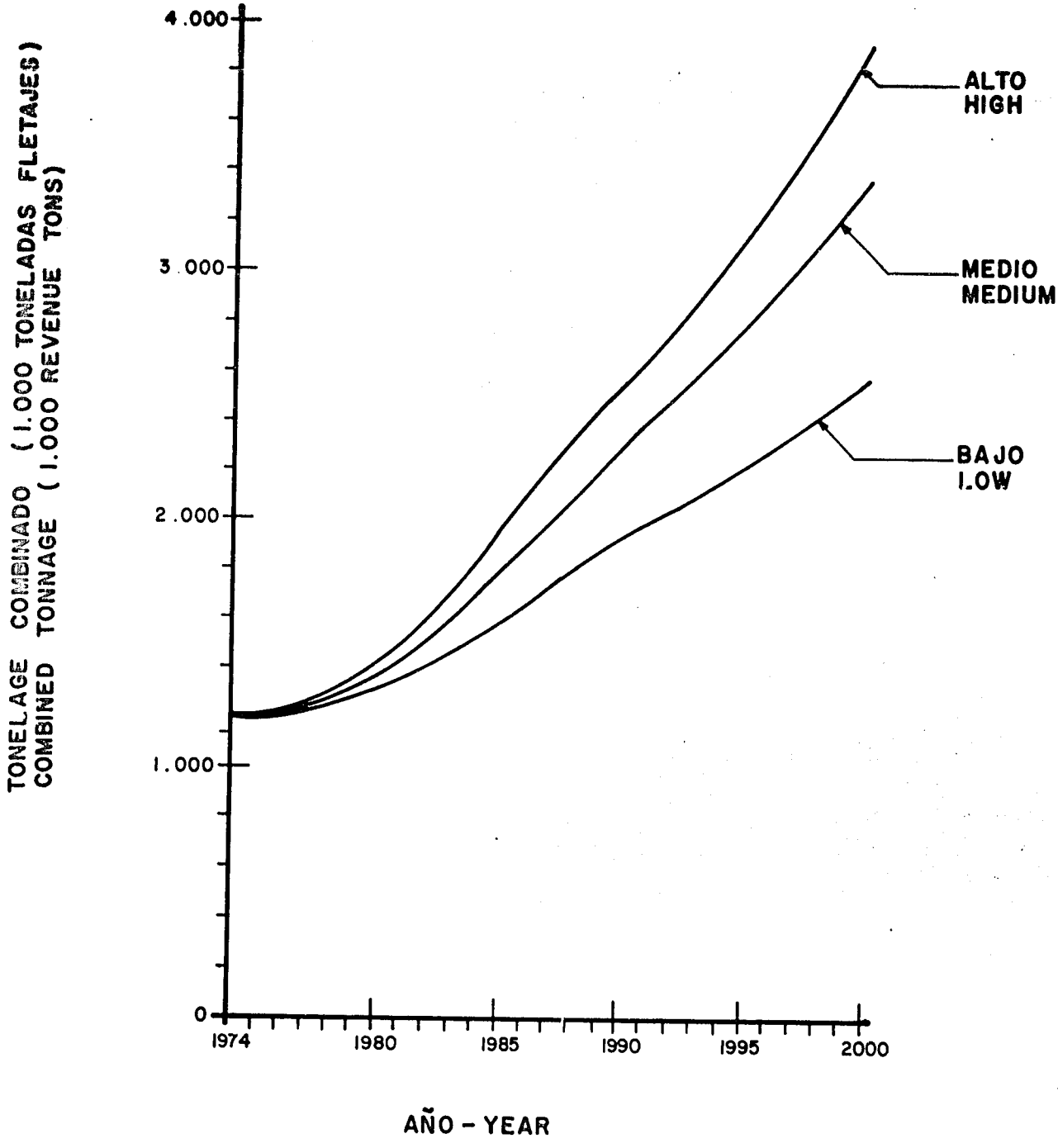


IMPORTACIONES ESTIMADAS
ESTIMATED IMPORTS

OLKO ENGINEERING
NEW YORK, N. Y.

DIC. 1975

PUERTO DE CORINTO
FIGURE H-6



ESTIMACIONES COMBINADAS DE EXPORTACION E IMPORTACION

ESTIMATED COMBINED EXPORTS AND IMPORTS

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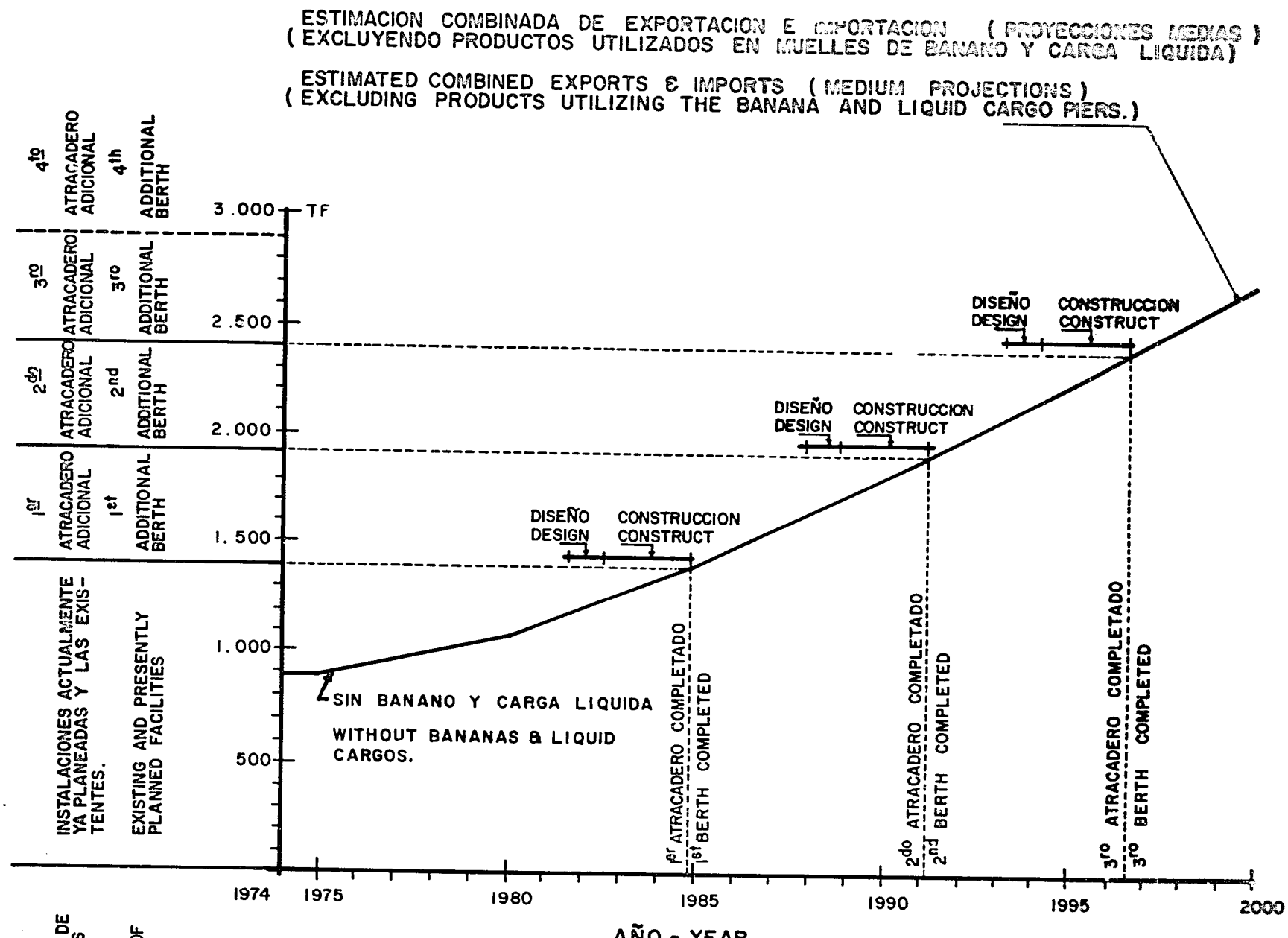
PUERTO DE CORINTO
FIGURE H-7



MUELLES REQUERIDOS EN EL FUTURO PARA CARGA GENERAL Y CONTENEDORES
REQUIRED FUTURE CONTAINER AND GENERAL CARGO WHARF

PUERTO DE CORINTO

FIGURE H.10

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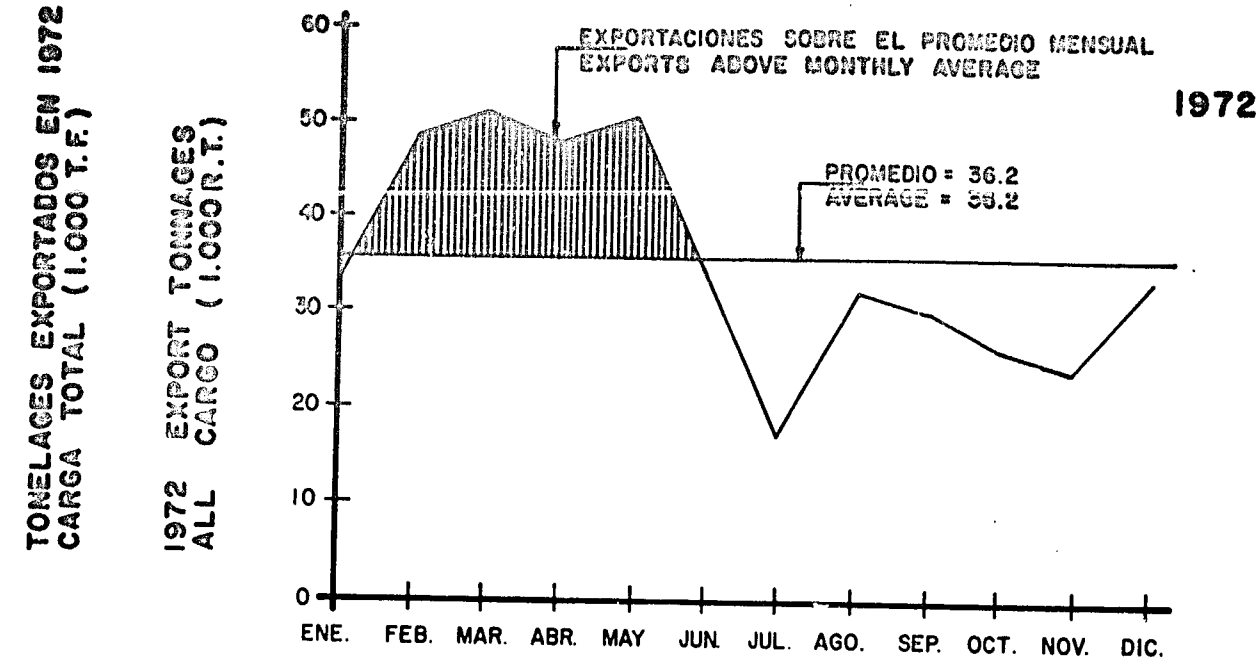

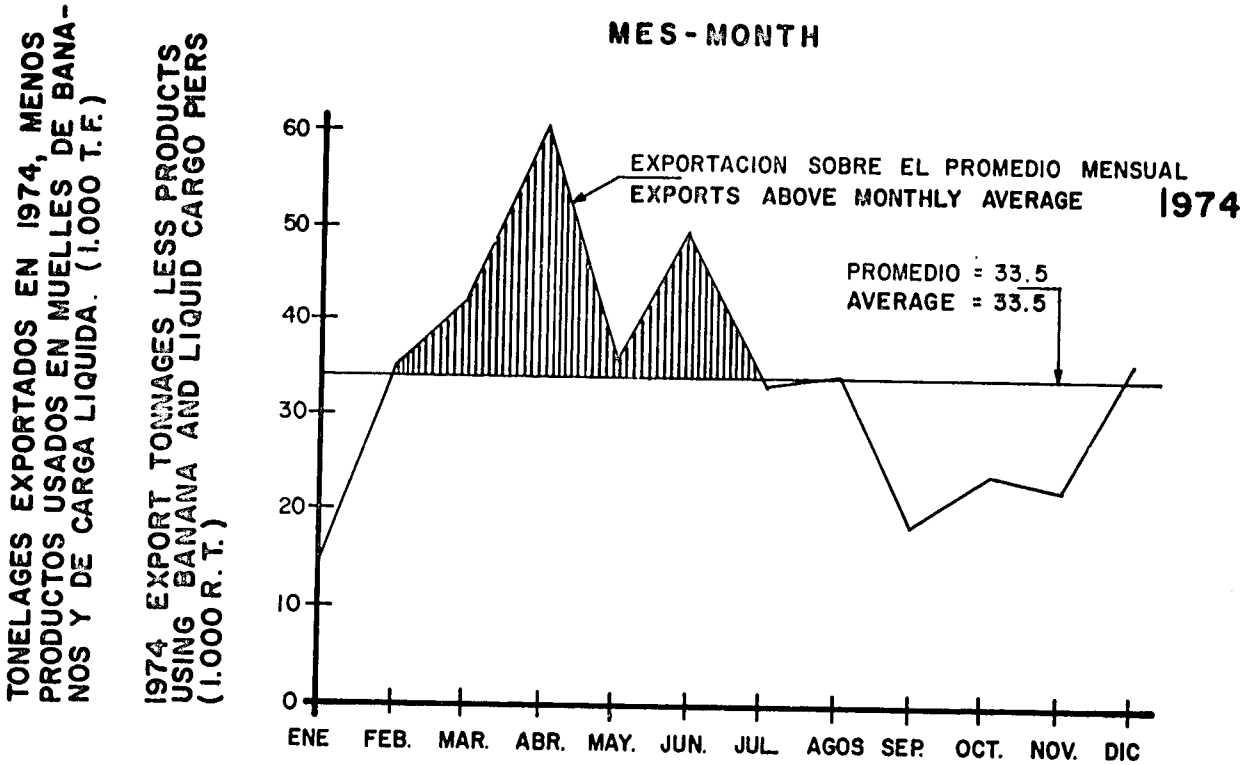

EXPORTACIONES MENSUALES - 1972 Y 1974

1972 & 1974 MONTHLY EXPORTS

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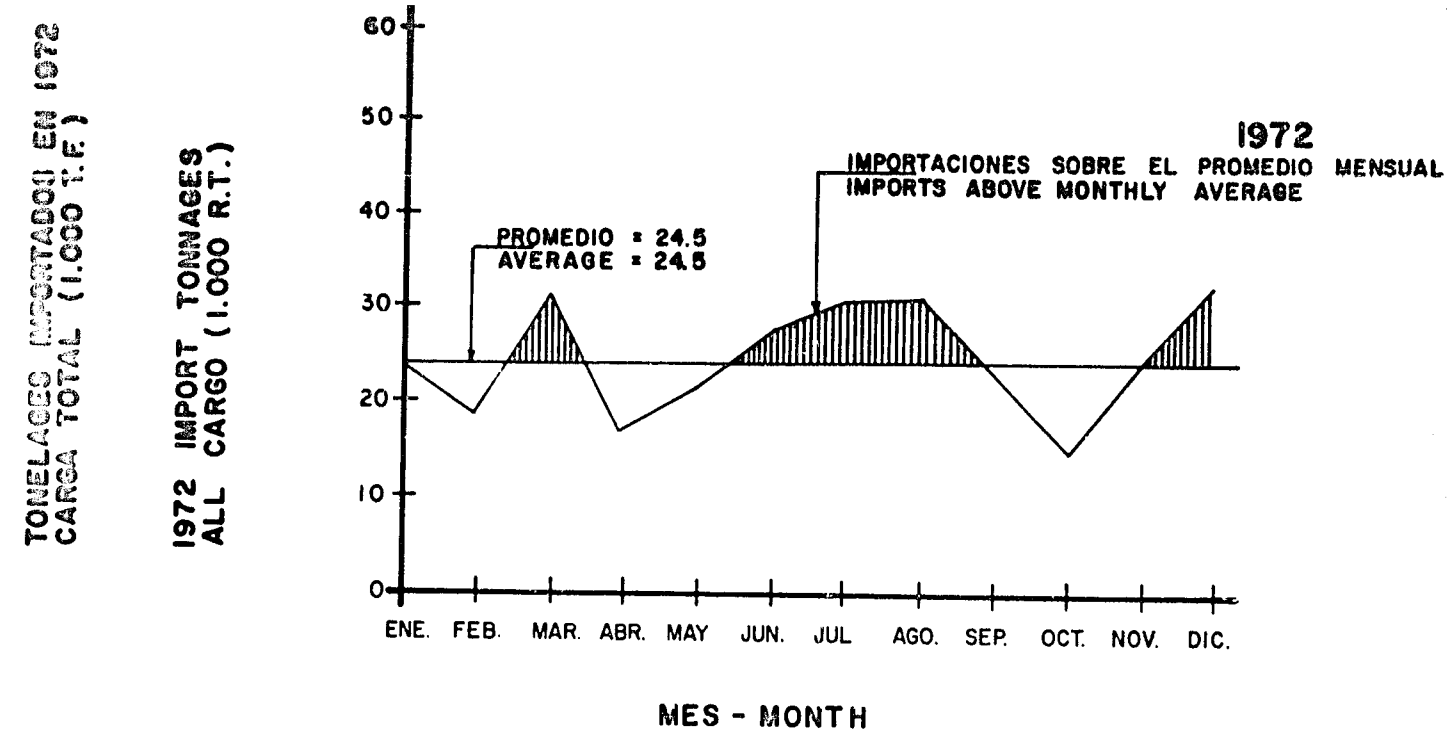
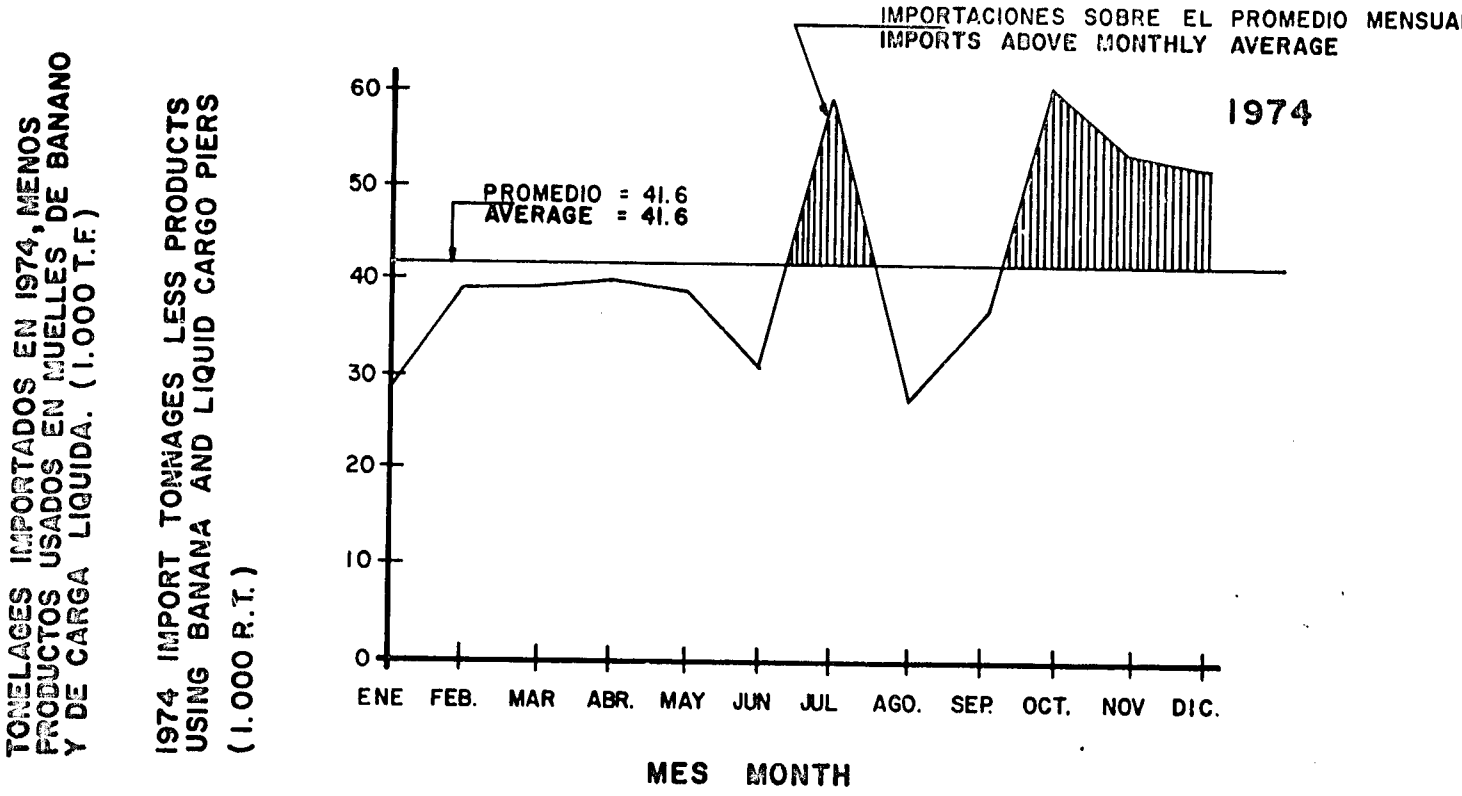
PUERTO DE CORINTO
FIGURE H-9





IMPORTACIONES MENSUALES 1972 Y 1974

1972 & 1974 MONTHLY IMPORTS

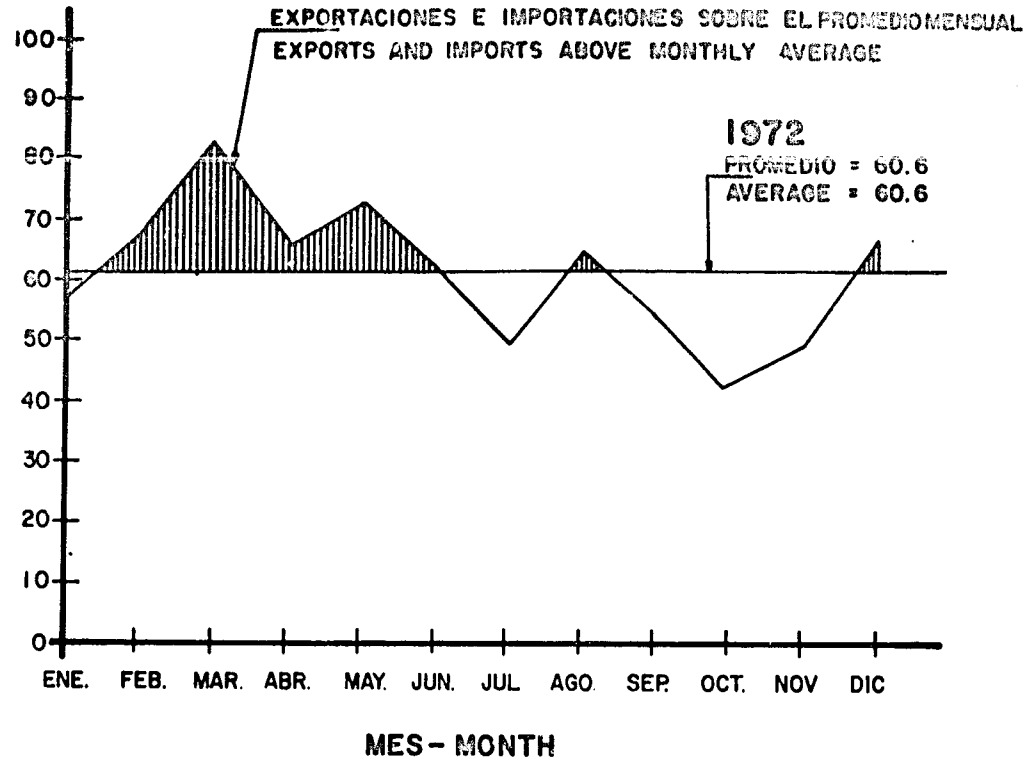
OLKO ENGINEERING
NEW YORK, N. Y.

DIC. 1975

PUERTO DE CORINTO
FIGURE N_10

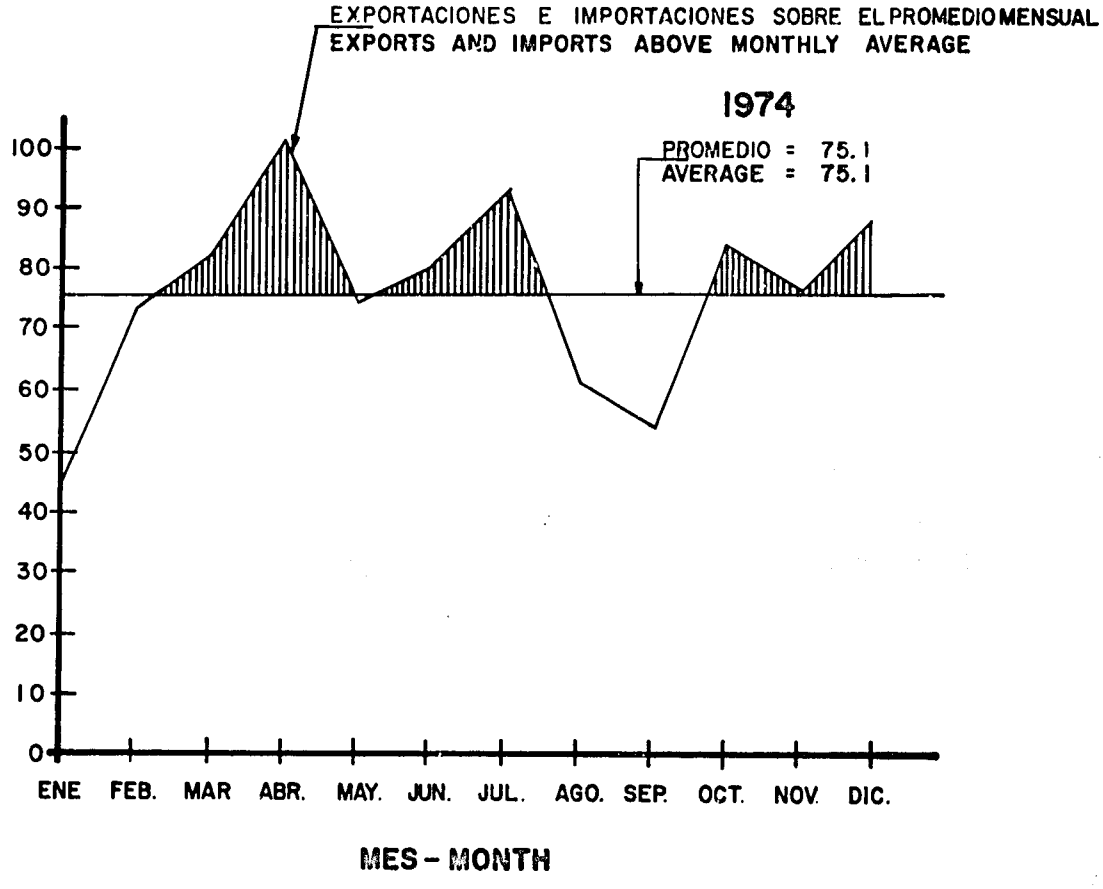
TONELADAS COMBINADOS DE EXPORT. E IMPORT. 1972
CARGA TOTAL
(EN 1.000 TONELADAS FLETAJE)

1972 COMBINED EXPORT & IMPORT TONNAGES
ALL CARGO
(IN 1.000 REVENUE-TONS)



COMBINACION DE EXPORTACION E IMPORT. DE TONELADAS EN 1974, MENOS PRODUCTOS USADOS EN MUELLES DE CARGA DE BANANO Y DE CARGA LIQUIDA. (1.000 T.F.)

1974 COMBINED EXPORT AND IMPORT TONNAGE LESS PRODUCTS USING BANANA AND LIQUID CARGO PIERS (1.000 R.T.)



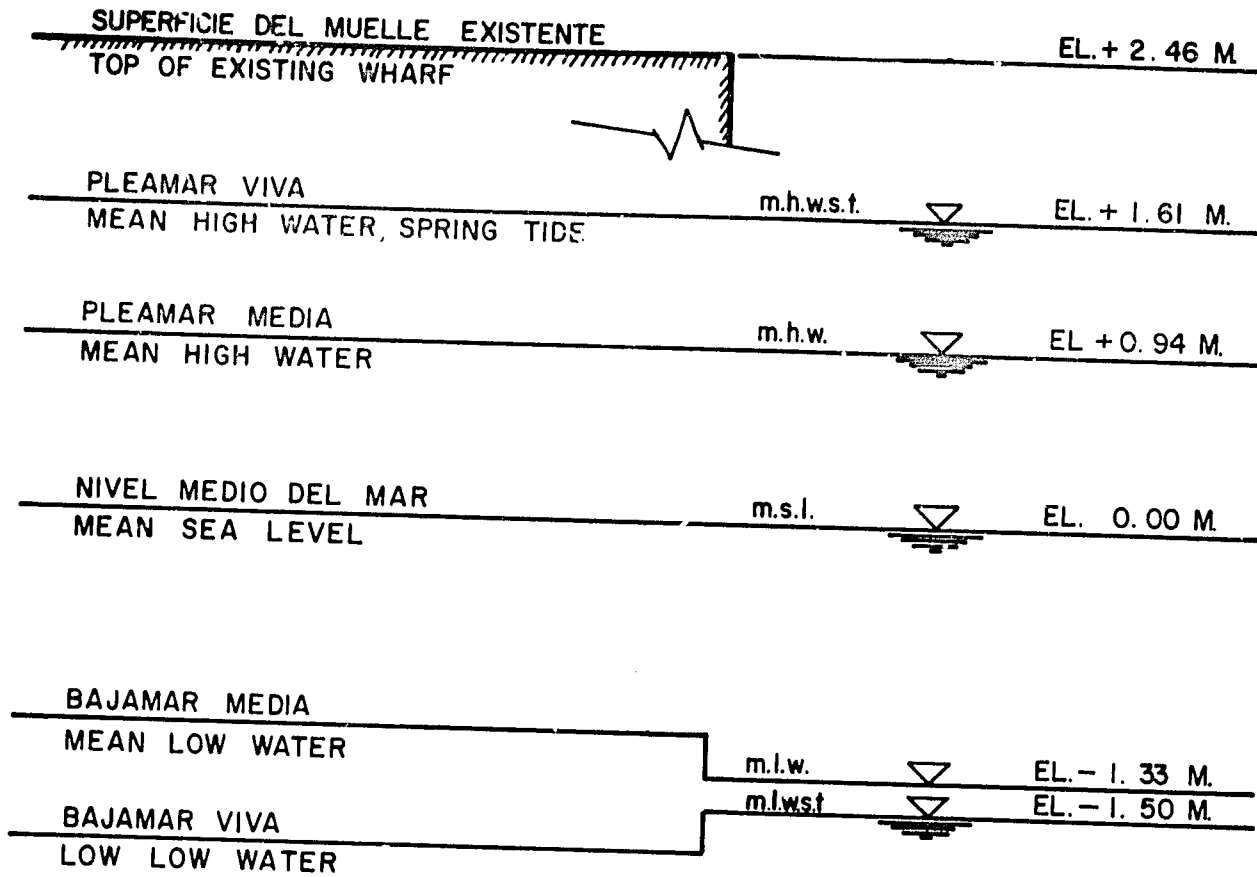
COMBINACIONES MENSUALES, EXPORT. E IMPORT. 1972 Y 1974

1972 & 1974 COMBINED MONTHLY EXPORT & IMPORTS

OLKO ENGINEERING
NEW YORK, N. Y.

DIC. 1975

PUERTO DE CORINTO
FIGURE H-II



ALCANCE DE MAREAS Y NIVELES
TIDE RANGES AND DATUM

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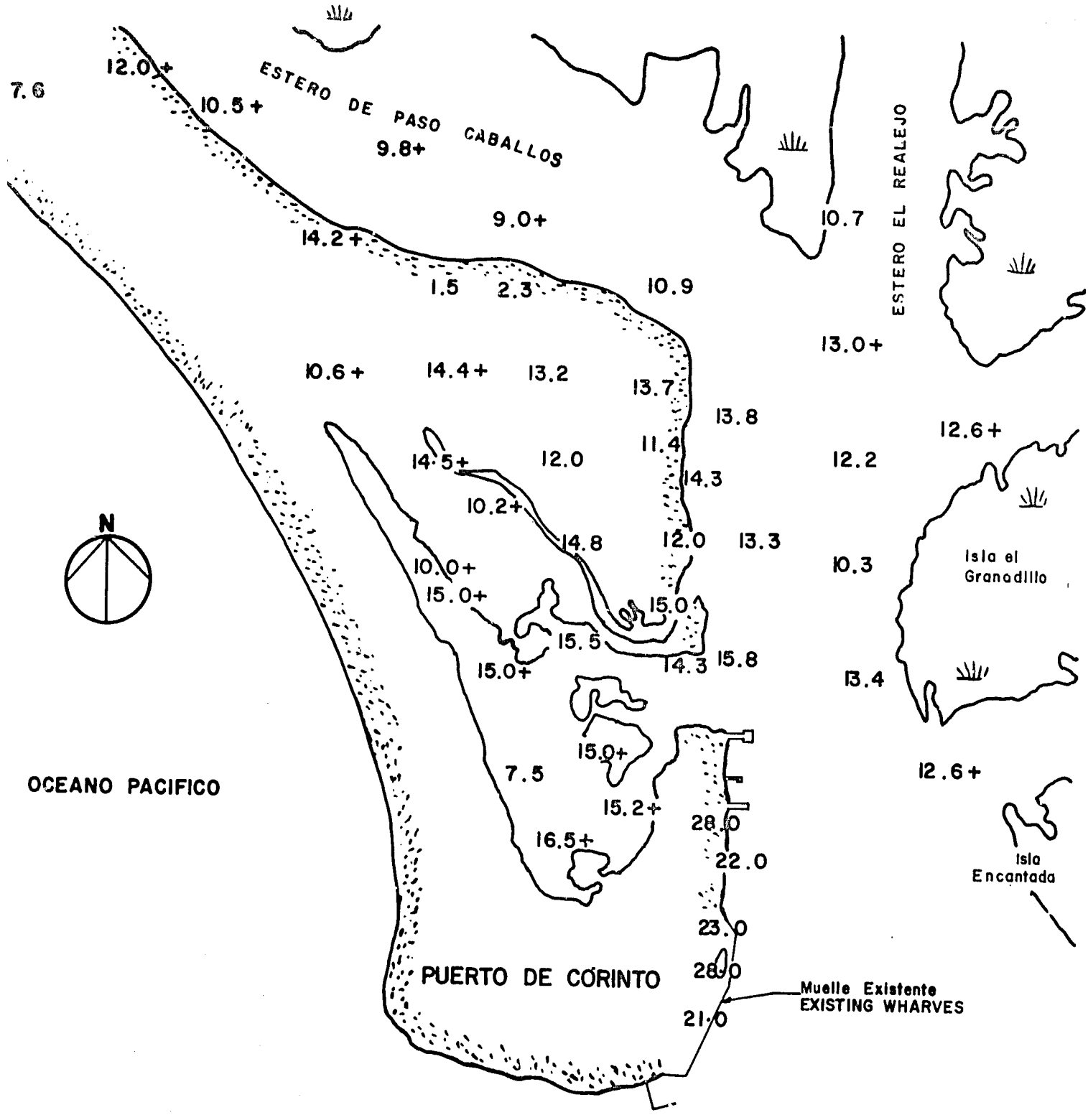
DIC. 1975

PUERTO DE CORINTO
FIGURE N-12



ELEVACIONES ROCOSAS
(METROS BAJO EL NIVEL DEL MAR).

ROCK ELEVATIONS
(METERS BELOW MEAN SEA LEVEL)

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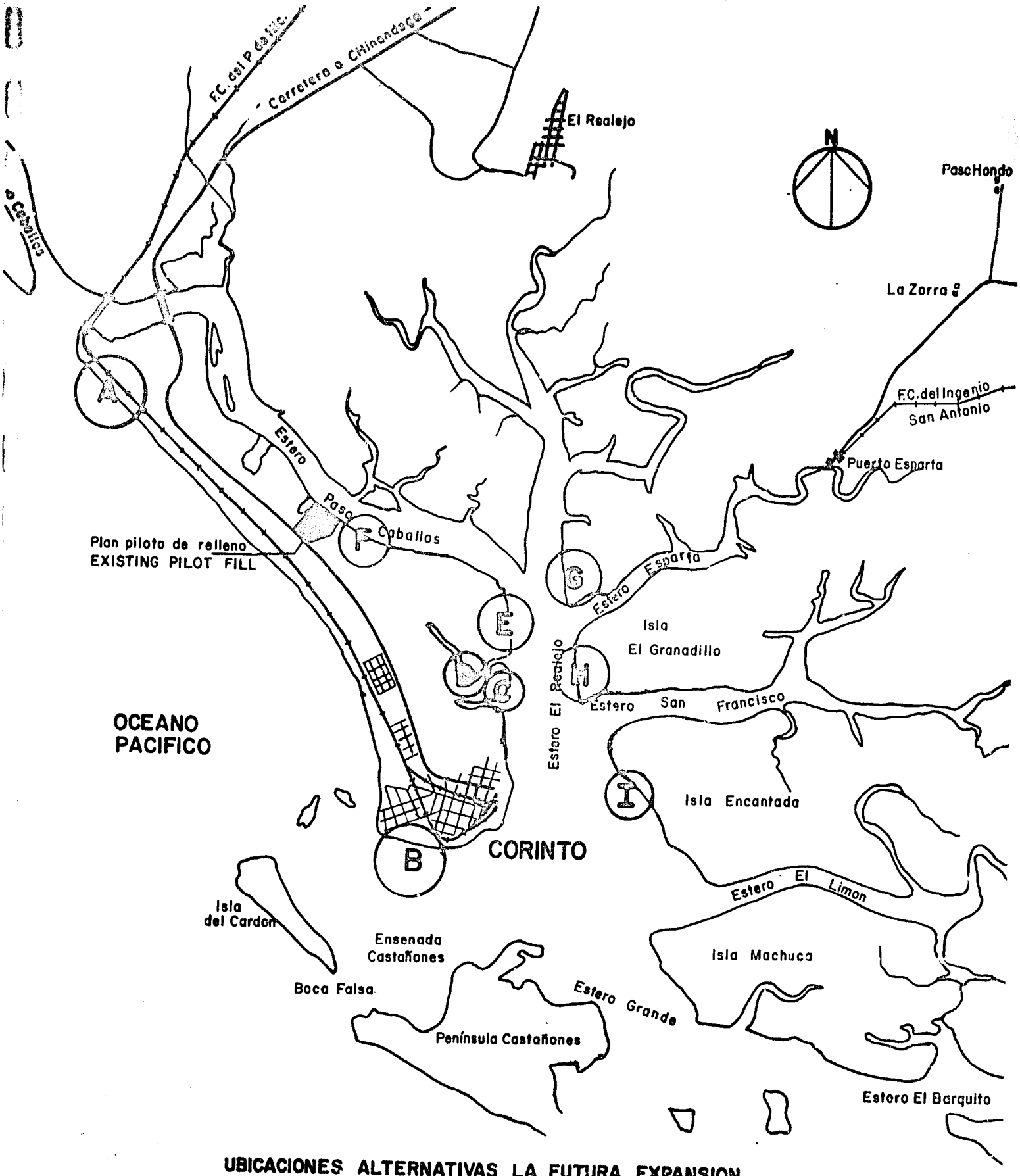
DIC. 1975

UERTO DE CORINTO
IGURE H_13



UBICACIONES ALTERNATIVAS LA FUTURA EXPANSION
ALTERNATIVE LOCATIONS FOR FUTURE EXPANSION

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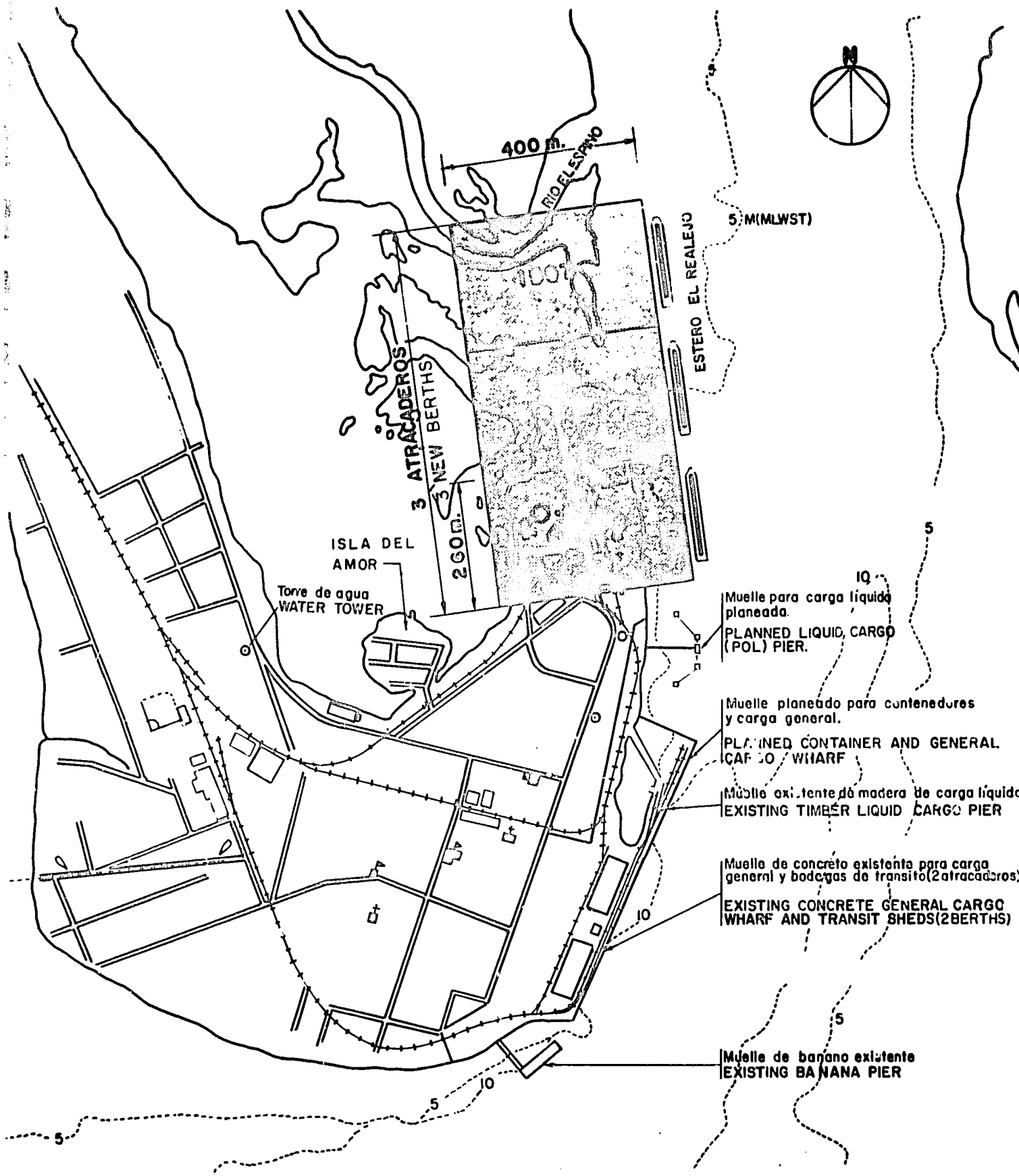
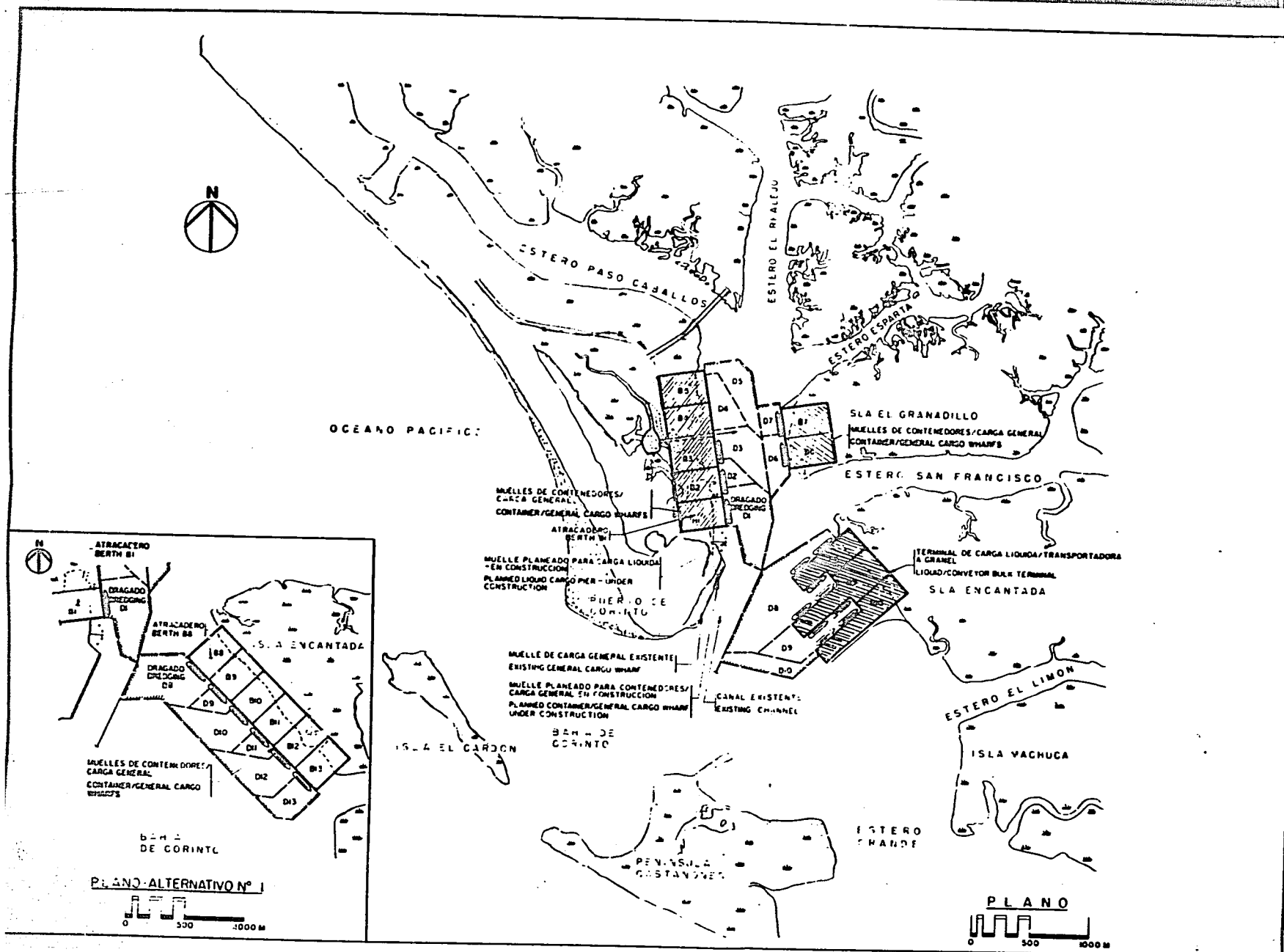
PUERTO DE CORINTO
FIGURE N.14



REQUIRED ADDITIONAL BERTHS—1997

OLKO ENGINEERING
NEW YORK, N.Y.
DIC. 1975

PUERTO DE CORINTO
FIGURE H-15



H_16

CAPACIDAD POTENCIAL PARA CONSTRUCCION DE ATRACADEROS

POTENTIAL ULTIMATE BERTHS

GRUPO EBRINZ/TRIBE
PLANIFICADORES PORTUARIOS
NEW YORK N.Y. USA

AUTORIDAD PORTUARIA DE CORINTO

ESTUDIO DE FACTIBILIDAD DEL PROYECTO DE RECLAMACION DE TIERRAS PARA EL DESARROLLO URBANO COMPLEMENTARIO DE LA CIUDAD DE CORINTO

FEASIBILITY STUDY FOR THE LAND RECLAMATION PROJECT FOR THE COMPLEMENTARY URBAN DEVELOPMENT OF THE CITY OF CORINTO

BOSWELL - MARTINEZ & WYNNEY - GARCIA
INGENIEROS CONSULTORES
CORINTO NICARAGUA

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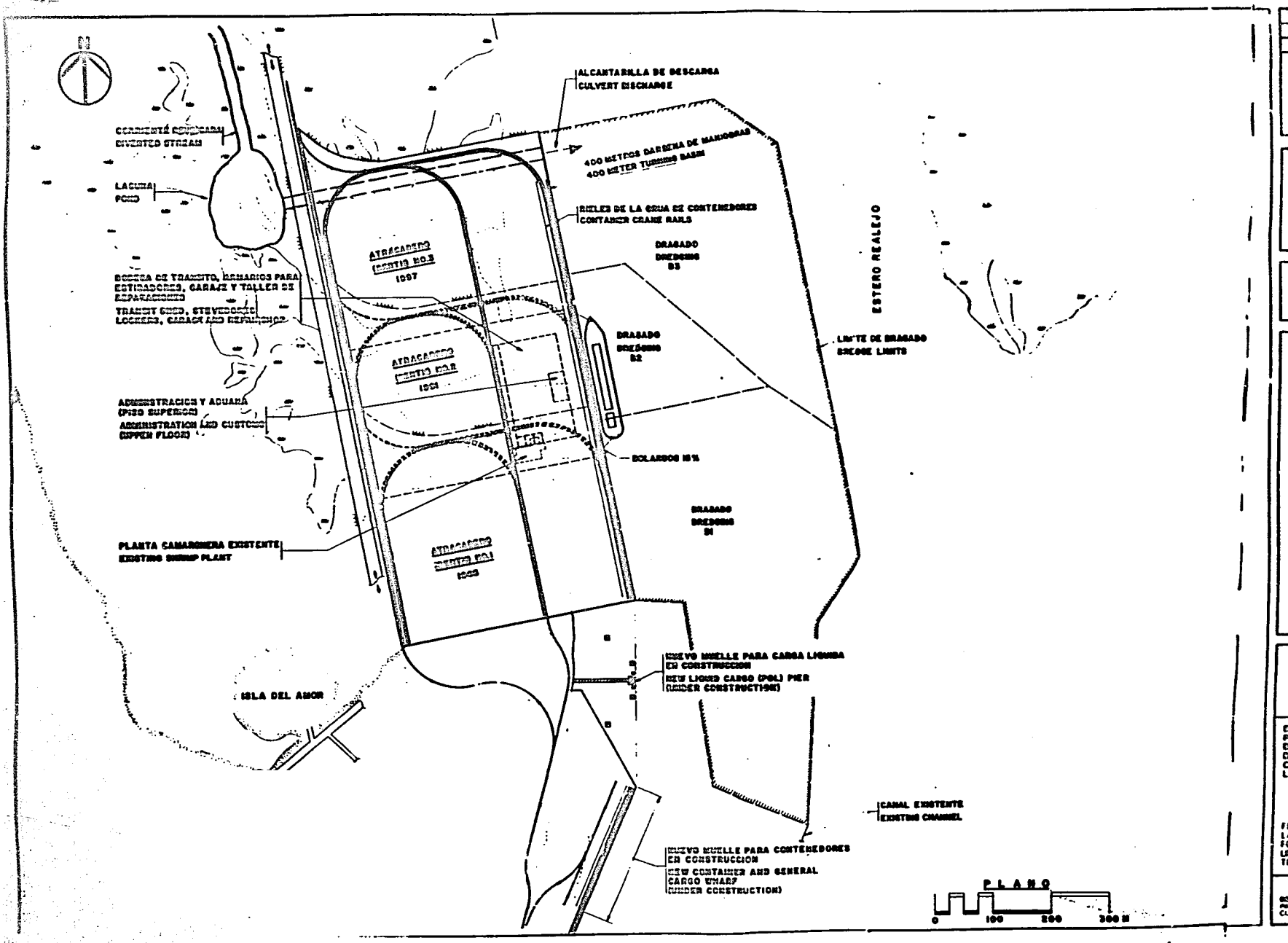

H-17

EXPANSION DE ATRACADEROS 1993, 1994 Y 1997

DEPTH EXPANSION – 1993, 1994 AND 1997

AUTORIDAD PORTUARIA DE CORINTO

ESTUDIO DE FACTIBILIDAD PARA PROYECTO DE RECLAMACIONES DE TIERRAS PARA DESARROLLO CONSTRUCTIVO DE LA CIUDAD DE CORINTO

FEASIBILITY STUDY FOR THE LAND RECLAMATION PROJECT FOR THE CONSTRUCTIVE DEVELOPMENT OF THE CITY OF CORINTO

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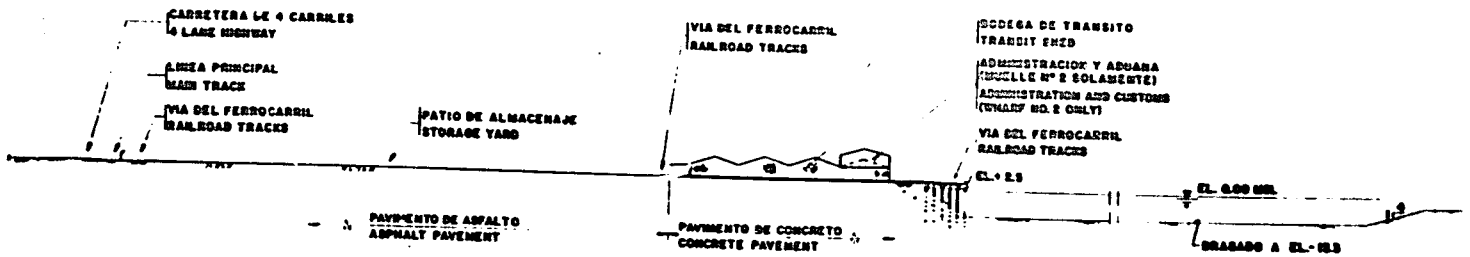
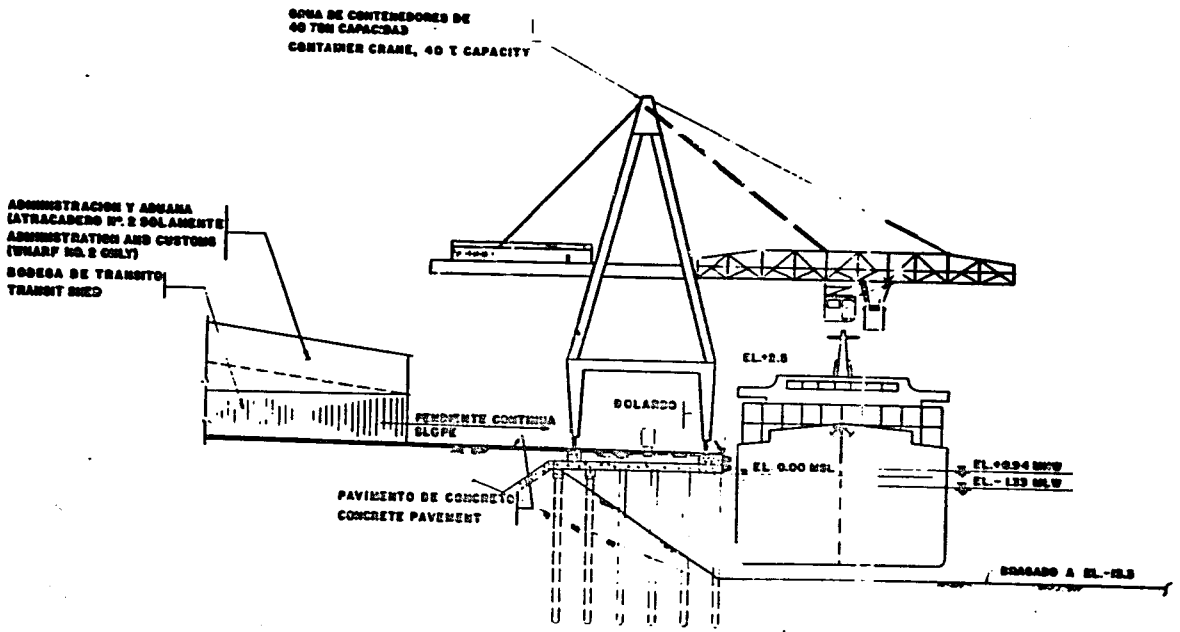


SECCION TRANSVERSAL TIPICA
TYPICAL CROSS SECTION



SECCION TRANSVERSAL DEL MUELLE
SECTION THRU WHARF

H-16

SECCIONES TRANSVERSALES TIPICAS DEL MUELLE

TYPICAL SECTIONS THRU WHARF

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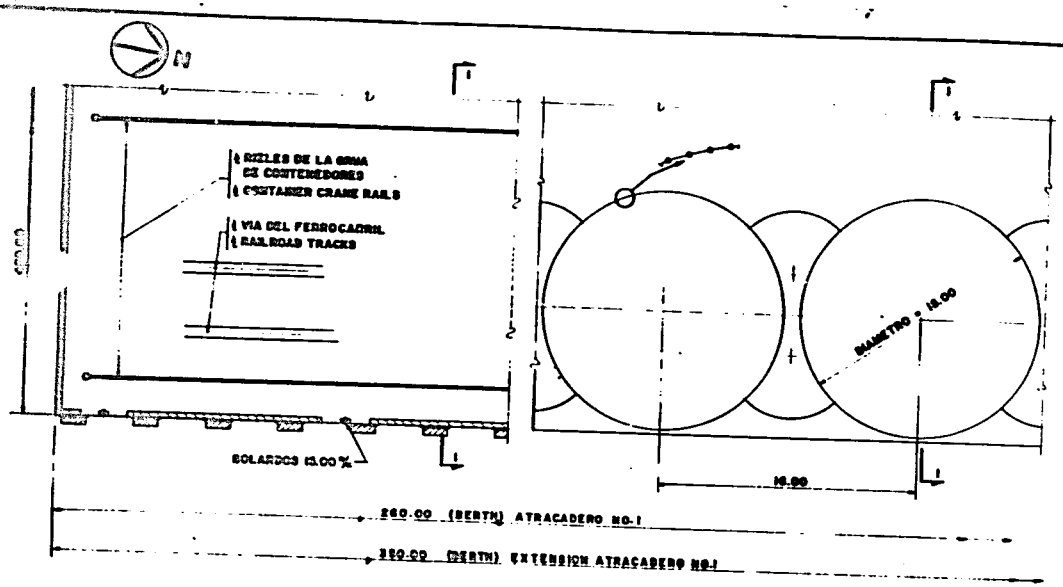
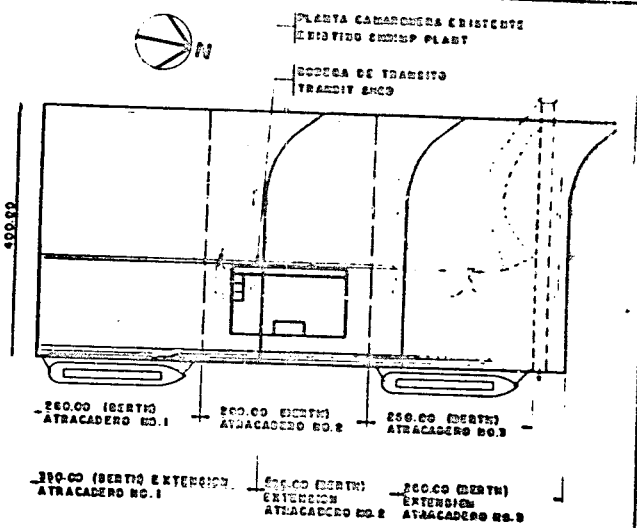


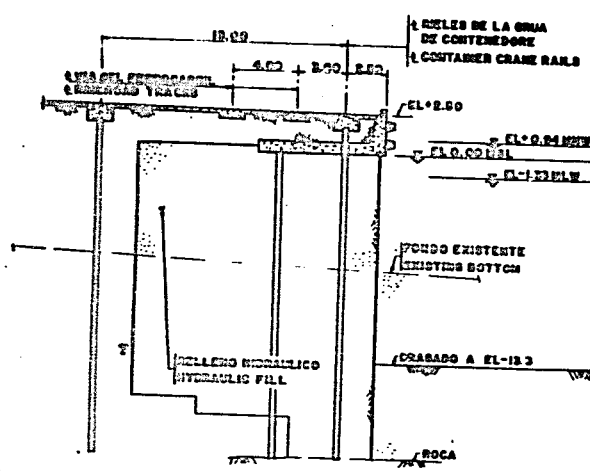
PLANO DE CUBIERTA
DECK PLAN

PLANO DE CELDAS
PLAN AT CELLS

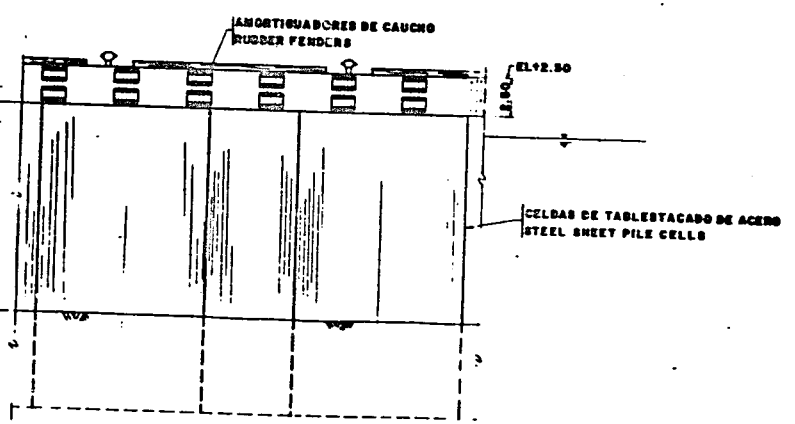


PLANO—AREA DE CONSTRUCCION
PLAN—EXTENT OF CONSTRUCTION

0 100 200 300 M



SECCION I-I (TIPICA)



VISTA FRONTAL

0 2 4 6 8 10 20

CELDAS DE TABLESTACADO DE ACERO

STEEL SHEET PILE CELLS

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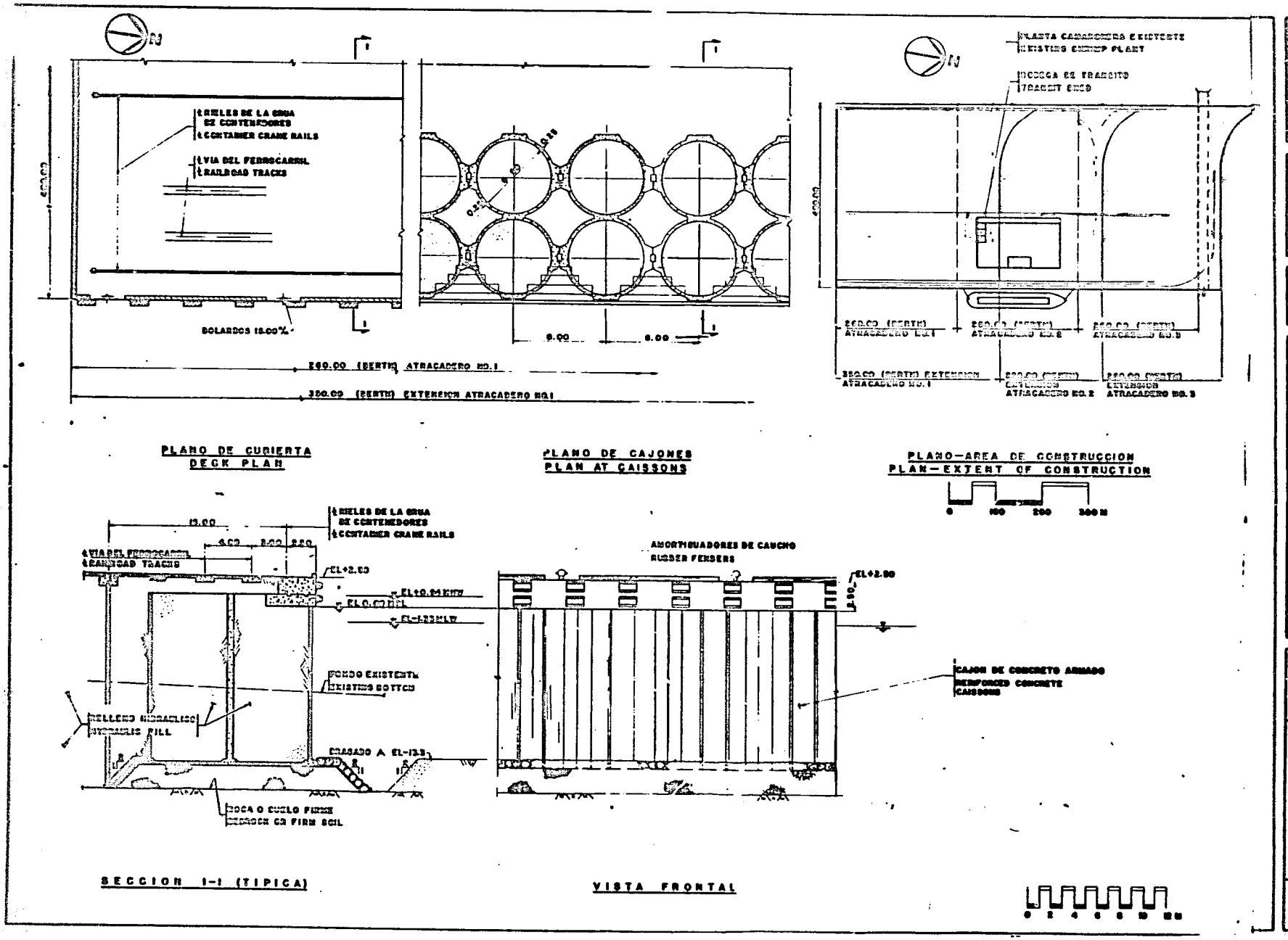

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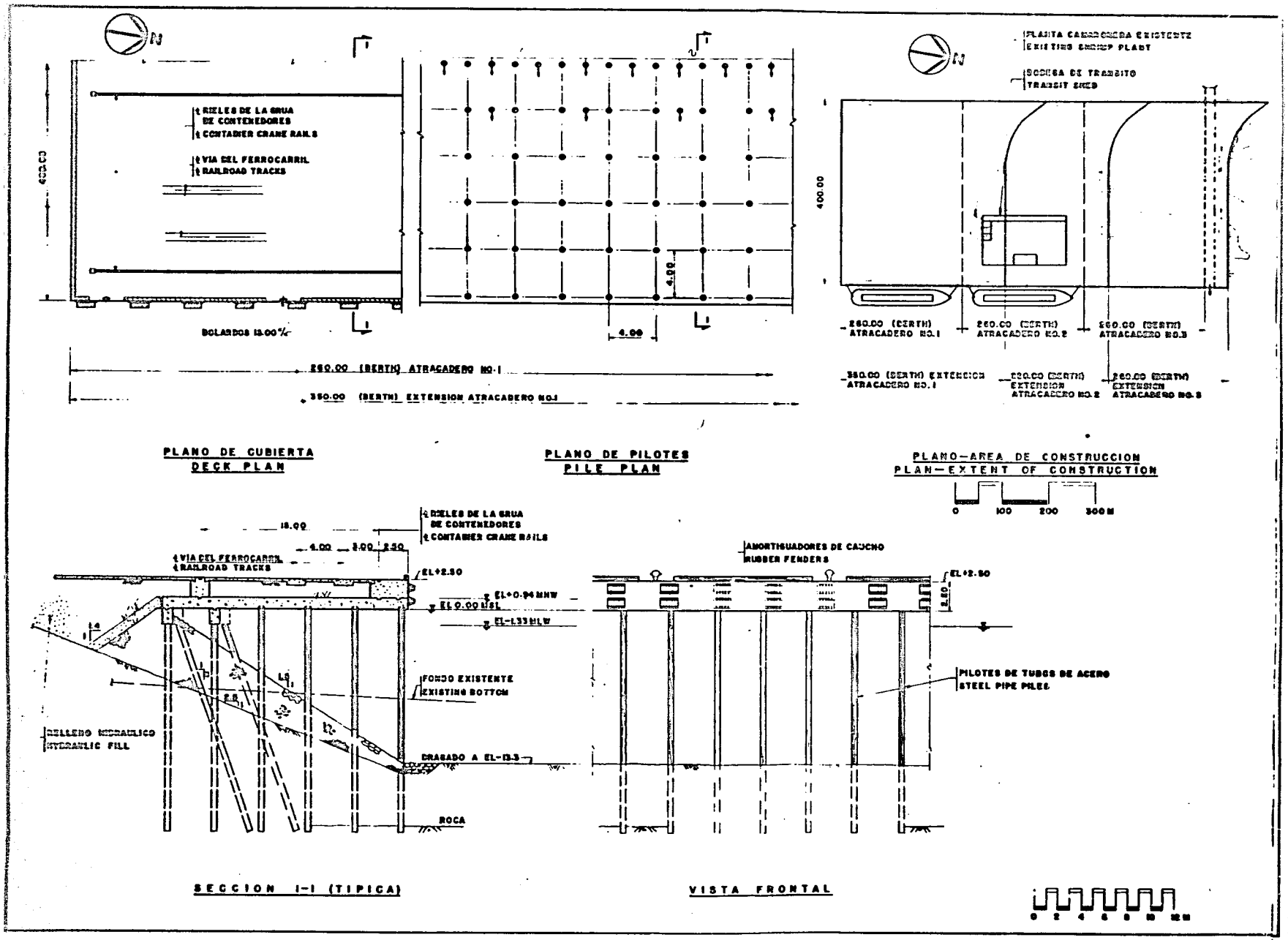

H-21

PILOTES DE TUBOS DE ACERO

STEEL PIPE PILE

AUTORIDAD PORTUARIA DE COLOMBIA

ESTUDIO DE FACTIBILIDAD DEL PROYECTO DE RELLENO DE TIERRAS PARA EL DESARROLLO URBANO COMPLEMENTARIO DE LA CIUDAD DE COLOMBO

FEASIBILITY STUDY FOR THE LAND RECLAMATION PROJECT FOR THE COMPLEMENTARY URBAN DEVELOPMENT OF THE CITY OF COLOMBO

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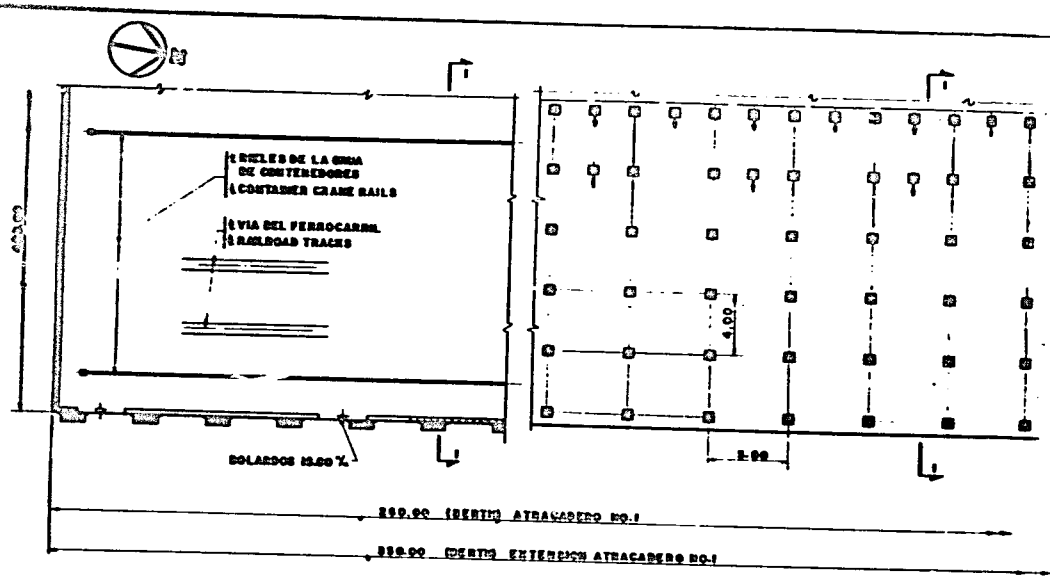
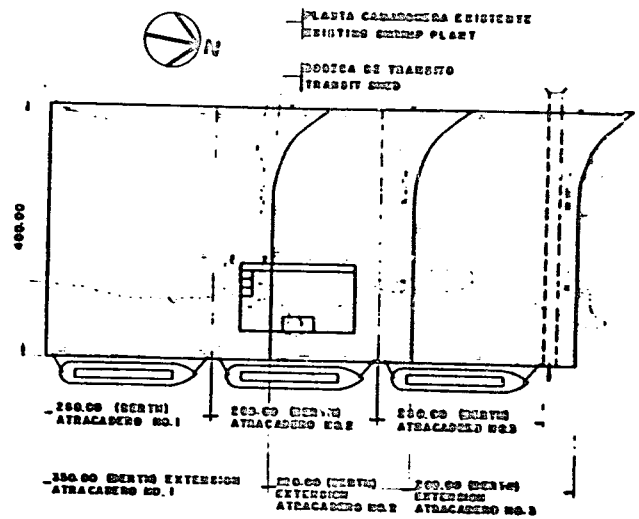
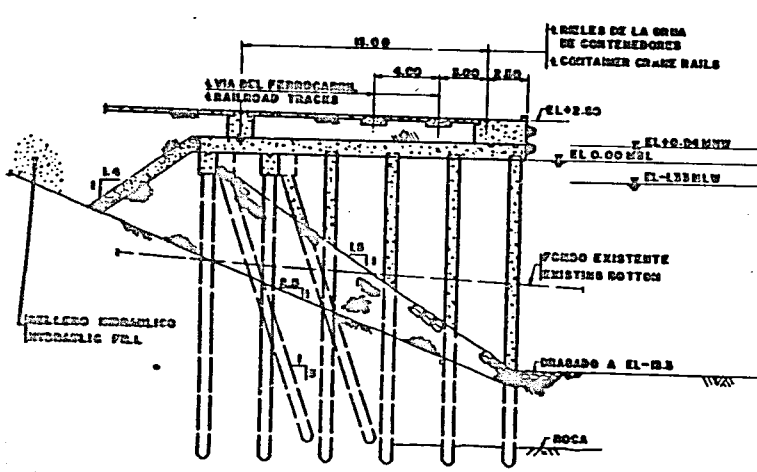


PLANO DE CUBIERTA
DECK PLAN

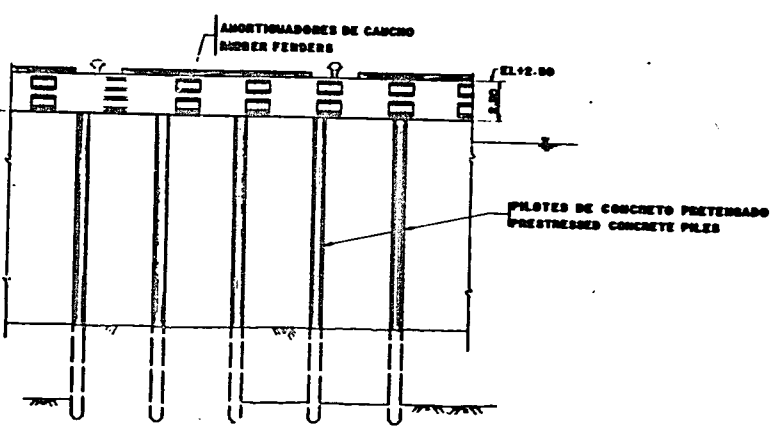


PLANO DE PILOTES
PILE PLAN

PLANO—AREA DE CONSTRUCCION
PLAN—EXTENT OF CONSTRUCTION



SECCION I-I (TIPICA)



VISTA FRONTAL

H-22

PILOTES DE CONCRETO PRETENSADO

PRESTRESSED CONCRETE PILES

AUTORIDAD PORTUARIA DE CONCEPCION

BEST AVAILABLE COPY

APPENDIX A-1

Evaluation Analysis - Purchase and Operation of Dredge

Alternative I - Purchase Present Cutterhead Suction Dredge

Alternative II - Purchase New Cutterhead Suction Dredge

Hopper Dredge

Cost Curve

Catalog Data

EVALUATION ANALYSIS

PURCHASE AND OPERATION OF DREDGE

BY THE

PORT AUTHORITY OF CORINTO NICARAGUA

INDEX

ALTERNATIVE I. PURCHASE PRESENT CUTTHERHEAD SUCTION DREDGE - SHEET

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ALTERNATIVE II. PURCHASE NEW CUTTERHEAD SUCTION DREDGE.

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ALTERNATIVE I. PURCHASE PRESENT DREDGE UPON COMPLETION OF DREDGING CONTRACT FOR THE NEW MARGINAL CONTAINERS WHARF AND LIQUID CARGO PIER.

DREDGE: Dixie Dredge Corporation, Model CS-3-20, hydraulic cutterhead portable dredge; 24" suction, 20" discharge; diesel engines.

General Dimensions: center hull- 15.2^m wide x 1.8^m deep side pontoons- 25.9^m/long x 2.4^m wide x 1.8^m deep ladder- 2.19^mlong Spuds- 0.61^m dia x 20.4^m long

Depth of dredging: 15^m (from mean high water)

Approximate capacity in m^3/hr:

DISTANCE	STATIC HEAD	
	3^m	8^m
600^m	560	540
900^m	460	430
1200^m	340	320
1500^m	280	270
2000^m	230	220

For purposes of this analysis, it is assumed that the dredge will pump a distance of 1350^m two third of the time, and a distance of 200^m one third of the time, with a maximum average output of $280m^3$/hr. Allowing 15% down time, normal average output= 230 m^3/hr.

Estimated useful life: 20 years

(For further information on Model CS-3-20 Dredge, see catalog data at end of this report Appendix, Sheets to D-9, inc.)

ALTERNATIVE I. (Continued)

EQUIPMENT: The quantities of dredge pipe and pontoons on hand are not known. For purposes of this analysis, the following quantities are assumed, similar to alternative II, described later on.

Float Pipe: 0.51^{m} dia x 4.76^{mm} wall
(20" Ø 0.88" wall)
Ball joints included. Pipe lengths 15.2^{m} (50')

4500 LF = 1372^{m}

Pontoons: 1.47^{m} dia. x 3.65^{m} long. Three required per length of float pipe

Total : 270Pontoons

Shore Pipe: 0.51^{m} dia. x 4.76 wall
Tapers, bands & lugs included .
Pipe lengths 6.1^{m} (20')

2000 LF = 610^{m}

Estimated useful life: 2 1/2 to 3 years.

ALTERNATIVE I. (Continued)

Capital Cost (December 1975 Prices)

			US DOLLARS	CORDOBAS
1.	One CS-3-20 Dredge, FOB, St. Louis, MO		799,325	
	Freight - Inland	$11,000		
	Ocean	120,000		
	Insurance	2,700		
			133,700	
	Total cost, CIF Corinto		933,025	6,531.175
2.	Equipment:			
	1372^m (4500')- 0.51^m Ø float pipe with fittings, plus 270 pontoons, at $523/LM FOB, St. Louis, MO.		718,650	
	610^m (2000') - 0.51^m Ø shore pipe with fittings, at $57.51/LM, FOB, St. Louis MO		35,080	
	Freight - Inland	$ 26,000		
	Ocean	244,000		
	Insurance	2,100		
			292,100	
	Total cost, CIF, Corinto		1,045,830	7,320,810
3.	Summation, Items 1 & 2.		$ 1,978,105	C 13,851,985
4.	Estimated value upon purchase:			
	Assume 20% depreciation- dredge		764,420	5,224,940
	Assume 67% depreciation equipment		384,610	2,440,270
	Total Estimated Value		1,095.030	7,665,000
5.	Spare parts- one year supply- Sheet #5		84,065	589,000
6.	TOTAL CAPITAL COST		1,179,095	8,254,000

ALTERNTIVE I. (Continued)

COST OF SPARE PARTS - ONE YEAR			US DOLLARS	CORDOBAS
FOB, St. Louis, MO see "Recommended Spare Parts List for Dixie Model CS-3-20 for One Yr's Operation" at end of this Appendix, Sheet D-10 to D-12 incl.			67,765	
Freight -	Inland	$ 1,000		
	Ocean	15,000		
	Insurance	300		
			16,300	
Total cost, CIF, Corinto			84,065	589,000

COST OF HAULING DREDGE & EQUIPMENT OVERLAND

Cubic measurement

Dredge	765 m^3
1982m of 0.51m Ø pipe	409
270 pontoons	1683
	2857 m^3, say 2,900 m^3

Cost:

2,900 m^3 x C$1.42/ m^3 /km = C$4,118, say 4,150 / Km

COST OF INSTALLING SKIDS AT SITE - LAUNCH & BACKHAUL DREDGE:

Estimated cost	C$100,000/site	100,000

COST OF ASSEMBLING & DISASSEMBLING DREDGE, INCLUDING LAUNCHING & BACKHAULING:

Estimated cost of assembly	C$ 7,000
Estimated cost of disassembly	C$ 3,600

ALTERNATIVE I. (Continued)

OPERATING COST PER HOUR (December 1975)

					CORDOBAS
1.	For the first 50 weeks, or less, crew will consist of:				
	a. 1 foreign dredgeman	at	$ 16/hr.	= C$112	
	b. 1 deckhand / oiler	at		7	
	c. 4 laborers	at	6.50	= 26	
			Total crew labor		C$145/hr.
2.	For balance of time, crew will consist of:				
	a. 1 dredgeman	local	C$12		
	b. 1 deckhand / oiler	local	7		
	c. 4 laborers	local	26		
			Total crew labor		C$ 45 /hr.
3.	Diesel fuel 85.11 gph at C$3.85				328 /hr.
4.	Oil & grease				24 /hr.
5.	Repairs & maintenance				
	a. Main engine			C$ 23	
	b. Dredge pump (wear parts)			69	
	c. Cutterhead, edges,bearings			7	
	d. Drives & winches			21	
	e. Hydraulic, major overhaul & intermediate repairs, plus misc. replacement of couplings, hose, filters, etc.			11	
	f. Misc. items- periodic replacement suction pipe & sleeve, discharge ell, repairs to aux. pump, periodic cleaning and painting.			20	
	g. Discharge pipeline & accesories			276	
	h. Contingencies			57	
			TOTAL		C$ 484 / hr.

ALTERNATIVE I. (Continued)

6. Total Operating Cost per Hour

a.	With foreign dredgeman	C$ 981 / hr.
b.	With all local personnel	881 / hr.
	Cost of line Boat	300 / shift
	Cost of tug Assistance	5,000 / shift

UNIT COST OF DREDGING:

1. Dredging Quantities:

Corinto Port Expansion	Wharf	Channel	Maintenance
Phase I 1984-85	1,028.000m^3	-	700,000 m^3
Phase II 1990-91	410,000	-	600,000
Phase III 1996-97	1,212,000	883,000	600,000
	2,650,000m^3	883,000m^3	1,900,000 m^3

Assumed exposed to wind & wave action; suction cutterhead dredge not feasible.

Other Pacific Coast Ports-Protected	Distance from Corinto
Potosí	± 65 Km
San Juan del Sur	± 325 Km

Assume ± 700,000 m^3 to be dredged at each port

Total quantity of Dredging

Corinto	2,650,000 m^3
2 other ports	1,400,000
	4,050,000 m^3

2. Unit Cost Dredging Contractor Comparison

December 1975- present contract, dredging for new marginal container wharf and liquid cargo pier: C$15.50/m^3. In order for the Port Authority to operate their own dredge; it is reasonable to assume that the unit cost of dredging would be about 2/3 of the contractor's unit price, or say ± C$10.00/m^3, taking into account administration, purchase orders, legal complications, etc. This compares with the following approximate breakdown:

Labor equipment, materials	C$ 10.00	
Overhead & profit	3.00	
Mobilization, demobilization	1,50	
Contingencies	0.70	TOTAL: C$15.50

ALTERNATIVE I. (Continued)

Unit cost of Dredging (Continued)

3. Dredge Production

2-10 hr. shifts/day , 6 day week = 120 hrs.

230 m^3 /hr = 120 — 27,600 m^3/wk

4. Dredging Time

Corinto Phase I-	1,028,000	÷	27,600	=	38	wks	
Corinto Phase II-	410,000	÷	27,600	=	15	wks	
Corinto Phase III	1,212,000	÷	27,600	=	44	wks	
Two other ports	1,400,000	÷	27,600	=	51	wks	
					148	wks	say 150 wks

50 weeks- foreign dredgeman

Dredge operating: 150 ÷ 1040 = 14% of time

ALTERNATIVE I. (Continued).

UNIT COST OF DREDGING. (Continued)

		CORDOBAS
a.	Capital cost of dredge, 1400^m of float pipe, 270 pontoons, 600^m of shore pipe (Sheet4)	7,665,000
b.	Install skids at 3 sites 3 x 100,000 (sheet 5)	300,000
c.	Assembly Corinto 3 Other 2x2=4 Total 7x7.000 (sheet 5)	49,000
d.	Disassembly 6x3.600 (sheet 5)	22,000
e.	Haulage . Potosí 65x2 trips = 130 kms (sheet 5) S.J. del Sur 325x2= 650 780 x 2 = 1650,say 1600^m at 4.150	6,640,000
f.	Replace pipe line material operating 150kms (sheet 4) (purchased material deteriorated). Replace twice 2x7,320,810	14,642.000
g.	Spare parts - 3 years operating 3x589.000 (sheet 5)	1,767,000
h.	Operating costs (sheet 6) 1. 50 wks at 120x981=117,720/wks x 50 2. 100 wks at 120x881= 105.720 /wks x 100	 5,886.000 10,572.000
i.	Idle time - 980 wks 1. Watchman 7 days x 24 hrs x 6.50/hr=1.092/wks 2. Maintenance 1-10hr shift /wks, say 6,000 7.092x890	6,312.000
j.	Line boat- 150 wks x 12 shiftsx 300 (sheet 7)	540,000
k.	Tug assistance, say 18 shifts x 5.000 (sheet 7)	90,000
	TOTAL COST	C$ 54,485.000

2. Unit Cost 54,485,000 ÷ 4.050.000 = C$ 13.45/m^3

ALTERNATIVE I. (Continued)

UNIT COST OF DREDGE (Continued)

6. DREDGE QUANTITY REQUIRED MODEL CS-3-20 DREDGE AT UNIT COST OF ± 10.00/m^3.

A cost curve has been plotted and attached to this Appendix to operate the P. A. dredge Model CS-3-20 at a unit cost of ± 10.00 /m^3, it will be necessary to dredge about 25% of the time. Based on a useful life of 20 years, the dredge will operate 5 years, or 260 weeks.

Total quantity of dredging required: 260x27.600 = 7,176.000 m^3

Development of unit cost / m^3	CORDOBAS
a. Capital cost of dredge & pipe,etc	7,665.000
b. Install skids- 3 sites	300,000
c. Assembly total 8 x 7,000	56,000
d. Disassembly 7 x 3.600	25,000
e. Haulage 50% more =1.5 x 1.600=2400 km at 4.150	9,960.000
f. Replace pipe line twice	14,642.000
g. Spare parts- 5 years x 589.000	2,945.000
h. Operating costs:	
1.50 weeks x 117,720	5,886,000
2.210 weeks x 105,720	22,201,000
i. Idle time- 780 weeks x 7.092	5,532.000
j. Line boat - 260 x 12 x 300	936,000
k. Tug assistance- 30 shifts x 5.000	150,000
TOTAL COST C$	70,298,000

2. Unit Cost 70,298.000 ÷ 7,176,000 = C$9.80/$m^3$ C$10.00/$m^3$

7. CONCLUSION: For the Port Authority Model CS-3-20 to dredge approximately 2,650,000 m^3 for the Port Expansion, and 1,400,000m^3 at other protected ports in Nicaragua, the dredge would operate 14% of the useful life of 20 years, at a unit cost of C$13.45/$m^3$. In order to obtain a unit cost of ±10.00/m^3, it would be necessary to dredge about 25% of the time , with a total production of 7,200.000m^3, which is not presently visualized.

NOTE: All costs are based on December 1975 prices, without escalation.

ALTERNATIVE II. PURCHASE NEW CUTTERHEAD SUCTION DREDGE

DREDGE: Purchase Dixie Dredge Corp., Model CS-2-16 hydraulic cutterhead portable dredge; 18" suction, 16" discharge diesel engines. In addition; purchase one booster pump to be used for above normal distances and static head of 8^m

General Dimensions: Center hull 16.7^m /long x $15.^m$ wide x 1.5^m deep.Side pontoons 22.9^m/long x 1.5^m wide x 1.5^m deep ladder- 18.9^m/long
Spuds- $0,46^m$ dia x 17.4^mlong

Depth of dredging: 15^m (from mean high water)

Approximate capacity in m^3/hr (without booster):

DISTANCE	STATIC HEAD 3^m	STATIC HEAD 8^m
600^m	310	
900^m	220	
1200^m	160	150
1500^m	130	
2000^m	-	250*

* With booster pump.

For purposes of this analysis, it is assumed that the dredge will pump a distance of 1350^m two thirds of the time, without booster, and a distance of 2000^m one third of the time, with booster, resulting in a maximum average output of $180m^3$/hr. Allowing 15% down time, normal average output = $136m^3$/hr.

Estimated useful life: 20 years.

Delivery: 4 to 6 months.

(For further information on Model CS-2-16 Dredge and CS-2-16 Booster Pump, see catalog data at end of this Appendix, Sheets D-13 to D-23 incl.)

ALTERNATIVE II. (Continued)

EQUIPMENT:

Float Pipe: 0.41^{m} dia. x 4.76^{mm} wall (16 Ø x 0.188^{m} wall)
Ball joints included. Pipe lengths 15.2^{m} (50')

4500 LF= 1372^{m}

Pontoons: 1.12^{m} dia. x 3.65^{m} long (44 Ø x 12')
Three required per length of float pipe

270 Pontoons

Shore pipes: 0.41^{m} dia. x 4.76^{mm} wall (16 Ø x 0.188^{m} wall)
Tapers, bands, and tugs included. Pipe length 6.1^{m} (20')

2000 LF= 610^{m}

Estimated useful life: 2 1/2 to 3 years.

ALTERNATIVE II. (Continued)

CAPITAL COST. (December 1975 prices)

			US DOLLARS	CORDOBAS
1. One CS-2-16 Dredge FOB St. Louis , MO			473,750	
Freight:	Inland	$ 5,500		
	Ocean	101,000		
	Insurance	1,400		
			107,900	
Total CIF Corinto			581,650	4,071,550
2. One CS-2-16 Booster Pump, FOB, St. Louis MO			150,500	
Freight:	Inland	$ 1,000		
	Ocean	15,000		
	Insurance	400		
			16,400	
Total CIF Corinto			166,900	1,168,300
3. Equipment:				
1372^{m} (4500') 0.41 Ø float pipe with fittings, plus 270 pontoons, at $391.45/LM,FOB St. Louis.			537,075	
610^{m} (2000') 0.41^{m} Ø shore pipe with fittings, at $46.16/LM, FOB St. Louis, MO			28,160	
Freight:	Inland	$19,000		
	Ocean	181,000		
	Insurance	1,600		
			211,600	
Total Cost CIF, Corinto			776,835	5,437,845
4. Summation: Item 1,2,&3			1,525,385	10,677,695
5. Spare parts- one year supply See sheet 15			61,029	427,203
6. Total Capital Cost			1,586,414	11,104,898
			SAY:	11,105,000

ALTERNATIVE II. (Continued)

COST OF SPARE PARTS. ONE YEAR.			US DOLLARS	CORDOBAS
FOB, St. Louis, MO - see "Recommended Spare parts for Dixie Model CS-2-16 for One Year Operation" at the end of this Appendix, Sheets D-24 to D-26, incl.			51,329	
Freight:	Inland	$ 500		
	Ocean	9000		
	Insurance	200		
			9,700	
		Total Cost CIF Corinto	61,029	427,203

COST OF HAULING DREDGE & EQUIPMENT OVERLAND:

Cubic Measurements:

Dredge & booster	$360m^3$
1982 of 0.41^m Ø pipe	263
270 Pontoons	970
	$1593\ m^3$, say $1,600\ m^3$

Cost: $1,600m^3$ x C$1.42/$m^3$/km = C$2272 say C$2,300/KM

COST OF INSTALLING SKIDS AT SITE- LAUNCH & BACKHAUL DREDGE:

Estimated cost 100,000/ site.

COST OF ASSEMBLING & DISASSEMBLING DREDGE, INCLUDING LAUNCHING & BACKHAULING.

Estimated cost of assembly	C$ 6,000
Estimated cost of disassembly	C$ 3,000

ALTERNATIVE II. (Continuation)

OPERATING COST PER HOUR: CORDOBAS.

1. Dredge without booster; for the first 50 weeks. the crew will consist of:

a.	1 foreign dredgeman	at C$16.00/hr=	C$112
b.	1 deckhand/oiler	at	7
c.	4 laborers	at C$ 6.50/hr=	26
		Total crew labor	C$145/hr

2. Dredge with booster; for the first 50 weeks the crew will consist of:

a.	1 foreign dredgeman	at C$16.00/hr=	C$112
b.	1 pump operator		10
c.	1 deckhand/oiler		7
d.	4 laborers	6.50/hr	26
		Total crew labor	C$155/hr

3. Dredge without booster; balance of time, crew will consist of:

a.	1 dredgeman	at	C$12
b.	1 deckhand/oiler		7
c.	4 laborers	at 6.50	26
		Total crew labor	C$45/hr

4. Dredge with booster; balance of time, crew will consist of:

a.	1 dredgeman	at C$	12
b.	1 pump operator		10
c.	1 deckhand/oiler		7
d.	4 laborers	C$6.50	26
		Total crew labor	C$55/hr

5. Average labor cost- first 50 weeks- $\frac{2}{3}$ of time w/o booster, 1/3 of time w/booster foreign dredgman= 148.33
say C$ 149/hr

6. Average labor cost- balance of time 2/3 of time w/o booster, 1/3 of time w/booster all local personnel 48.33
say C$ 49/hr

ALTERNATIVE II. (Continued)

OPERATING COST PER HOUR. (Continued)

		CORDOBAS.
7.	Diesel, Fuel oil, dredge - 49.71 at C$3.85	191/hr
8.	Diesel, Fuel oil, dredge + booster 84.4 gph at 3.85	325/hr
9.	Average cost of fuel- dredge only operating 2/3 of time dredge + booster operating 1/3 of time C$235.66/hr	236/hr
10.	Oil & grease, dredge + booster	14/hr
11.	Oil & grease, dredge + booster	24/hr
12.	Average cost oil & grease- dredge only operating 2/3 of time, dredge + booster operating 1/3 of time = C$17.33/hr . say,	18/hr

13. Repairs & maintenance- dredge only

a.	Main engine	C$ 16
b.	Dredge pump(wear parts)	40
c.	Cutterhead, edges, bearing	4
d.	Drives and winches	9
e.	Hydraulics	7
f.	Miscellaneous, items	13
g.	Discharge pipeline & accesories	164
h.	Contingencies	43
	Total	C$296/hr

14. Repairs and maintenance - dredge+booster

a.	Main engines	28
b.	Pumps (wear parts)	81
c.	Cutterhead	4
d.	Drives & winches	11
e.	Hydraulics	7
f.	Misc. items	13
g.	Discharge pipeline and accesories	273
h.	Contingencies	56
	Total	C$473/hr

ALTERNATIVE II. (Continued)

OPERATING COST PER HOUR. (Continued)

15. Average cost of repairs & maintenance- dredge only operating 2/3 of time, dredge+booster operating 1/3 of time. C$355/ hr

16. Total operating Cost per Hour (Avg)

a. With foreign dredgeman- first 50 weeks
Sum of Items 5,9,12,15 758/hr

b. With all local personnel
Sum of items 6,9, 12, 15 658/hr

COST OF LINE BOAT 300/shift

COST OF TUG ASSISTANCE 5,000/shift

UNIT COST OF DREDGING

1. Dredging Quantities
Refer to sheet 8 4,050,000 m^3

2. Unit Cost Dredging Contractor Comparison

a. December 1975 price -contractor refer to sheet 8. C$ 15.50/m^3

b. Port Authority owned dredge feasible at C$ 10.00/m^3±

ALTERNATIVE II. (Continued)

UNIT COSTS OF DREDGING. (Continued)

3. Dredge Construction.

3. 2- 10hr shifts/day, 6 day week = 120hrs. **16,320 m^3/wk**

136 m^3/hr x 120

4. Dredging Time

Port Expansion

Corinto Phase I -1,028,000 ÷ 16,320 =	63 wks	
Corinto Phase II- 410,000 ÷ 16,320 =	25 wks	
Corinto Phase III 1,212,000 ÷ 16,320=	75 wks	
Two other ports- 1,400,000 ÷ 16,320 =	86 wks	
	249 wks	say, 250 wks

50 weeks - foreign dredgeman

200 weeks - all local personnel

20 year useful life = 1040 wks

Dredge operating: 250 ÷ 1040= 24% of time

ALTERNATIVE II. (Continued)

UNIT COSTS OF DREDGING. (Continued)

		CORDOBAS
5.	Unit Cost- P.A. Dredge Model CS-2-16- 4,050,000 M^3	
a.	Capital cost of dredge & booster pump, 1400^m of float pipe, 270 pontoons, 600^m of shore pipe (sheet14)	10,678,000
b.	Install skids at 3 sites 3x100,000 (sheet 15)	300,000
c.	Assembly Corinto 3 Other 2x2=4 Total 7x6,000 (sheet 15)	42,000
d.	Dissasembly 6x3.000 (sheet 15)	18,000
e.	Haulage Potosí 65x2 trips = 130 kms (sheet 15) S.J.del Sur 325x2= 650 780x2=1560 round trip say 1600Kms at 2.300	3,680,000
f.	Replace pipeline material - operating 5 years ± (sheet 14) Replace twice 2x5,437.845	10,876,000
g.	Spare parts- 5 years operation including 1 set at purchase of dredge 5x427.203 (sheet14)	2,136,000
h.	Operating costs	
	1. 50 weeks at 129x758 (sheet 18)=90.960/wks x 50	4,548,000
	2. 200 wks at 120x658=78,960/wk x 200	15,792,000
i.	Idle time- 790 wks.	
	1. watchman 7 days x 24hrs x C$6.50/hr= 1,092/wk	
	2. maintenance crew 1-10hr day/wk, say 5,000 6.092x790	4,813,000
j.	Line boat 250 wks x 12 shifts x 300 (sheet18)	900,000
k.	Tug assistance , say 30 shifts x 5,000 (sheet 18)	150,000
	TOTAL COST	C$ 53,933,000
l.	Unit Cost 53,933,000 ÷ 4,050,000 =	C$ 13.32/m^3

ALTERNATIVE II. (Continued).

Unit Costs of Dredging. (Continued)

6. Dredge Quantity Required Model C-S-2-16 Dredge at Unit Cost of C$ ± C$10.00/$M^3$

A cost curve has been plotted and attached to this Appendix. To operate the P. A. dredge Model C-S-2-16 at a unit cost of ± C$10.00 M^3, it will be necessary to dredge about 60% of the time. Based on a useful life of 20 years, the dredge will operate 12 years, or 624 weeks.

Total quantity of dredging required: 624x16,320= 10,184.000 m^3

Development of unit cost m^3:	CORDOBAS
a. Capital Costs	10,678.000
b. Install skids- 3 sites	300.000
c. Assembly- Total 8x6000	48.000
d. Dissasembly Total 7x300	21.000
e. Haulage 50% more = 1.5x1600=2.400Km at 2.300	5,520.000
f. Replace pipe line $\frac{12Yrs}{2.75}$ = 4.4 say 4 $\frac{1}{2}$ x 5.437.845	24,471.000
g. Spare parts - 12 years x 427.203	5,127.000
h. Operating costs:	
1. 50 wks x 90.960	4,548.000
2. 2.574 wks x 78.960	45,323.000
i. Idle time- 416 wks x 6,092	2,534.000
j. Line boat- 624x12x300	2,247.000
k. Tug assistance- 65 shifts x 5.000	325.000
Total Cost	C$ 101,142.000

2. Unit Cost 101.142.000 ÷ 10,184.000= C$9.93/$m^3$ ≠ C$10.00/$m^3$

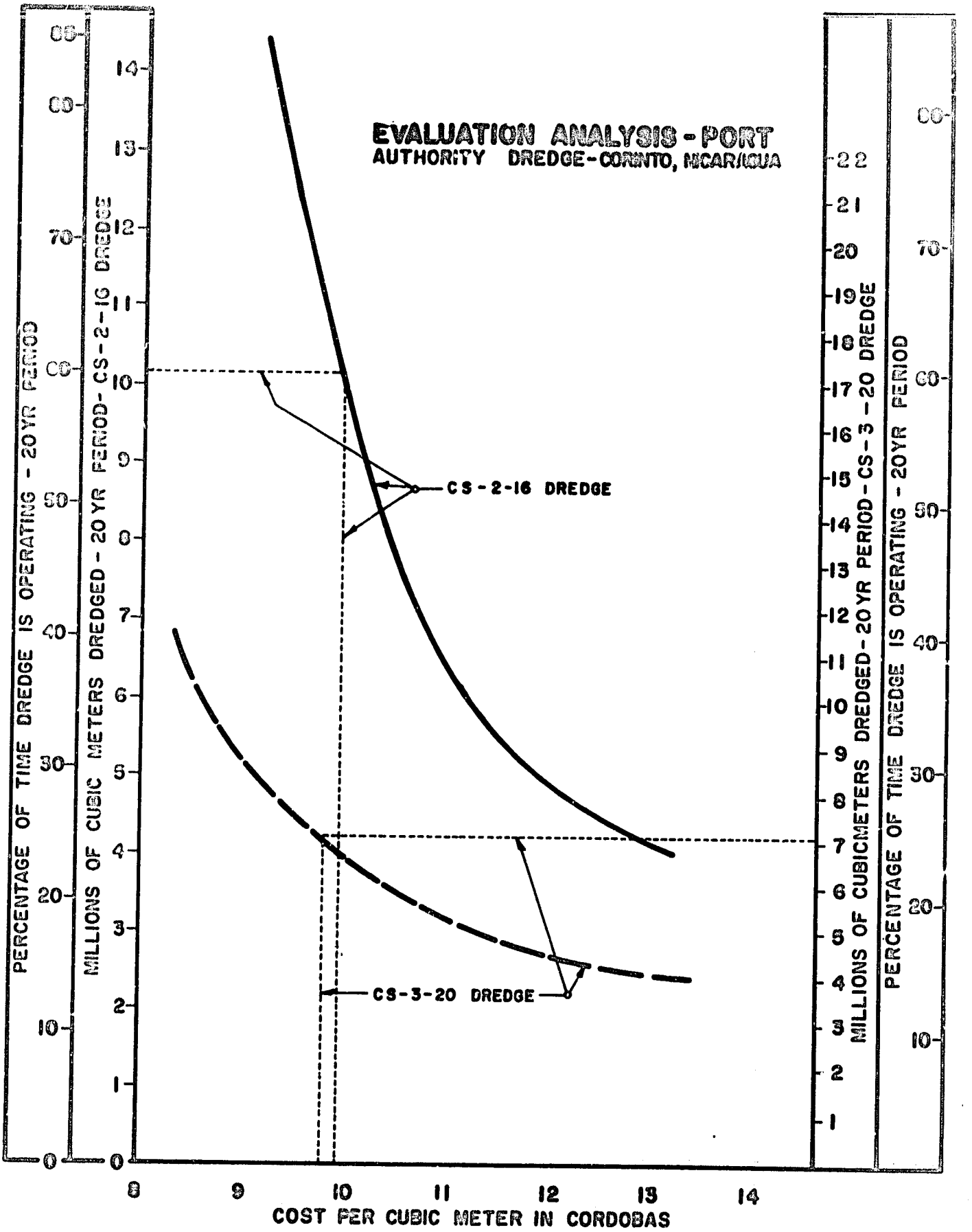
7. CONCLUSION: For the Port Authority Model C-S-2-16 with booster as needed, to dredge approximately 2,650.000 M^3 for the Port Expansion at Corinto, at 1,400.00 m^3 at other projected ports in Nicaragua, the dredge would operate 24% of the useful life of 20 years, at a unit of C$13.32/$m^3$. In order to obtain a unit cost of ±C$10.00/$m^3$ it would be necessary to dredge about 60% of the itme, with a total production of 10,200.000 m^3, which is not present visualized.

NOTE: All costs are based on December 1975 prices, without escalation.

HOPPER DREDGE.

The bare cost of a new hopper dredge with pump-out capabilities and a hold capacity of 4.000 cubic meters is approximately US$ 30,000.000 ; or 210.000.000 córdobas, delivered at U.S.A. shipyard.

Since this is a sea-going vessel with full crew, and costly to operate, it is not considered feasible for the Port Authority to purchase a hopper dredge for the "limited"amount of material to be removed.

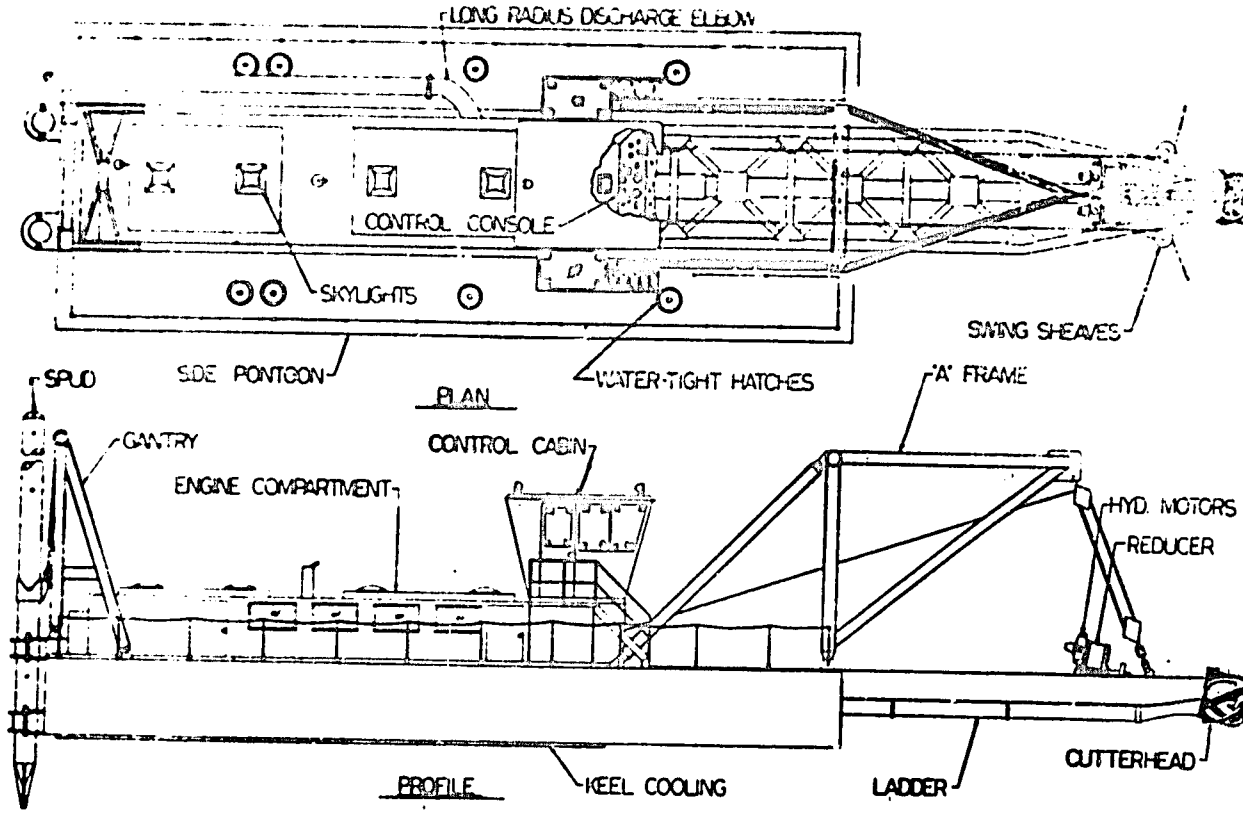


COST CURVES PROPOSED P.A. DREDGE

DIXIE DREDGE CORPORATION.

DETAILED SPECIFICATIONS
TWENTY-INCH PORTABLE DREDGE
MODEL CS-3-20 SERIES 300

GENERAL ARRANGEMENT (STANDARD)



WEIGHT & DIMENSIONS (APPROXIMATE)

	WGT.	L	W	D	CU/FT
HULL CENTER SECTION	160,000#	50' (56.5')	12' (12')	6' (11.5')	7794
CONTROL CABIN	3,000#	10' (11')	8.5' (9')	7' (10')	990
HULL SIDE SECTION (EACH)	39,000#	70' (70')	8' (8')	6' (7')	3920
LADDER ASSEMBLY	45,000#	56'	9'	7'	3528
LADDER A-FRAME	11,000#	18'	11'	18'	3564
SPUD GANTRY	8,000#	8'	10'	24'	1920
SPUDS (EACH)	8,500#	55'	24"	24"	220
MISCELLANEOUS	20,000#				
ASSEMBLED TOTAL	342,000#				26,076

DIMENSIONS IN PARENTHESES INCLUDE APPURTENANCES. CU/FT INDICATES APPROXIMATE VOLUME FOR SHIPPING PURPOSES.

	fwd.	DRY	aft	fwd.	WET	aft
DRAFT	59"		27"	58"		40"
FREEBOARD	13"		45"	14"		32"

CS-3-20

GENERAL

This twenty-inch cutter suction dredge is designed for hydraulic dredging in a wide range of categories. Its modern design has been thoroughly engineered, using the most recent technology in the dredging industry, to offer the cutomer:

- outstanding component reliability
- sturdy construction
- ease of operation
- simplicity of maintenance
- versatility
- high degree of portability

PRODUCTION CAPACITY

This dredge has a production rate of from 320 to 1415 cubic yards per hour of medium type material up to 10" in diameter, at discharge distances up to 6000 ft. depending upon the material and pumping conditions.

DREDGE PUMP

The dredge pump is a centrifugal, single suction, volute type, engineered for efficient operation under a wide range of pumping conditions. It is a heavy duty dredge pump constructed for continuous dredging duty. DIXIE mounts the center line of the dredge pump at water level, thereby, lowering the center of gravity, substantially increasing operating efficiency and eliminating costly priming procedures. All wear parts are available in a variety of abrasion resistant metal alloys, chemically compounded for the individual job. Other features include: pump shaft of high strength steel designed to withstand usual dredging conditions, heavy duty bearings for both radial and thrust loads, and lateral impeller adjustment to compensate for wear, thus maintaining pumping efficiency throughout the life of the pump. Attached is a long radius discharge elbow allowing free flow of materials to the discharge pipe.

The standard dredge pump has a 24" suction and 20" discharge with an impeller diameter of 48".

PUMP DRIVE

The dredge pump is diesel driven through a totally enclosed, oil-lubricated, speed reduction gearbox. This positive drive system, providing direct engine shaft to pump shaft power transmission, assures optimum utilization of available horsepower, minimum maintenance and longer life. The standard reduction ratio is 2.462:1 with alternate ratios available for differing pumping conditions.

DREDGE PUMP DRIVE

The dredge pump is driven by a Caterpillar D-399 turbocharged and raw water aftercooled diesel engine with air starting. This engine is rated at 1125 continuous horsepower at 1200 RPM.

AUXILIARY ENGINE

The hydraulic system, service water system, air compressor and generator are driven by an electric starting Caterpillar D-343 turbocharged and aftercooled diesel engine rated at 390 intermittent horsepower at 1800 RPM.

NOTE: Alternate main and auxiliary diesel power, or other power systems, are available as an option; additional cost, if any, to be determined according to power preference.

COOLING SYSTEM

The diesel engines are keel cooled to provide engine cooling by transference of heat to the body of water in which the dredge is working. Heat exchangers are available as a regular production option according to customer preference.

SHUTDOWN SYSTEM

The diesel engines are equipped with automatic shutdowns in case of low oil pressure, high water temperature or engine overspeed.

AUXILIARY WATER PUMP

This pump supplies fresh water for the dredge pump packing gland, cutter shaft cutless bearings and is a source of water for general maintenance.

HAULING & HOISTING MACHINERY

The dredge is equipped with a 5-drum DIXIE Model V5D-22 winch, specifically designed for dredging service, arranged with the two swing drums and ladder drum on the forward shaft and the two spud drums on the aft shaft. Each drum is individually controlled by air clutches and brakes, automatically energized in the case of a power failure. All bearings are of the anti-friction type. Shafts are gear driven by a single, low speed, high torque hydraulic motor with variable speed control.

	SWING DRUMS	LADDER DRUM	SPUD DRUMS
line pull rating (max.)	22,000#	22,000#	15,800#
line pull rating (working)	17,800#	16,500#	11,900#
wire rope size	3/4"	3/4"	3/4"
drum barrel diameter	13"	18"	13"
wire rope capacity	500'	400'	175'

MAIN HULL CENTER SECTION

This main section (50' long x 12' wide x 6' deep) houses all of the main machinery and is transported intact. It is sturdily constructed of appropriately spaced heavy angle transverse framing with 3/4" end plates, 1/4" bottom plate and 1/4" side plates. All structural work is in conformance with standard barge construction. Additional longitudinal hull strength is provided by the addition of keel cooling channels. The engine, reduction gear and pump is mounted on a modular foundation which facilitates ease of manufacture, assembly and maintenance. Additional bracing is provided at areas such as spud gantry, a-frame mounting and ladder trunnions.

HULL SIDE SECTIONS

The hull side sections are each 70' long (one 40' section and one 30' section), 8' wide and 6' deep for portability purposes. These side sections each have three watertight compartments used for fuel storage and ballast. These side sections are assembled to the hull center section by bolting at deck level and by an overlapping slot arrangement at the bottom. This method of connection permits pontoon repositioning for trim purposes if the original ladder length is varied.

Assembly of the complete hull by the above method is a DIXIE exclusive, and does not require any bolting below water level.

DREDGING LADDER

The dredging ladder is ruggedly constructed of fabricated structural steel designed to withstand the stresses and impact of continuous dredging duty. The trunnion ends have 8" pins for lasting durability. The suction pipe is 24" O.D., 1/2" wall, suspended within the structure of the ladder by u-bolts and may be rotated or without involving altering the structure of the ladder. A specially designed, re-wall steel suction bellmouth is provided at the suction opening. Bronze bushed grease lubricated 24" diameter swing sheaves are positioned for the most effective digging force. The cutter drive is located at the forward end of the ladder more weight on the working end, eliminating long shafting and bearings.

VARIABLE LENGTH

The ladder can be engineered with provisions for lengthening, in the field, by the insertion of an optional extension section. Extensions of up to 30 feet may be added without the necessity of further structural changes. When the ladder length is increased, the DIXIE design permits repositioning of the hull side sections, if necessary, to maintain proper trim. In some cases, additional flotation may be required.

The digging angle of the cutter may be varied, if desired, by the insertion of an optional wedge piece in the ladder.

BEST AVAILABLE COPY

HYDRA-DRIVE CUTTERHEAD ASSEMBLY

The short shaft, underwater cutter drive was originated by DIXIE. This concept has been engineered and refined by DIXIE engineers for over 20 years. The dredge is equipped with a Hydra-Drive unit rated at 36,400 ft. lbs. torque with a maximum speed of 26 RPM as standard. Higher torque units are available as a regular production option according to job requirements.

The Hydra-Drive unit is powered by two hydraulic motors driving the cutterhead through a heavy duty, totally enclosed gearbox. A special seal is used for sealing the output shaft against exterior contamination. The 5" cutter shaft is fitted with bronze sleeves turning in water-lubricated cutless bearings. A heavy duty 5 or 6 blade 46" I.D. basket type cutterhead is equipped with replaceable serrated edges. Other edges are available in a variety of designs for different materials.

HYDRAULIC OIL SYSTEM

The hydraulic oil system incorporates three independent circuits controlling the cutter drive, winch drive and spud movement. The pumps are direct driven by the diesel engine through enclosed gearing. Only highest grade industrial hydraulic hose, valves and fittings are used. A dual filtering system consisting of suction line external filters with magnetic rods and return line external canister type filters is used. This system utilizes telltale gauges to indicate when filters need cleaning or replacing. Pressure relief valves in each system prevent damage due to overload or stalling and gauges in the control console indicate the pressures of each system being used.

ELECTRICAL SYSTEM

A DC electrical system is provided for starting the diesel engine. An adequate AC generating unit provides electrical power for internal and external lighting, convenience outlets, small tool operation, etc. All wiring is protected by armored jacketing or conduit. All fixtures and switches are of marine grade.

ELEVATED CONTROL CABIN

The control cabin is an independent compartment of modular design, elevated for unobstructed 360° visibility, carefully planned for one-man operation. Special design consideration has been devoted to reducing operator fatigue while maintaining operating efficiency. Opening front and side windows with screens are provided to allow cross flow ventilation. The forward is raked to reduce reflected glare and improve visibility in foul weather. The rear non-opening window is also raked. All glass is tinted. Locking doors, a fully adjustable operator's seat, dome lights and convenience storage shelves are built in as standard equipment.

MODULAR CONSTRUCTION

Modular design means standardization of machinery components resulting in substantially increased availability of models, interchangeability of many major components and increased simplicity of assembly and disassembly.

PAINTING

All DIXIE DREDGES are painted according to a carefully planned painting schedule, designed for durability and minimum maintenance. Steel surfaces are appropriately prepared for painting by sandblasting, chemical treatment or power buffing. Exterior hull surfaces of both center and side sections are given a heavy coat of self priming expoxy tar. The engine compartment and control room, exterior and interior, are given a coat of red lead primer and a finish coat of marine grade enamel. The ladder, frames, spuds, walkways and decks receive a coat of red lead primer and finish coat of marine grade hull black enamel.

POLICY

It is the policy of DIXIE DREDGE CORPORATION to continually strive to improve its product design. Accordingly, we reserve the right to change these specifications to incorporate any such improvements that may be developed prior to the time of manufacture.

ASSEMBLY & CREW TRAINING

DIXIE DREDGE provides a thoroughly qualified field engineer to supervise and assist in the assembly and launching of the dredge at the jobsite, and, thereafter, to train the owner's personnel in the proper operation and maintenance of the machine to assure maximum production, minimum downtime.

AUXILIARY EQUIPMENT (STANDARD)

The following items of auxiliary equipment are standard on the model:

- 110/220 volt electrical system with interior and exterior lighting
- jib crane mounted on side section for pump maintenance
- wire rope - all necessary for hauling and hoisting operation
- two anchors, 750 lbs. each
- batteries
- special watertight hatches in side sections
- chain type safety handrails on side sections

AUXILIARY EQUIPMENT (OPTIONAL)

The following items of accessory equipment are available on this model:

- standby auxiliary generator
- special outside lighting, searchlight, identification lights, etc.
- insulated control room with air conditioner and/or heater
- mass flow measuring equipment
- vacuum and discharge pressure recorder
- radio-positioning equipment
- bottom profiling equipment
- compass
- ladder extension
- venturi twin hydra-jet suction boost
- discharge flap valve
- discharge stern swivel
- discharge hose
- x-mas tree (3-wire stern positioning system)
- anchor booms and rigging
- coast guard documentations
- A.B.S. inspection - To inspect dredge for contract conformance
- safety equipment, life preservers, etc.
- bilge and fire pump
- special tools

A special electric version of this dredge is available with the following:

- electric prime power
- dual-stator drive electric winches
- ELECTROVATOR, submarine electric cutterhead and dredge pump drives

PERFORMANCE GEOMETRY

Ladder Length	Hull Side Sections Dimensions			Ladder Inclined						
				0°	15°		30°		45°	
	L	W	D	B	A	B	A	B	A	B
50'	70'	8'	6'	150'	13'	146'	26'	139'	36'	127'
60'	80'	8'	6'	164'	16'	160'	31'	151'	43'	137'
70'	85'	8'	6'	178'	18'	173'	36'	163'	50'	147'
80'	85'	8'	6'	192'	21'	187'	41'	176'	57'	157'

A = Depth @ Ladder Angle B = Swing Range @ Given Ladder Angle and Depth

ESTIMATED PRODUCTION CHART

CS-3-20

20 x 24 DREDGE PUMP
48" IMPELLER
TOTAL CONTINUOUS BHP, AVAILABLE, 1125
20" DIAMETER DISCHARGE PIPE, 10' STATIC HEAD
2.462:1 RATIO

DISCHARGE DISTANCE FEET	SLURRY GPM	VELOCITY FPS	ENGINE SPEED	BHP REQUIRED (NOMINAL)	CUBIC YARDS PER HOUR MATERIALS A LIGHT	B MEDIUM	C COARSE
500	21,000	23.3	927	791	1470/1615	1285/1415	1105/1210
1000	18,250	20.3	980	845	1160/1275	995/1090	825/905
1500	16,500	18.3	1026	890	950/1045	795/875	645/705
2000	15,500	17.3	1061	931	845/930	705/770	560/610
2500	15,200	17.0	1107	1033	825/910	685/755	550/600
3000	14,100	15.7	1130	1059	710/775	585/640	460/500
3500	13,400	14.9	1093	1040	570/630	470/520	335/375
4000	12,900	14.3	1110	1075	520/575	430/475	305/335
4500	12,300	13.7	1120	1085	470/520	385/430	270/300
5000	11,900	13.2	1125	1085	435/480	355/395	240/265
5500	11,200	12.5	1125	1085	380/420	320/350	
6000	10,500	11.7	1125	1085	330/370		

PRODUCTION ESTIMATES

A - BASED ON 11-23% SOLIDS BY VOLUME

B - BASED ON 10-21% SOLIDS BY VOLUME

C - BASED ON 9-17% SOLIDS BY VOLUME

THIS PERFORMANCE DATA RESULTED FROM CONTROLLED TESTS AND CALCULATIONS CONDUCTED BY PERSONNEL OF DIXIE, AND, IN PART, REPRESENTS REASONABLE EXTRAPOLATIONS FROM THE TEST RESULTS. THIS DATA IS NOT, AND SHOULD NOT BE CONSTRUED TO BE, A WARRANTY OR GUARANTY THAT THE DIXIE DREDGE TO BE SOLD HEREUNDER WILL PERFORM AS HEREIN INDICATED. DIXIE CAUTIONS THAT MATERIALS DREDGED FREQUENTLY VARY SUBSTANTIALLY FROM SAMPLE TEST RESULTS. MOREOVER, THE SKILL OF THE OPERATING PERSONNEL OF THE DREDGE PLAY A SUBSTANTIAL ROLE IN ITS PRODUCTION.

DIXIE DREDGE CORPORATION.

RECOMMENDED SPARE PARTS LIST FOR DIXIE MODEL CS-3-20 FOR ONE (1) YEAR'S OPERATION

DREDGE PUMP

QUANTITY	DESCRIPTION	PRICE
1	Shell	$20,654.00
1	Impeller	6,144.00
1	Suction Side Liner	4,478.00
1	Engine Side Liner	3,415.00
1	Shaft Sleeve	980.00
1	Water Ring	514.00
1	Copper Washer	168.00
1	Set of Rubber Packing	90.00
2	Door Seals (Rubber)	51.00
1	Box of Packing	119.00
	TOTAL	$36,613.00

II. HYDRAULIC EQUIPMENT

QUANTITY	DESCRIPTION	PRICE
1	Hydraulic Pump, Swing and Spuds	$ 678.00
1	Seal Kit for Swing and Spud Pump	9.00
1	Hydraulic Pump, Cutter	678.00
1	Seal Kit for Cutter Pump	9.00
1	Hydraulic Motor, Cutter	3,170.00
1	Seal Kit for Cutter Motor	97.00
24	Return Line Filter Elements	210.00
2	Suction Line Filter Elements	81.00
3	Hydraulic Pressure Gauges, 0-3000#	156.00
	TOTAL	$ 5,088.00

Recommended Spare Parts List for DIXIE Model CS-3-20 for One (1) Year's Operation
Page 2

III. CUTTER AND CUTTER DRIVE EQUIPMENT

QUANTITY	DESCRIPTION	PRICE
1	Cutterhead	$ 5,680.00
12	Cutter Edges, Top	516.00
12	Cutter Edges, Bottom	444.00
1	Star Coupling	1,229.00
1	Cutter Shaft	2,146.00
2	Cutless Bearings	972.00
2	Bronze Sleeves for Cutter Shaft	381.00
	TOTAL	$11,368.00

IV. SERVICE WATER PUMP

QUANTITY	DESCRIPTION	PRICE
1	Repair Kit consisting of the following:	$ 996.00
	(1) Impeller (1) Shaft (1) Shaft Sleeve (1) Gasket (1) Impeller Cap Screw (1) Washer (1) Gasket (1) Gasket O-Ring (1) Impeller (1) Gasket (1) Set of Packing (6 Rings/Set)	
2	Sets of Drive Belts (2 Belts/Set)	48.00
	TOTAL	$ 1,044.00

Recommended Spare Parts List for DIXIE Model CS-3-20 for One (1) Year's Operation
Page 3

V. MISCELLANEOUS

QUANTITY	DESCRIPTION	PRICE
1	Suction Hose, 24"	$ 5,656.00
1	Discharge Elbow, 20"	4,849.00
1	Coupling Element, Reducer to Dredge Pump	366.00
1	Set of Clutch Friction Plates	705.00
2	Swing Sheave Block Repair Kits each consisting of: ...	943.00
	(1) Sheave Assembly (1) Bushing (1) Sleeve (2) Adjusting Caps (2) Piston Ring Grease Seals (1) Center Pin w/Nut	
1	Suction Vacuum Gauge, 0-30"	47.00
1	Discharge Pressure Gauge, 0-160#	47.00
2	Sets of Drive Belts for AC Generator (3 Belts/Set) ...	75.00
	TOTAL	$12,688.00

VI. HAULING GEAR

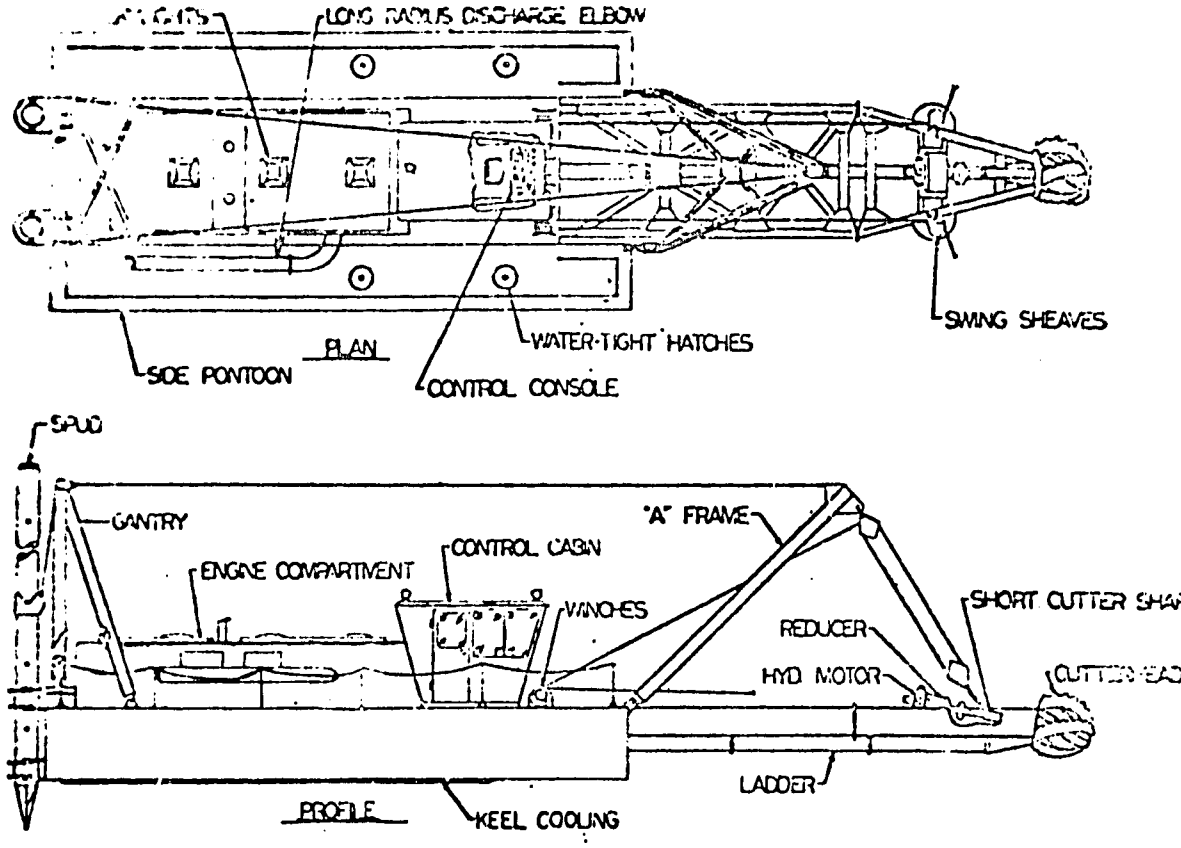
QUANTITY	DESCRIPTION	PRICE
1	Ladder Drum Brake Drum	$ 310.00
1	Spring	25.00
1	Brake Chamber (Ladder)	216.00
1	Brake Chamber (Anchor)	129.00
1	Shuttle Valve	18.00
1	Quick Release Valve	18.00
1	Roto Seal	95.00
	Duo Roto Seal	153.00
	TOTAL	$ 964.00

GRAND TOTAL $67,765.00

DIXIE DREDGE CORPORATION.

DETAILED SPECIFICATIONS
SIXTEEN-INCH PORTABLE DREDGE
MODEL CS-2-16 SERIES 300

GENERAL ARRANGEMENT (STANDARD)



WEIGHT & DIMENSIONS (APPROXIMATE)

	WGT.	L	W	D	CU/FT
HULL CENTER SECTION	92,900#	40' (45')	10' (10')	5' (12')	5400
CONTROL CABIN	3,000#	10' (11')	8.5' (9')	7' (10')	990
HULL SIDE SECTION (EACH)	18,000#	55' (55')	5' (5')	5' (5.5')	1513
LADDER ASSEMBLY	20,000#	35'	9'	3.5'	1103
LADDER A-FRAME	3,000#	17'	11'	1'	187
SPUD GANTRY	4,000#	5'	10'	14'	700
SPUDS (EACH)	3,300#	33'	18"	18"	75
MISCELLANEOUS	14,000#				
ASSEMBLED TOTAL	179,500#				,556

DIMENSIONS IN PARENTHESES INCLUDE APPURTENANCES. CU/FT INDICATES APPROXIMATE VOLUME FOR SHIPPING PURPOSES.

	fwd.	DRY	aft	fwd.	WET	aft
DRAFT	39"		33"	43"		42"
FREEBOARD	21"		27"	17"		18"

CS-2-16

GENERAL

This sixteen-inch cutter suction dredge is designed for hydraulic dredging in a wide range of categories. Its modern design has been thoroughly engineered, using the most recent technology in the dredging industry, to offer the customer:

- outstanding component reliability
- sturdy construction
- ease of operation
- simplicity of maintenance
- versatility
- high degree of portability

PRODUCTION CAPACITY

This dredge has a production rate of from 165 to 885 cubic yards per hour of medium type material up to 8" in diameter, at discharge distances up to 4500 ft. depending upon the material and pumping conditions.

DREDGE PUMP

The dredge pump is a centrifugal, single suction, volute type, engineered for efficient operation under a wide range of pumping conditions. It is a heavy duty dredge pump constructed for continuous dredging duty. DIXIE mounts the center line of the dredge pump at water level, thereby, lowering the center of gravity, substantially increasing operating efficiency and eliminating costly priming procedures. All wear parts are available in a variety of abrasion resistant metal alloys, chemically compounded for the individual job. Other features include: pump shaft of high strength steel designed to withstand usual dredging conditions, heavy duty bearings for both radial and thrust loads, and lateral impeller adjustment to compensate for wear, thus maintaining pumping efficiency throughout the life of the pump. Attached is a long radius discharge elbow allowing free flow of materials to the discharge pipe.

The standard dredge pump has an 18" suction and 16" discharge with an impeller diameter of 40".

PUMP DRIVE

The dredge pump is driven through a timing gear belt drive. This positive drive system, providing direct engine shaft to pump shaft power transmission, assures optimum utilization of available horsepower, minimum maintenance and longer life. The standard reduction ratio is 3.26:1 with alternate ratios available for differing pumping conditions.

DREDGE PUMP ENGINE

The dredge pump is driven by a pair of Caterpillar D-343 turbocharged and jacket water aftercooled diesel engines with electric starting. These engines are each rated at 335 continuous horsepower at 1800 RPM.

AUXILIARY ENGINE

The hydraulic system, service water system and generator are driven by an electric starting Caterpillar 3306 turbocharged and aftercooled diesel engine rated at 215 intermittent horsepower at 1800 RPM.

NOTE: Alternate main and auxiliary diesel power, or other power systems, are available as an option; additional cost, if any, to be determined according to power preference.

COOLING SYSTEM

The diesel engines are keel cooled to provide engine cooling by transference of heat to the body of water in which the dredge is working. Heat exchangers are available as a regular production option according to customer preference.

SHUTDOWN SYSTEM

The diesel engines are equipped with automatic shutdowns in case of low oil pressure, high water temperature or engine overspeed.

AUXILIARY WATER PUMP

This pump supplies fresh water for the dredge pump packing gland, cutter shaft cutless bearings and is a source of water for general dredge maintenance.

HAULING & HOISTING MACHINERY

The dredge is equipped with three hydraulic planetary gear winches, specifically designed for dredging service. Each drum is individually controlled by automatic internal clutches and brakes. These are activated by the hydraulic control valves on the control console. The brake is automatically energized in the case of a power failure. All bearings are of the anti-friction type. Each winch is gear driven by a single, low speed, high torque hydraulic motor with variable speed control.

The spuds are operated by the use of separate hydraulic cylinders each rated at 42,400 pounds lift.

	SWING DRUMS	LADDER DRUM	SPUD CYLINDERS
line pull rating	18,000#	15,000#	
wire rope size	3/4"	5/8"	3/4"
drum barrel diameter	8"	8"	
wire rope capacity	300'	300'	65'

MAIN HULL CENTER SECTION

This main section (40' long x 10' wide x 5' deep) houses all of the main machinery and is transported intact. It is sturdily constructed of approprietely spaced heavy angle transverse framing with 1/2" end plates, 1/4" bottom plate and 1/4" side plate All structrual work is in conformance with standard barge construction. Additional longitudinal hull strength is provided by the addition of the keel cooling channels. The dredge pump, engine and reduction gear are supported by an integral fabricated steel foundation rigidly attached to the bottom transverse framing. Additional bracing is provided at areas of concentrated loads such as spud gantry, a-frame mounting and ladder trunnions.

HULL SIDE SECTIONS

The hull side sections are each 55' long, 5' wide and 5' deep for portability purpos These side sections each have four watertight compartments used for fuel storage and ballast. These side sections are assembled to the hull center section by bolting at deck level and by an overlapping slot arrangement at the bottom. This method of connection permits pontoon repositioning for trim purposes if the original ladde length is varied.

Assembly of the complete hull by the above method is a DIXIE exclusive, and does not require any bolting below water level.

DREDGING LADDER

The dredging ladder is ruggedly constructed of fabricated structural steel designed to withstand the stresses and impact of continuous dredging duty. The trunnion ends have 8" pins for lasting durability. The suction pipe is 18" O.D., 1/2" wall, suspended within the structure of the ladder by u-bolts and may be rotated or replaced without altering the structure of the ladder. A specially designed, replaceable heavy wall steel suction bellmouth is provided at the suction opening. Bronze bushed grease lubricated 20" diameter swing sheaves are positioned for the most effective digging force. The cutter drive is located at the forward end of the ladder placing more weight on the working end, eliminating long shafting and bearings.

VARIABLE LENGTH

The ladder can be engineered with provisions for lengthening, in the field, by the insertion of an optional extension section. Extensions of up to 40 feet may be added without the necessity of further structural changes. When the ladder length is increased, the DIXIE design permits repositioning of the hull side sections, if necessary, to maintain proper trim. In some cases, additional flotation may be required.

The digging angle of the cutter may be varied, if desired, by the insertion of an optional wedge piece in the ladder.

HYDRA-DRIVE CUTTERHEAD ASSEMBLY

The short shaft, underwater cutter drive was originated by DIXIE. This concept has been engineered and refined by DIXIE engineers for over 20 years. The dredge is equipped with a Hydra-Drive unit rated at 17,506 ft. lbs. torque with a maximum speed of 30 RPM as standard. Higher torque units are available as a regular production option according to job requirements.

The Hydra-Drive unit is powered by a hydraulic motor driving the cutterhead through a heavy duty, totally enclosed gearbox. A special seal is used for sealing the output shaft against exterior contamination. The 4 1/2" cutter shaft is fitted with bronze sleeves turning in water-lubricated cutless bearings. A heavy duty 5 or 6 blade, 38" I.D. basket type cutterhead is equipped with replaceable offset serrated edges. Other edges are available in a variety of designs for different materials.

HYDRAULIC OIL SYSTEM

The hydraulic oil system incorporates three independent circuits controlling the cutter drive, winch drive and spud cylinders. The pumps are direct driven by the diesel engine through enclosed gearing. Only highest grade industrial hydraulic hose, valves and fittings are used. A dual filtering system consisting of suction line external filters with magnetic rods and return line external canister type filters is used. This system utilizes telltale gauges to indicate when filters need cleaning or replacing. Pressure relief valves in each system prevent damage due to overload or stalling and gauges in the control console indicate pressures of each system being used.

ELECTRICAL SYSTEM

A DC electrical system is provided for starting the diesel system. An adequate AC generating unit provides electrical power for internal and external lighting, convenience outlets, small tool operation, etc. All wiring is protected by armored jacketing or conduit. All fixtures and switches are of marine grade.

CONTROL CABIN

The control cabin is an independent compartment with unobstructed 360° visibility, carefully planned for one-man operation. Special design consideration has been devoted to reducing operator fatigue while maintaining operating efficiency. Opening front and side windows with screens are provided to allow cross flow ventilation. The forward is raked to reduce reflected glare and improve visibility in foul weather. The rear non-opening window is also raked. All glass is tinted. Locking doors, a fully adustable operator's seat, dome lights and convenience storage shelves are built in as standard equipment.

OPERATING CONTROLS

The DIXIE control console is engineered to provide the operator total utilization of the machinery at his command. The carefully arranged combination of positive control levers including vacuum and discharge gauges, hydraulic and water pressures and all engine monitoring gauges are designed for maximum operator accessibility. Variable speed controls for the cutter and swing functions and engine throttle and clutch controls are incorporated in the console.

ENGINE DECKHOUSE

The deckhouse is designed to provide shelter for the machinery against the elements and as security against vandalism or theft. The deckhouse is sturdily constructed of heavy gage steel plate and provided with sliding windows with locks and screens to provide ventilation and forms an integral part of the hull structure for maximum portability. Roof sections with skylights are individually removable for major maintenance.

SPUDS

Two heavy-wall tubular steel spuds (18" dia. x 33' long are standard) of suitable strength for the designed dredging depth are furnished. Each spud is fitted with a specially designed cast steel point for better penetration and positive holding in hard materials and for reduced resistance when lifting. Heavy-wall positioning holes, appropriately spaced, and cross pins are provided with sliding side lift collars activated by wire rope haulage, remotely controlled from the lever room. Spuds are set by free-fall control to facilitate setting and maximum penetration. The spuds are actuated by heavy-duty hydraulic cylinders.

FRAMES & RIGGING

The ladder a-frame/gallows frame, and the spud frame, are fabricated from heavy structural steel, pin connected through cast steel brackets for portability. Deck brackets are mounted on heavy, reinforcing plate. Ladder and spud lifting blocks are of diamond pattern construction with lubricated bronze bushing.

PORTABILITY

DIXIE DREDGE originated the concept of a standard model portable dredge and was a pioneer in the development of this important construction tool. Top engineering priority is given to maintaining maximum portability of design consistent with sound construction. Modern design and engineering practice eliminates unnecessary weight and assures ample strength.

MODULAR CONSTRUCTION

Modular design means standardization of machinery components resulting in substantially increased availability of models, interchangeability of many major components and increased simplicity of assembly and disassembly.

PAINTING

All DIXIE DREDGES are painted according to a carefully planned painting schedule, designed for durability and minimum maintenance. Steel surfaces are appropriately prepared for painting by sandblasting, chemical treatment or power buffing. Exterior hull surfaces of both center and side sections are given a heavy coat of self priming epoxy tar. The engine compartment and control room, exterior and interior, are given a coat of red lead primer and a finish coat of marine grade enamel. The ladder, frames, spuds, walkways and decks receive a coat of red lead primer and finish coat of marine grade hull black enamel.

POLICY

It is the policy of DIXIE DREDGE CORPORATION to continually strive to improve its product design. Accordingly, we reserve the right to change these specifications to incorporate any such improvements that may be developed prior to the time of manufacture.

ASSEMBLY & CREW TRAINING

DIXIE DREDGE provides a thoroughly qualified field engineer to supervise and assist in the assembly and launching of the dredge at the jobsite, and, thereafter, to train the owner's personnel in the proper operation and maintenance of the machine to assure maximum production, minimum downtime.

AUXILIARY EQUIPMENT (STANDARD)

The following items of auxiliary equipment are standard on this model:

- 110/220 volt electrical system with interior and exterior lighting
- jib crane mounted on side section for pump maintenance
- wire rope - all necessary for hauling and hoisting operation
- two anchors, 750 lbs. each
- batteries
- special watertight hatches in side sections
- chain type safety handrails on side sections

AUXILIARY EQUIPMENT (OPTIONAL)

The following items of accessory equipment are available on this model:

- standby auxiliary generator
- special outside lighting, searchlight, identification lights, etc.
- insulated control room with air conditioner and/or heater
- mass flow measuring equipment
- vacuum and discharge pressure recorder
- radio-positioning equipment
- bottom profiling equipment
- compass
- ladder extension
- venturi twin hydro-jet suction boost
- discharge flap valve
- discharge stern swivel
- discharge hose
- x-mas tree (3-wire stern positioning system)
- anchor booms and rigging
- coast guard documentations
- A.B.S. inspection - To inspect dredges for contract conformance
- safety equipment, life preservers, etc.
- bilge and fire pump
- special tools

A special electric version of this dredge is available with the following:

- electric prime power
- dual-stator drive electric winches
- ELECTROVATOR, submarine electric cutterhead and dredge pump drives

PERFORMANCE GEOMETRY

Ladder Length	Hull Side Sections Dimensions			Ladder Inclined						
				0°	15°		30°		45°	
	L	W	D	B	A	B	A	B	A	B
30'	55'	5'	5'	107'	8'	105'	15'	101'	22'	94'
40'	60'	5'	5'	121'	11'	119'	20'	113'	29'	104'
50'	65'	5'	5'	136'	13'	133'	25'	125'	36'	114'
60'	75'	5'	5'	149'	16'	146'	30'	138'	43'	124'
70'	75'	6'	5'	163'	18'	160'	34'	150'	50'	134'

A = Depth @ Ladder Angle B = Swing Range @ Given Ladder Angle and Depth

ESTIMATED PRODUCTION CHART

CS-2-16

16 x 18 DREDGE PUMP
40" IMPELLER
TOTAL CONTINUOUS BHP, AVAILABLE, 670
16" DIAMETER DISCHARGE PIPE, 10' STATIC HEAD
3.26:1 RATIO

DISCHARGE DISTANCE FEET	SLURRY GPM	VELOCITY FPS	ENGINE SPEED	BHP REQUIRED (NOMINAL)	CUBIC YARDS PER HOUR MATERIALS A LIGHT	B MEDIUM	C COARSE
500	13,500	23.7	1500	562	905/1005	800/885	665/735
1000	11,500	20.2	1590	580	690/760	595/660	480/530
1500	10,500	18.5	1701	630	585/645	490/540	380/420
2000	9600	16.7	1731	638	475/525	390/430	290/320
2500	8500	14.9	1744	640	360/400	300/330	215/240
3000	8100	14.2	1779	660	320/355	270/300	190/210
3500	7500	13.2	1800	670	270/300	230/255	155/170
4000	7100	12.5	1800	670	240/265	200/220	140/150
4500	6600	11.5	1800	660	205/230	165/185	
5000	6350	11.0	1800	650	185/205		

PRODUCTION ESTIMATES

A - BASED ON 11-23% SOLIDS BY VOLUME

B - BASED ON 10-21% SOLIDS BY VOLUME

C - BASED ON 7-17% SOLIDS BY VOLUME

THIS PERFORMANCE DATA RESULTED FROM CONTROLLED TESTS AND CALCULATIONS CONDUCTED BY PERSONNEL OF DIXIE, AND, IN PART, REPRESENTS REASONABLE EXTRAPOLATIONS FROM THE TEST RESULTS. THIS DATA IS NOT, AND SHOULD NOT BE CONSTRUED TO BE, A WARRANTY OR GUARANTY THAT THE DIXIE DREDGE TO BE SOLD HEREUNDER WILL PERFORM AS HEREIN INDICATED. DIXIE CAUTIONS THAT MATERIALS DREDGED FREQUENTLY VARY SUBSTANTIALLY FROM SAMPLE TEST RESULTS. MOREOVER, THE SKILL OF THE OPERATING PERSONNEL OF THE DREDGE PLAY A SUBSTANTIAL ROLE IN ITS PRODUCTION.

DIXIE DREDGE CORPORATION.
SIXTEEN-INCH, SERIES 200, BOOSTER STATION

GENERAL

This sixteen-inch booster station is designed for use when additional discharge length is required in a light range of materials. Its modern design has been thoroughly engineered, using the most recent technology in the dredging industry.

DREDGE PUMP

The dredge pump is a centrifugal, single suction, volute type, engineered for efficient operation under a wide range of pumping conditions. It is a heavy duty dredge pump constructed for continuous dredging duty. All wear parts are available in a variety of abrasion resistant metal alloys, chemically compounded for the individual job. Other features include: pump shaft of high strength steel designed to withstand usual dredging conditions, heavy duty bearings for both radial and thrust loads, thus maintaining pumping efficiency throughout the life of the pump.

The standard dredge pump has an 18" suction and 16" discharge with an impeller diameter of 40".

PUMP DRIVE

The dredge pump is diesel driven through a totally enclosed, oil-lubricated, speed reduction gearbox. This positive drive system, providing direct engine shaft to pump shaft power transmission, assures optimum utilization of available horsepower, minimum maintenance and longer life. The standard reduction ratio is 3.1:1 with alternate ratios available for differing pumping conditions.

DREDGE PUMP ENGINE

The dredge pump is driven by a Caterpillar D-348 JWAC diesel engine with electric start. This engine is rated at 642 continuous horsepower at 1800 RPM. The same engine drives the service water pump. Fuel tank, fuel supply piping and connections to engine to be supplied by customer.

CONTROL CONSOLE

A monitoring console is supplied which includes:

- engine tachometer
- engine oil pressure gauge
- engine water temperature gauge
- engine intake manifold high temperature warning light
- pressure gauge to monitor inlet of dredge pump
- pressure gauge to monitor outlet of dredge pump
- gauge to monitor service water pressure
- warning horn for low service water pressure

COOLING SYSTEM

The diesel engine is radiator cooled to assure adequate engine cooling under the usual dredging conditions.

SHUTDOWN SYSTEM

The diesel system is equipped with automatic shutdowns in case of low oil pressure, high water temperature or engine overspeed.

AUXILIARY WATER PUMP

This pump supplies fresh water for the dredge pump packing gland. This pump is capable of 220' of TDH. Filtered water supply for pump to be supplied by customer.

PAINTING

All DIXIE BOOSTERS are painted according to a carefully planned painting schedule, designed for durability and minimum maintenance. Steel surfaces are appropriately prepared for painting by sandblasting, chemical treatment or power buffing.

ALL COMPONENTS DESCRIBED ABOVE ARE MOUNTED ON A HEAVY DUTY STRUCTURAL STEEL FRAME.

POLICY

It is the policy of THE DIXIE DREDGE CORPORATION to continually strive to improve its product design. Accordingly, we reserve the right to change these specifications to incorporate any such improvements that may be developed prior to the time of manufacture.

OPTIONS

Shelter for weather protection

High ambient air temperature radiator

DIXIE DREDGE CORPORATION.

RECOMMENDED SPARE PARTS FOR DIXIE MODEL CS-2-16 FOR ONE (1) YEAR'S OPERATION

I. DREDGE PUMP

QUANTITY	DESCRIPTION	PRICE
1	Shell	$13,948.00
1	Impeller	4,999.00
1	Suction Side Liner	3,205.00
1	Engine Side Liner	2,695.00
1	Shaft Sleeve	1,156.00
1	Water Ring	454.00
1	Copper Washer	168.00
1	Set of Rubber Packing	73.00
2	Door Seals	64.00
1	Box of Packing	119.00
	TOTAL	$26,881.00

II. HYDRAULIC EQUIPMENT

QUANTITY	DESCRIPTION	PRICE
1	Hydraulic Pump, Swing and Spuds	$ 1,188.00
1	Seal Kit for Swing and Spud Pump	18.00
1	Hydraulic Pump, Cutter	1,624.00
1	Seal Kit for Cutter Pump	20.00
1	Hydraulic Motor, Cutter	3,170.00
1	Seal Kit for Cutter Motor	97.00
2	Hydraulic Cylinder Seal Kits for Spud Lift	119.00
24	Return Line Filter Elements	210.00
2	Suction Line Filter Elements	122.00
3	Hydraulic Pressure Gauges, 0-3000#	156.00
	TOTAL	$ 6,724.00

Recommended Spare Parts for DIXIE Model CS-2-16 for One (1) Year's Operation
Page 2

III. CUTTER AND CUTTER DRIVE EQUIPMENT

QUANTITY	DESCRIPTION	PRICE
1	Cutterhead	$ 3,358.00
12	Cutter Edges, Top	360.00
12	Cutter Edges, Bottom	360.00
1	Star Coupling	1,175.00
1	Cutter Shaft	1,461.00
2	Cutless Bearings	872.00
2	Bronze Sleeves for Cutter Shaft	334.00
	TOTAL	$ 7,920.00

IV. SERVICE WATER PUMP

QUANTITY	DESCRIPTION	PRICE
1	Repair Kit consisting of the following:	$ 851.00
	(1) Impeller (1) Shaft (1) Shaft Sleeve (1) Gasket (1) Impeller Cap Screw (1) Washer (1) Gasket (1) Gasket "O" Ring (1) Impeller Key (1) Gasket (1) Set of Packing (6 Rings/Set)	
2	Sets of Drive Belts (2 Belts/Set)	48.00
	TOTAL	$ 899.00

Recommended Spare Parts for DIXIE Model CS-2-16 for One (1) Year's Operation
Page 3

QUANTITY	DESCRIPTION	PRICE
1	Suction Hose, 18"	$ 3,388.00
1	Discharge Elbow, 16"	2,381.00
2	Gear Belts	2,082.00
2	Swing Sheave Block Repair Kits each consisting of: ...	885.00
	(1) Sheave Assembly (1) Bushing (1) Sleeve (2) Bronze Thrust Rings (1) Lubricating Fitting (1) Center Pin w/Nut	
1	Suction Vacuum Gauge, 0-30"	47.00
1	Discharge Pressure Gauge, 0-160#	47.00
2	Sets of Drive Belts for AC Generator (3 Belts/Set) ...	75.00
	TOTAL	$ 8,905.00
	GRAND TOTAL	$51,329.00

APPENDIX A-2

Estimated Project Costs

I. Unit Cost Breakdown - Port Development - Basic Structure

II. Unit Cost Breakdown - Port Development - Completed Interior Facilities

III. Estimated Project Costs - Port Development - Basic Structure

Berth No. 1 - 1985 - 350 m (length)

Berth No. 2 - 1991 - 170 m (length)

Berth No. 3 - 1997 - 260 m (length)

IV. Estimated Project Costs - Port Development - Completed Interior Facilties

Berth No. 1 - 1985 - 350 m (length)

Berth No. 2 - 1991 - 170 m (length)

Berth No. 3 - 1997 - 260 m (length)

V. Relocation of Existing Facilities

Tank Farm

Shrimp Facilities

Miscellaneous Structures

COSTO DE UNIDADES EN CORDOBAS -DESARROLLO DEL PUERTO - ESTRUCTURA BASICA

A-2-IA

UNIT COSTS IN CORDOBAS - PORT DEVELOPMENT - BASIC STRUCTURE

ARTICULO	DESCRIPCION		UNIDAD							TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJ	LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	TOTAL
1	LIMPIEZA DE MANGLARES CLEARING MANGROVE		H	27,000	------	----	-----	23,000	------	50,000	-----	50,000
2	EXCAVAR FANGO Y RELLENO EXCAVATE MUCK & BACKFILL		M^3	29	9	----	-----	26	14	55	23	78
3	DRAGADO (DARSENAS Y CANAL) DREDGING (BASINS & CHANNEL)		M^3	2.50	3	----	-----	-----	10	2.50	13	15
4	EXCAVACION DEL MUELLE WHARF EXCAVATION		M^3	10	6	----	-----	-----	14	10	20	30
5	RELLENO (DRAGADO DE DARSENAS) BACKFILL (FROM BASIN DREDGING)		M	7	3	----	-----	1	10	8	13	21
6	PIEDRA DE CORAZA ARMOR STONE		M^3	45	45	110	-----	28	27	183	72	255
7	PIEDRA SUBYACENTE y PIED. DE FILTR. UNDERLAYER STONE & FILTER STONE		M^3	27	28	105	-----	28	27	160	55	215
8	PILOTES DE CONC.REF. VERT. (26cm AVG.) REINF. CONC. PILES - VERT. (26cm AVG)		Ea	1,300	3,200	1,900	10,500	----	14,000	3,200	27,700	30,900
9	PILOTES DE CONC.REF.DESPLOME (36cm AVG) REINF. CONC.PILES-BATTER (36cm AVG.)		Ea	2,100	4,600	3,000	16,000	----	21,000	5,100	41,600	46,700
10	CABECERO DE CONCRETO CONCRETE PILE CAP		M^3	760	40	800	400	----	200	1,560	640	2,200
11	LOSA DE CONCRETO REFORZADO REINFORCED CONCRETE SLAB		M^3	1,040	60	800	400	----	200	1,840	660	2,500
12	RIEL PARA GRUA DE CONTENEDORES FUND. CONTAINER CRANE RAIL FND.		M^3	500	30	460	160	----	100	960	290	1,250
13	TRABAJO DE VIA FERREA (MUELLE) RAILROAD TRACKWORK (WHARF AREA)		M	90	210	20	970	30	-----	140	1,180	1,320
14	TRAB. DE VIA FERREA(VIA,TRAVES.BOLAS) RAILROAD TRACKWORK (TRACK,TIES & BALLAST)		M	70	180	585	680	35	-----	690	860	1,550
15	RIELES DE GRUA DE CONT. (2 CARRILES) CONTAINER CRANE RAILS (2 RAILS		M	150	280	30	1,770	70	----	250	2,050	2,300

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COSTO DE UNIDADES EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA
UNIT COSTS IN CORDOBAS - PORT DEVELOPMENT - BASIC STRUCTURE

A-2-ID

ARTICULO	DESCRIPCION		UNIDAD							TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	TOTAL
16	PAVIMENTO DE CONCRETO		M^2	70	----	100	60	10	----	180	60	240
	CONCRETE SURFACE PAVEMENT											
17	CORDON DE MADERA (12" x 12")		M	40	----	170	-----	20	----	230	----	230
	TIMBER CURB (12" x 12")											
18	DESAGUE		H	40,000	------	80,000	-----	50,000	----	170,000	----	170,000
	DRAINAGE											
19	PROTECCION CONTRA INCENDIO		H	3,000	3,000	----	12,000	2,000	----	5,000	15,000	20,000
	FIRE PROTECTION											

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COSTO DE UNIDADES EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES
UNIT COSTS IN CORDOBAS - PORT DEVELOPMENT - COMPLETION OF INTERIOR FACILITIES

A-2-II

ARTICULO	DESCRIPCION		UNIDAD	MANO DE OBRA		MATERIAL		EQUIPO		TOTAL COSTO UNIDAD		
				LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	LOCAL	EXTRANJERO	TOTAL
1	SISTEMA DE DEFENSA		M	600	----	----	2,400	600	----	1,200	2,400	3,600
	FENDERING SYSTEM											
2	BOLARDOS (100 T)		Ea	2,800	----	----	18,900	2,800	----	5,600	18,900	24,500
	BOLLARDS (100 T)											
3	PAVIMENTO DE CONCRETO		M^2	70	----	100	60	10	----	180	60	240
	CONCRETE SURFACE PAVEMENT (25 cm)											
4	CAPA DE BASE DE GRAVA (45 cm)		M^2	11	----	27	-----	6	----	44	----	44
	GRAVEL BASE COURSE (45 cm)											
5	CAPA DE PENETRACION DE ASFALTO		M^2	1	----	3	-----	-----	6	4	6	10
	ASPHALT PENETRATION COAT											
6	PAVIMENTO BITUMINOSO		M^2	6	----	10	30	4	----	20	30	50
	BITUMINOUS SURFACE PAVEMENT (2 at 10cm)											
7	ALAMBRADO		M	7	-----	----	50	3	----	10	50	60
	FENCING											

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA - ATRACADERO No.1 - 1985 (350 METROS)

ESTIMATED COST OF THE PROYECT IN CORDOBAS - PORT DEVELOPMENT - BASIC STRUCTURE - BERTH No.1 - 1985 (350 METERS)

A-2-EIA

ARTICULO	DESCRIPCION / DESCRIPTION	CANTIDAD	UNIDAD	UNITARIO LOCAL	UNITARIO EXTRANJERO	UNITARIO TOTAL	TOTAL COSTO ESTIMADO LOCAL	TOTAL COSTO ESTIMADO EXTRANJERO	TOTAL COSTO ESTIMADO TOTAL
1	LIMPIEZA DE MANGLARES CLEARING MANGROVE	0.5	H	50,000	----	50,000	25,000	----	25,000
2	EXCAVAR FANGO Y RELLENO EXCAVATE MUCK & BACKFILL	10,000	M^3	55	23	78	550,000	230,000	780,000
3	DRAGADO DE DARSENA DE MANIOBRAS (RECLAMAR TIERRA) DREDGE TURNING BASIN (RECLAIM LAND)	564,000	M^3	2.50	13	15.50	1,410,000	7,332,000	8,742,000
4	EXCAVACION DE MUELLE WHARF EXCAVATION	50,000	M^3	10	20	30	500,000	1,000,000	1,500,000
5	RELLENO DEL ATRACADERO BERTH FILL	260,000	M^3	8	13	21	2,080,000	3,380,000	5,460,000
6	PIEDRA DE CORAZA ARMOR STONE	4,600	M^3	183	72	255	841,800	331,200	1,173,000
7	PIEDRA SUBYACENTE Y PIEDRA DE FILTRACION UNDERLAYER STONE & FILTER STONE	14,300	M^3	160	55	215	2,288,000	786,500	3,074,500
8	PILOTES DE CONCRETO REFORZADO -VERT. (24m. AVG.) REINF. CONC. PILES - VERTICAL (24m AVG.)	564	Ea	3,200	27,700	30,900	1,804,800	15,622,800	17,427,600
9	PILOTES DE CONCRETO REFORZADO - DESPLOME (36m AVG.) REINF. CONC. PILES - BATTER (36m AVG.)	141	Ea	5,100	41,600	46,700	719,100	5,865,600	6,584,700
10	CABECERO DE CONCRETO CONCRETE PILE CAP	653	M^3	1,560	640	2,200	1,018,680	417,920	1,436,600
11	LOSA DE CONCRETO REFORZADO REINFORCED CONCRETE SLAB	7,000	M^3	1,840	660	2,500	12,8[illegible]	4,620,000	17,500,000
12	RIEL PARA GRUA DE CONTENEDORES FUND. CONTAINER CRANE RAIL FND.	2,600	M3	960	290	1,250	2,496,000	754,000	3,250,000
13	TRABAJO DE VIA FERREA (AREA DEL MUELLE) RAILROAD TRACK WORK (WHARF AREA)	1,100	M	140	1,180	1,320	154,000	1,298,000	1,452,000
14	TRABAJO DE VIA FERREA (VIA, TRAVESAÑOS Y BALASTO) RAILROAD TRACK WORK (TRACK, TIES & BALLAST)	2,200	M	690	860	1,550	1,518,000	1,892,000	3,410,000
15	RIELES PARA GRUA DE CONTENEDORES (2 CARRILES) CONTAINER CRANE RAIL (2 RAILS)	350	M	250	2,050	2,300	87,500	717,500	805,000
						SUB-TOTAL	28,372,880	44,247,520	72,620,400

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA- ATRACADERO No.1 - 1985 - (350 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - BASIC STRUCTURE - BERTH No.1 - 1985 - (350 METERS)

A-2-IIII

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO LOCAL	UNITARIO EXTRANJERO	UNITARIO TOTAL	TOTAL COSTO ESTIMADO LOCAL	TOTAL COSTO ESTIMADO EXTRANJERO	TOTAL COSTO ESTIMADO TOTAL
16	PAVIMENTO DE CONCRETO CONCRETE SURFACE PAVEMENT	5,900	M^2	180	60	240	1,062,000	354,000	1,416,000
17	CORDON DE MADERA (12" x 12") TIMBER CURB (12" x 12")	350	M	230	---	230	80,500	---	80,500
18	DESAGUE DRAINAGE	14	H	170,000		170,000	2,380,000	---	2,380,000
19	ALCANTARILLADO SEWERAGE	---	LS	----	---	----	1,000,000	---	1,000,000
20	SISTEMA DE ABASTECIMIENTO DE AGUA WATER SUPPLY SYSTEM	---	LS	----	---	----	2,600,000	10,400,000	13,000,000
21	SERVICIO ELECTRICO (LINEA PRIMARIA) ELECTRICAL SERVICE (MAIN LINE)	---	LS	----	---	----	----	2,800,000	2,800,000
22	PROTECCION CONTRA INCENDIO FIRE PROTECTION	14	H	----	20,000	20,000	----	280,000	280,000
23	TELEFONO TELEPHONE	---	LS	----	---	----	----	1,500,000	1,500,000
24	MISCELANEA (SEÑALES,CURVAS, ETC.) MISCELLANEOUS (SIGNS, CURBS, ETC.)	---	LS	----	---	----	100,000	---	100,000
25	MOVILIZACION Y DESMOVILIZACION MOBILIZATION & DEMOBILIZATION			----	---	----	2,500,000	7,500,000	10,000,000
						TOTAL	38,095,380	67,081,520	105,176,900

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA - ATRACADERO No.2 - 1991 - (170 METROS)
ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - BASIC STRUCTURE - BERTH No.2 - 1991- (170 METERS)

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO			COSTO TOTAL ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
1	LIMPIEZA DE MANGLARES	0.7	H	50,000	-----	50,000	35,000	-----	35,000
	CLEARING MANGROVE								
2	EXCAVAR FANGO Y RELLENO	5,000	M^3	55	23	78	275,000	115,000	390,000
	EXCAVATE MUCK & BACKFILL								
3	DRAGADO DARSENA DE MANIOBRAS (RECLAMAR TIERRA)	4,000	M^3	2.50	13	15.50	10,000	52,000	62,000
	DREDGING TURNING BASIN (RECLAIM LAND)								
4	EXCAVACION DE MUELLE	5,000	M^3	10	20	30	50,000	100,000	150,000
	WHARF EXCAVATION								
5	RELLENO DEL ATRACADERO	400,000	M^3	8	13	21	3,200,000	5,200,000	8,400,000
	BERTH FILL								
6	PIEDRA DE CORAZA	2,300	M^3	183	72	255	420,900	165,600	586,500
	ARMOR STONE								
7	PIEDRA SUBYACENTE Y PIEDRA DE FILTRACION	7,000	M^3	160	55	215	1,120,000	385,000	1,505,000
	UNDERLAYER STONE & FILTER STONE								
8	PILOTES DE CONCRETO REFORZADO - VERT. (24m. AVG.)	276	Ea	3,200	27,700	30,900	883,200	7,645,200	8,528,400
	REINF. CONC. PILES - VERT. (24m. AVG.)								
9	PILOTES DE CONCRETO REFORZADO-DESPLOME (36m. AVG.)	69	Ea	5,100	41,600	46,700	351.900	2,870,400	3,222,300
	REINF. CONC. PILES - BATTER (36m. AVG.)								
10	CABECERO DE CONCRETO	320	M^3	1,560	640	2,200	499,200	204,800	704,000
	CONCRETE PILE CAP								
11	LOSA DE CONCRETO REFORZADO	3,400	M^3	1,840	660	2,500	6,256,00	2,244,000	8,500,000
	REINFORCED CONCRETE SLAB								
12	RIEL PARA GRUA DE CONTENEDORES FUND.	1,200	M^3	960	290	1,250	1,152,000	348,000	1,500,000
	CONTAINER CRANE RAIL FND.								
13	TRABAJO DE VIA FERREA (AREA DEL MUELLE)	630	M	140	1,180	1,320	88,200	743,400	831,600
	RAILROAD TRACKWORK (WHARF AREA)								
14	TRABAJO DE VIA FERREA (VIA,TRAVESAÑOS y BALASTO)	1,900	M	690	860	1,550	1,311,000	1,634,000	2,945,000
	RAILROAD TRACKWORK (TRACK, TIES & BALLAST)								
15	RIELES PARA GRUA DE CONTENEDORES (2 CARRILES)	170	M	250	2,050	2,300	42,500	348,500	391,000
	CONTAINER CRANE RAILS (2 RAILS)								
						SUBTOTAL	15,694,900	22,055,900	37,750,800

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA - ATRACADERO No.2 - 1991 (170 METROS)
ESTIMATED COST OF THE PROJECT IN CORDOBAS- PORT DEVELOPMENT- BASIC STRUCTURE - BERTH No.2 - 1991 9170 METERS)

A-2-III D

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO			TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
16	PLATAFORMA DE CONCRETO DEL MUELLE	2,300	M^2	180	60	240	414,000	138,000	552,000
	CONCRETE DECK PAVEMENT								
17	CORDON DE MADERA (12" x 12")	170	M	230	---	230	39,100	---	39,100
	TIMBER CURB (12" x 12")								
18	DESAGUE	6	M	170,000	---	170,000	1,020,000	---	1,020,000
	DRAINAGE								
19	ALCANTARILLADO	---	LS	---	---	----	350,000	---	350,000
	SEWERAGE								
20	SISTEMA DE DISTRIBUCION DE AGUAS	---	LS	---	---	----	260,000	1,040,000	1,300,000
	WATER DISTRIBUTION SYSTEM								
21	SERVICIO ELECTRICO (LINEA PRIMARIA)	---	LS	---	---	----	----	150,000	150,000
	ELECTRICAL SERVICE (MAIN LINE)								
22	PROTECCION CONTRA INCENDIOS	6	M	---	20,000	20,000	----	120,000	120,000
	FIRE PROTECTION								
23	TELEFONO	---	LS	---	---	----	----	150,000	150,000
	TELEPHONE								
24	MISCELANEA (SEÑALES, CURVAS, ETC.)	---	LS	---	---	----	50,000	----	50,000
	MISCELLANEOUS (SIGNS, CURBS, ETC.)								
25	MOVILIZACION Y DESMOVILIZACION	---		---	---	---	1,000,000	3,000,000	4,000,000
	MOBILIZATION & DEMOBILIZATION								
						TOTAL	18,828,000	26,653,900	45,481,900

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA - ATRACADERO No.3 - 1997 - (260 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT- BASIC STRUCTURE- BERTH No.3 - 1997- (260 METERS) A-2-[illegible]

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO			TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
1	LIMPIEZA DE MANGLARES	2.5	H	50,000	----	50,000	125,000	----	125,000
	CLEARING MANGROVE								
2	EXCAVAR FANGO Y RELLENO	25,000	M3	55	23	78	1,375,000	575,000	1,950,000
	EXCAVATE MUCK & BACKFILL								
3	DRAGADO (DARSENA DE MANIOBRAS)	552,000	M3	2.50	13	15.50	1,380,000	7,176,000	8,556,000
	DREDGING (TURNING BASIN)								
4	DRAGADO (CANAL)	833,000	M3	2.50	13	15.50	2,082,500	10,829,000	12,911,500
	DREDGING (CHANNEL)								
5	EXCAVACION DE MUELLE	12,000	M3	10	20	30	120,000	240,000	360,000
	WHARF EXCAVATION								
6	RELLENO (DEL DRAGADO DE LA DARSENA)	443,000	M3	8	13	21	3,544,000	5,759,000	9,303,000
	BACKFILL (FROM BASIN DREDGING)								
7	PIEDRA DE CORAZA	3,500	M3	183	72	255	640,500	252,000	892,500
	ARMOR STONE								
8	PIEDRA SUBYACENTE Y PIEDRA DE FILTRACION	10,700	M3	160	55	215	1,712,000	588,500	2,300,500
	UNDERLAYER STONE & FILTER STONE								
9	PILOTES DE CONCRETO REFORZADO- VERT. (24M. AVG.)	420	Ea	3,200	27,700	30,900	1,344,000	11,634,000	12,978,000
	REINF. CONC. PILES - VERT. (24m AVG.)								
10	PILOTES DE CONCRETO REFORZADO-DESPLOME (36M. AVG.)	105	Ea	5,100	41,600	46,700	535,500	4,368,000	4,903,500
	REINF. CONC. PILES - BATTER (36m AVG.)								
11	CABECERO DE CONCRETO	500	M3	1,560	640	2,200	780,000	320,000	1,100,000
	CONCRETE PILE CAP								
12	LOSA DE CONCRETO REFORZADO	5,200	M3	1,840	660	2,500	9,568,000	3,432,000	13,000,000
	REINFORCED CONCRETE SLAB								
13	RIEL PARA GRUA DE CONTENEDORES FUND.	1,900	M3	960	290	1,250	1,824,000	551,000	2,375,000
	CONTAINER CRANE RAIL FND.								
14	TRABAJO DE VIA FERREA (AREA DEL MUELLE)	680	M	140	1,180	1,320	95,200	802,400	897,600
	RAILROAD TRACKWORK (WHARF AREA)								
15	TRABAJO DE VIA FERREA (VIA, TRAVESAÑOS Y BALASTO)	1,500	M	690	860	1,550	1,035,000	1,290,000	2,325,000
	RAILROAD TRACKWORK (TRACK, TIES & BALLAST)								
						SUBTOTAL	26,160,700	47,816,900	73,977,600

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - ESTRUCTURA BASICA - ATRACADERO No.3 - 1997 (260 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - BASIC STRUCTURE - BERTH No.3 - 1997- (260 METERS)

A-2-IIIF

ARTICULO	DESCRIPCION.	CANTIDAD	UNIDAD	UNITARIO			TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
16	RIELES PARA GRUA DE CONTENEDORES (2 CARRILES)	260	M	250	2,050	2,300	65,000	533,000	598,000
	CONTAINER CRANE RAILS (2 RAILS)								
17	PAVIMENTO DE CONCRETO	3,500	M2	180	60	240	630,000	210,000	840,000
	CONCRETE SURFACE PAVEMENT								
18	CORDON DE MADERA (12" x 12")	260	M	230	---	230	59,800	---	59,800
	TIMBER CURB (12" x 12")								
19	DESAGUE	11	H	170,000	---	170,000	1,870,000	---	1,870,000
	DRAINAGE								
20	ALCANTARILLADO	---	LS	----	---	---	350,000	---	350,000
	SEWERAGE								
21	SISTEMA DE DISTRIBUCION DE AGUAS	---	LS	----	---	---	400,000	1,600,000	2,000,000
	WATER DISTRIBUTION SYSTEM								
22	SERVICIO ELECTRICO (LINEA PRIMARIA)	---	LS	----	---	---	----	200,000	200,000
	ELECTRICAL SERVICE (MAIN LINE)								
23	PROTECCION CONTRA INCENDIO	11	H	----	20,000	20,000	----	220,000	220,000
	FIRE PROTECTION								
24	TELEFONO	---	LS	----	---	---	----	150,000	150,000
	TELEPHONE								
25	MISCELANEA (SEÑALES, CURVAS, ETC.)	---	LS	----	---	---	75,000	---	75,000
	MISCELLANEOUS (SIGNS, CURBS, ETC.)								
26	MOVILIZACION Y DESMOVILIZACION	---		----	---	---	2,000,000	6,000,000	8,000,000
	MOBILIZATION & DEMOBILIZATION								
						TOTAL	31,610,500	56,729,900	88,340,400

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES - ANEXO No.1 - 1985 - (350 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - COMPLETED INTERIOR FACILITIES - ANEX No.1 - 1985 - (350 METERS) A-2-IV A

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO LOCAL	UNITARIO EXTRANJERO	UNITARIO TOTAL	TOTAL COSTO ESTIMADO LOCAL	TOTAL COSTO ESTIMADO EXTRANJERO	TOTAL COSTO ESTIMADO TOTAL
1	SISTEMA DE DEFENSA FENDERING SYSTEM	350	M	1,200	2,400	3,600	420,000	840,000	1,260,000
2	BOLARDOS (100 T.) BOLLARDS (100 T)	23	Ea	5,600	18,900	24,500	128,800	434,700	563,500
3	PAVIMENTO DE CONCRETO CONCRETE SURFACE PAVEMENT (25 cm)	45,500	M^2	180	60	240	8,190,000	2,730,000	10,920,000
4	CAPA DE BASE DE GRAVA GRAVEL BASE COURSE (45 cm)	87,500	M^2	44	----	44	3,850,000	----	3,850,000
5	CAPA DE PENETRACION DE ASFALTO ASPHALT PENETRATION COAT	87,500	M^2	4	6	10	350,000	525,000	875,000
6	PAVIMENTO BITUMINOSO BITUMINOUS SURFACE PAVEMENT (2 at 10 cm)	87,500	M^2	20	30	50	1,750,000	2,625,000	4,375,000
7	ALMACEN. (ALMACENAJE DE EQUIPO,HERRAM. SUMINISTRO) MAINTENANCE BLDG. (EQUIPMENT,TOOL & SUPPLY STORAGE)	----	L.S.	----	----	----	700,000	300,000	1,000,000
8	CASETA DE GUARDAS GUARD STATION	----	L.S	----	----	----	20,000	10,000	30,000
9	GASOLINERA FUEL STATION	----	L.S	----	----	----	70,000	210,000	280,000
10	GRUA TRUCK CRANE	1	Ea.	----	410,000	420,000	----	420,000	420,000
11	MONTACARGAS FORKLIFT TRUCKS	10	Ea	----	105,000	105,000	----	1,050,000	1,050,000
12	REMOLQUES CAMA BAJA LOW BOYS	3	Ea.	----	12,000	12,000	----	36,000	36,000
13	TRACTORES TRACTORS	2	Ea	----	56,000	56,000	----	112,000	112,000
14	"DOLLIES" DOLLIES	5	Ea	----	4,200	4,200	----	21,000	21,000
15	TRANSPORTADOR DEL PERSONAL PERSONNEL CARRIER	1	Ea	----	32,000	32,000	----	32,000	32,000
						SUBTOTAL	15,478,800	9,345,700	24,842,500

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES - ATRACADERO No. 1 - 1985 (350 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - COMPLETED INTERIOR FACILITIES - BERTH No. 1 - 1985 - (350 METERS) A-2-IV B

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO LOCAL	UNITARIO EXTRANJERO	UNITARIO TOTAL	TOTAL COSTO ESTIMADO LOCAL	TOTAL COSTO ESTIMADO EXTRANJERO	TOTAL COSTO ESTIMADO TOTAL
16	GRUA DE CONTENEDORES CONTAINER CRANE	1	Ea	----	21,000,000	21,000,000	----	21,000,000	21,000,000
17	ESLINGAS,CADENAS,GANCHOS,PASTECAS,ESLABONES,PALETAS,Etc. (SLING HOIST, SLINGS,CHAINS, HOOKS, SNATCH BLOCKS,ROPES,PALLETS,etc)	---	L.S.	----	----	----	----	1,400,000	1,400,000
18	ALAMBRADO FENCING (3 m)	1,100	M	10	50	60	11,000	55,000	66,000
19	SISTEMA DE ILUMINACION LIGHTING SYSTEM	---	L.S.	----	----	----	300,000	700,000	1,000,000
20	POLTON CON GRUA WORKBOAT W/DERRICK	1	Ea	----	175,000	175,000	----	175,000	175,000
21	LANCHON DE SUMINISTRO (EQUIPADO) SUPPLY BARGE (OUTFITTED)	1	Ea	----	350,000	350,000	----	350,000	350,000
22	BOYAS DE CANAL CHANNEL BUOYS	6	Ea	----	210,000	210,000	----	1,260,000	1,050,000
23	MAREOMETRO TIDE GAUGE	1	Ea	3,500	----	3,500	3,500	----	3,500
24	BOYAS DE AMARRE MOORING BUOYS	1	Ea	----	1,050,000	1,050,000	----	1,050,000	1,050,000
25	MOVILIZACION Y DESMOVILIZACION MOBILIZATION & DEMOBILIZATION	---	L.S.	----	----	----	1,250,000	3,750,000	5,000,000
						TOTAL	17,043,300	39,085,700	56,129,000

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES -ATRACADERO No.2 - 1991 - (170 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - COMPLETED INTERIOR FACILITIES - BERTH No.2 - 1991 - (170 METERS)

A-2-IV C

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO			TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
1	SISTEMA DE DEFENSA	170	M	1,200	2,400	3,600	204,000	408,000	612,000
	FENDER SYSTEM								
2	BOLARDOS (100 T)	12	Ea	5,600	18,900	24,500	67,200	226,800	294,000
	BOLLARDS (100 T)								
3	PAVIMENTO DE CONCRETO (25 cm)	22,100	M^2	180	60	240	3,978,000	1,326,000	5,304,000
	CONCRETE SURFACE PAVEMENT (25 cm)								
4	CAPA DE BASE DE GRAVA	42,500	M^2	44	---	44	1,870,000	----	1,870,000
	GRAVEL BASE COURSE (45 cm)								
5	CAPA DE PENETRACION DE ASPALTO	42,500	M^2	4	6	10	170,000	255,000	425,000
	ASPHALT PENETRATION COAT								
6	PAVIMENTO BITUMINOSO	42,500	M^2	20	30	50	850,000	1,275,000	2,125,000
	BITUMINOUS SURFACE PAVEMENT (2 at 10 cm)								
7	BODEGAS DE TRANSITO	-----	L.S.	----	----	----	21,600,000	10,800,000	32,400,000
	TRANSIT SHED								
8	CUARTEL DE ESTIBADORES	-----	L.S.	----	----	----	200,000	400,000	600,000
	STEVEDORES QUARTERS								
9	OFICINAS	-----	L.S.	----	----	----	200,000	300,000	500,000
	OFFICES								
10	MONTACARGAS	10	Ea.	----	105,000	105,000	----	1,050,000	1,050,000
	FORKLIFT TRUCKS								
11	REMOLQUE CAMA BAJA	3	Ea	----	12,000	12,000	----	36,000	36,000
	LOW BOYS								
12	TRACTORES	2	Ea	----	56,000	56,000	----	112,000	112,000
	TRACTORS								
13	"DOLLIES"	5	Ea	----	4,200	4,200	----	21,000	21,000
	DOLLIES								
14	GRUA PARA CONTENEDOR	1	Ea	----	21,000,000	21,000,000	----	21,000,000	21,000,000
	CONTAINER CRANE								
15	REDES,ESLINGAS,CADENAS,GANCHOS,PASTECAS,MECATES,PALETAS,ETC.	---	L.S	----	----	----	----	1,400,000	1,400,000
	CARGO NETS,SLINGS,CHAINS,HOOKS,SNATCH BLOCKS,ROPES,PALLETS,ETC.								
						SUB-TOTAL	29,139,200	38,609,800	67,749,000

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(COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES - ATRAQUERO No.2 - 1991 - (170 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - COMPLETED INTERIOR FACILITIES - BERTH No.2 - 1991 - 170 METERS)

A-2-IV D

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO			TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
16	ALAMBRADO (3M)	500	M	10	50	60	5,000	25,000	30,000
	FENCING (3M)								
17	SISTEMA DE ILUMINACION	---	LS	----	----	----	300,000	700,000	1,000,000
	LIGHTING SYSTEM								
18	REMOLCADOR CON BOMBA CONTRA INCENDIO	1	Ea	----	10,500,000	10,500,000	----	10,500,000	10,500,000
	COMBINATION FIRE AND TUG BOAT								
19	BOTE PARA ATRAQUE	1	Ea	----	70,000	70,000	----	70,000	70,000
	LINE BOAT								
20	BOYAS DE CANAL	3	Ea	----	210,000	210,000	----	630,000	630,000
	CHANNEL BUOYS								
21	BOYAS DE AMARRE	1	Ea	----	1,050,000	1,050,000	----	1,050,000	1,050,000
	MOORING BUOYS								
22	MOVILIZACION Y DESMOVILIZACION	---	LS	----	----	-----	2,000,000	6,000,000	8,000,000
	MOBILIZATION AND DEMOBILIZATION								
						TOTAL	31,444,200	57,584,800	89,029,000

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES - ATRACADERO No.3 - 1997 - (260 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - COMPLETED INTERIOR FACILITIES - BERTH No.3 - 1997 - (260 METERS) A-2-IV E

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO LOCAL	UNITARIO EXTRANJERO	UNITARIO TOTAL	TOTAL COSTO ESTIMADO LOCAL	TOTAL COSTO ESTIMADO EXTRANJERO	TOTAL COSTO ESTIMADO TOTAL
1	SISTEMA DE DEFENSA FENDERING SYSTEM	260	M	1,200	2,400	3,600	312,000	624,000	936,000
2	BOLARDOS BOLLARDS (100 T)	17	Ea	5,600	18,900	24,500	95,200	321,300	416,500
3	PAVIMENTO DE CONCRETO CONCRETE SURFACE PAVEMENT (25 cm)	33,800	M^2	180	60	240	6,084,000	2,028,000	8,112,000
4	CAPA DE BASE DE GRAVA GRAVEL BASE COURSE (45 cm)	65,000	M^2	44	---	44	2,860,000	---	2,860,000
5	CAPA DE PENETRACION DE ASFALTO ASPHALT PENETRATION COAT	65,000	M^2	4	6	10	260,000	390,000	650,000
6	PAVIMENTO BITUMINOSO BITUMINOUS SURFACE PAVEMENT (2 at 10 cm)	65,000	M^2	20	30	50	1,300,000	1,950,000	3,250,000
7	CUARTEL DE GUARDAS GUARD STATION	---	LS	---	---	---	20,000	10,000	30,000
8	MONTACARGAS FORKLIFT TRUCKS	10	Ea		105,000	105,000	---	1,050,000	1,050,000
9	REMOLQUES CAMA BAJA LOW BOYS	3	Ea	---	12,000	12,000	---	36,000	36,000
10	TRACTORES TRACTORS	2	Ea	---	56,000	56,000	---	112,000	112,000
11	"DOLLIES" DOLLIES	5	Ea	---	4,200	4,200	---	21,000	21,000
12	GRUA DE CONTENEDORES CONTAINER CRANE	1	Ea		21,000,000	21,000,000	---	21,000,000	21,000,000
13	REDES,ESLINGAS,CADENAS,GANCHOS,PASTECAS,MECATES,PALETAS,ETC.) CARGO NETS-SLINGS-CHAINS-HOOKS-SNATCH BLOCKS-ROPES-PALLETS.Etc.	--	LS	---	---	---	---	1,400,000	1,400,000
14	ALAMBRADO (3.0) FENCING (3.0)	610	M	10	50	60	6,100	30,500	36,600
15	SISTEMA DE ILUMINACION LIGHTING SYSTEM	--	LS	---	---	---	300,000	700,000	1,000,000
						SUBTOTAL	11,237,300	29,672,800	40,910,100

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COSTO ESTIMADO DEL PROYECTO EN CORDOBAS - DESARROLLO DEL PUERTO - TERMINACION DE LAS INSTALACIONES INTERIORES - ATRAQUE No.3 - 1997 - (260 METROS)

ESTIMATED COST OF THE PROJECT IN CORDOBAS - PORT DEVELOPMENT - COMPLETED INTERIOR FACILITIES - BERTH No.3 - 1997 - (260 METERS)

A-2-XV F

ARTICULO	DESCRIPCION	CANTIDAD	UNIDAD	UNITARIO			TOTAL COSTO ESTIMADO		
				LOCAL	EXTRANJERO	TOTAL	LOCAL	EXTRANJERO	TOTAL
16	BOYAS DEL CANAL CHANNEL BUOYS	4	Ea	----	210,000	210,000	----	840,000	840,000
17	MOVILIZACION Y DESMOVILIZACION MOBILIZATION AND DEMOBILIZATION	----	LS	----	----	----	1,000,000	3,000,000	4,000,000
						TOTAL	12,237,300	33,512,800	45,750,100

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Puerto Corinto

Relocation of Existing Facilities

I. Tank Farm

A. Demolition				
1. Large Tanks	6 @	105,000	630,000
2. Small Tanks	11 @	35,000	385,000
3. Large Buildings	4 @	70,000	280,000
4. Medium Buildings . . .	2 @	50,000	100,000
5. Small Buildings	7 @	35,000	245,000
B. Construction of New Facilities			
1. Large Tanks	6 @	1,190,000	7,140,000
2. Small Tanks	8 @	420,000	3,360,000
3. Large Buildings	4 @	5,000,000	20,000,000
4. Medium Buildings . . .	2 @	1,000,000	2,000,000
5. Small Buildings	7 @	70,000	490,000
	Subtotal:	Cordobas	34,630,000

II. Shrimp Facilities

A. Demolition			
1. Shrimp Processing Plant	1 @	105,000	105,000
2. Large Buildings	1 @	70,000	70,000
3. Medium Buildings . . .	6 @	50,000	300,000
4. Small Buildings	1 @	35,000	35,000
5. Large Docks	2 @	175,000	350,000
6. Medium Docks	2 @	105,000	210,000
7. Small Docks	1 @	35,000	35,000
B. Construction of New Facilities			
1. Shrimp Processing Plant (including relocation of existing equipment)	1 @	4,200,000	4,200,000
2. Large Buildings	1 @	5,000,000	5,000,000
3. Medium Buildings . . .	6 @	1,000,000	6,000,000
4. Small Buildings	1 @	300,000	300,000
5. Wharf Facility	230 m @	45,000	10,350,000
	Subtotal:	Cordobas	26,955,000

Puerto Corinto

Relocation of Existing Facilities

(Continued)

III.	Miscellaneous Structures		
	A. Demolition		
	1. Small Buildings . . . . 8 @	35,000	280,000
	B. Construction of New Buildings		
	1. Small Buildings . . . . 8 @	70,000	560,000
	Subtotal:	Cordobas	840,000
	Total:	Cordobas	62,425,000

APPENDIX A-3

Outline Specifications

1. Dredging and Filling
2. Concrete
3. Prestressed Concrete Piles
4. Rip Rap Slope
5. Concrete and Bituminous Pavements
6. Miscellaneous Appurtenances

PUERTO CORINTO

OUTLINE SPECIFICATIONS

PRE-STRESSED CONCRETE PILE

MARGINAL WHARF

SECTION 1

DREDGING AND FILLING

1.01 SCOPE

Furnish all plant, labor, equipment, appliances and material and perform all operations and related work, complete in accordance with this Section of the Specifications and the applicable drawings.

1.02 SAFETY

The dredging Contractor shall be solely responsible for safe working conditions.

1.03 WORK INCLUDED

Work shall include but not be limited to:

1. Dredging,
2. Disposal of dredged materials,
3. Placement and retention of dredged materials for land reclamation.

1.04 SOIL CONDITIONS

Boring Logs and Soil Reports are furnished for information purposes only. The Contractor shall draw his own conclusions as to actual subsoil conditions and their effects on dredging, disposal and equipment required. Soil conditions may vary between borings from the condition shown on the logs. The Contractor shall, at his own expense, take additional borings if the logs provided do not contain sufficient and adequate information.

1.05 NAVIGATION INTERFERENCE

The Contractor shall conduct his operations so as to minimize interference with use of channels, berthing spaces, fairways and passages. The Contractor shall provide, install and maintain all required signs, signals, lights and other devices.

1.06 SAFETY OF STRUCTURES

The Contractor shall use reasonable and proper care in the prosecution of his work to safeguard adjacent structures. The Contractor shall repair all damages resulting to adjacent structures as a result of his operations.

1.07 SILTING OF CHANNELS

The Contractor will be held responsible for the silting in of existing adjacent channels caused by his operations. The Contractor shall dredge and restore such channels to their original depths wherever his operations caused silting.

1.08 DREDGING METHODS

Dredging shall comply with all applicable permits and the operation shall be carried out in such a manner as to prevent excessive disturbance of the harbor bottom that would cause materials to be stirred up and transported to other areas.

1.09 DREDGING EQUIPMENT

The equipment shall be of a size sufficient to meet the requirements of the work and kept in good condition for efficient operation at all times. All discharge pipelines shall be kept in good condition and all leaks and breaks shall be promptly and properly repaired. Upon completion of the work, the Contractor shall promptly remove his plant, including range, buoys, piles and other markers placed in navigable waters or on shore.

1.10 OVERDREDGING

The Contractor will be paid for overdredging up to a maximum of 0.5 meter. No payment will be made for material dredged below the 0.5 limit.

Underdredging will not be permitted and dredging on side slopes shall follow as closely as practicable the lines indicated on the drawings with a maximum vertical tolerance of 0.5 meter above and 0.5 meter below the theoretical slope.

1.11 SWEEPING

At the completion of the work and prior to final soundings the Contractor shall sweep the dredged area to ensure that all the materials above the required elevations have been removed. The sweeping shall be done in an approved manner, both parallel and perpendicular to the channel.

1.12 SOUNDINGS

The entire dredged area shall be sounded immediately before and after dredging for the purposes of determining the quantities of materials removed. The elapsed time shall not exceed two weeks before and after dredging. Soundings shall be recorded to the nearest five centimeters and referenced to a common datum.

1.13 UNAUTHORIZED DISPOSAL

Material shall not be deposited elsewhere than in places designated or approved. Any material deposited in unauthorized places shall be removed by the Contractor at no cost to the Port Authority. Should the Contractor during progress of the work, lose, dump, or throw overboard or misplace any materials, plant or machinery, they shall be recovered and removed immediately. If immediate removal is not possible, they shall be otherwise marked or buoyed temporarily until the obstruction is removed, with due notice given to the general public.

1.14 DIKING ON SHORE

Dikes on shore shall be constructed of sound fill material of sufficient width to withstand the pressures of the hydraulic fill. The minimum crown width shall be 2 meters and a maximum slope of 2-1/2 horizontal to 1 vertical. The stability of the dikes are the Contractor's responsibility. Only dry fill shall be used to form dikes, placed by truck or bulldozed into position. A minimum

freeboard of 0.5 meter shall be provided above the hydraulic pool level to the top of dike. Sufficient pool capacity and retention shall remain within the diked area to insure an effluent meeting the required water quality standards.

1.15 DISCHARGE LINES

The dredged discharged lines shall be provided with approved distribution devices to produce dispersion and directional control of the hydraulic fill placement. Lines shall be moved to produce dispersion and settlement. Retention booms or similar devices shall be employed to trap floating debris and silt slicks. Splash pads shall be provided at the discharge end of the intake pipe.

1.16 DRAINAGE DIVERSION

The Contractor shall construct and maintain ditches to divert the hydraulic fill surplus water off the areas filled and discharge into the harbor. Particular care shall be provided to prevent inundation of any surrounding developed areas. Drainage includes maintaining the present drainage pattern in the areas where the fill will not be placed and, in particular, those areas depending on natural drainage for removal of sewage effluent.

1.17 SILT CONTROL

The diking system and flow of surplus water along with the locations and positioning of the discharge structures shall be such as to maximize the settlement of the fill and to eliminate discharge of silt into the harbor. In particular, care shall be exercised not to create silt pockets where the future fill would not be of a suitable nature to serve as a base for future paving.

1.18 CHEMICAL COAGULANTS

Should the effluent, due to colloidal or finely suspended particles, not meet the water quality standards set by the authorities, chemical coagulants shall be added. Such coagulants shall be approved by the authorities as not being injurious to health or to sea life.

1.19 FLOATING SKIRTS

The Contractor shall provide floating skirts in the harbor area as required to prevent any concentration of silt slicks from accumulating within the harbor limits or/and to retain such silt slicks.

1.20 TIDAL CURRENT COORDINATION

Should it develop that in certain areas to be dredged the quantity of fine grained silt is excessive to the extent of stirring up the harbor bottom and creating excessive turbidity, the Contractor shall schedule his operations in such areas to coincide with slack tide periods or other tidal sequence so as to permit stirred up material to settle or to be carried away by tidal currents without interfering with the harbor or fish and shellfish areas.

1.21 PAYMENT

Payment will be made on the basis of the contract unit price per cubic meter for dredging, measured in the dredged area, calculated from soundings taken before and after dredging. No separate payment will be made for filling or disposal of dredged material or for construction and maintenance of the filled areas. For purposes of comparing bids, an assumed total quantity of material to be dredged is estimated. The actual quantities, based on soundings made before and after dredging, will vary from this estimated quantity.

SECTION 2

CONCRETE

2.01 SCOPE

Furnish all plant, labor, equipment, appliances and material and perform all operations and related work, complete in accordance with this Section of the Specifications and the applicable drawings.

2.02 SAFETY

The General Contractor shall be solely responsible for safe working conditions.

2.03 GENERAL STANDARDS

The latest issue of the Specifications Standards of the American Concrete Institute or similar recognized authority shall pertain with respect to the following:

ACI 211.1	Recommended Practice for Selecting Proportions for Normal Weight Concrete.
ACI 304	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 305	Recommended Practice for Hot Weather Concreting
ACI 308	Recommended Practice for Curing Concrete
ACI 315	Manual of Standard Practice for Detailing Reinforced Concrete Structures
ACI 318	Building Code Requirements for Reinforced Concrete (Working Stress Design)
ACI 347	Recommended Practice for Concrete Formwork

2.04 MATERIALS

Materials shall conform to the latest issue of the following standards or their equivalent.

Cement -

Specifications for Portland Cement ASTM C 150, Type II or IIa.

Aggregates -

Specifications for Concrete Aggregates, ASTM C 33.

Water -

Clean and clear per ACI 318.

Admixtures -

Specifications for Air-Entraining Admixtures for Concrete, ASTM C 260, and Specifications for Chemical Admixtures, ASTM C 494.

Reinforcement -

Specification for Billet-Steel Bars for Concrete Reinforcement, ASTM A 615, Grade 40.

2.05 SHOP DRAWINGS

The Contractor shall submit completed and checked shop drawings for approval before starting construction.

2.06 FORMS

All forms shall be constructed to the slopes, lines and dimensions shown on the drawings. Forms shall be made of moisture resistant plywood, masonite or metal forms. Form ties shall be of the snap-off type.

2.07 CONCRETE MIX

Concrete shall have a minimum ultimate strength of 4,000 psi at 28 days with a slump less than 10 cm and a minimum of 8.5 bags of cement per

cubic meter of concrete shall be used. All concrete shall be air-entrained. Accelerating or retarding admixtures shall not be used.

2.08 AGGREGATES

All aggregates shall be clean, hard, durable material, free from loam, clay, dust or vegetable matter. The fine aggregate shall have 100 per cent passing the 3/8 inch sieve with 2 to 10 per cent passing the No. 100 sieve. Coarse aggregate shall have 100 per cent passing the 1-1/2 inch sieve and 0 to 5 per cent passing the No. 4 sieve.

2.09 REINFORCING STEEL

All reinforcing steel shall be new billet steel, accurately placed in position, wired together with minimum concrete cover as shown on the drawings.

2.10 EMBEDDED ITEMS

All embedded items shall be set in place before concrete is placed. The various subcontracts and trades shall be coordinated.

2.11 PLACING OF CONCRETE

All concrete shall be mixed in a mechanical batchlike mixing plant with ready mix concrete conforming to ASTM C 94. The concrete shall be conveyed without separation or loss of materials. Concrete shall be placed in position no later than 30 minutes after mixing water is applied and the free fall shall be less than 1.5 meters. The concrete shall be compacted by mechanical vibrators of the immersion type.

2.12 BONDING AND JOINTS

Concrete shall be bonded to previously set concrete by cleaning and roughening the surface and washing with fresh water before applying a grout coat. Construction joints shall be located to provide least impairment to the structure.

2.13 FINISHING, CURING AND STRIPPING

Concrete shall be screeded, lightly floated and given a smooth finish. Curing shall be accomplished by maintaining the concrete moist for at least five days by wetting down or use of approved curing compounds. Stripping may be permitted from side forms after 7 days and bottom forms after 14 days, but in no case shall the concrete be stripped until sufficient strength has been achieved to support the loads on the structure at the time of stripping with the normal factor of safety.

2.14 INSPECTION AND TESTS

Formwork and materials shall be inspected and tests performed on concrete to check its strength and conformance with the Specifications.

2.15 PAYMENT

Payment for work covered by this section will be included as a lump-sum contract item.

SECTION 3

PRESTRESSED CONCRETE PILES

3.01 SCOPE

Furnish all plant, labor, equipment, appliances and material and perform all operations and related work, complete in accordance with this Section of the Specifications and the applicable drawings.

3.02 SAFETY

The General Contractor shall be solely responsible for safe working conditions.

3.03 WORK INCLUDED

The work shall include but not be limited to:

1. Forming and casting of prestressed, concrete piles,
2. Handling, positioning and driving of prestressed concrete piles,
3. Bracing, cut-off and/or extension of prestressed concrete piles.

3.04 CONCRETE

The concrete shall be as heretofore specified but with a minimum 28-day compressive strength of 5,000 psi.

3.05 REINFORCEMENT

The main reinforcement shall be wire or strand, pretensioned before placing concrete. It shall have a minimum tensile strength of 250,000 psi and a minimum elongation of 4 per cent in 25 cm at the ultimate strength of the wire and 4 per cent in 60 cm at the ultimate strength of the strand. and anchorage for wire or strand may be required depending on the type and size used. The maximum initial prestress shall be 70 per

cent of the ultimate strength of wire or strand. Allowance shall be made for creep, shrinkage and elastic deformation.

3.06 HANDLING OF PILES

The piles shall be stored and stacked in such a manner so as not to overstress the piles in the storage yard. They shall be lifted and placed in position with a 2 point or 3 point pickup or more as required so as not to overstress the piles.

3.07 PILE LOADS

The piles shall be driven to the bearing capacity specified on the drawings, with a minimum of 3 meters penetration into soil overburden on rock.

3.08 PILE LOCATION

The piles shall be located in plan within 0.2 meter of the design location and a deviation in vertical or batter no greater than 1.5 per cent.

3.09 PILE DRIVING

The pile shall be driven to rock to a minimum safe load capacity of twice the design load, based on use of an acceptable pile-driving formula consistent with the type, weight and size of pile and proportional hammer weight and energy. A light-weight low-energy hammer will not be permitted. Driving and penetration shall continue until practical refusal is attained, measured as 1 cm penetration per 20 blows. Piles which are damaged shall be replaced.

3.10 CUT-OFF AND BRACING

The top of piles shall be cut off to design elevation and all piles shall be braced prior to placing of cap beams and decking.

3.11 PAYMENT

Payment will be made on the basis of the contract unit price per linear meter of approved and accepted pile in place.

SECTION 4

RIP RAP SLOPE

4.01 SCOPE

Furnish all plant, labor, equipment, appliances and material and perform all operations and related work, complete in accordance with this Section of the Specifications and the applicable drawings.

4.02 SAFETY

The General Contractor shall be solely responsible for safe working conditions.

4.03 WORK INCLUDED

The work shall include but not be limited to:

1. Trimming of underwater slope beneath the marginal wharf,

2. Placing of graded rip rap and filtered layers between piles.

4.04 QUARRY RUN SLOPE PROTECTION

Quarry run slope protection material shall be placed on the dredged and trimmed natural soil slope. It shall be placed to the minimum thickness, slope and configuration shown on the drawings, The quarry run stone shall be hard, dense, angular, sound, natural stone resistant to weathering and disintegration with a minimum specific gravity of 2.4 after saturation and free drainage. Not more than 10 per cent shall be smaller than 2 cm in size and not more than 10 per cent by volume shall be larger than 0.3 meter in size.

4.05 RIP RAP SLOPE PROTECTION

Rip rap slope protection shall be placed on top of the quarry run material. The rip rap shall be placed to a minimum thickness of two stone layers.

The rip rap stone shall be hard, dense, angular, sound, natural stone, resistant to weathering and disintegration. The individual pieces shall have a specific gravity of at least 2.6 after saturation and free drainage. The least principal dimension shall be not less than one third the greatest dimension. Flat slabs and round boulders shall not be used. At least 75 per cent by volume shall be within the limits shown on the drawing. A maximum of 15 per cent by volume may weigh more and ten per cent by volume may weigh less. The armor rip rap shall be stable and interlocked without ravelling or movement the tide, wave and current action. The finished slope shall be unifrom, neat and trim, with a maximum tolerance of 20 cm below and 50 cm above the theoretical slope shown on the drawings.

4.06 FILTER COURSE

A filter course of gravel or crushed stone or small quarry stone shall be placed between the rap rap core and the hydraulic fill so as to prevent washout of hydraulic fill through the rap rap core. The filter layer shall be a minimum 0.5 meter thick with no more than 10 per cent passing the No. 4 sieve and 30 to 50 per cent shall be smaller than 2 cm in size with no more than 10 per cent by weight larger than 10 cm in size.

4.07 PAYMENT

Payment for work covered by this section will be included in the lump sum contract price.

SECTION 5

CONCRETE AND BITUMINOUS PAVEMENTS

5.01 SCOPE

Furnish all plant, labor, equipment, appliances and material and perform all operations and related work, complete in accordance with this Section of the Specifications and the applicable drawings.

5.02 SAFETY

The General Contractor shall be solely responsible for safe working conditions.

5.03 WORK INCLUDED

Work shall include but not limited to:

1. Final grading,
2. Placing of base course and concrete pavement,
3. Placing of base course and bituminous pavement.

5.04 CONCRETE PAVEMENT

The concrete materials shall conform to the general requirements of concrete work hereintobefore specified, except that the concrete shall have a 28-day strength of at least 4,000 psi. The base course, prior to placing of concrete, shall be thoroughly compacted to a minimum of 90 per cent optimum density, welded wire fabric reinforcement shall be used of the size and position shown on the drawings with premolded bituminous joint filler and all contraction joints saw cut. The finished surface shall be screeded, smooth, excess mortar removed and burlaped dragged. The surface deviation shall be no greater than 1 cm in 3 meters.

5.05 BITUMINOUS PAVEMENT

The subbase shall be compacted to a minimum of 95 per cent optimum density and the pavement shall consist of a penetrated, crushed stone base, followed

by a tack coat, plus a binder course, another tack coat and finally an upper surface layer all hot mixed. The thicknesses of base and surface layers shall be as shown on the drawings. The plant mix, heating, transportation and similar aspects shall be in accordance with standard highway specifications. The finished surface shall be within a tolerance of 1 cm per 5 meters.

5.06 PAYMENT

Payment for work covered by this section will be included in the lump sum contract items.

SECTION 6

MISCELLANEOUS APPURTENANCES

6.01 SCOPE

Furnish all plant, labor, equipment, appliances and material and perform all operations and related work, complete in accordance with this Section of the Specifications and the applicable drawings.

6.02 SAFETY

The General Contractor shall be solely responsible for safe working conditions.

6.03 WORK INCLUDED

Work shall include but not be limited to:

1. Installation of fendering system,
2. Installation of curbing,
3. Installation of bollards and bitts and cleats,
4. Installation of crane and railroad tracks,
5. Installation of drainage system,
6. Installation of utilities, consisting of water, sewage, electric power and lighting,
7. Installation of navigational aids, such as buoys and lights,
8. Installation of buildings.

6.04 SPECIFICATIONS

Standard specifications for the above work will be in accordance with normal, recognized standards for materials and installation procedures and methods. The details are as shown on the drawings.

6.05 PAYMENT

Payment for work covered by this section will be included in the lump sum contract items.