Feasibility Study of Palo Seco/Farfán Land Reclamation to Develop a Port Facility

Estudio de Factibilidad de un Relleno en Palo Seco/Farfán para el Desarrollo de una Facilidad Portuaria

Moffatt & Nichol

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Resumen Ejecutivo

AUTORIDAD DEL CANAL DE PANAMA

CONTRACT No. CMC-146911

FEASIBILITY STUDY OF PALO SECO/FARFAN LAND RECLAMATION TO DEVELOP A PORT FACILITY

EXECUTIVE SUMMARY

June 2005

MOFFATT & NICHOL

Golder Associates

CONTENTS

1 Introduction 1

2 Market Overview 3

2.1 Facility Requirements 3
2.1.1 Ship Size 3
2.1.2 Summary of Requirements 4

3 Existing Site Conditions 6

3.1 Bathymetry & Topography 6
3.2 Existing Land Use 6
3.2.1 Marine 6
3.2.2 Landside 6
3.3 Geotechnical Conditions 11

4 Technical Studies 14

4.1 Materials Source Options 14
4.1.1 Material from the New Locks Project 14
4.1.2 Hydraulic Fill Materials 15
4.1.3 Cost Analysis of Materials Source Options 17
4.2 Port Location Assessment 18
4.3 Marine Structures 18
4.4 Wave & Protection Assessment 20
4.5 Navigation 20
4.6 Infrastructure Network 20
4.7 Highway Access 20
4.8 Intermodal connections to the Atlantic Side 22
4.8.1 Rail Link 22
4.8.2 Other Intermodal options 23

5 Environmental & Socio Economic Impacts 25

5.1 Hydrodynamic Model 25
5.1.1 Changes in the hydrodynamic regime of Panama Bay 25
5.1.2 Impacts on Coastal Resources 26
5.1.3 Impacts on Beaches and Western coastline 26
5.1.4 Sedimentation in the Panama Canal access channel 26
5.2 Environmental Impacts 26
5.3 Mitigation and Monitoring 29

6 Recommended Project Concept 29

6.1 Container Terminal at Location 3 29

6.2 Container Terminal at Location 5 34
7 Cost Estimates 38
7.1 Basis for costing 38
7.2 Container Terminal at Location 3 38
7.3 Container Terminal at Location 5 41
7.4 Highway Improvements 42
8 Implementation Program 43
9 Summary & Recommendations 45
9.1 Highway Access 45
9.2 Rail Access 45
9.3 Environmental Assessment 46
9.4 Cost Estimates 46

LIST OF TABLES

Table 1: Expected Dimensions for New Locks....4

Table 2: Transportation Costs for Alternative Materials and Sources....17

Table 3 : Preliminary Estimate for Rail connection & Intermodal Yard 23

Table 4: Ranking of Environmental Impact Values and Color Code....27

Table 5: Summary of Impacts, Artificial Island (Access through Upgraded Existing Roads and Intersections)....28

Table 6: Cost Breakdown of 85%ile Outcome - Terminal at Location 3....39

Table 7: Cost Breakdown of 85%ile Outcome - Terminal at Location 5....42

Table 8: Estimated Cost of Permanent Four Lane Highway to Port Site 42

LIST OF FIGURES

Figure 1: General Location of Proposed Port....2

Figure 2: Basic Planning Module for the Proposed Container Port....5

Figure 3: Existing uses of Marine Project area. 7

Figure 4: General Topography and Ground cover of Study Area 8

Figure 5: Existing Coastal Highway to Port Site....9

Figure 6: Existing and Proposed Land Use in Project Area....10

Figure 7: Bathymetry of Study area 12

Figure 8: Elevation of Rock at Project Site....13

Figure 9: Location of Potential Dredged Materials Disposal and Sand Borrow Sites for the Project....16

Figure 10: Island Location Study – Location Options 3 and 5....19

Figure 11: Recommended Alignment of Upgraded Site Access Roads....21

Figure 12: Existing Swing Bridge at Miraflores Locks....22

Figure 13: Potential Rail Corridor and Connections from Port to Miraflores Area....24

Figure 14: Detail model bathymetry and grid 25

Figure 15: Container Terminal Concept at Location 3 31
Figure 16: Cross Sectional View of Terminal at Location 3 32
Figure 17: Location 3 - Options for Long Term Expansion 33
Figure 18: Container Terminal Concept at Location 5 35
Figure 19: Typical Cross Section - Terminal at Location 5 36
Figure 20: - Location 5 - Long Term Expansion Potential..... 37
Figure 21: Range of Outcomes for Construction Cost - Location 3 39
Figure 22: Cost Item Sensitivity Ranking - Location 3 40
Figure 23: Range of Outcomes for Construction Cost - Location 5 41
Figure 24: Implementation Schedule for the design, procurement and construction of the Project..... 44

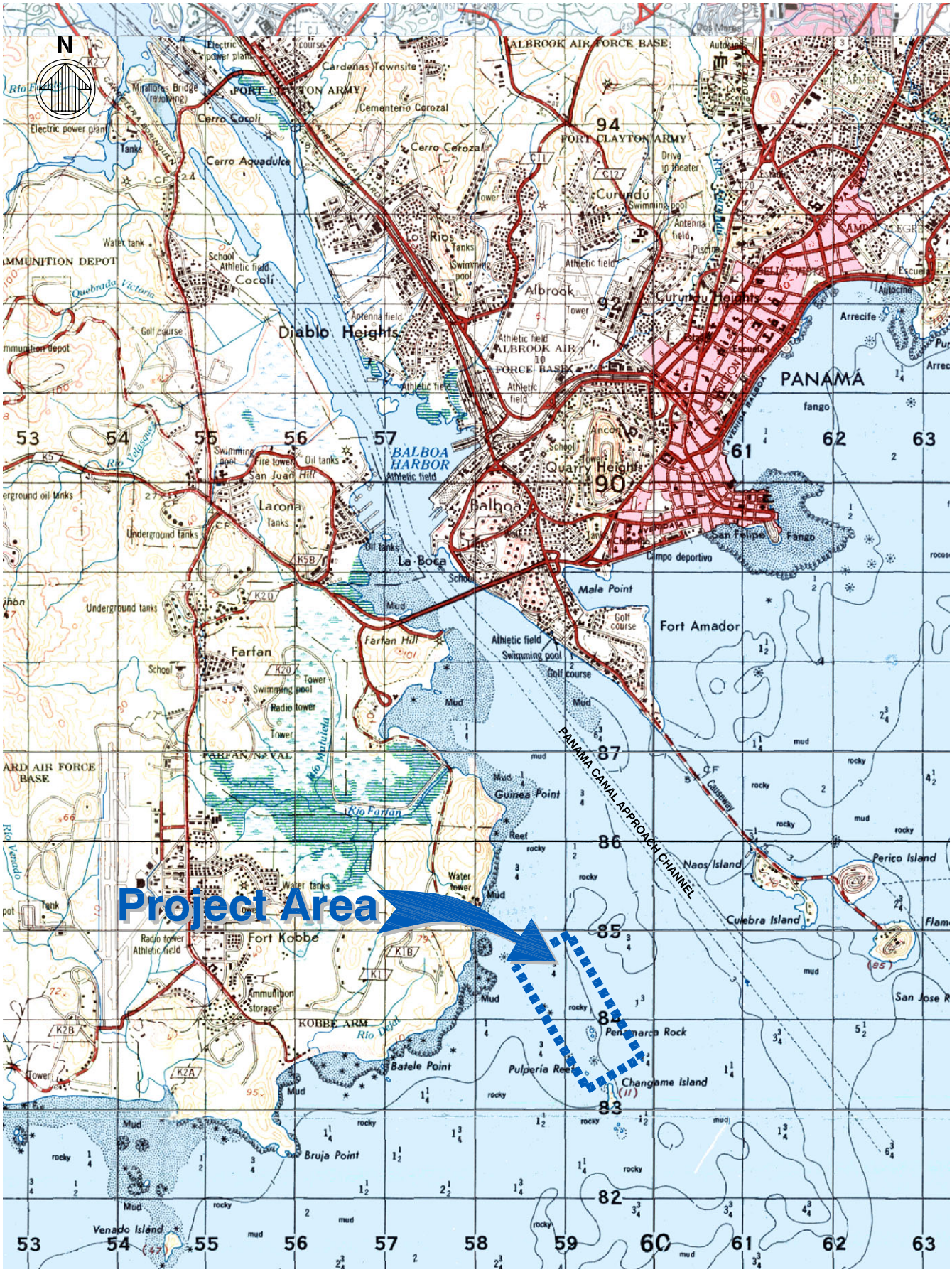
1 INTRODUCTION

The Government of Panama has requested the assistance of the Panama Canal Authority (ACP) with the assessment of the potential to develop a new Container port within ACP controlled waters at the Pacific entrance to the Panama Canal.

There are a number of market and other factors that favor Panama as a transshipment center for containers at this time. These include:

- Congestion at West Coast US ports
- Rapid growth of Asian trade to the US
- The move to larger container vessels on the main trade routes
- Expectations of strong growth in South American trade
- Lack of modern deepwater container terminals in many of the South American countries
- Success of Manzanillo and Balboa Terminals in Panama
- The recent rehabilitation of the Panama Canal Railroad by Kansas City Southern
- Expectations that the Panama Canal Authority will proceed with the construction of New Locks in the near future

The general location under study for the project is shown in Figure 1.



Note: Background courtesy of Tommy Guardia

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Figure 1
General Location Area of Proposed Project

ACP
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2 MARKET OVERVIEW

The primary factor influencing the selection of a transshipment center is location close to main trade routes as indicated by the success of Singapore and other major hubs in the world. The move to the all water route for Asian cargoes and expectations of expansion of the Canal indicate a strong geographical and market advantage for Panama at this time.

According to a recent presentation[1] in Miami, the market for transshipment facilities in the Caribbean is expected to reach 8.4 million TEUs by 2015. Panama has 34% of the total transshipment volume at this time and is well positioned to increase its market share as capacity ceilings are reached by 2010 – 2012. Strong growth is also expected on the Pacific side as the main ports on the West Coast of South America continue to improve and update container terminals, coupled with optimistic trade growth projections for Chile, Peru and Colombia, plus the west coast of Central America.

The proximity of the former Howard Air Force Base also offers the potential for Panama to become a regional logistics and distribution center and the terminal may also service local markets.

Based on discussions with several of the major shipping companies and port management firms, the demand for additional transshipment facilities on the Pacific Coast could reach 2.5 to 3.0 million TEUs per year within the next ten to fifteen years.

2.1 Facility Requirements

2.1.1 Ship Size

The final dimensions and configuration of the new Locks are still under study and may change during the final design process. According to ACP, the expected dimensions for the new Locks and the maximum vessels sizes expected to transit the New Locks are as shown in Table 1, below.

[1] Strategic Port Planning in the 21st Century, Jorgen Steving of Maersk Sealand, Feb 2005

Table 1: Expected Dimensions for New Locks

	Length (m)	Breadth (m)	Depth (m)
Locks	**426.8**	**55**	**18.3**
Limiting Vessel Size	**360 to 385**	**46**	**15.0 (Draft)**

The transshipment terminal will also receive a wide range of container vessels, which may be short haul or regional feeders or larger feeder ships servicing all water routes to the US Gulf and East coasts.

At least four berths and 18 cranes are required to support an annual throughput of 2.4 million TEUs of primarily transshipment traffic. These berths will require a total length of approximately 1,600 m, depending on the mix of vessel sizes to be accommodated.

To meet the projected throughput, a total storage area of 111 ha is indicated, assuming a medium to high density operation using Rubber Tired Gantry (RTG) type of yard equipment.

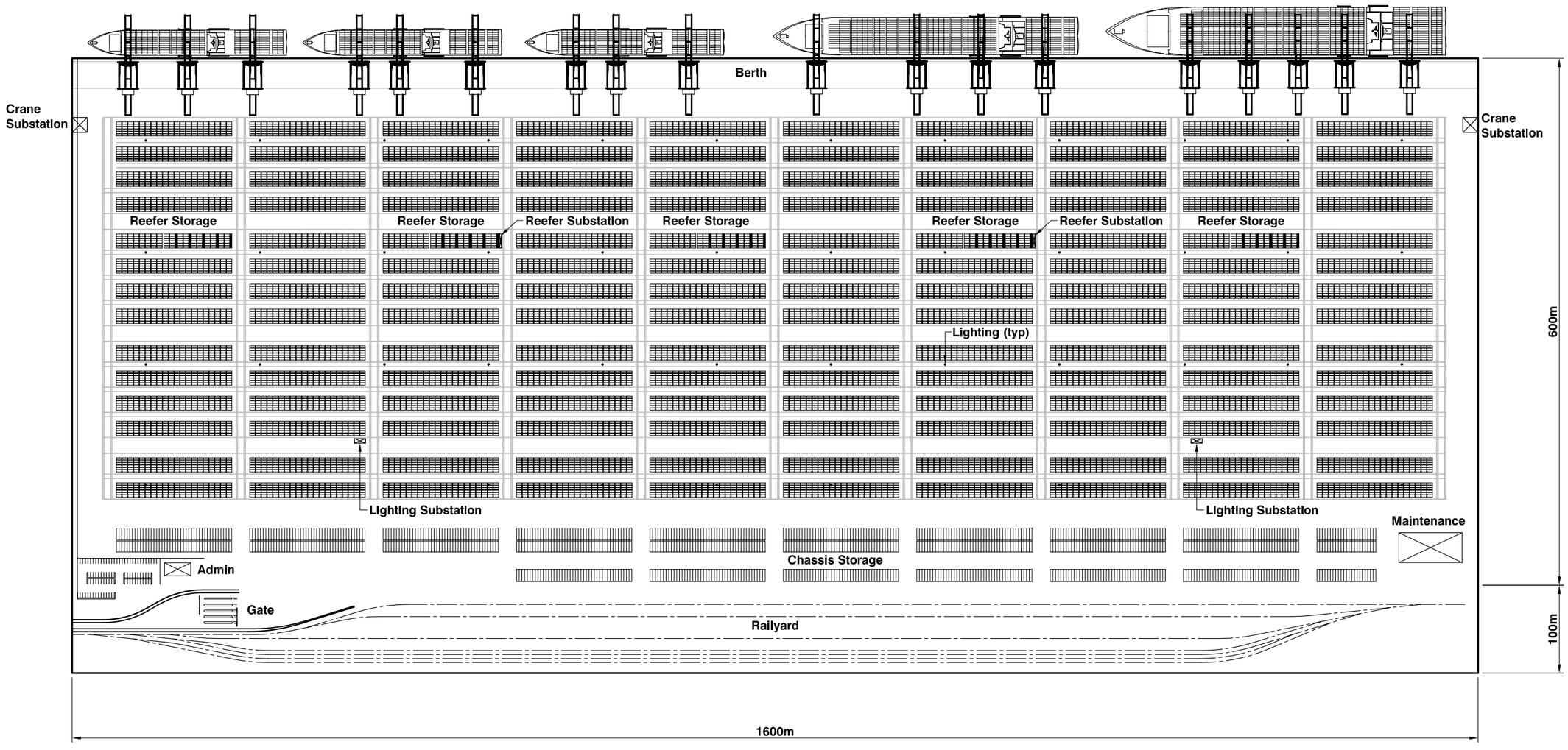
2.1.2 Summary of Requirements

The primary design criteria for the terminal are considered to be:

- Maximum Vessel Size [2]..... 10,500 TEU
- Cranes required to meet projected throughput.....18
- Berth Length.....385 to 425 m
- Maximum loaded vessel draft.....15.0 m
- Recommended Dredged Depth for Initial Development.....16.5 m
- Gross Terminal area .....111 ha
- Minimum berth length for 2.4 million TEUs per year .....1,600 m
- Width of Island, including berths .....750 m

Figure 2 shows the basic container yard planning module developed to respond to the functional requirements indicated above.

[2] Maximum vessel size should be used as a basis for navigation channel and marine structures design criteria.



50m 0m 50m 100m

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Dwn by: DJMac
Ckd by: MGH
Reviewed by: MGH
Submitted by: MGH
Date: April 2005
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FEASIBILITY STUDY FOR
PORT DEVELOPMENT AT PALO SECO

Basic Planning Module for Proposed Container Port

Fig 2

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3 EXISTING SITE CONDITIONS

3.1 Bathymetry & Topography

The depth of the water in front of the project site ranges from -2.00 m to -8.00 m below MLWS. The presence of numerous rock outcrops and the high tidal range make navigation hazardous to even small craft inshore of Changame Island.

As seen in Figure 4, the shoreline rises to some 100 m above Mean Sea Level (MSL) and extending 600 – 750 m inshore. The main road from the Bridge of the Americas to Howard and Veracruz is located approximately 700 m inshore of the project site.

3.2 Existing Land Use

3.2.1 Marine

As indicated in Figure 3, the proposed area under consideration for the new Port falls within the jurisdictional limits of ACP and no development can take place without prior ACP approval. The sub tidal zone has traditionally been used as dredge disposal site for the Canal, while the areas south of Isla Changame are designated anchorages for vessels carrying explosives or hazardous cargoes.

3.2.2 Landside

The area inshore of the project site includes areas under the control of ACP, property under the jurisdiction of the Autoridad de la Región Interoceaníca (ARI) and also the former Howard Air Force Base, which is now being developed under the management of the recently established Agencia del Area Económica Especial Panamá-Pacífico (AAEEPP). There have been a number of concessions authorized in the area, with the most important being the assignment of approximately 100 ha in the Kobbe Beach area to the Paradise Beach Corporation. Construction is in progress at this site, with the final development to include a resort hotel, beach front enhancements, golf course and links to the ecological reserve at Punta Bruja, located west of Kobbe Beach.

West of the Howard Area, the beaches of Veracruz are popular destinations for people from Panama City with heavy bus and passenger car traffic at weekends and holiday periods. The only access to these beaches is via the road from the Pan American Highway, as shown in Figure 5.

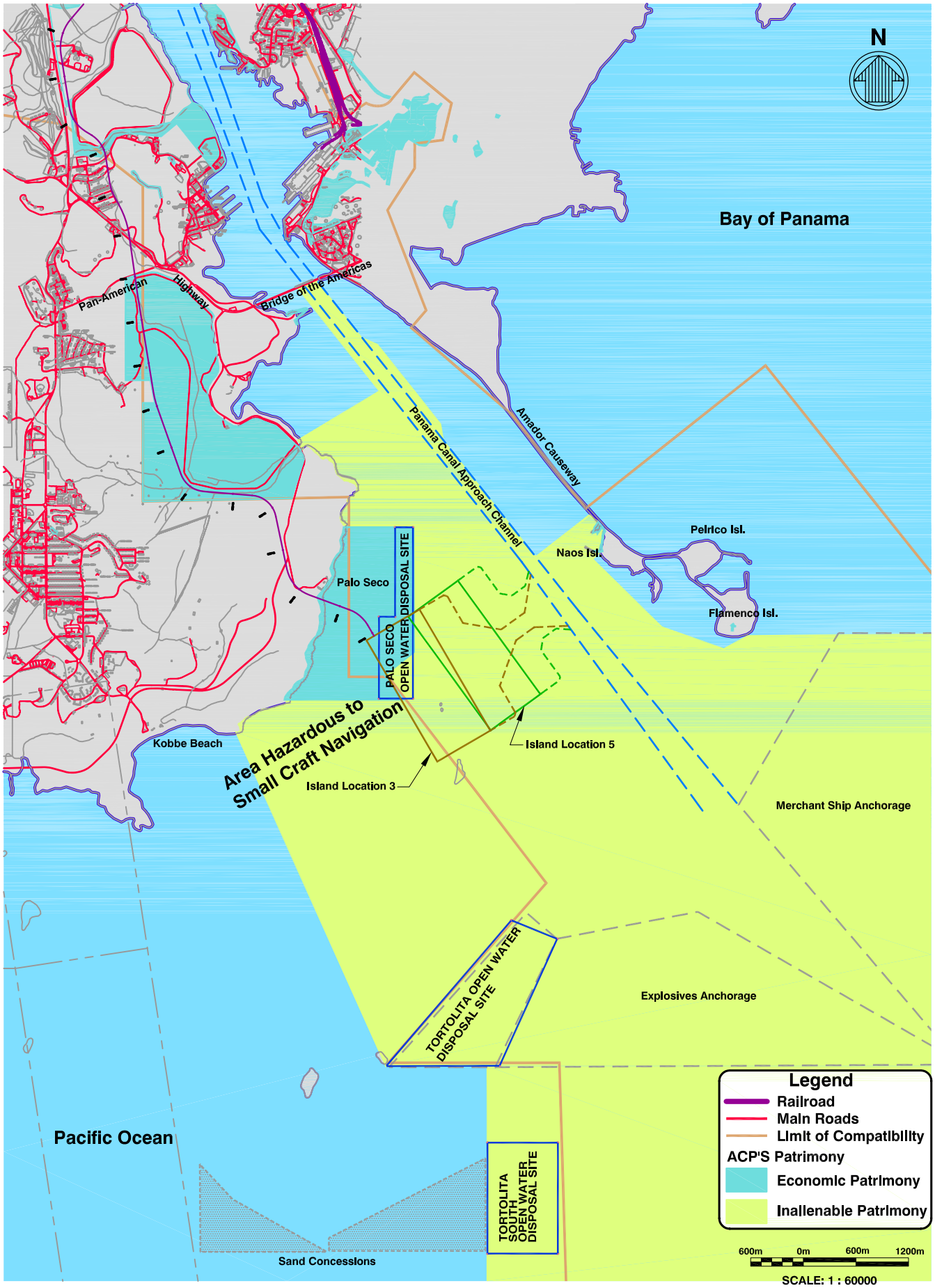

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Figure 3
Panama Canal Authority Economic/Inalienable Patrimony areas south of Bridge of the Americas.

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Fig 4

FEASIBILITY STUDY FOR
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General Topography and Ground Cover in Study Area to Port Site

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		Plot scale: 1=1 (11"x17")	

Note: Aerial image courtesy of ACP

250m 0m 250m 500m

SCALE: 1 : 25000

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Figure 5
Existing Highway Access to Port Site

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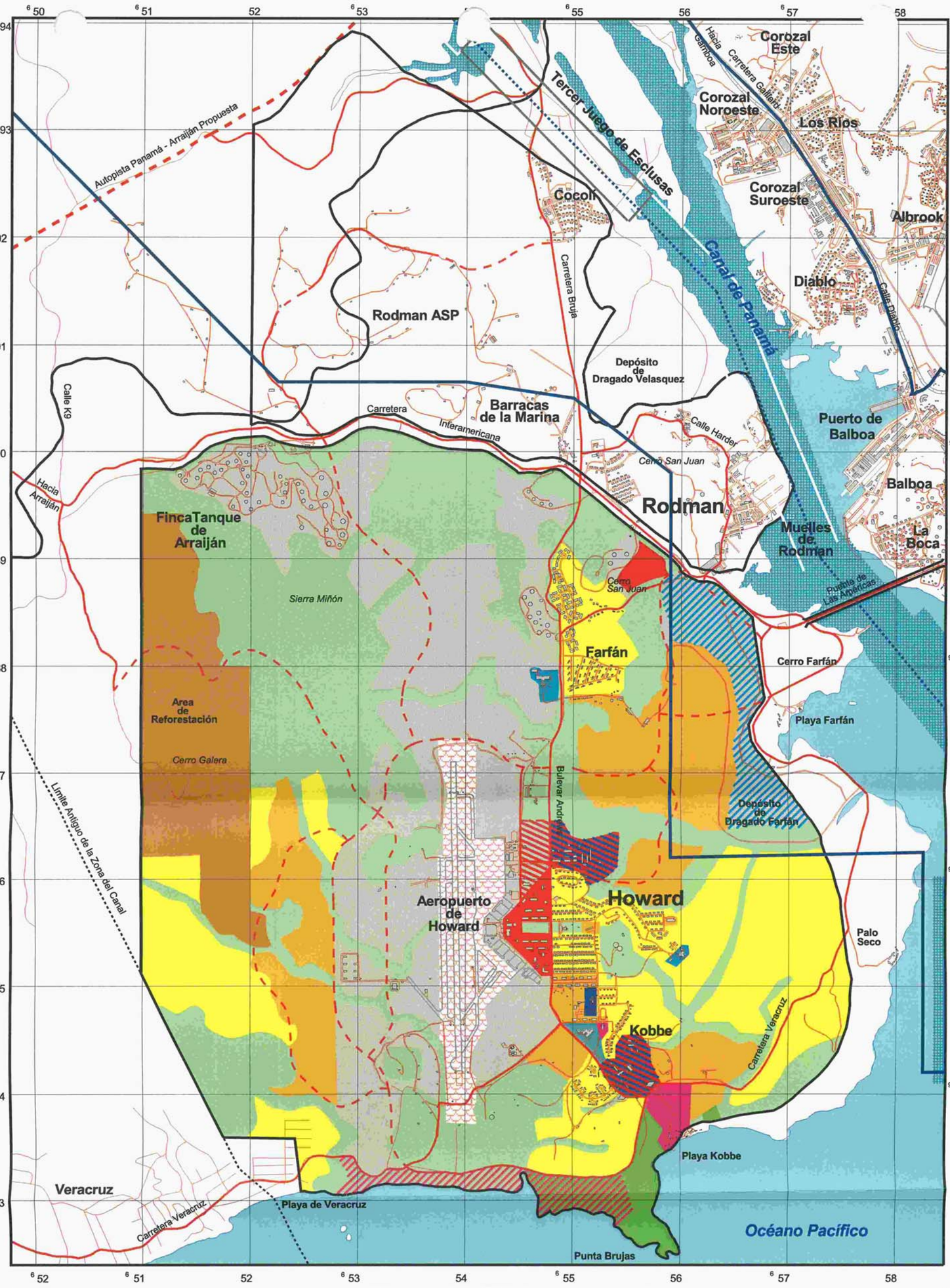

Localización Regional

Escala 1:35,000

500 0 500 1000 Metros

Escala Gráfica

Mapa preparado por Intercarib, S.A/Nathan Associate Inc. Para la Autoridad de la Región Interoceánica (ARI) de la República de Panamá

Diciembre de 2000

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Convenciones

- Vías Arteriales Mayores Propuestas
- Vías Arteriales Menores
- Vías Arteriales Menores Propuestas
- Vías Existentes
- Ferrocarril
- Pista de Aterrizaje
- Esclusa
- Antiguos Límites de la Zona del Canal
- Límite de Area de Estudio
- Límite de la Cuenca del Canal
- Ruta del Tercer Juego de Esclusas
- Tercer Juego de Esclusas
- Area de Compatibilidad del Canal (propuesto)
- Forestal (Boscoso / Agroforestal)
- Areas Protegidas
- Areas Verdes y Usos Públicos
- Industrial Liviano y Mediano
- Comercial-Banca-Finanzas
- Turismo
- Viviendas Baja Densidad
- Viviendas Mediana Densidad
- Institucional - Administrativo
- Institucional - Educación
- Inst.-Seguridad, Cívicas, Cultural, Religión
- Comercial Urbano / Institucional Administrativo
- Comercial Urbano / Industrial
- Usos Diferidos
- Areas Protegidas con Turismo
- Areas Verdes y Usos Públicos / Turismo
- Transporte Aeronáutico
- Area de Operación del Canal (área de agua)

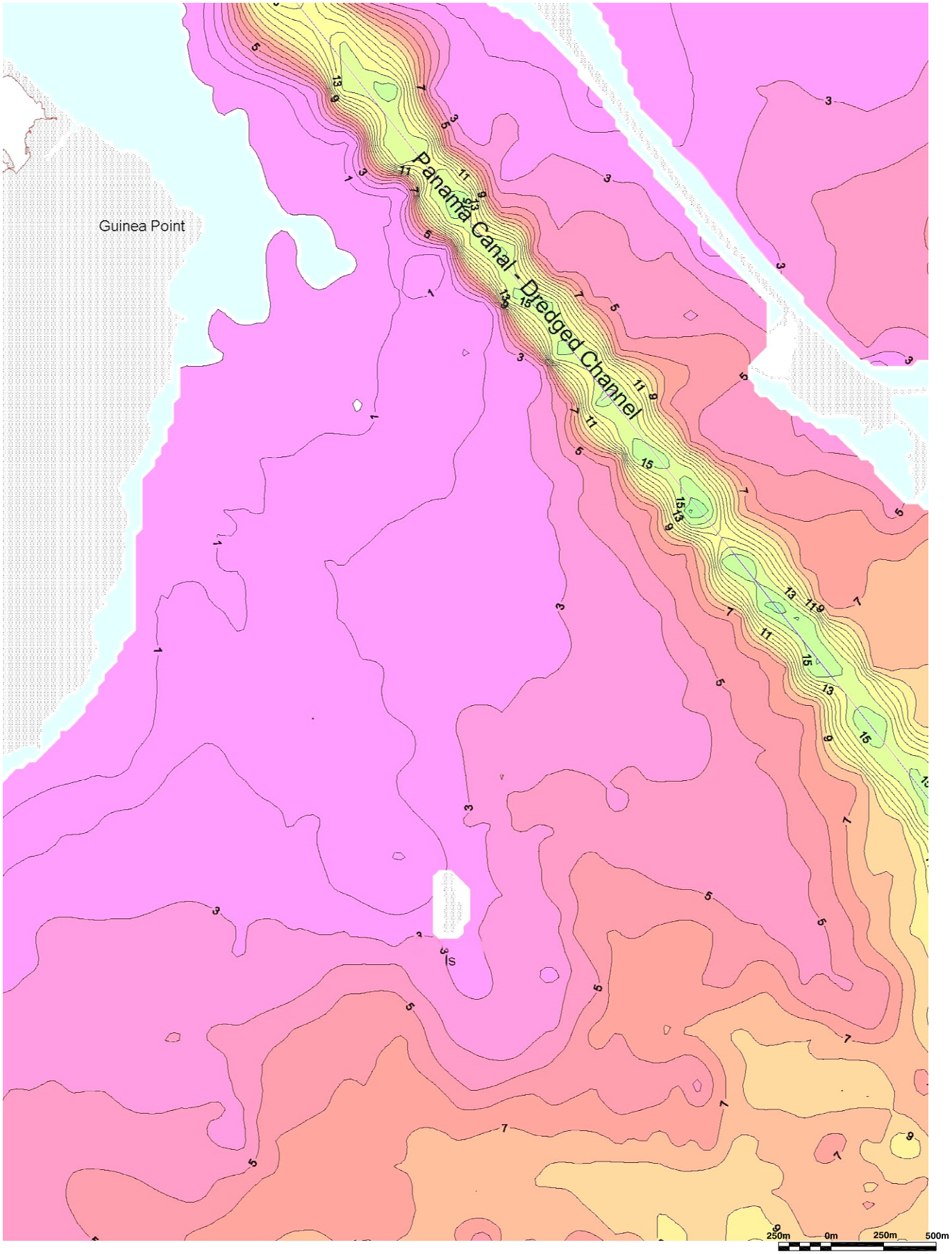
Plan General de Uso, Conservación y Desarrollo del Area del Canal

Figure 6
Land Use Mapping
Former Howard AFB

3.3 Geotechnical Conditions

Figure 8 shows the elevation of the andesitic rock encountered during the geophysical survey in the vicinity of the project site. The rock is very shallow directly due south of the Palo Seco Hospital, but drops to elevations between 12.00 and 20 m below MLWS at a distance of approximately 1,200 m from the west bank of the Pacific entrance channel of the Canal.

The depth of soft sediments varies from minimal due south of the Palo Seco shorefront to 18 – 20 m in the areas close to the Canal.



Note: Contour elevations referenced to MLWS courtesy of Golder Associates.

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Figure 7
Bathymetry of Study Area from 2003 Geophysical Survey

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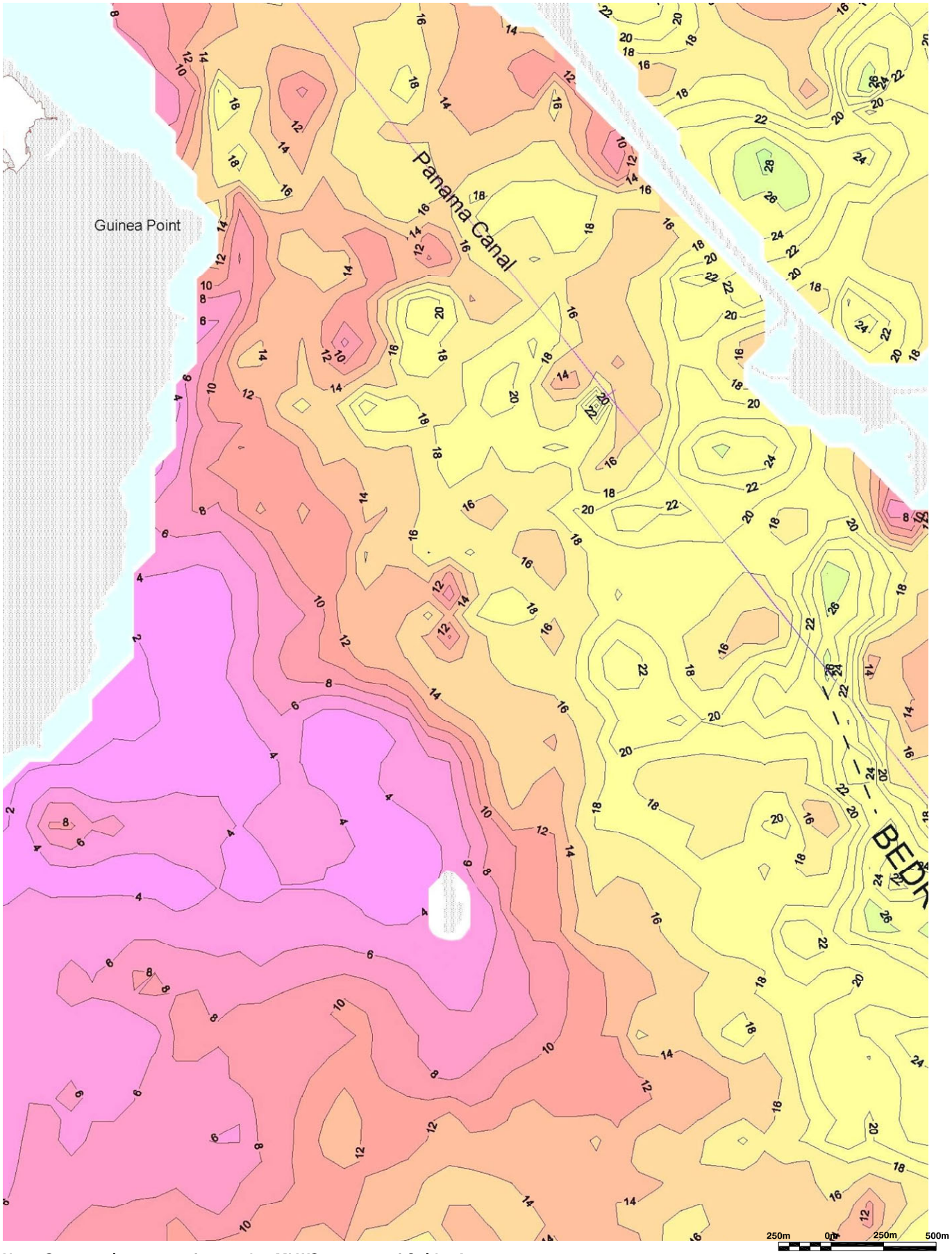

Note: Contour elevations referenced to MLWS courtesy of Golder Associates.

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Figure 8
Elevation of Competent Rock at Project Site

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4 TECHNICAL STUDIES

4.1 Materials Source Options

The two basic sources of materials that can be used for construction of the Port are:

- Excavated and dredged material from the New Locks Project
- Imported sand from a borrow site at an acceptable distance from the Project location, combined with rock from local quarries close to the Port site.

4.1.1 Material from the New Locks Project

Most of the material from the Locks excavation will make excellent fill for the proposed terminal. According to analyses presented in earlier reports, it is primarily rock, that will probably be excavated in pieces of less than 60 cm diameter.

Assuming a positive decision to proceed with the New Locks project, ACP could begin excavation of the Locks area using its own resources for financing of the work.

In this case, material could be available for the container project by mid to late 2006. If excavation is to be scheduled to await completion of the final designs on the Locks, the material would not be available until about 2008 to 2010.

Transportation cost Assessment

Cost models were prepared covering movement of the excavated material by the following methods

- Truck Haul over dedicated haul road using off road large sized dump trucks
- Rail transport, with the expectation that the rail would remain for future use
- Barge transport.

A barge haul system is likely to be the cheapest option, assuming the movement of 16.5 million m3 of material, with an estimated unit transportation cost of $7.16 per m3. Both rail and truck haul costs are similar at $10.97 per m3, but in both cases, a significant percentage of the cost involves the construction of a haul corridor from the Locks to the project site.

4.1.2 Hydraulic Fill Materials

Sand has traditionally been dredged and extracted for building and construction projects from the Punta Chame area until this activity ceased in the early 1990s. At the time of cessation of this sand extraction, property owners in the Punta Chame area were expressing concern that erosion was taking place on the beach front and requesting a prohibition on future concessions in this area.

There is very little reliable information on the characteristics and extent of the sand deposits in the project area, but the geophysical and other studies indicate that the transition from soft silts to sands takes place at approximately the -10.00 m contour.

The construction of the island will require the dredging and disposal of soft sediments and the import of clean fill. Preliminary assessments of the required volumes indicate that the total volume of dredging is close to the amount of fill required for the project.

This balance then offers the potential to combine a dredge disposal operation with the sand borrow activities in order to generate significant cost savings for both elements of the project.

While more detailed studies will be required at the final design phase, it is suggested that a deepwater dredged materials location due south west of Taboga Island, and clear of the Vacamonte entrance channel would then represent a good combination with a sand borrow site in the same general vicinity. Figure 9 shows the tentative location of the two sites.

The cost model indicates typical unit costs of $6.09 per m3 for recovery and transport of fill material if combined with a dredged disposal operation. Based on this assessment of cost, it would appear that the use of hydraulically dredged sand contained within rock dikes is the preferred construction system for the new Port

The closest rock source to the project is located at the south end of the Howard runway and material from this quarry was used to build an extension to the runway some years ago. However, it would appear that the hills inshore of the project area have substantial rock deposits that will need to be excavated for improve the road access to the Port. This material, if suitable, could be used to build retaining dikes for the fill at a relatively low cost.

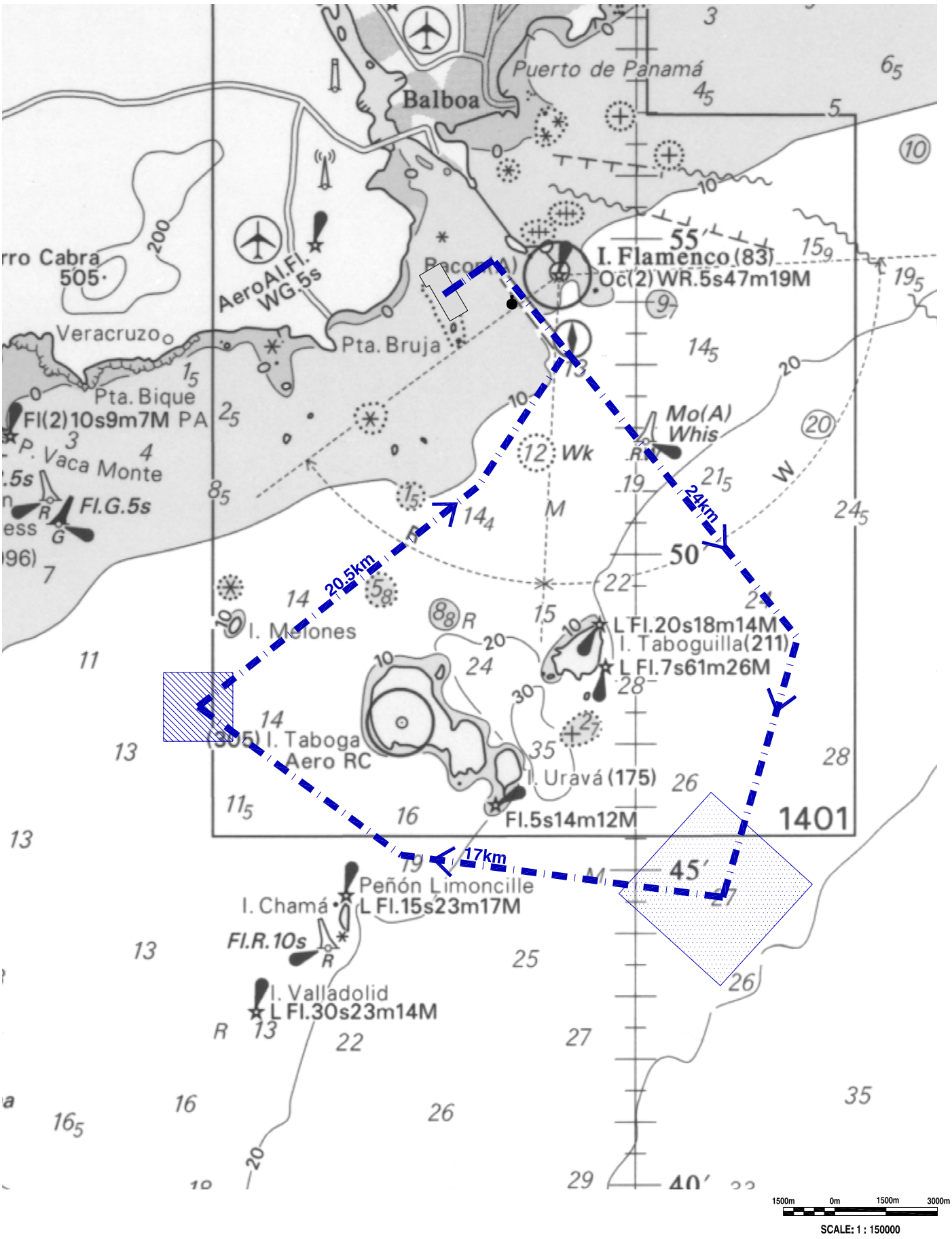

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Figure 9
Location of Potential Dredged Materials Disposal and Sand Borrow Sites

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4.1.3 Cost Analysis of Materials Source Options

A cost model was run of the various materials options that could be used for the reclamation and fill elements of the project. The cost estimates all assume that there would be no fee payable for materials extraction.

The results of the transportation cost analyses are presented in Table 2. While it is acknowledged that there are many variables associated with the cost comparisons and analyses, it would appear that the use of imported sand and local quarry material represents the most cost effective option from a pure transportation point of view.

The major advantage of the use of imported sand is that the work schedule will not be tied to the implementation and work program for the New Locks project. This indicates that the use of imported sand will be the island construction method of choice, assuming that all permits and approvals can be obtained for its extraction.

Table 2: Transportation Costs for Alternative Materials and Sources

Material/Source	Transport Method	Estimated Volume (m3)	Unit Transport Cost ($/m3)	Total Transport Cost ($)
Excavation from Locks Project	Truck	16,500,000	$10.97	$181,005,000
	Rail	16,500,000	$10.97	$181,005,000
	Barge	**16,500,000**	**$7.16**	**$118,140,000**
LOWEST COST USING LOCKS MATERIAL				***$118,140,000***
Sand Fill from Borrow Site				
As return leg after dredge disposal	**Barge**	**16,317,400**	**$6.09**	**$99,372,966**
As independent voyage	Barge	16,317,400	$7.03	$114,711,322
Quarry Material from Howard	**Truck**	**1,915,000**	**$7.50**	**$14,362,500**
Quarry Material from Bique	Barge	1,915,000	$12.25	$23,458,750
LOWEST COST USING IMPORTED SAND FILL				***$113,735,466***

4.2 Port Location Assessment

A total of six alternative locations were evaluated to determine the least cost option for the basic island construction, based on the following work tasks

- Trestle/causeway connection from shoreline to island
- Pre dredging of soft materials in fill and berth areas
- Dredging of access channel, berthing area and turning circles
- Dredging of rock
- Dikes or revetments to retain fill, assuming imported sand option
- Fill material.

It is important to note these work tasks do not include berth construction, terminal paving, rail connections and utilities which are common to all locations and do not impact the outcome of the selection process.

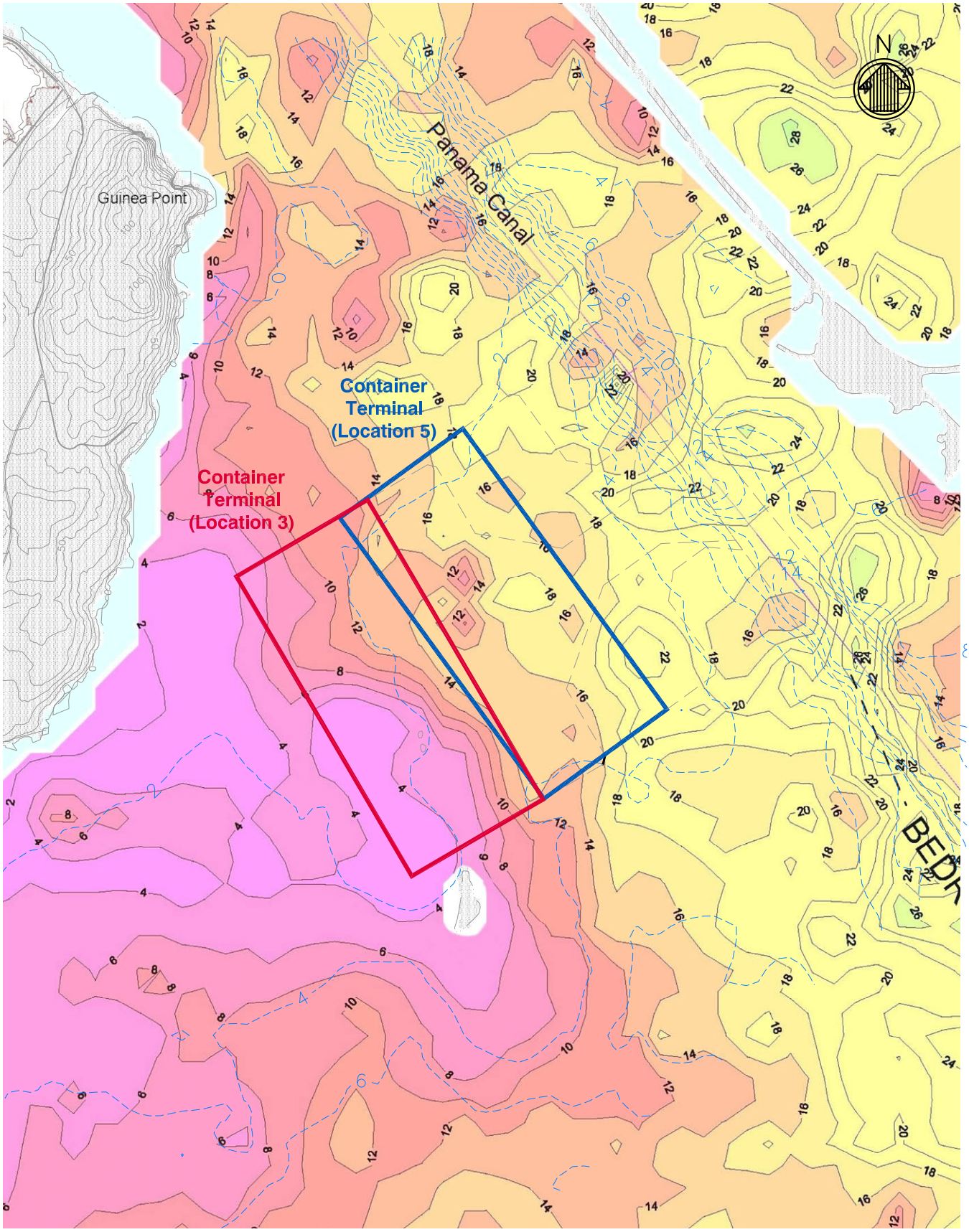
The estimated cost of the basic island construction of all the options varied from $249 million to $351 million. The cost of either of the two most economic options, designated Locations 3 and 5 and shown in Figure 10, was approximately US$250 million, excluding the cost of the marine terminals and other structures. .

Operationally, there may be limitations on the development of Location 5, since the berths will be relatively close to the Pacific entrance channel to the Canal.

4.3 Marine Structures

Two structural concepts were considered for the marginal wharf of the container terminal. The first involves the use of rock filled cellular cofferdams which retain the fill materials and also support the deck of the berths. The second alternative is an open piled wharf structure. In this case, the fill material is retained by rock dikes constructed below the main deck area. For this option, the volume of rock required for the dike structure below the wharf can be substantial. It is also critical that the rock is small enough for piles to penetrate without deviation, which generally indicates that no pieces should be larger than 150 mm in diameter.

The cofferdam alternative appears to be the most economical berth section for this project, with an equivalent cost of $60,000 per linear meter of wharf.



Notes:
1. Contours Referenced to MLWS
2. Seabed Contours Shown Thus ----2---- Bedrock Contours Shown Thus ——8——

250m 0m 250m 500m
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Figure 10
Island Location Study - Location Options 3 and 5

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4.4 Wave & Protection Assessment

Panama Bay is well protected from ocean swells generated in the Pacific Ocean, which limits the 100 year significant wave height at the island site to 0.70 m from the south or south west, with a 17 second period. Locally generated wind waves are higher at 1.0 m from the east, with a 4.1 second period, but the site is well protected by the Amador Causeway.

According to the wind data used for this analysis, the 1.8 m maximum wind generated wave from the south and southwest is of very short duration.

As a cautionary measure, it is strongly recommended that a wave gauge with the capability to detect long period waves should be installed for at least a 12 month period at the project site before final design work is commenced on the project.

4.5 Navigation

The initial channel depth is set at 16.75 m to accommodate a loaded vessel draft of 15.00 m, to match the vessel sizes and design parameters for the New Locks project. However, since it is expected that 12,500 TEU ships will be constructed within the next 10 to 15 years, provision should be made for future deepening to 18.50 m.

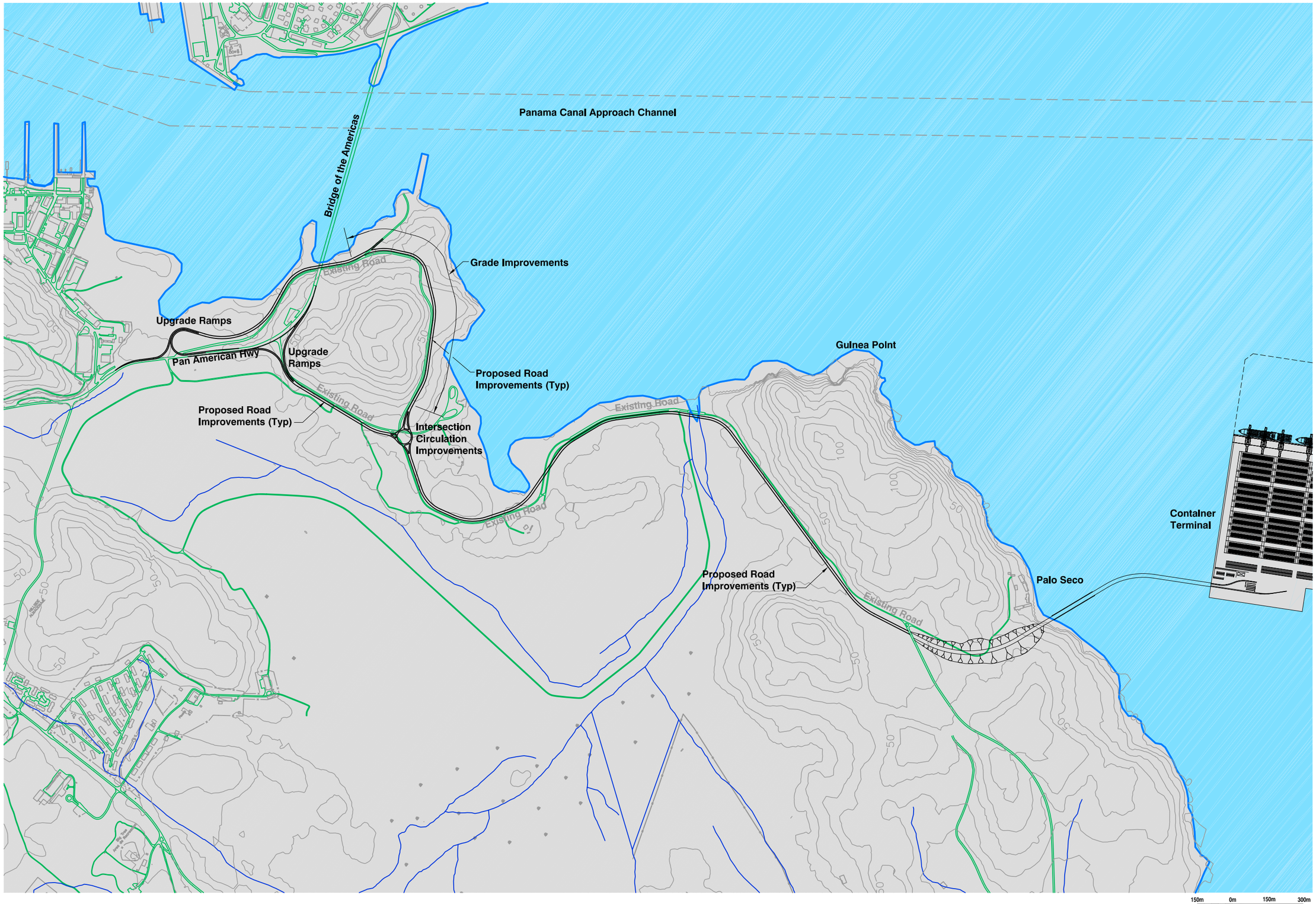
4.6 Infrastructure Network

All primary utilities must be extended to the site and a new network established. In particular, the electrical loading for up to 20 gantry cranes will be high and power demand for up to 600 reefer outlets will be substantial

4.7 Highway Access

Figure 11 shows a suggested alignment for the access road section from the Bridge of the Americas to the Port site. During construction, a temporary haul road will be built alongside the existing highway to separate the construction traffic and form part of the expanded road on completion of the port construction.

In the longer term, a connection from the Port to the recently completed Centenario Bridge will become increasingly important, particularly if plans to improve and upgrade the Trans-Isthmian highway proceed as expected.



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PORT DEVELOPMENT AT PALO SECO

Recommended Alignment of Upgraded Site Access Roads

Fig 11

4.8 Intermodal connections to the Atlantic Side

Alternatives to provide an Intermodal connection from to the Atlantic Side include:

- Construction of a new rail line from the port to the locks area
- Moving containers by truck from the Port to the Balboa Rail Yard
- Establishment of a Barge service
- Truck haul across the Isthmus

4.8.1 Rail Link

At this time, there is no rail connection across the Bridge of the Americas or the recently completed Centenario Bridge. However, there is a swing bridge at the south end of the Miraflores Locks and the structure seen in Figure 12 has provision for a single rail line. The bridge is not used for regular traffic and is only opened for maintenance or testing or to move heavy equipment from one side of the Locks to another.

Figure 12: Existing Swing Bridge at Miraflores Locks

In order to cross the Canal at this location, and assuming the construction of the New Locks goes ahead, a second opening bridge will be needed. Figure 13 shows a tentative rail alignment from the new Port site to the east side of the Canal, including the crossings at the existing and proposed new Locks. A cost estimate for the rail connection and intermodal yard is presented in Table 3.

Table 3 : Preliminary Estimate for Rail connection & Intermodal Yard

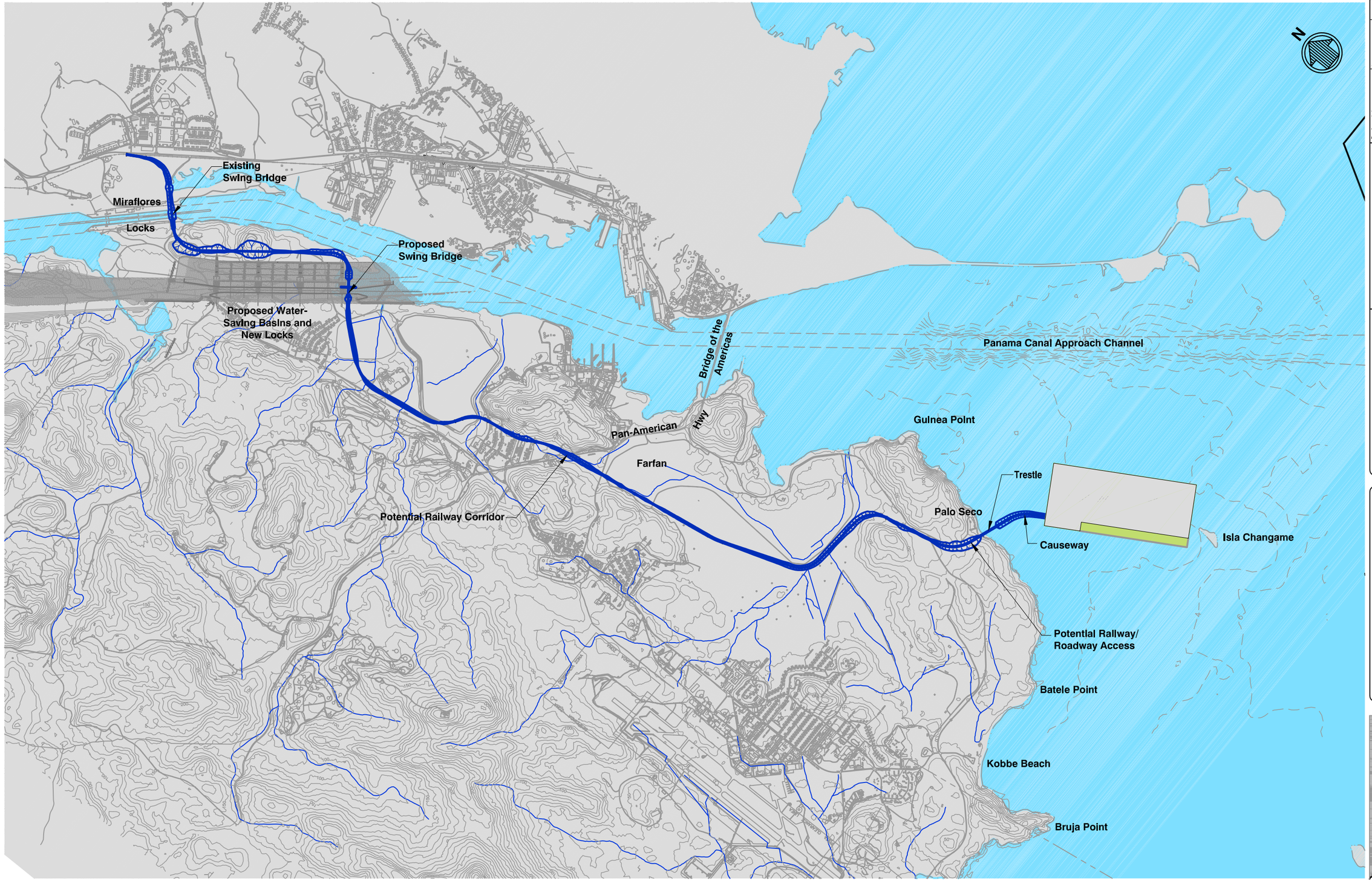
Description	Amount
Mobilization & Demob	**$3,157,893**
Intermodal Yard	**$27,083,200**
Rail Line	**$51,932,500**
Crossings	**$47,300,000**
Admin & Engineering Costs	$1,562,500
Contingencies	$32,368,398
Estimated Project Cost	**$175,904,491**

4.8.2 Other Intermodal options

Given the extremely high cost of the rail connection, primarily due to the need for the new and upgraded rail bridges at the Miraflores Locks, other options were assessed to connect the Atlantic and Pacific Coast Ports.

- Drayage of containers to the Existing Balboa Yard
- Establishment of a Barge service – Port to Port
- Truck haul across the Isthmus

Based on an initial assessment of potential costs for the three systems, it would appear that barge and truck haul from coast to coast are the most cost effective options for intermodal transfer. While the barge cost appears to be the cheapest, a balanced directional flow of containers is required as the Canal fees for a return empty or partially loaded trip will be the same as for a full load, unless special exceptions are made.



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FEASIBILITY STUDY FOR
PORT DEVELOPMENT AT PALO SECO

Potential Rail Corridor and Connections from Port to Miraflores Area

Fig 13

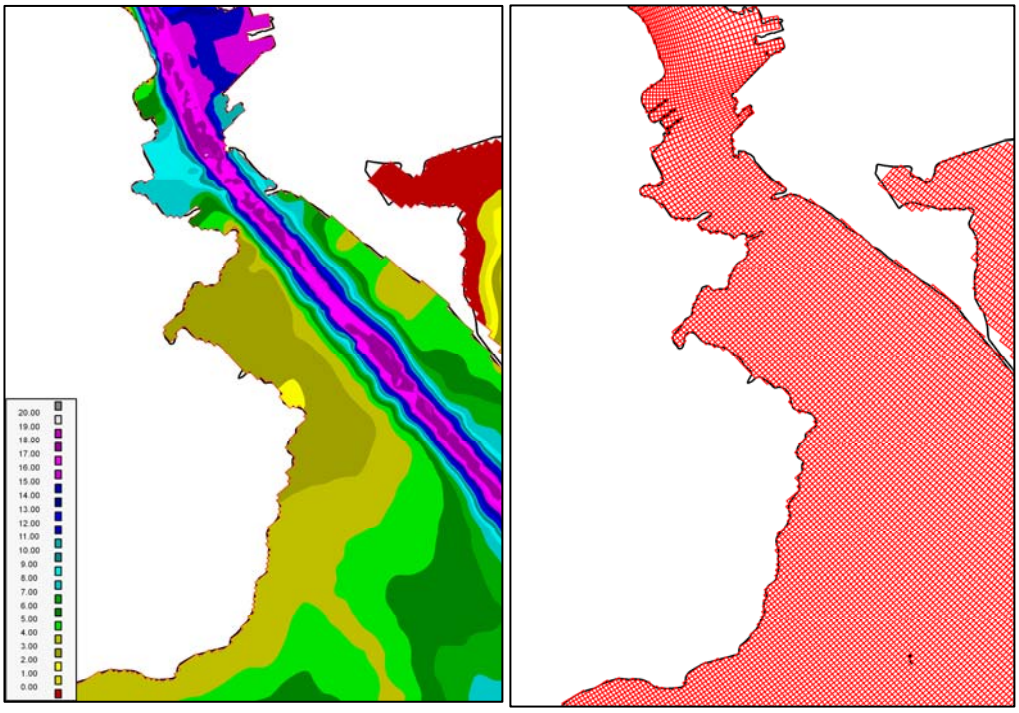
558200_Fig13.dwg 10 Jun 2005 - 1:16pm; JMacPherson; © Moffatt & Nichol

5 ENVIRONMENTAL & SOCIO ECONOMIC IMPACTS

5.1 Hydrodynamic Model

A hydrodynamic model was run for the area with and without the new port in order to assess potential current and sedimentation changes along the shoreline and within the Pacific entrance to the Canal. Figure 14 shows the coverage of the model and the bathymetry of the study area.

Figure 14: Detail model bathymetry and grid



5.1.1 Changes in the hydrodynamic regime of Panama Bay

Hydrodynamic effects on the currents will be limited to areas in the immediate vicinity of the project. The separation of the island from the shoreline by a distance of at least 200 m will assist the circulation of the water flows along the Palo Seco/Farfan Shoreline area.

5.1.2 Impacts on Coastal Resources

The artificial island does not produce any change in the flow patterns in the vicinity of Isla Otoque and the areas where coral growth can still be found.

5.1.3 Impacts on Beaches and Western coastline

The shoreline located immediately west of the project could experience a slight increase in sedimentation carried by the water along the modified shoreline as it clears the island area. The shoreline located at the northwest tip of the artificial island could experience some exposure of the rock faces due to the higher velocities through that narrow area. However, the headland at the eastern end of Kobbe Beach is expected to act as a barrier to material moving westwards between the island and the existing shoreline.

5.1.4 Sedimentation in the Panama Canal access channel

Velocities will increase slightly during Spring Tides in the area of the entrance channel following the construction of the island. This may lead to a slight reduction in sedimentation of the Canal Pacific Entrance.

5.2 Environmental Impacts

Potential environmental impacts of the project were identified for construction and operation of the Project alternatives and connections. To assess the impact of the Project alternatives, attributes and values were defined for the impact analysis based on the characteristics and the interaction of the project activities and the environment.

The attributes defined for the evaluation of the potential impacts included:

- Type
- Geographic extent
- Length
- Magnitude
- Probability of occurrence
- Frequency
- Reversibility

To visualize the quantitative and qualitative characteristics of the impact, a rank of values was established assigning a color code as shown in Table 4.

Table 4: Ranking of Environmental Impact Values and Color Code

Ranks of Value				
			Predicted Effect	**Color Code**
15	to	+.1	Positive	
0		0	NEUTRAL	
-5	to	-.1	Slightly negative	
-10	to	-5.1	Moderately negative	
-15	to	-10.1	Highly negative	

Construction of an artificial island will result in a loss of marine bottom habitat that may be utilized by benthic invertebrates, shrimp, spiny lobsters, bivalves, and certain fishes. The large rip-rap that will be placed on three sides of the artificial island will provide habitat for certain types of invertebrates and fish, but cannot be considered in-kind replacement for habitat lost through construction.

Upgrading the existing roads and intersections to provide automotive access only to the artificial island would have the least amount of negative environmental and social impacts because only a minimal amount of new alignment would be needed and most construction would occur in existing right-of-way or already disturbed areas.

Visual impacts and noise levels from road and rail traffic may discourage development of the coastal areas.

A rail terminal on the artificial island would minimize environmental and social impacts as all construction would be on a previously disturbed site. Construction on land would eliminate dry forest habitat, which is becoming rare in Central America, and has the potential to unearth or destroy previously undiscovered archaeological objects.

The results of the evaluation process are shown in the matrix presented in Table 5.

Table 5: Summary of Impacts, Artificial Island (Access through Upgraded Existing Roads and Intersections)

Environment	Component	Change Indicators	Project Phase							
			Construction				Operation			
			Transportation and Mobilization	Site Preparation	Construction of Infrastructure and Utilities	Construction of Container Port Island	Operation of Container Port Terminal	Operation of Access Road and Rail	Maintenance of Terminal and Related Structures	Closure of Operations and Abandonment
Physical	Air	A-1								
	Noise	R-1								
	Water	H-1								
		H-2								
	Soil and Landforms	SU-1								
		SU-2								
		SU-3								
Biological	Terrestrial and Aquatic Flora and Fauna	FF-1								
		FF-2								
		FF-3								
		FF-4								
		FF-5								
Social	Social	S-1								
		S-2								
		S-3								
		S-4								
	Economics	E-1								
		E-2								
		E-3								
	Cultural	AR-1								

5.3 Mitigation and Monitoring

ACP and the government of Panama have agreed on a range of tariffs or mitigation fees associated with projects involving the loss of natural resources. On this basis the allowance for mitigation is expected to be approximately $800,000.

Mitigation projects may also be used in lieu of or in conjunction with tariffs to offset negative environmental and social impacts. Potential mitigation projects for this development could include:

- Protection of the dry forest at Palo Seco
- Restoration of contaminated intertidal areas in the Rodman area that are used by migratory birds
- Enhancement of the protected forest area at Punta Bruja
- Beach enhancements or improvement of shore side facilities at Veracruz
- Community benefit projects, such as a road link from Veracruz to the Vacamonte Highway.

A monitoring program should be also be developed in conjunction with the appropriate agencies and interest groups to ensure that the Project construction and operation activities are incompliance with all applicable regulations.

6 RECOMMENDED PROJECT CONCEPT

6.1 Container Terminal at Location 3.

Figure 15 shows the recommended concept for the container Port at Location 3. The terminal has an overall footprint of 1600 m x 700 m, offering a total reclaimed area of 112 ha and a projected ultimate capacity for 2.4 million TEUs per year, assuming 80% transshipment cargo.

Depending of the results of detailed geotechnical investigations, the area will be surcharged to an expected height of 3.00 m and wick drains installed to accelerate the consolidation process. Each surcharge load would be left in place for nine to twelve months before being moved to a new filled area.

As seen in Figure 16, the berths are built on a cofferdam structure that is also used to retain the main fill material. Provision is made for gantry cranes with 100 ft rail gauge,

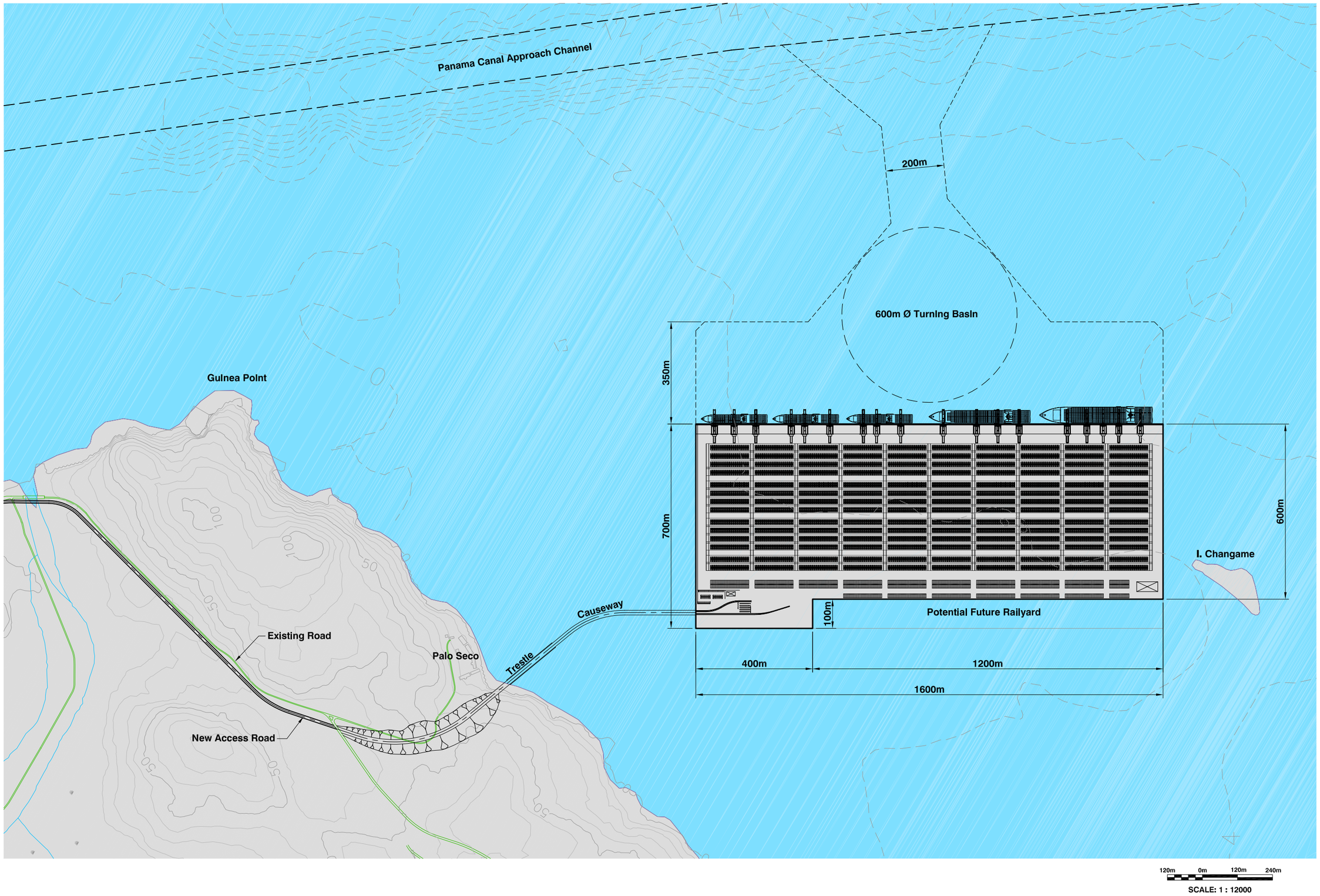
based on the assumption that this will remain the standard for container crane design to vessels up to a maximum size of 12,500 TEU.

The port is connected to the shoreline by a combination causeway and trestle with an overall length of 700 m. It is designed to accommodate two lanes of traffic in each direction, with 3.00 m shoulders on either side.

The terminal is connected to the Pacific Entrance channel of the Panama Canal by a new navigation channel with an initial depth of 16.75 m and a width of 200 m. Future expansion would deepen the channel to 18.75 m, although this would involve the need to remove substantial volumes of hard rock. Similarly, the channel could be widened for two way traffic of main line vessels, with an expected width of some 300 m.

A 600 m turning circle is provided at the mid point of the terminal. Depending on the results of detailed geotechnical studies and field investigations, it may be possible to adjust the location of the channel and turning circle to avoid or minimize rock dredging without impact the operational efficiency of the Port.

Options for future expansion of the Port at Location 3 are shown in Figure 17. The preferred first expansion phase would be towards the north where wave protection is good and an additional 1,200 m of berth could be built, offering a possible throughput increase of some 1.25 million TEUs per year. Extension of the port to the south beyond approximately 800 m would be subject to satisfactory results from wave penetration and ship motion analyses as the protection afforded to the Amador Causeway is lost.



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FEASIBILITY STUDY FOR
PORT DEVELOPMENT AT PALO SECO
Container Terminal Concept at Location 3

Fig 15

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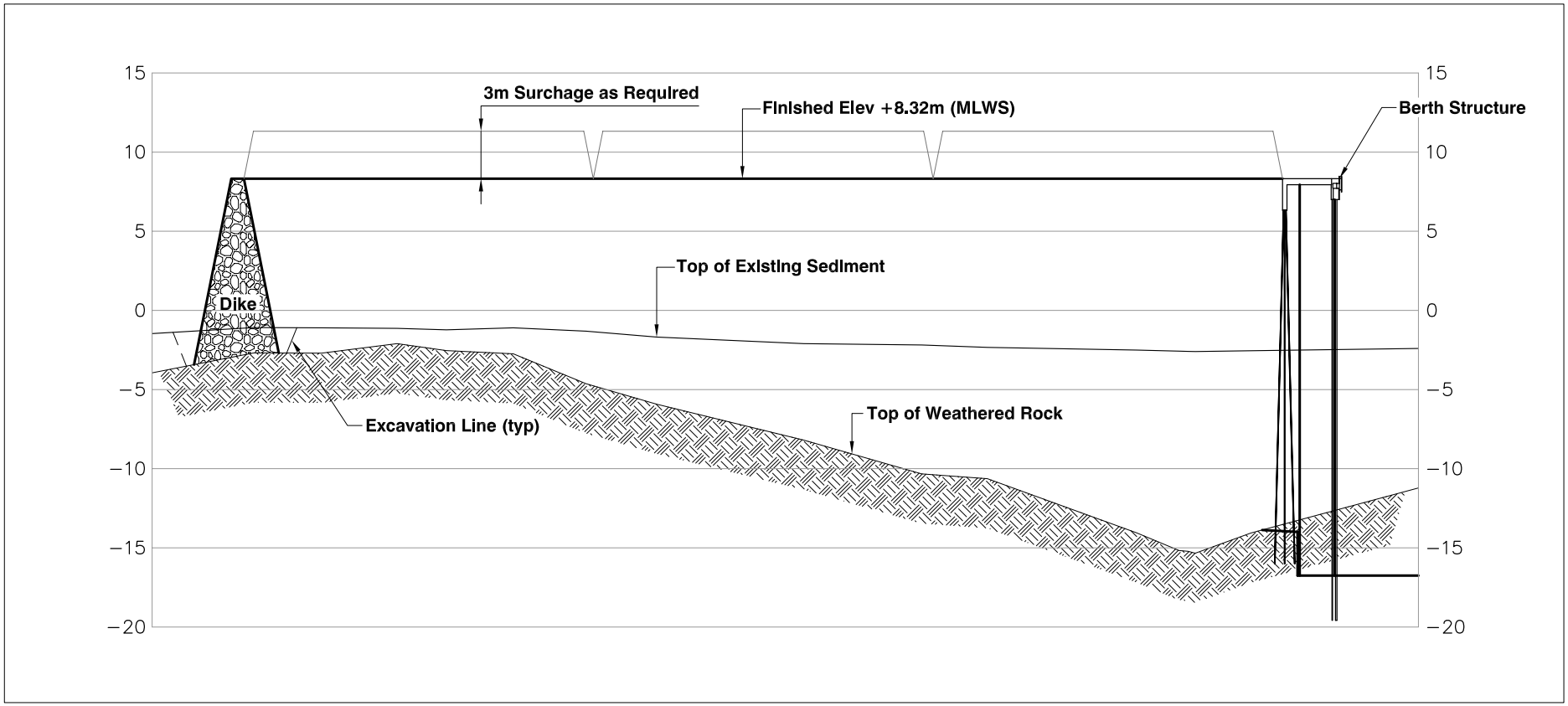

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40m 0m 40m 80m
HORIZ SCALE: 1 : 4000

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Fig 16
Cross Sectional View of Island Location 3

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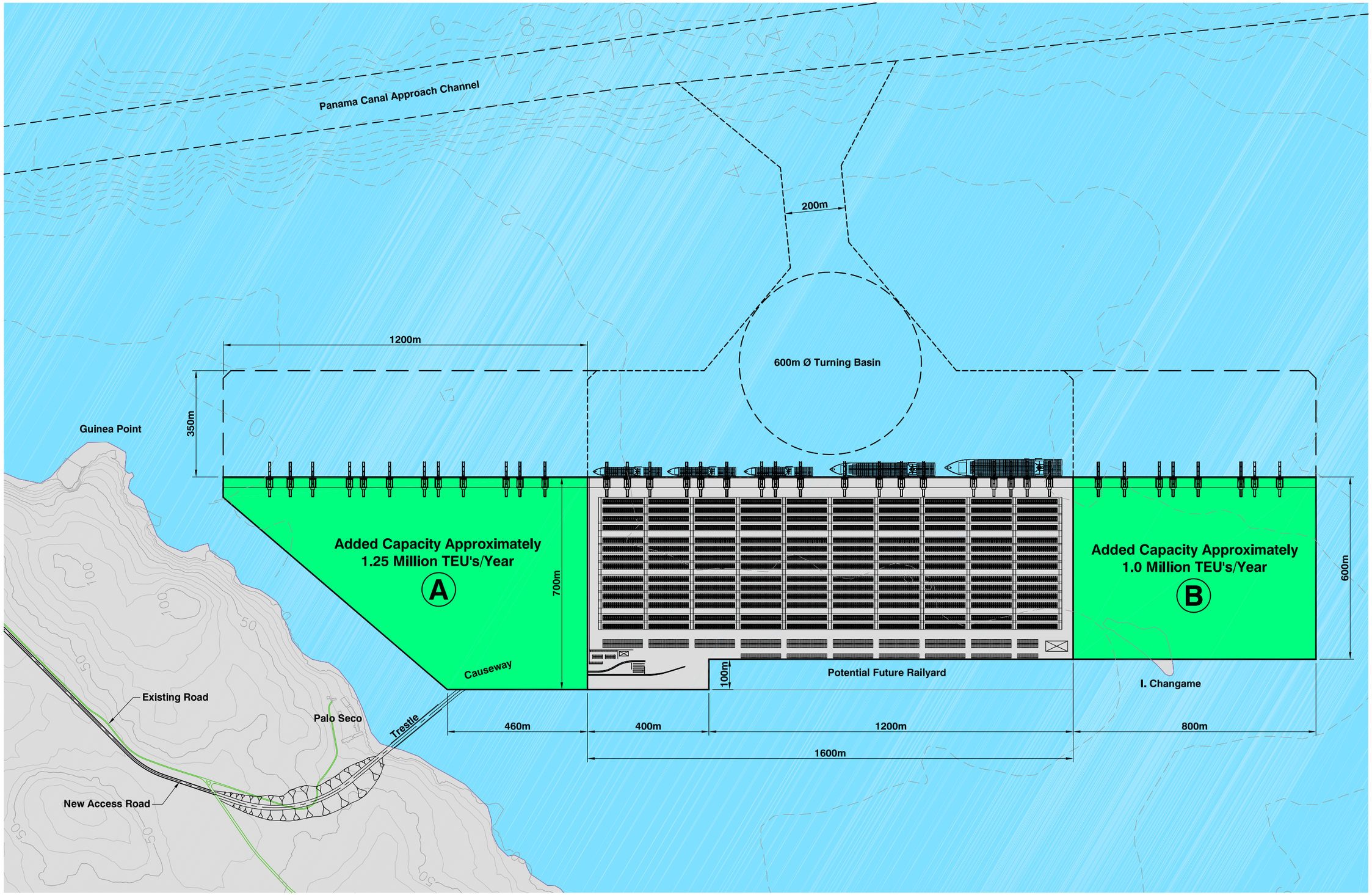

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FEASIBILITY STUDY FOR
PORT DEVELOPMENT AT PALO SECO
Container Terminal Concept at Location 3
Long Term Expansion Potential

Fig 17

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6.2 Container Terminal at Location 5

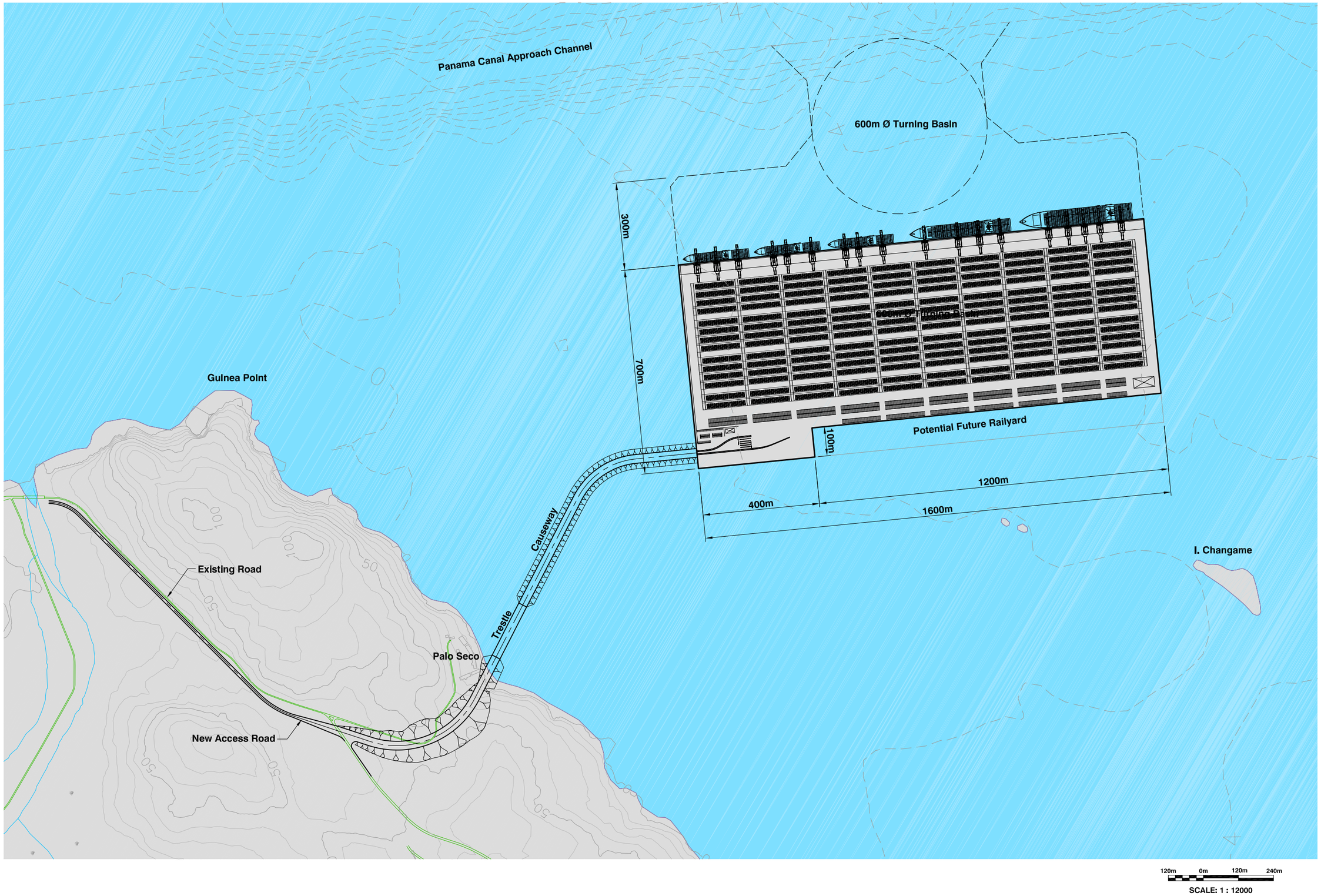
This was the least cost option compared to the other four locations assessed, although very close to the cost of Option 3 shown in the previous section.

The main terminal area shown in Figure 18 is located in an area with relatively shallow water and a substantial depth of soft material before rock is encountered. This will then require a more intensive ground improvement program and long term settlement is a more serious concern in the main yard area than for Location 3. Highway connections to the terminal are similar to those illustrated for Location 3.

As can be seen from Figure 18, the port is located much closer to the west bank of the Pacific Entrance channel than Location 3. While this reduces the length of the channel to some 700m, there may be navigational concerns over the impact of maneuvering vessels on the flow of Panama Canal traffic. This key issue must therefore be resolved before any commitment is made to this option.

Location 5 offers a wide range of expansion options, as indicated in Figure 20. Approximately 1,600 m of berth and back up area can be added north of the first phase development, offering some 1.75 million TEUs of additional capacity. Alternatively, the port can be extended westwards which would permit feeder vessel berths to be constructed on the west face of the first stage development and a new terminal to be built to share the main access channel. Total added capacity for this alternative would be approximately 2.5 million TEUs per year.

This option is not practical for Location 3, as the new main line vessel berths would be located in an area where the rock elevation is extremely shallow.



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FEASIBILITY STUDY FOR PORT DEVELOPMENT AT PALO SECO

Container Terminal Concept at Location 5

Fig 18

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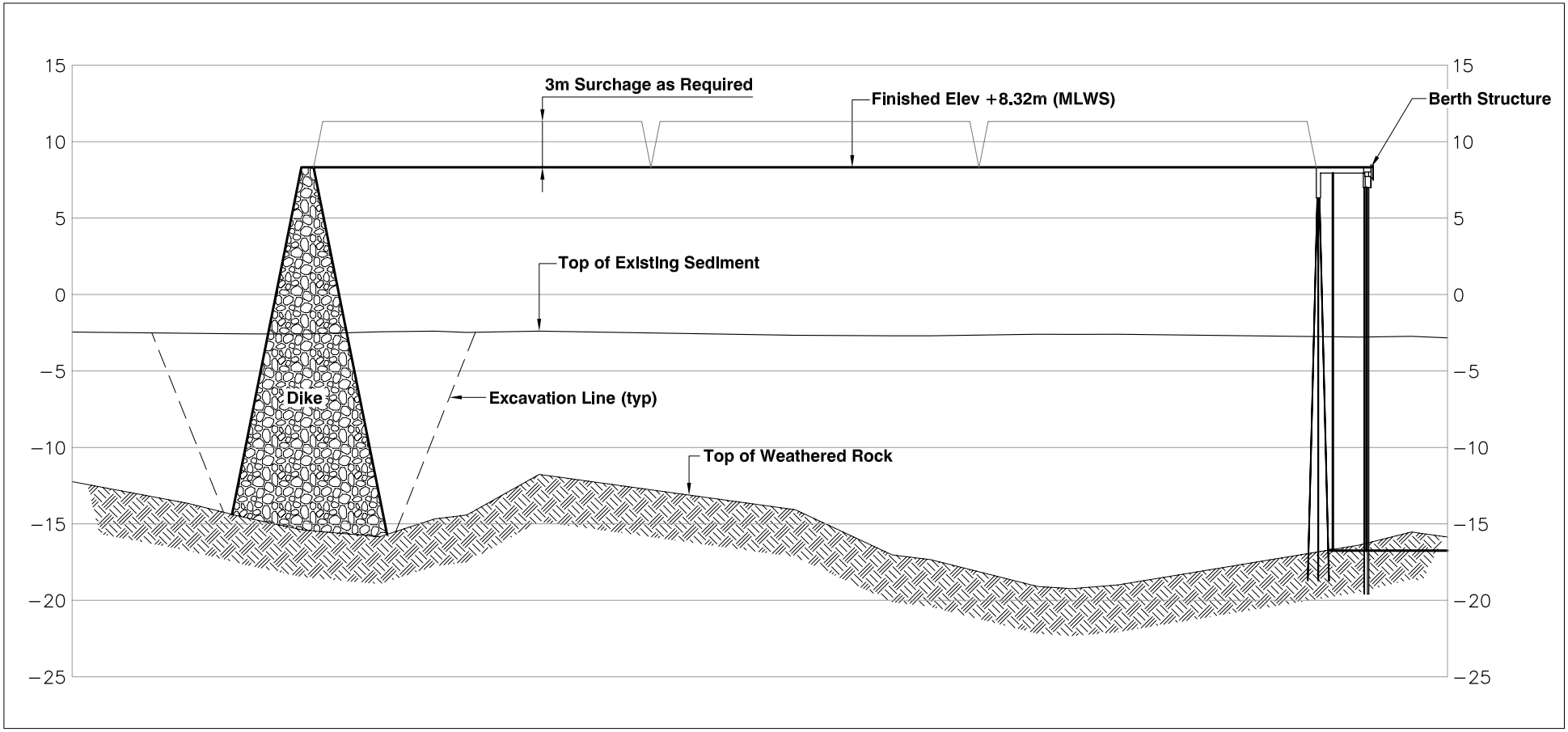

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VERT SCALE: 1 : 400

40m 0m 40m 80m

HORIZ SCALE: 1 : 4000

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Fig 19
Cross Sectional View of Island Location 5

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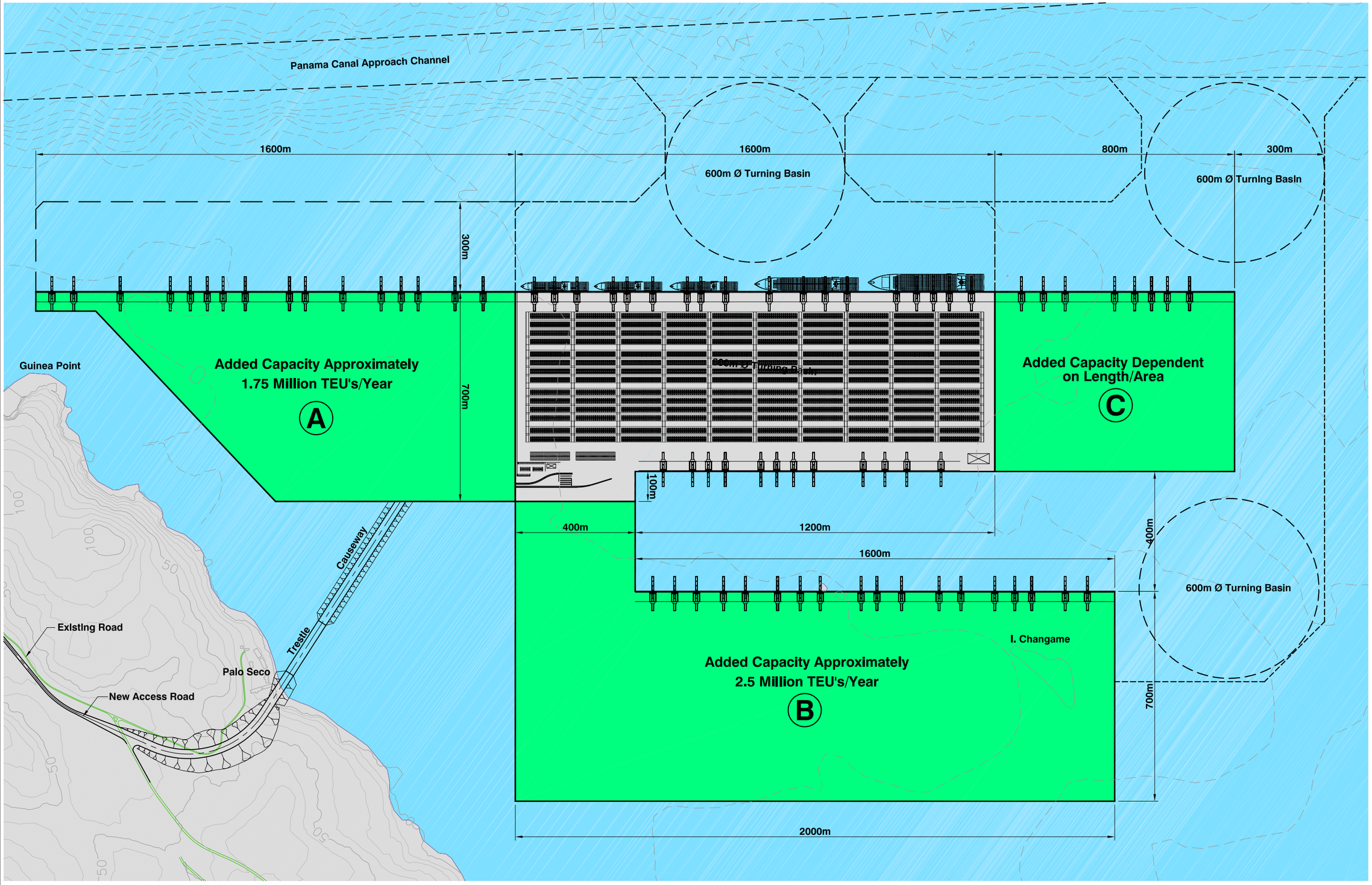

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FEASIBILITY STUDY FOR
PORT DEVELOPMENT AT PALO SECO

Container Terminal Concept at Location 5 Long Term Expansion Potential

Fig 20

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7 COST ESTIMATES

7.1 Basis for costing

This project is vulnerable to a wide spread of cost outcomes, as it involves high volumes of materials and relatively few major work items. Almost 50 percent of the cost is in dredging and reclamation work and another 15 percent is the berth construction. Small variations in unit costs for the dredging and reclamation work will therefore have a large impact on final cost, while continuing steel and cement cost increases could make a significant difference to the final cost of the marine structures.

In order to provide a realistic budget for the project, a cost sensitivity analysis was run for the two preferred concepts, in order to identify the most sensitive items and also to present the likely spread of costs that can be tested financially by potential investors in the project.

It is expected that the Port operator will implement its own management system and provide its own equipment. Consequently, the cost estimates do not include equipment or any of the mobile assets of the project.

7.2 Container Terminal at Location 3

Figure 21 shows the statistically developed range of cost outcomes for the project using the techniques presented above. At this feasibility level of study the 85 percentile outcome should be used for financial evaluations and budgeting purposes. This indicates that there is an 85 percent level of probability that the cost of the construction of the port at Location 3 will not exceed $598 million, excluding land acquisition, cranes and yard equipment and licensing fees for sand and rock fill. The estimate also does not include rail access, long term improvements to the Coastal Highway.

Table 6 shows the primary cost elements of the 85% outcome of the simulation and Figure 22 shows the relative sensitivity of the variable items, indicating the project elements where additional study and site investigation will produce the highest return.

Figure 21: Range of Outcomes for Construction Cost - Location 3

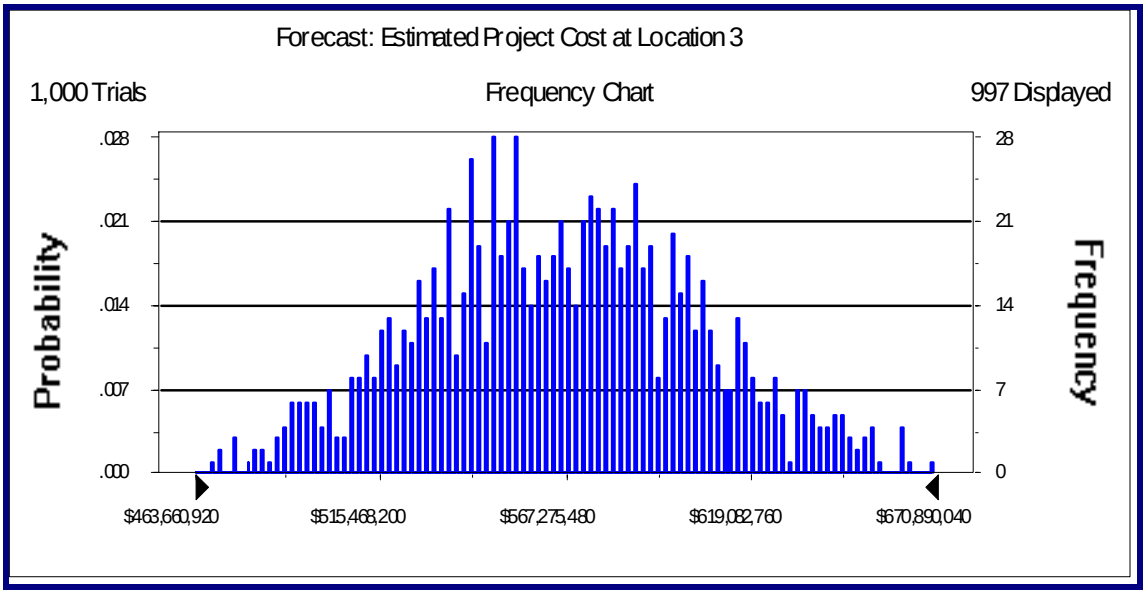
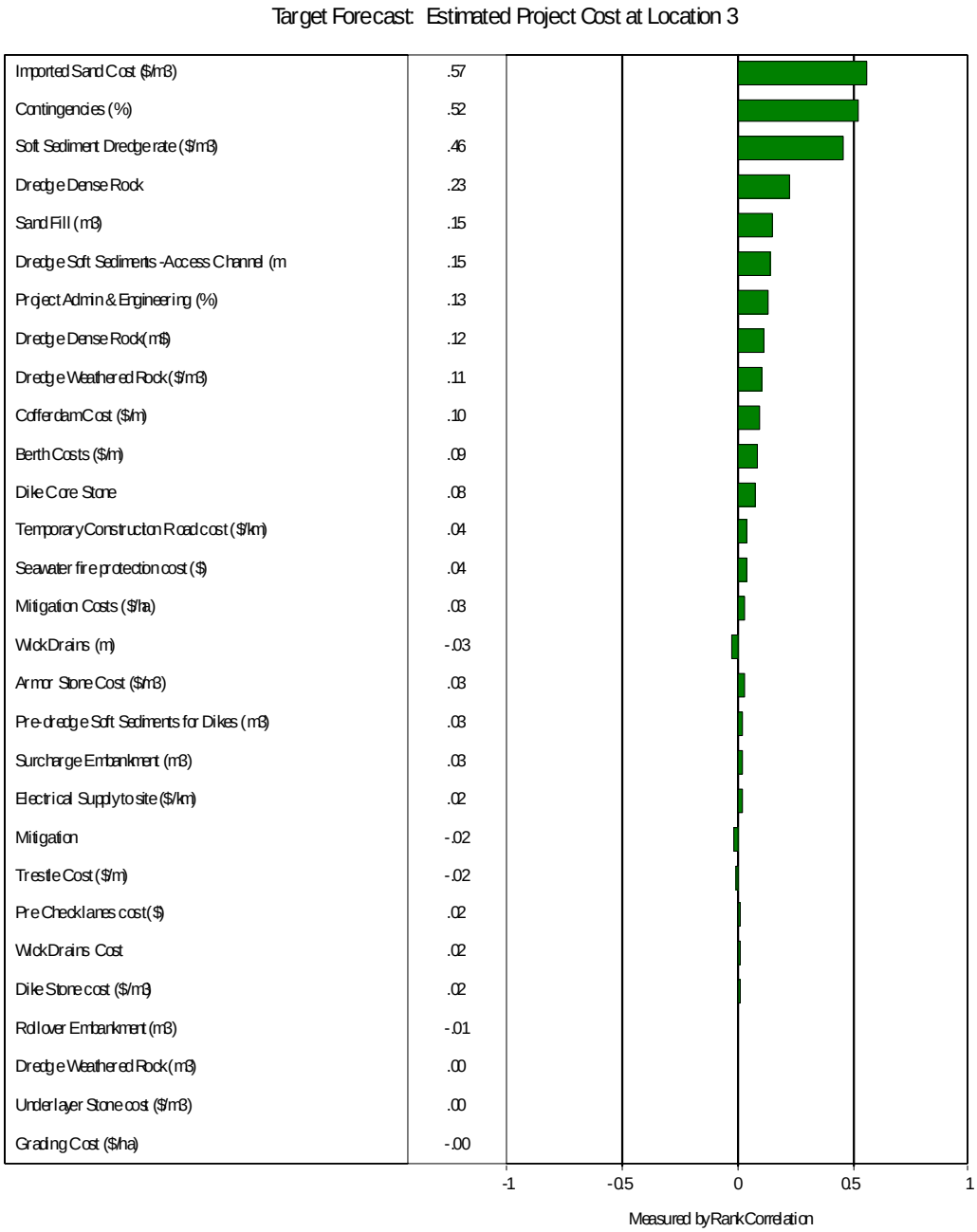


Table 6: Cost Breakdown of 85%ile Outcome - Terminal at Location 3

Description	Total
Dredging and Reclamation	**$265,948,573**
Marginal Wharf and Access Trestle	**$71,716,425**
Site Stabilization	**$26,558,965**
Terminal Infrastructure	**$89,668,181**
Construction Road & Site Connection	**$16,601,343**
Entrance Gates and Buildings	**$7,467,705**
Mitigation	**$665,857**
SUBTOTAL	**$478,627,049**
Contingency	$83,759,734
Planning, Engineering and Project Management	$35,852,157
TOTAL	**$598,238,940**

Figure 22: Cost Item Sensitivity Ranking - Location 3



7.3 Container Terminal at Location 5

Using the same assumptions as the previous case, Figure 23 shows that there is an 85 percent probability that the cost of the project at Location 5 will not exceed $672 million or approximately $74 million higher than Location 3.

Table 7 shows the main cost items from the 85% probability outcome. Cost sensitivities of the unit rates and quantities are similar to those shown for Location 3.

Figure 23: Range of Outcomes for Construction Cost - Location 5

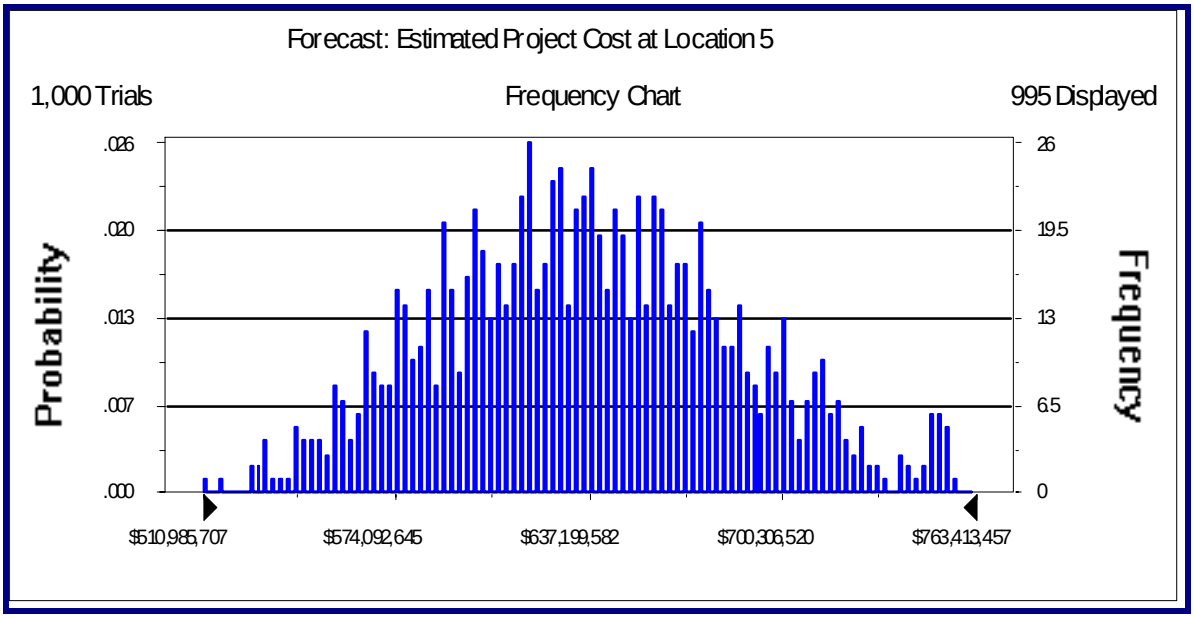


Table 7: Cost Breakdown of 85%ile Outcome - Terminal at Location 5

Description	Total
Dredging and Reclamation	**$300,100,641**
Marginal Wharf and Access Trestle	**$73,308,559**
Site Stabilization	**$47,036,176**
Terminal Infrastructure	**$91,658,851**
Construction Road & Site Connection	**$16,969,899**
Entrance Gates and Buildings	**$7,633,491**
Mitigation	**$680,640**
SUBTOTAL	**$537,388,258**
Contingency	$94,042,945
Planning, Engineering and Project Management	$40,253,739
TOTAL	**$671,684,942**

7.4 Highway Improvements

Table 8 presents a preliminary cost estimate for the conversion of the haul road and upgrading of the existing highway on completion of the project. In the longer term, a new connection is recommended linking Howard and the Port to the Centenario Bridge.

Table 8: Estimated Cost of Permanent Four Lane Highway to Port Site

Description	Amount
Pave Temporary Haul road	$5,400,000
Add two lanes over existing highway	$7,350,000
Landscaping, drainage & lighting	$1,510,000
Sub Total	**$14,260,000**
Contingencies, Engineering & Admin	$5,575,660
Estimated Project Cost	**$19,835,660**

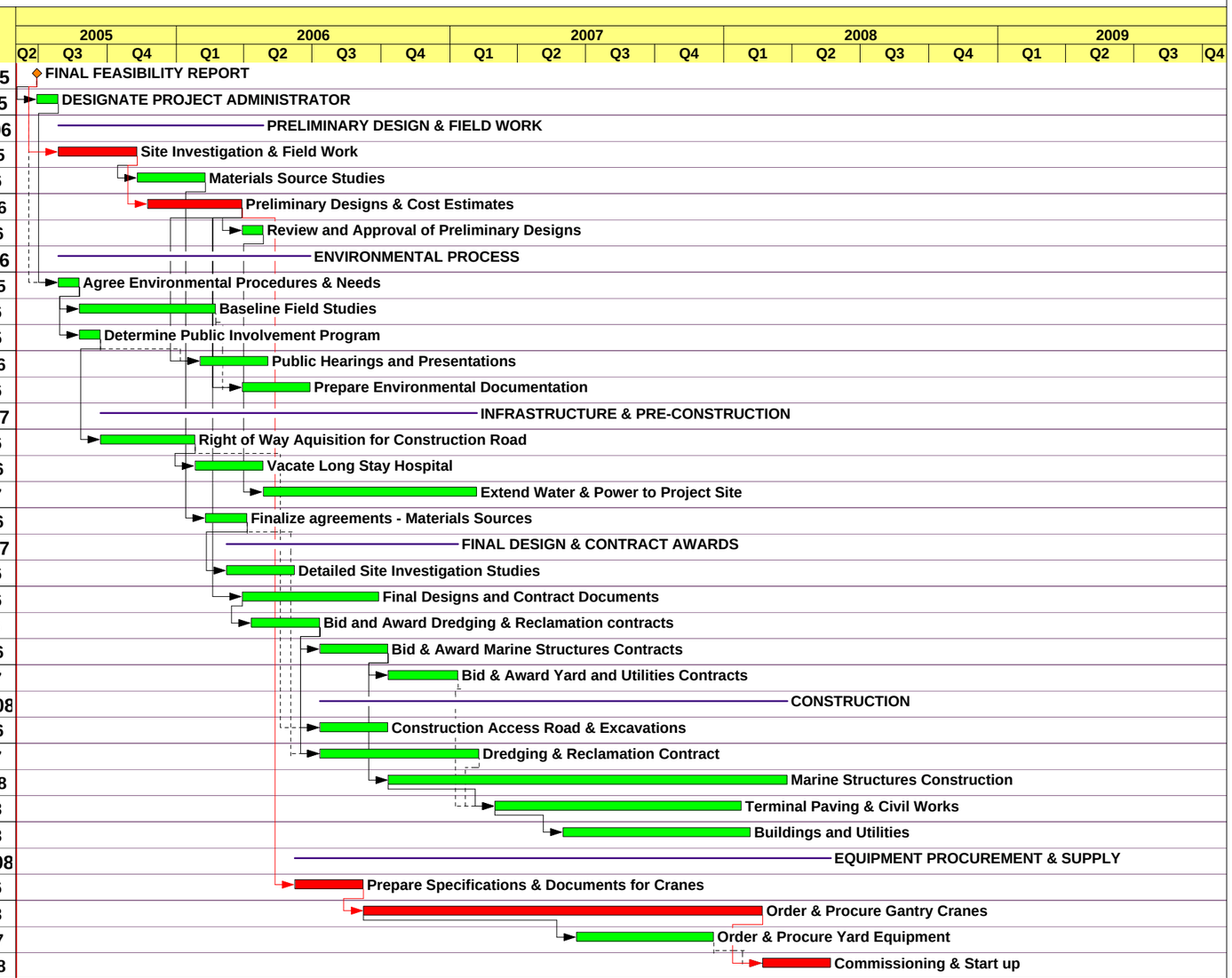
8 IMPLEMENTATION PROGRAM

An implementation plan for the design, procurement and construction elements of the project is presented in Figure 24.

Assuming an immediate decision to proceed with the site investigation and preliminary engineering works for the project, and depending on the acquisition of all approvals and environmental documentation for the work, a phased construction sequence would enable the new Port to be functioning by May of 2008.

Figure 24: Project Implementation Schedule

Activity ID	Description	Orig Dur	Early Start	Early Finish
1070	FINAL FEASIBILITY REPORT	0		28JUN05
1000	DESIGNATE PROJECT ADMINISTRATOR	4w	29JUN05	27JUL05
1030	PRELIMINARY DESIGN & FIELD WORK	39w *	28JUL05	26APR06
1210	Site Investigation & Field Work	15w	28JUL05	09NOV05
1240	Materials Source Studies	13w	10NOV05	08FEB06
1200	Preliminary Designs & Cost Estimates	18w	24NOV05	29MAR06
1190	Review and Approval of Preliminary Designs	4w	30MAR06	26APR06
1020	ENVIRONMENTAL PROCESS	48w *	28JUL05	28JUN06
1230	Agree Environmental Procedures & Needs	4w	28JUL05	24AUG05
1150	Baseline Field Studies	26w	25AUG05	22FEB06
1160	Determine Public Involvement Program	4w	25AUG05	21SEP05
1170	Public Hearings and Presentations	13w	02FEB06	03MAY06
1180	Prepare Environmental Documentation	13w	30MAR06	28JUN06
1340	INFRASTRUCTURE & PRE-CONSTRUCTION	71w *	22SEP05	05FEB07
1350	Right of Way Aquisition for Construction Road	18w	22SEP05	25JAN06
1360	Vacate Long Stay Hospital	13w	26JAN06	26APR06
1370	Extend Water & Power to Project Site	40w	27APR06	05FEB07
1390	Finalize agreements - Materials Sources	8w	09FEB06	05APR06
1040	FINAL DESIGN & CONTRACT AWARDS	43w3d	09MAR06	11JAN07
1400	Detailed Site Investigation Studies	13w	09MAR06	07JUN06
1250	Final Designs and Contract Documents	26w	30MAR06	28SEP06
1270	Bid and Award Dredging & Reclamation contracts	13w	11APR06	11JUL06
1280	Bid & Award Marine Structures Contracts	13w	12JUL06	10OCT06
1140	Bid & Award Yard and Utilities Contracts	13w	11OCT06	11JAN07
1050	CONSTRUCTION	88w *	12JUL06	25MAR08
1410	Construction Access Road & Excavations	13w	12JUL06	10OCT06
1310	Dredging & Reclamation Contract	30w	12JUL06	08FEB07
1320	Marine Structures Construction	75w	11OCT06	25MAR08
1330	Terminal Paving & Civil Works	46w2d	02MAR07	24JAN08
1420	Buildings and Utilities	35w	01JUN07	05FEB08
1060	EQUIPMENT PROCUREMENT & SUPPLY	101w *	08JUN06	22MAY08
1480	Prepare Specifications & Documents for Cranes	13w	08JUN06	07SEP06
1430	Order & Procure Gantry Cranes	75w	08SEP06	21FEB08
1440	Order & Procure Yard Equipment	26w	19JUN07	18DEC07
1450	Commissioning & Start up	13w	22FEB08	22MAY08



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Page number	1A

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ACP CONTRACT CMC 146911 - FEASIBILITY STUDY OF PALO SECO/FARFAN LAND RECLAMATION TO DEVELOP A PORT FACILITY

- Early bar
- Progress bar
- Critical bar
- Summary bar
- Start milestone point
- Finish milestone point

9 SUMMARY & RECOMMENDATIONS

The study results indicate that the selected location meets the objectives of a technically and financially viable container terminal project that does not generate unacceptable environmental or socio-economic impacts on the immediate and surrounding areas. Key conclusions from the analyses are summarized below.

Based on the expected size of the proposed new Locks for the Panama Canal, the new Port should have the capacity to accommodate at least an 8,500 TEU vessel, which will have a length of 385 m and a draft of 15.00 m. This then requires a water depth of 16.75 m at the berth face. However, there are clear indications that major carriers will be ordering and dedicating vessels of 10,500 and even 12,500 TEU capacity within the next ten to fifteen years. It is therefore recommended that provision be made for deepening the approach channel and berth areas to at least 18.75 m below MLWS.

For operational flexibility and efficiency of crane allocation, all berths should be in a straight line, thereby indicating that the total length of the terminal should be on the order of 1,600 m.

9.1 Highway Access

This major construction project will place substantial demands on the existing Coastal Highway from the Bridge of the Americas to Veracruz. It is recommended that a temporary construction road be built alongside the existing highway and converted to a four lane highway on completion of the construction. Intersection and sight line improvements are also essential and should be incorporated into the temporary and permanent designs. The estimated cost of the conversion of the temporary road and existing highway connection to the Port is $19.84 million.

In the longer term, a new corridor should be defined to connect the Howard/Palo Seco complex to the upgraded Trans-Isthmian Highway via the Centenario bridge, thereby establishing a high speed link between the two major economic development zones on both coasts of Panama.

9.2 Rail Access

The construction of the bridges, rail line and intermodal yard for the rail link across the Canal is expected to cost $176 million, which will be difficult to justify on the basis of the

expected traffic volumes. Other options include the establishment of a barge transfer service between the Pacific and Atlantic ports or trucking of containers to the existing Intermodal yard in Balboa. In the event that the trucking option is adopted, it is essential that the four lane highway should be provided.

9.3 Environmental Assessment

Environmental impacts generated by the project are relatively modest if the landside development is restricted to the construction of a corridor from the port to the existing highway and adherence to the existing routing for the connection to the Bridge of the Americas. In the marine areas, concerns exist over loss of habitat under the footprint of the terminal, although the project area is outside the fishing grounds due to the shallow water depth and presence of numerous rock outcrops.

The project will have a significant visual impact from Amador Causeway and also from the Kobbe beaches and Punta Bruja area. The reaction to this impact will vary according to the viewer's personal image of the area, and may or may not be a significant cause of objection to the project. It is therefore important that public reaction to the project should be tested at the earliest opportunity possible.

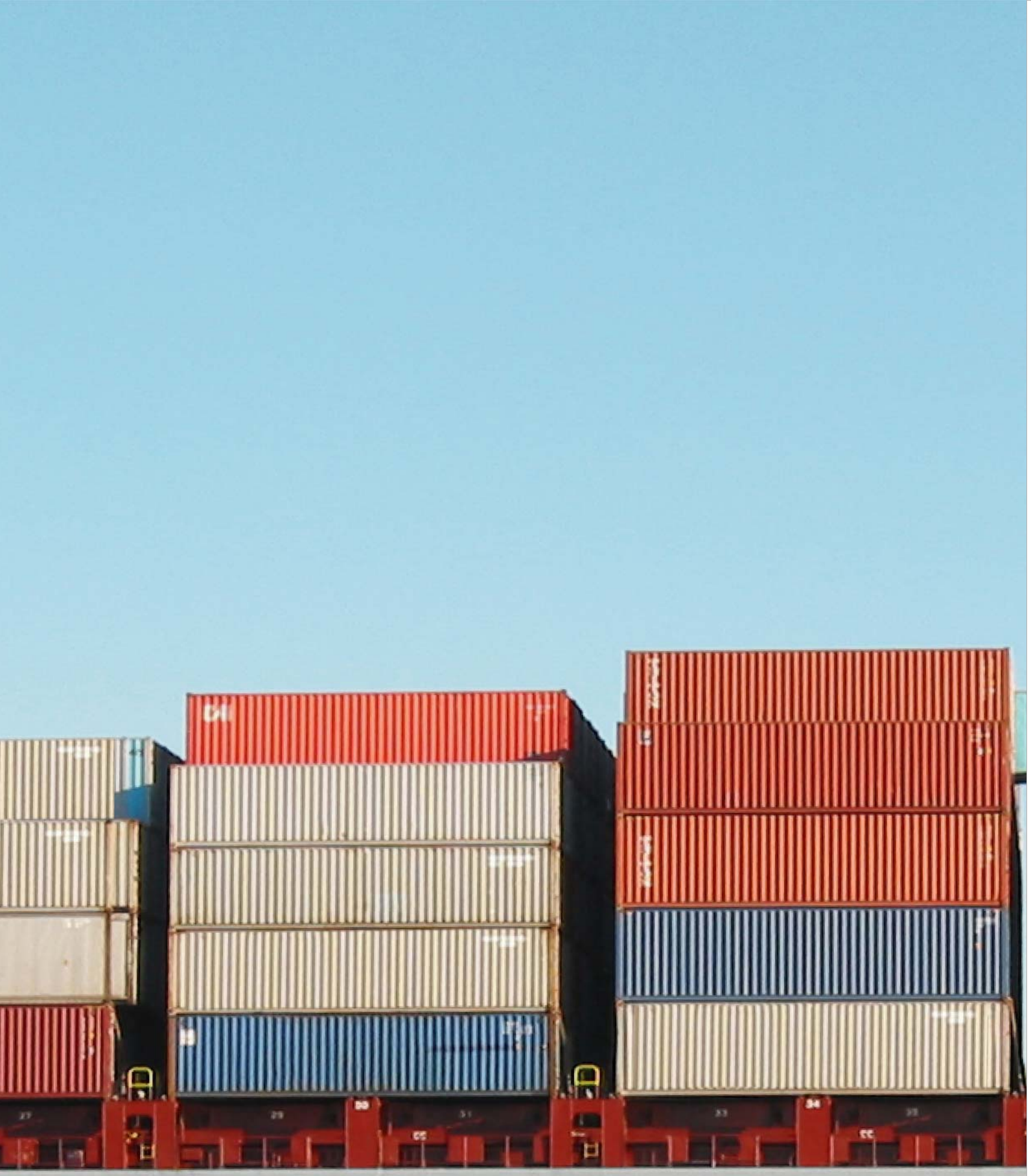
Socio economic impacts are expected to be positive, with up to 1,000 employment opportunities created once the terminal is at full capacity and other support activities are developed. The Port will also be a cornerstone of the logistics and value added activities of the Howard area and will assist the overall success of the regional economic development program for this multi-modal center.

9.4 Cost Estimates

The cost simulation models indicate an 85% level of confidence that the cost will not exceed $598 million at Location 3 or $672 million at Location 5, closer to the Canal. This is considered to be a reasonable target for the budget for this project.

However, this project is particularly sensitive to the unit costs of dredging, fill materials and the need to drill and blast rock in the navigation approaches. Modest variations in unit costs for these high volume items will make a significant difference in the total project cost.

Consequently it is recommended that an intensive field investigation program should be initiated to provide the highest quality of geotechnical information to support the preliminary engineering and final design studies.



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