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Feasibility Study of Island Development at the Pacific Entrance of the Panama Canal

Final Report

Volume 2 of 4

Basis for Planning, Transportation Alternatives & Development Options

May 2004

MOFFATT & NICHOL ENGINEERS

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10 BASIS FOR ISLAND PLANNING

10.1 Introduction

The concept of artificial island construction as a beneficial use of dredged or excavated material is not new. Particularly in Asia and the Middle East, islands have been created to relieve pressure on densely populated areas and move airports and ports from urban areas. Island construction for major infrastructure or transportation facilities also resolves the problematic issue of urban creep that usually follows the establishment of major employment or economic centers on the fringes of major cities. Typical examples of artificial islands used in this way are Kansai Airport off Osaka in Japan, the new Hong Kong Airport and port developments in Kobe Japan, Los Angeles and other locations around the world.

Artificial islands have also been used to create exclusive or high value residential or commercial developments, such as the Palm Island Projects in Dubai and resorts at a number of Asian locations.

Other islands, such as Poplar Island in the Chesapeake are designed to re-create lost habitat or land masses through the beneficial use of dredged materials.

10.2 Recent Artificial Island Projects

As noted above, there have been a number of artificial islands constructed around the world, with different objectives and environmental conditions, four of the more recent projects are briefly described below.

10.2.1 Kansai Airport, Japan

Kansai International Airport (KIAC) was built on an artificial island, about five kilometers off the coast of Senshu in Osaka Bay. The island accommodates a 3,500 m runway and space for future expansion. The approximate area of the island is 400 ha. Construction of the island took seven and one half years, including the terminals and airport facilities. The airport opened officially on September 4, 1994.

The artificial island was located in 18 m of water in an area of very soft deposits. Considerable efforts were taken to accelerate the predicted settlement of 12.0 m.[1]. According to reports published by KIAC, settlement to 2000 was 11.70 m, of which 9.8 m occurred during the construction period. The island continues to settle approximately 25 cm per year, with the annual settlement reducing by approximately 3 cm every year.

[1] Source Kansai International Airport Co Ltd, Summary of Settlement issues paper, 2000.

Figure 10-1: Kansai International Airport, Japan

10.2.2 Palm Island Resort, Dubai

Palm Island Resort, just one mile off the coast from Dubai, is scheduled to be complete by 2006. Advertised as “being visible from the Moon” this man-made structure will have 17 huge fronds surrounded by a crescent-shaped breakwater. This island is being built from 80 million cubic meters of material being dredged from the approach channel to the Jebel Ali port, which is being deepened to 17 meters.

When complete, it is understood that the resort will have approximately 1200 single-family residences each with private beachfront, 600 multi-family residences, an aquatic theme park, shopping centers, cinemas, and more. A twin island is planned to be built nearby.

Figure 10-2: Palm Island - under Construction in Dubai[2]

10.2.3 Poplar Island – Chesapeake Bay, US

Poplar Island has been constructed to make beneficial use of clean sediments dredged from the Chesapeake Bay shipping channels. The island construction has created about 1,110 acres[3] of wetland and upland habitat.

The Island will restore four tiny remnant islands located northwest of Tilghman Island near the confluence of Chesapeake and Eastern Bays to its 1847 footprint, providing a valuable nesting and nursery area for many wildlife species. In addition to restoring upland habitat, new wetlands are being created to promote plant, animal, and fish diversity, including the recolonization of submerged aquatic vegetation.

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[2] Photo courtesy of NASA

[3] Source Moffatt & Nichol Engineers

Figure 10-3: Poplar Island - Chesapeake Bay, US

10.2.4 Pier 400 – Port of Los Angeles, US

Pier 400 was constructed within Los Angeles harbor to meet demand for additional container terminal and cargo capacity. The port was facing a shortage of land within the existing footprint and also needed additional deep water berths for the Post Panamax container vessels and VLCC tanker traffic.

The artificial island covers an area of approximately 275 ha and is located in 15 to 18 m of water. Settlement of the island has been minimal, due in large part to the presence of firm sands in the construction area.

Figure 10-4: Pier 400, Port of Los Angeles, US

10.3 Land Use Options for the Artificial Island

The original terms of reference for this study limited the potential development alternatives to Port related development, primarily based on container terminal construction. However, as the study proceeded, it became clear that the limitation of the feasibility study to just one development classification would severely restrict the recommendations and conclusions of the work. It also became clear that there are a number of other potential uses for the artificial island, each with its own particular set of characteristics, impacts, benefits and costs. In turn, different long term uses for the island will also have differing environmental and socio economic impacts and varying levels of added value from the use of the excavated materials.

As noted above, islands have historically been used for airports, ports, commercial, residential or tourism related development, or as habitat restoration or ecological reserves.

For this project, the proximity of the former Howard Air Force Base, Albrook Field and Tocumen Airport are clear indications that the island would not be used for airport development. However, the remaining general use categories are valid options. This project is also a necessary element of the Locks construction work, and the provision of an adequate and cost effective disposal site is critical to the success of the overall project. Many other island construction projects are demand driven and constructed from imported material. This important difference in the objectives of this project then imposes a number of critical limitations on the designers in terms of size, location,

materials and construction schedule for the island. At the same time, the fact that the island is essentially a disposal site then gives a broader range of long term development options for the site, once the fill process is sufficiently well advanced.

Based on these considerations, the following potential uses are considered to be valid candidates for the island:

- Port development.
- Multi-use (residential, light commercial, resorts, recreational etc)
- Public Park
- No development

Clearly, each one of the above potential uses will have its own set of specific characteristics. These in turn will impact the location options, topography, landside connections, navigation access, utility requirements, wave protection and design features. Construction planning criteria for different final uses will also vary.

Given these fundamental differences, the study effort was divided into general field investigation, technical and environmental evaluations that characterize the entire study area and all options, and those that are specific to the particular development option under consideration. This is particularly important for the socio economic and environmental evaluations, where in many cases, the primary impacts or reactions to the proposals will be based on the long term use, rather than the existing of the island itself.

Consequently, the site characterization of the general study area presented in the previous volume applies to all of the options presented, while this volume deals specifically with the implications and development of each of the potential alternative long term uses for the island.

11 TRANSPORTATION SYSTEM ALTERNATIVES

11.1 Objectives

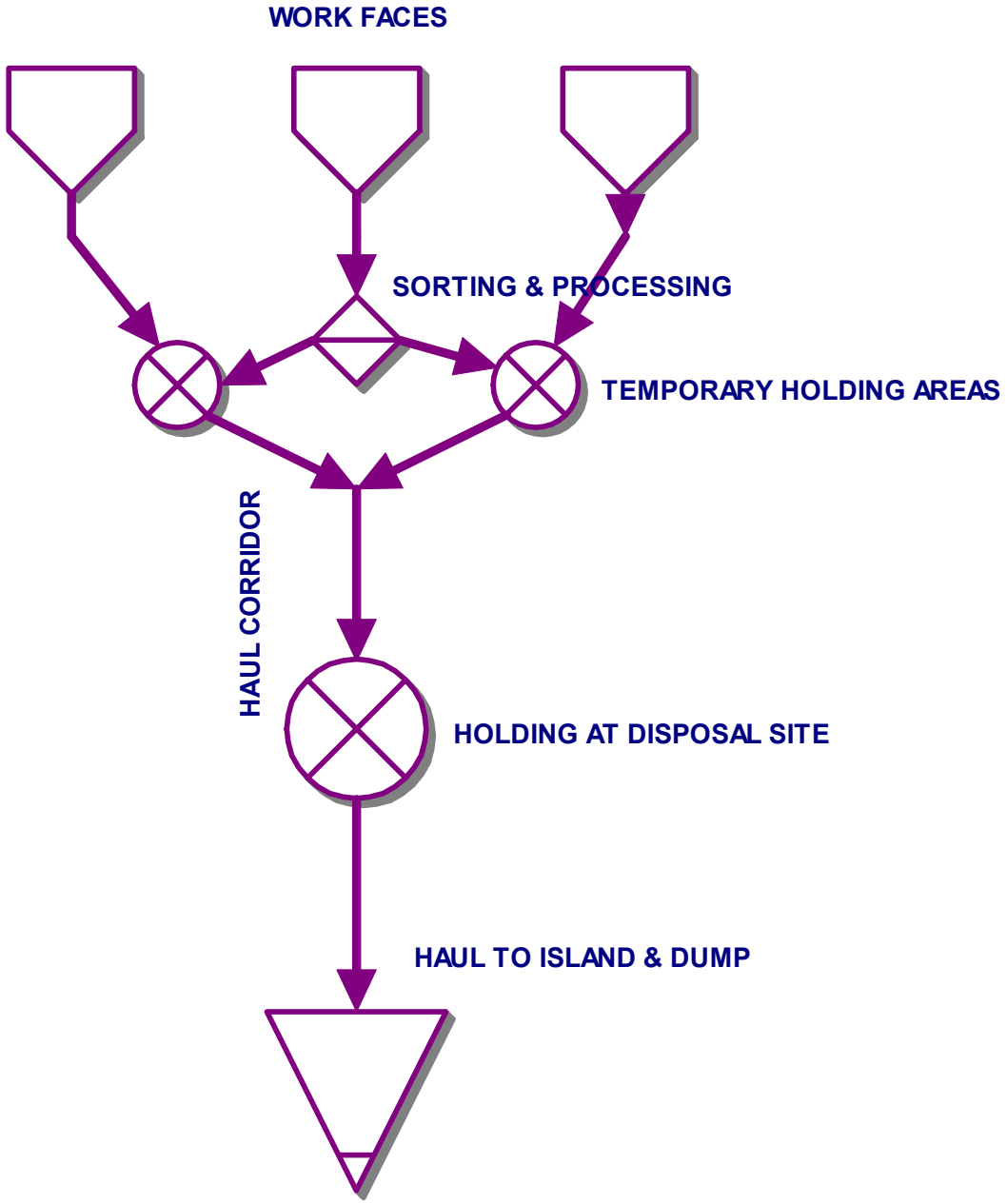
The fundamental elements of an efficient materials transport system for this project are indicated in Figure 11-1 and include:

- Collection and temporary storage of material from multiple work faces in the excavation area.
- Processing of material to respond to project construction or transport system requirements
- Loading of the material to the main transport system
- Transport to a shoreline holding area
- Movement of the material to the island

While there may be some minor modifications to the routing of the delivery corridor to the proposed site for the artificial island, the excavation schedule, required productivity and unit transportation costs to the shoreline connection with the island are essentially the same for all of the alternatives presented in this report. However, movement of the material from the existing shoreline to the proposed island site will differ according to the location and proposed long term use. For this reason, the transportation analyses and costs are separated at this critical break point.

The following section presents alternatives for the movement of the excavated materials to a stockpile or transfer station at the shoreline, while the means of moving the material to the specific island alternative are presented later as part of the construction planning for each option.

Figure 11-1: Primary Elements of Materials Transport System



11.2 Delivery Schedule

At the time of preparation of this report, the excavation and construction schedule for the Locks project had not yet been finalized. In discussion with senior ACP staff, it was agreed that for the purposes of this study, it is assumed that all excavation work will be completed over a five year period. Within this overall timetable, work would commence on the Locks area first, with excavation of the entry and exit channels to follow.

For the purposes of the transportation assessment, the following key assumptions are made:

- Excavation schedule will be five years
- Excavation would commence with removal of overburden material from the Locks area
- Next priority would be removal of material from the Locks construction zone
- Removal of the material from the entry and exit channels to the new Locks would follow
- Excavation work would continue at multiple locations, possibly with different contractors.
- Temporary stockpiles will be necessary at each major work face or collection area to balance excavation and transport productivity.
- Some sorting of larger materials would take place at the initial stockpile area.

In addition to the above, it is also assumed the early material from the excavations will be initially used for any fill required for the construction of the transportation corridor. However, every attempt is made in this study to attain a balanced cut and fill of the transportation corridor, such that the system could be in place in time to receive the early excavation material without the need for major stockpiling.

There is also a high probability that up to 7.0 million m3 of material might be used to fill the 1939 Locks excavation lagoons that are within the construction area for the new alignment[4]. This might be used to hold early material or could occur later in the overall excavation work program.

[4] See Pacific Side Disposal Options Study, Moffatt & Nichol, January 2004

11.3 Transportation Options.

According to the quantity estimates used for this report, the Locks and channels excavation projects will require the movement of 87,381,000 m3 of material away from the work faces over a five year period. Assuming 345 working days per year and 24 hour operations, the transport system will need to move an average of 50,000 m3 of material from the work face to the disposal site every day. This then indicates that the design capacity of the system will need to exceed this volume by approximately 25 to 30% to account for maintenance, inclement weather and other system losses.

The basic transport systems evaluated in this report to address this requirement include:

- Barge transport
- Truck Haul
- Rail
- Conveyor Systems

Transportation cost models were developed for each of the above systems, together with an analysis of infrastructure requirements, stockpile needs and corridor development costs.

At this stage of the analysis, it has been assumed that the most economic transportation system will apply to all of the long term development scenarios at all of the alternative locations. While this general assumption is valid at this level of analysis, it is accepted that the final design of the island and the preferred transportation system must be re-evaluated once a decision has been made on the preferred long term use strategy, the final location and the size of the island.

In this respect, the allocation of material to sites outside the island concept could well change the fundamentals and basic economics of the transport system.

11.3.1 Barge System

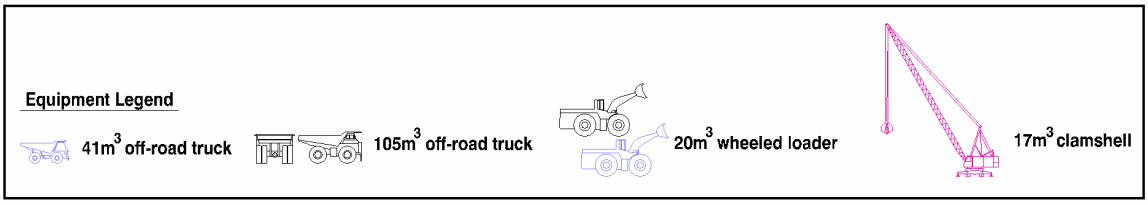
Under this system, material would be moved by truck to a stockpile at a transfer station adjacent to the Pacific entry to the Miraflores locks. Material would be loaded onto 4,500 cubic yard barges as indicated in Figure 11-2 and then transported in single or multiple barge strings to the work site[5]. It should be noted that 3,000 cy capacity barges are

[5] At this level of analysis, the transportation model assumes one tug assignment per barge. Multiple barges on a single tow might reduce system costs, but productivity and operational interference with Panama Canal traffic may be a concern.

proposed for the disposal of material arising from the Gaillard Cut project[6], due to the navigational limitations of the channel. However, for movement of material from the Locks project to the island site, these limitations are not so severe and it is considered that larger barges will be more economic and efficient.

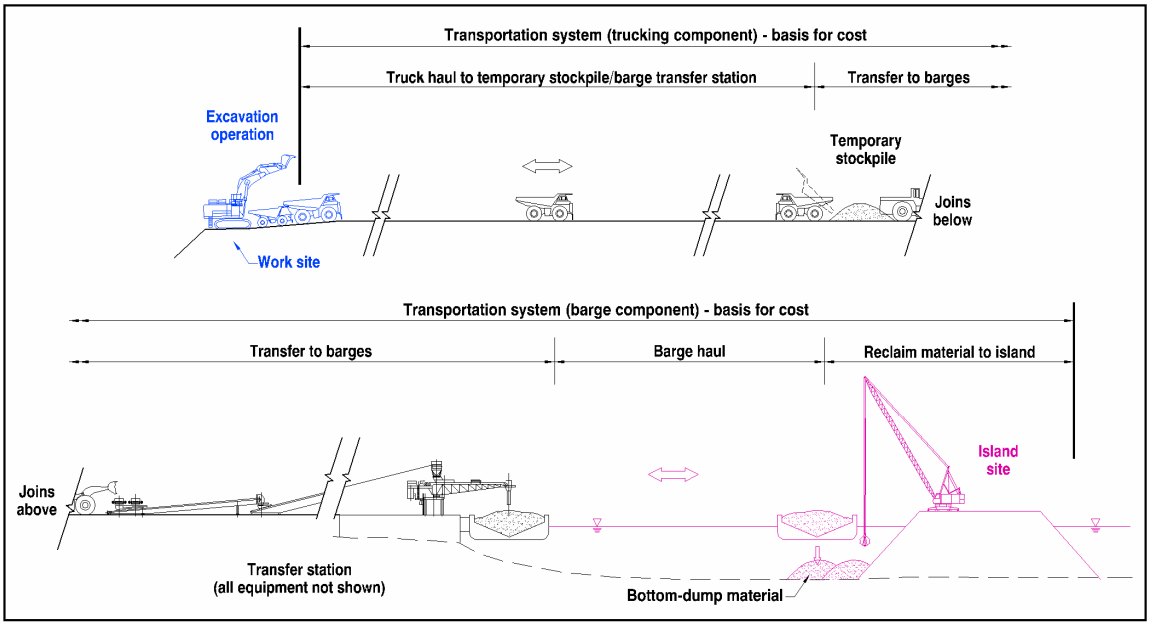
At the island location, the material would be bottom dumped in the general island work area, and then recovered or re-graded using floating equipment with clamshell devices or back hoe type excavators. Alternatively, the barges could be unloaded using grabs or mechanical systems at a transfer station, although the initial system model runs indicate that this would impose limits on productivity and could also be less economic than the bottom dumping alternative.

Once the material was re-deposited to a level above water, land based earthmoving equipment would be used to move it to the final location and elevation. The following legend indicates equipment symbols used for the transportation schematics.



[6] Pacific Side Excavation & Dredging Material Disposal Alternatives Study, Moffatt & Nichol, March 2004 (PSED2004)

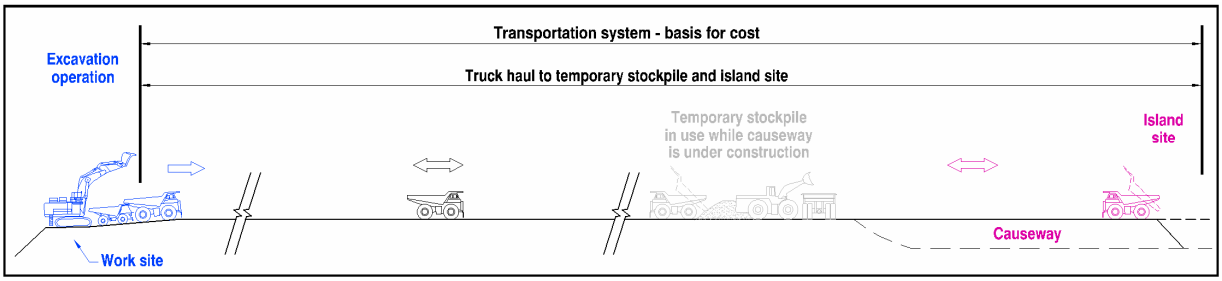
Figure 11-2: Truck/Barge Transportation Schematic



11.3.2 Truck Haul

Truck haul offers the most flexible alternative for movement of material from the Locks excavation to any of the island sites. High capacity off road dump trucks would collect material from stockpile areas close to the excavation work faces and deposit fill directly into the island working area, or alternatively to a shore side stockpile in the event that transport productivity exceeded the capacity of the receiving system.

Figure 11-3: Truck Transportation Schematic



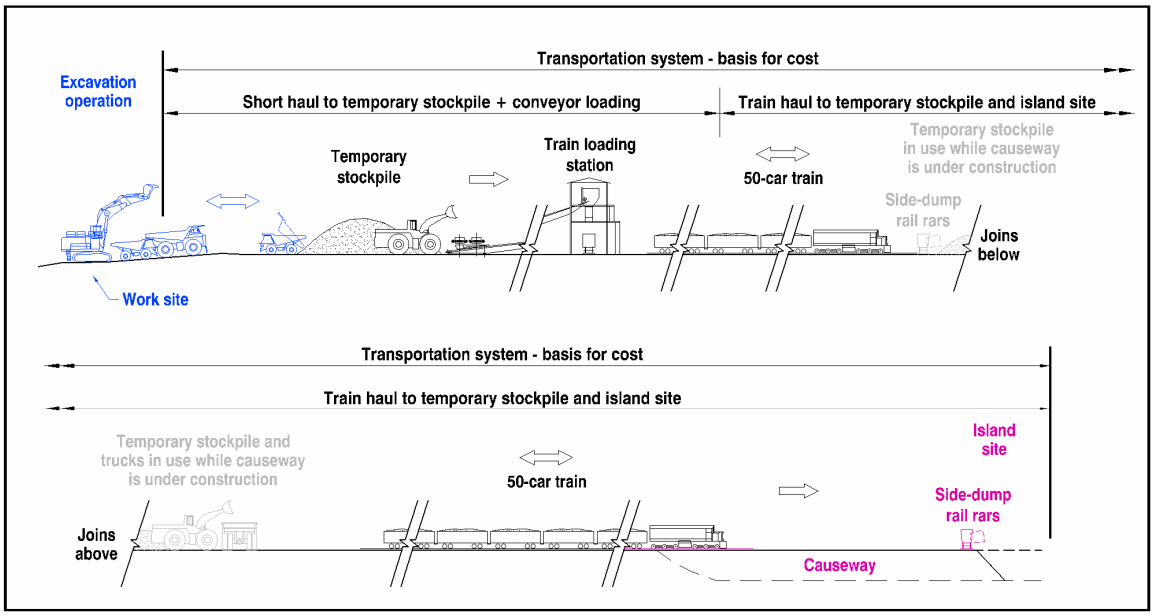
11.3.3 Rail

As is well known, the original builders of the Canal used rail extensively to move excavated material from the work sites. Amador Causeway, much of the Albrook area and many other filled areas around the Canal were created using side tipping or flat bed wagons running on rail lines that were regularly moved as the work areas advanced.

While there have been many technological developments in rail and other transport systems in the 100 years since the construction of the Canal, rail transport still remains a very cost effective means of moving large volumes of material over long distances.

Figure 11-4 shows the primary steps in the rail transport system. A major concern with the rail delivery system is the logistics associated with moving the material from the shoreline to the island work face. An intermediate system will be required until rail access and a return loop can be constructed on the island and this will necessitate the provision of a stockpile area until direct delivery to the work site can be achieved.

Figure 11-4: Rail Transportation Schematic



11.3.4 Conveyor

Conveyors are commonly used to move large volumes of bulk materials over long distances. The most common application is for port operations where mechanized unloading or unloading systems, coupled with high volume conveyor systems can move

up to 15 million tons of dry material per year. Hourly productivity rates of 2,500 tons per hour are common for ore or coal movements.

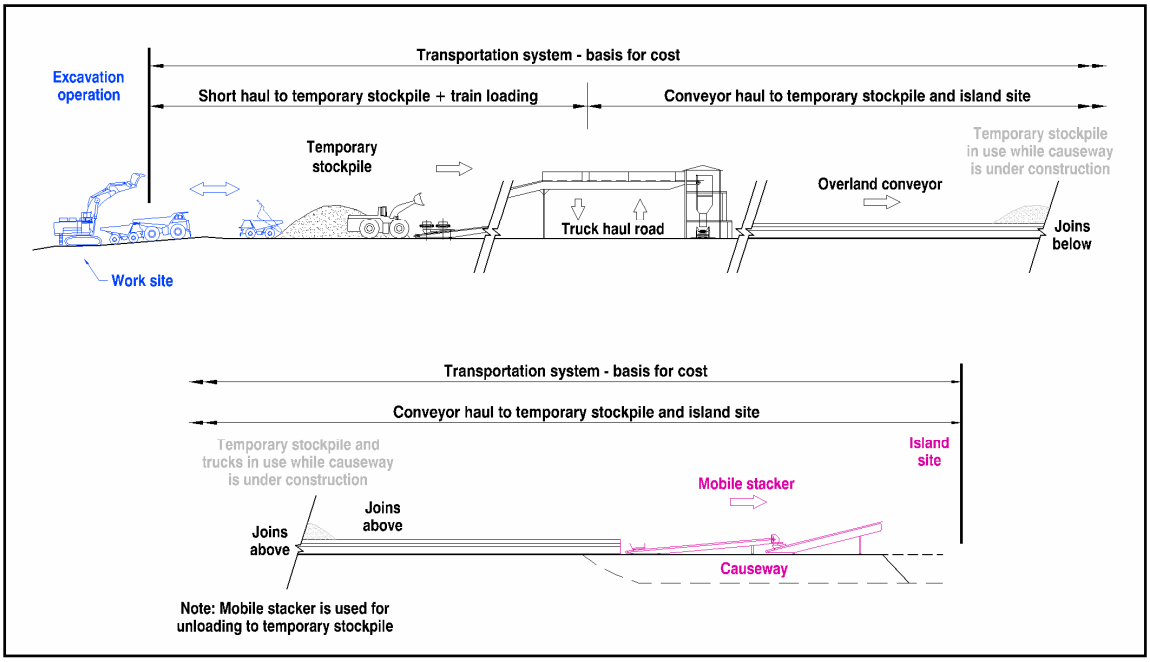
A major advantage of the conveyor system is that it is relatively independent of terrain imperfections and stream or highway crossings are relatively inexpensive to install. The corridor is also narrower than would be required for a truck haul. Conveyor galleries can be moved from one site to another and mobile loading or unloading systems can be relocated with ease amongst the work faces.

Disadvantages of the system for this project would be the length of haul, which at 20 km is towards the high end of systems currently operating in the world, and the varied characteristics of the excavated material. Since a considerable proportion of the rock may exceed the capability of the conveyor system, it would be necessary to separate the large rock pieces and either transport them by another means or break them down to a size that can be handled by the system.

Finally the system reliability must be taken into consideration. A failure or cessation of the conveyor system effectively stops movement of all materials, unlike other systems that can maintain production during maintenance or local system failures.

Figure 11-5 shows the primary elements of the conveyor delivery system. As for the train delivery, an intermediate stockpiling and transport system will be required until the conveyor system can be extended to reach the island work area.

Figure 11-5: Conveyor Transportation Schematic



11.4 Barge System Analysis

11.4.1 System Overview

The barge system offers a major advantage over the land based transportation options since it is not necessary to develop the transportation corridor or construct the causeway before filling can take place at the island. It is also less equipment intensive than the other systems, although the cost of the barges and tugs is relatively high.

Assuming a productivity target of 51,000 m3/day over the life of the project, an average of 12 to 13 barge trips per day will be needed to meet the delivery schedule. Since each round trip will take approximately 6 hours to complete, at least three, but probably four barges will be needed to support the system. This then implies a 4,500 m3 barge leaving and entering the loading area every 90 to 120 minutes, for 24 hours per day.

Clearly, this number of barge movements may impact Panama Canal operations, and there are few locations where the tug/barge combinations could operate outside the main channel at the Pacific entrance. It is entirely possible that barges could be doubled up to the same tug to reduce the number of transits, but effective speed of the combination would be reduced, which again has impacts on the Canal operation for normal ship traffic.

11.4.2 Materials Collection System

A key element of the barge transport system is the movement of material from the excavation zone to the marine transfer station. The work face of the excavation covers a distance of approximately 8.0 km and the only effective means of movement of this material is by truck haul. Assuming that the total distance from the northern limit of the excavation to the mid point of the island is approximately 23 km, this represents a significant added cost to the barge transport system.

Figure 11-6 shows the recommended stockpile or collection point for the transfer of material from the truck haul component to the marine sector. The stockpile is located over the Velasquez ACP designated dredge spoils area and the loading stations for the barge system are located on the shoreline at the entrance to the 1939 Locks excavation south of Miraflores locks.

11.4.3 Materials Transfer System

As shown in Figure 11-7, excavated material would be transferred from high capacity dump trucks to barges at the temporary berth area set up at the south end of the lagoons excavated for the 1939 Locks project.

The mechanical loading system shown in Figure 11-8 is recommended in order to maintain a high level of productivity and provision is made for a lay berth for a second barge. If necessary, transfer production could be increased with the addition of a second loading station, but for the purposes of cost computations, it is considered that one station is adequate to meet the project schedule.

Figure 11-6: Stockpile, Transfer Station and Route for Barge Transport System.

Figure 11-7: Materials Transfer Station for Barge Transportation Option

Figure 11-8: Mechanical Loading System for Barge Transportation Option

11.4.4 Materials Delivery System

A complication of the barge system is the need to recover the material from the barges at the island site and move it to a level where final grading can be achieved. While the barges can bottom dump material according to the tidal cycle, until fill levels approximate MLWS, all material above this elevation must be double handled.

This type of operation is normally managed using pontoon mounted cranes with clamshell buckets. In order to meet the delivery schedule for the project, it is considered that at least four large capacity cranes would be needed to recover the bottom dumped material for approximately 50 % of the project duration.

Another alternative would be to employ self unloading barges for the project, with the ability to place the material to above water and avoid double handling. However the barges are more expensive, unloading time is longer and the larger rock pieces must be separated before loading onto the barges. Since the overall unit transportation costs are similar to the bottom dump alternative, the cost estimates presented in this study are based on the simpler, more flexible bottom dump-recovery system.

Cost Estimate

Table 11-1 shows the estimated cost of the barge haul transportation system and infrastructure. Here it is important to note that the costs include the double handling of the fill material at the island, based on the assumption that bottom dumping barges would be used.

It is worthy of note that it could be argued that the provision of the access road to the excavation working area could be considered as part of the Locks excavation contract. However, it is included in this cost estimate to meet the basic objective of collection of the excavated material at the work face.

Based on a bulked materials volume of 87,381,000 m3, the total cost of the barge haul system then translates to a unit rate of $5.80 per m3.

Table 11-1: Estimated Cost of Materials Transportation by Barge System

Description	Estimated Cost (US$ 2004)
Truck Haul Component	
Haul Road alongside Excavation site	$18,000,000
Off Road Trucks & Transport	$198,817,373
Loading and Equipment	$49,680,000
Haul road Maintenance	$8,625,000
Marine Component	
Marine Transfer System	$2,000,000
Stockpile Yard and Equipment	$2,600,000
Stockpile & Loading Operations	$17,154,675
Tug and Barge Haul	$167,016,837
Materials handling at Island	$43,056,000
Estimated Sytem Cost	**$506,949,885**

11.5 Land Transport Corridor Analysis

For the purposes of this study, it has been assumed that the truck, rail and conveyor system corridors would follow the same route, with minor variations related to the specifics of each system.

Reconnaissance surveys made as part of the Preliminary Island Evaluation study in 2001 identified a preferred route for the Transportation corridor. However, site inspections by ACP staff and the consultants revealed a number of inconsistencies between the vertical elevations indicated by aerial photographic mapping and measurements taken on the ground. This is a common occurrence in areas where tree cover is extensive, since the aerial mapping is unable to penetrate to solid ground.

Consequently, ACP staff carried out extensive topographic surveys of the recommended corridor, as discussed in Volume 1 of this report.

11.5.1 Mapping

As noted in Volume 1, ACP survey crews conducted a detailed topographic survey of the preferred transportation corridor presented in the Preliminary Study Report. The area covered by the survey is indicated in Figure 11-9

Figure 11-10 shows the comparison between the surface profiles generated by the aerial survey mapping used for the Preliminary Study and the results of the topographic survey carried out by ACP. As suspected the survey revealed inconsistencies between the aerial photographic mapping and the terrain survey which in general reduced the elevations expected along the corridor.

Figure 11-9: ACP Field Survey Coverage – June 2002

Figure 11-10: Comparison of Aerial and Topographic Mapped Profiles on Transportation Corridor

11.5.2 Route Selection

Due to the temporary nature of the transportation systems, consideration has been given to reducing impact on existing terrain such that it can be returned to its existing condition upon completion of the island construction.

While the horizontal alignment for the transportation corridor for all land based systems follows the same basic route from the excavation site to the island, each system imposes different constraints over vertical profiles, stream and highway crossings.

Figure 11-11 shows the preferred transportation corridor for the land based delivery systems. As can be seen from the figure, the extended work face at the Locks site presents a significant challenge to the logistics of the system, and it is assumed that the rail line would run parallel to the excavation to enable collection to be made at the active work faces. A temporary stockpile area is also shown at the southern limit of the work face for sorting of large rock etc as needed.

Figure 11-11: Proposed Transportation Corridor for Land Based Materials Delivery Systems

11.5.3 Geotechnical Conditions along the Transportation Corridor

In conjunction with the topographic surveys noted above, a series of boreholes and trial pits were taken by ACP geotechnical staff along the proposed transport corridor. In general terms, trial pits were taken to a depth of approximately 2.5 m at intervals of 500 m, with boreholes being taken at all major stream crossings or potential bridge sites.

A total of eight boreholes were taken over the corridor. Between five and nine samples were taken at each borehole location for a total of 56 samples.

Typical results from the test pits and borehole samples indicate that the study area is overlain by sandy or clay deposits to depths averaging 12.00 m, below which sandstone and other rock deposits are encountered.

11.5.4 Truck Transportation System

Corridor Profile – Truck Haul System

The Truck haul system offers the minimum impact on the vertical profile of the corridor since gradient limitations are less stringent than for the rail system. The alignment and station references for the corridor are shown in Figure 11-13. Figure 11-14 and Figure 11-15 show the recommended profiles for the system. From the figures, it can be seen that cut and fill are well balanced over the main section of the route, where the average cut is not expected to exceed 5.00 m. However, in order to access the hilly area due west of the north section of the Lake side channel to the new locks presents some difficulties for access to the excavation works. Under the truck haul system, it is assumed that the dump trucks would collect the excavated material close to the work face, run up ramps to the haul road and then follow the corridor shown in Figure 11-13.

Haul Corridor Specifications

In order to meet the delivery schedule of five years, high capacity trucks will be needed to meet the needs of the project. Based on the class of equipment available at this time, it is expected that an international contractor would select equipment such as the CAT 789C off road truck for the project, with a capacity of 105 m3 of material.

These enormous vehicles cannot be run on public highways and the haul road required to accommodate the trucks must be designed to resist the high loads imposed by the equipment.

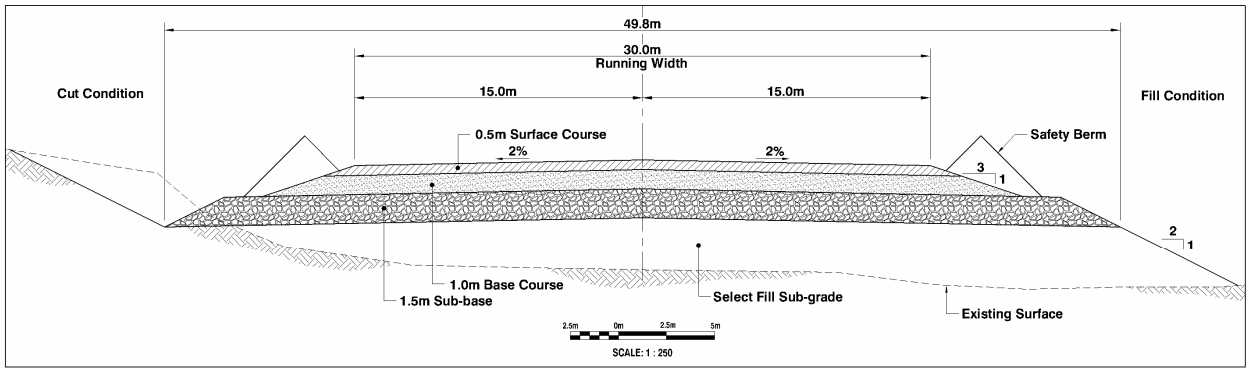
There are no design standards established for this class of road, but recent research work on the design of roads for large volume open mines gives a good indication of the specifications required for the haul road for the Island project.

According to a recent study by the University of Alberta[7], key elements of haul road design for large equipment are:

- Grades should not exceed 8%
- Width of the haul road should be at least 30 m to accommodate two way traffic
- Safety Berms should be constructed adjacent to the running surface
- Base Course should be at least 1.00 m of selected rock
- Surface course should be at least 0.50 m deep
- Road surface cross slopes should be at least 4% for adequate drainage.

Figure 11-12 shows a typical section of a haul road design that meets the standards recommended in the University of Alberta Study.

Figure 11-12: Typical Cross Section of Haul Road to the Island



[7] Guidelines for Mine Haul Road Design, University of Alberta, 2001

Figure 11-13: Truck Haul Road Alignment

Figure 11-14: Truck Haul Road Profile (Sheet 1)

Figure 11-15: Truck Haul Road Profile (Sheet 2)

Bridge and Stream Crossings

The haul road will cross a number of minor streams and drainage channels necessitating the construction of small bridges or culverts. A listing of stream and small crossings can be seen in Appendix C to this report.

However, the main crossing would be over the Panamerican Highway as shown in Figure 11-13. To meet the production needs of the haul system, this bridge will have a width of 21.4 m to allow the passage of two of the large dump trucks with adequate safety clearances. Given the design requirements for the bridge, it is expected that it can also be used in the future as a crossing point for traffic from Veracruz and the beach areas.

The bridge section shown in Figure 11-16 uses a configuration of longitudinal plate girders supporting a 0.4 m composite deck spanning 44.0 m. Consideration was given to the provision of a two span bridge with the pier on the median strip, but cost savings are minimal at $100,000 and safety concerns indicate a preference for a single span.

High strength cable systems and chain link fencing are attached to fence posts on the outer walls of the bridge to reduce the risk to traffic below from falling rock. The cost of the bridge as shown, without contingency allowances, engineering and administration costs is estimated to be $4.8 million. The costs of the approaches to the bridge are computed separately within the overall haul road costs.

Haul Road Lighting

Productivity calculations for all transportation systems are based on 24 hour working. For safety reasons, consideration should be given to the provision of lighting along the haul roads. Truck lighting systems are probably not adequate for regular night operations and an allowance should be made in the cost estimates for lighting along the haul corridor. Based on standard highway specifications, it is recommended that provision be included for the supply and installation of 15 m high lighting standards spaced at 75 m intervals along the haul route.

Figure 11-16: Typical section - Truck Haul Bridge over the Pan-American Highway

Cost Estimate

Table 11-2 shows the anticipated cost of the truck haul system. Detailed equipment, production computations and unit costs are shown in Appendix B of this report.

As can be seen from the table below, the combined cost of infrastructure and transportation using the truck haul system is equivalent to a unit cost of $8.49 per m3 for the transport of material from the excavation zone to a mid point in the island.

Table 11-2: Estimated Costs of Truck Transportation System

Description	Estimated Cost (US$ 2004)
Haul Road Construction	$60,000,000
Bridge over Panamerican Highway	$4,800,000
Miscellaneous Bridges and Culverts	$5,000,000
Haul road lighting and operation	$15,600,000
Haul road Maintenance	$17,250,000
Loading and Equipment	$49,680,000
Transport using 105 m3 Dump Trucks	$521,430,847
Transport using 41.5 m3 Dump Trucks	$68,310,000
Estimated Sytem Cost	**$742,070,847**
Equivalent Unit cost of System ($/m3)	**$8.49**

11.5.5 Rail Transportation System

Corridor Alignment

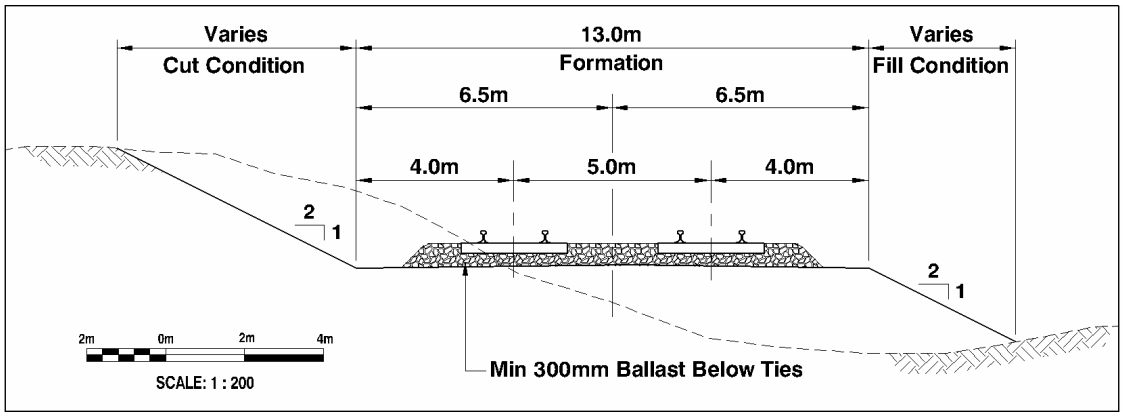
The rail corridor will have most impact on existing terrain due to moderate track grade requirements, which then increase cuts and fill. Figure 11-18 shows the recommended alignment and station references for the rail corridor.

Corridor Profile

In order to maximize efficiency and minimize operational costs for the railway option, it is assumed critical that rail access be provided in close proximity to the locks excavation site. Due to the hilly terrain in the area of the Lake side Channel, construction of the rail corridor will require earthwork cuts approximately 30 – 40m deep in order to maintain track grades of 2% or less. Taking the railway loading areas away from the excavation zone to avoid additional excavation increases the requirement for truck haul, which dramatically increases the total cost of the operation.

Figure 11-17 shows a typical section of the two way rail corridor that would be developed for the project.

Figure 11-17: Typical Section of Rail Corridor



The longitudinal profiles of the rail corridor shown in Figure 11-19 and Figure 11-20 show significant areas of excavation at the rail connection areas, but this material is used for fill at other locations to provide a balance of cut and fill for the construction of the rail corridor.

Bridge and Stream Crossings

As can be seen in the following illustrations, the rail corridor system will need to cross the Pan-American Highway and a bridge is required for the duration of the project. In the event that a permanent rail connection is desired from the maritime island back to the Locks area, it would be prudent to construct a bridge that meets the long term use specifications. For two way rail traffic, a width of 11.40 m is required for the bridge, which would cross the main highway at an angle of approximately 42 degrees. Span lengths for the bridge are set to permit the addition of one extra lane to the Panamerican Highway in each direction. Preliminary design study indicates that a through girder

bridge is the most economic concept for the rail bridge, following the cross section indicated in Figure 11-21.

The cost of the bridge shown in the figure is estimated to be $2.70 million. Approach ramps to the bridge are included in the corridor construction costs.

In addition to the main highway crossing, the rail corridor crosses a number of small streams and drainage channels. However, due to the limited width of the rail corridor, the estimated costs associated with the construction of these crossings are significantly less than for the truck haul system. A full listing of the stream and small crossings identified in the ACP topographic survey is presented in Appendix C of this report.

Figure 11-18: Rail Corridor Alignment

Figure 11-19: Rail Corridor Profile (Sheet 1)

Figure 11-20: Rail Corridor Profile (Sheet 2)

Figure 11-21: Typical Section and Profile of Rail Bridge over Panamerican Highway

Materials Collection System

As in all of the alternative transportation systems, the interface between the excavation contractor and the transportation operator will be critical to the success and cost efficiencies of the system and there are many ways that the materials collection and delivery system can be fine tuned to meet these objectives. For the purposes of the cost estimates presented in this evaluation, it has been assumed that material would be moved from the excavation faces by dump trucks and loaded into the rail cars via overhead dumping stations or at sections where the rail corridor would be located in trenches. Temporary stockpile areas would also be necessary to balance the delivery, loading and transportation elements of the operations.

Post Construction Use of the Corridor

The use of a rail system for materials transport also offers the potential to develop a permanent connection from the island site to the Panama Canal Railroad that was recently upgraded and rehabilitated to move cargo and passengers between the Atlantic and Pacific Coasts. However, any permanent link to the existing line would necessarily need to cross both the existing Miraflores locks and the New Locks. While there is an existing bascule bridge over the existing locks, it may not be financially viable to include a second crossing as part of the new locks construction project.

Figure 11-22: Materials Collection Concept for Rail Transport System

Cost Estimate

Table 11-3 shows the anticipated cost of the rail transportation system. Support calculations for the transport and infrastructure costs are presented in detail in Appendix B of this report. Converting the combined system costs to a unit rate indicates an estimated cost of $4.83 per m3 for the transport of material by rail from the excavation zone to a mid point in the island.

Table 11-3: Estimated Costs of Rail Transportation System

Description	Estimated Cost (US$ 2004)
Rail corridor and Rail track construction	$66,218,650
Temporary Bridge over Panamerican Hwy	$2,700,000
Stream and Drainage channel crossings	$3,250,000
Rail Car Loading Stations	$12,000,000
Misc Short Haul Roads	$7,500,000
Track Maintenance	$61,065,000
Haul road Maintenance	$2,000,000
Rail Equip/Maintenance & Operation	$175,286,286
Stockpile & Loading Operations	$49,680,000
Short haul - 105 m3 trucks	$11,306,433
Short haul - 41.5 m3 trucks	$31,089,535
Estimated System Cost	**$422,095,904**
Equivalent Unit cost of System ($/m3)	**$4.83**

11.5.6 Conveyor Systems

System Requirements

High productivity long haul conveyor systems have been used for mining and bulk handling systems for many years and delivery rates of 5,000 tons per hour are not unusual.

The key issue to be considered for the use of a conveyor system for the Island project relates to the size of the material to be transported. Preliminary geological evaluation of the material presented in Volume 1 indicates that the joint spacing in the Basalt materials will approximate 0.6 m, indicating that standard blasting techniques will produce angular pieces of rock from a few millimetres up to 0.6 m in size. The joint spacing of the agglomerates ranges from 0.6 to 2.0 m, which would generate rock pieces from a few millimetres to over 1.0 m in size.

The sedimentary rock formations are expected to have similar characteristics to the agglomerates.

The conveyor system evaluation carried out by specialist bulk materials handling consultants for this project indicates that the limiting size for material moved on a belt conveyor is on the order of 0.6 m. This is considered to be an “abusive” condition, requiring close spacing of support and headers for the conveyor, but within acceptable operational levels.

One means of dealing with this issue is to screen the material at the excavation area and crush the oversized pieces to an acceptable size for the conveyor system. This represents an additional cost, since most of the large pieces can be absorbed in the main body of the island fill without major difficulties. A more important consideration is the need for shoreline protection to the island, or the need for a breakwater in certain cases. It is estimated that armor stone protection to the island will require approximately 3.00 million m3 of rock, varying in size from 0.50 m to 1.0 m diameter. For breakwater construction larger pieces may be required.

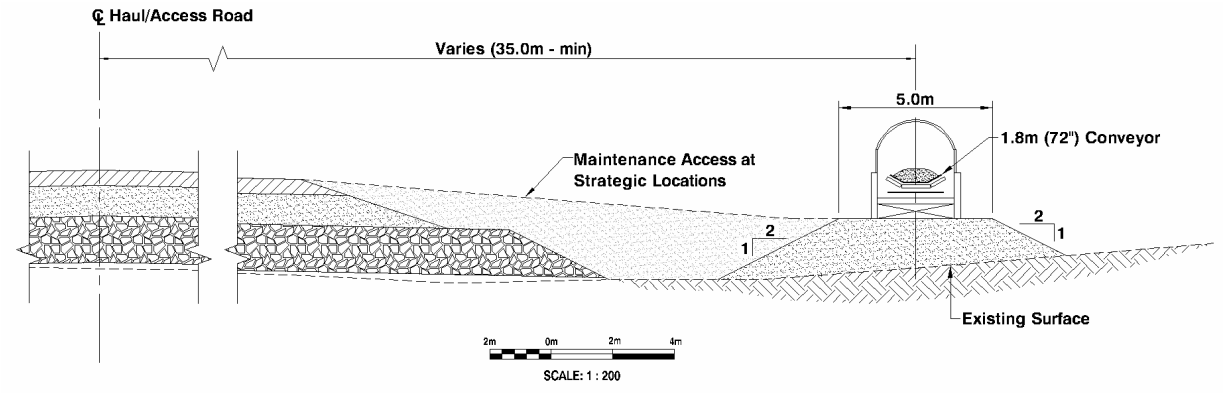
If it assumed that this material is to be hauled over the existing highway, legal sized trucks are needed, and a delivery rate of some 150 m3 per hour is needed over a four year period to meet the project schedule. The average loading of a highway legal truck towing a second gondola is on the order of 30 m3, indicating an average traffic level of five trucks per hour for the duration of the project.

Apart from the costs of this additional transport requirement, the constant passage of these vehicles, combined with the high volume of construction traffic that would accompany the locks project, pose safety and highway maintenance concerns for both projects.

Alternatively larger dump trucks could be used to haul the material, but this then necessitates the construction of a haul road, that would run alongside the main conveyor route to the island.

At this level of study, it is not possible to determine whether or not the separation of the trucked element of the conveyor system requires a dedicated haul road or not. However, for the purposes of cost estimating, it has been assumed that this additional transportation element would be provided. Figure 11-23 shows a typical section showing the haul/service road and the conveyor system.

Figure 11-23: Typical Section of Haul/Service Road for Conveyor System.



Corridor Alignment

Conveyor and road systems can sustain steeper grades and therefore have lesser impact on existing terrain.

Horizontal alignment of the overland conveyor will be identical to the railway in the area south of the new locks, although vertical alignments will differ. Conveyor and haul roads would take a more direct route in the area adjacent to the excavation zone, assuming a maximum grade of 15% and 8% respectively.

Figure 11-24 shows the recommended alignment and station references for the conveyor transportation corridor from the excavation zone to the island.

Corridor Profile

The profile for the conveyor system is similar to the truck haul corridor, since a service and haul road is required alongside the conveyor for maintenance and access. Hence the profiles shown earlier in Figure 11-14 and Figure 11-15 are representative of both systems.

Figure 11-24: Conveyor System Corridor

Bridge & Stream Crossings

A major advantage of the conveyor system is its ability to span small streams and highways at a relatively low cost. In most instances, the placement of the foundations for the conveyor galleries can be adjusted such that no specific structures are needed for crossings of up to 20 to 25 m.

However, as for the road and rail systems, the conveyor gallery must cross the Panamerican highway. While the crossing distance is within the capabilities of the towers supporting the conveyor galleries, safety considerations dictate that the conveyor be totally enclosed over the road way, which increases the weight of the structure.

An allowance is therefore made in the cost estimates to provide a more robust and enclosed conveyor crossing over the main highway.

The conveyor system also requires a service road for maintenance access. In order that the system impose the minimum constraints on the existing streams along the corridor, it is not essential that this service road should be continuous although a number of crossings may be required. It is also not necessary for the road to follow the conveyor over the Pan-American Highway and vehicles would join the main highway system in order to move from one side of the system to the other.

In the event that a dedicated haul road is required to supplement the conveyor system, a highway bridge will be required, similar to that shown in Section 11.5.4. However, the traffic lanes would be reduced in width in order to accommodate the conveyor gallery.

Materials Collection System

As for the other systems, the interface between the excavation contractor and the transportation system will be critical. As noted earlier, the conveyor system is less sensitive to gradient changes and it is considered that the materials connection sections of the system can be located in trenches adjacent to receiving hoppers to move the rock and other material directly on to the conveyor belt. For the purposes of the cost estimates presented in this evaluation, it has been assumed that three or more of these truck unloading stations would be located alongside the work face, as shown in Figure 11-25, fed by dump trucks directly moving from the excavation area. Temporary stockpile areas would also be necessary to balance the delivery, loading and transportation elements of the operations.

Figure 11-25: Conveyor System Loading Station Details

Cost Estimate

Table 11-4 shows the anticipated cost of the conveyor system and corridor. Galleries and equipment requirements to meet the production rate targets are presented in Appendix B of this report.

Combining the infrastructure and construction costs for the system indicates an equivalent unit cost of $5.45 per m3 for the movement of material from the excavation zone to the island.

Table 11-4: Estimated Costs of Conveyor Transportation System

Description	Estimated Cost (US$ 2004)
Haul/Service road construction	$55,800,000
Bridge over Panamerican Highway	$4,800,000
Culverts & Stream crossings	$3,300,000
Materials Loading Stations	$12,000,000
Conveyor Systems	$57,500,000
Stacking & Sorting Equipment	$3,000,000
Transport by Conveyor	$179,609,965
Transport by off road trucks	$156,591,555
Haul road Maintenance	$3,350,000
Estimated System Cost	**$475,951,520**
Equivalent Unit cost of System ($/m3)	**$5.45**

11.5.7 Comparison of Transportation System Costs

Based on the estimates presented above the equivalent unit costs for the four alternative transportation costs are:

Barge Haul ..... $5.80 per m3

Truck Haul..... $8.49 per m3

Rail System..... $4.83 per m3

Conveyor System..... $5.45 per m3

From the foregoing analyses, it would appear that movement of material by the rail system is likely to be the most economic alternative, but the barge or conveyor systems would also be viable, since costs are close to those of the rail system. Conveyor transport also seems economic, even with the added burden of a separate haul road for large rock pieces. However, the reader is cautioned against making rapid judgments on the costs, since not all systems can be compared directly.

For example, the difference in cost between the rail and barge systems could well be absorbed by a marine contractor with floating equipment available to economically move the excavated material by barge. The rail, truck and conveyor systems all require the construction of a causeway to the island before material can be moved directly, but the causeway then becomes part of the permanent link to the island for the maritime based development, thereby reducing the island construction costs. The rail and road bridges over the Panamerican Highway also become permanent installations with a potential residual value that would not apply to the barge system. Finally the impact of a barge operation on Panama Canal traffic operations should be assessed and agreed with the appropriate ACP Division before this system can be implemented.

Given the many permutations of transportation preferences, island locations and long term development scenarios for the completed island, it is suggested that:

- The most economic and practical transport systems are the barge haul, rail transport or the conveyor system
- The contractor selected to undertake the work should be permitted to adopt its own preferred system, within environmental, ACP operational and corridor routing limitations imposed by ACP or the permitting agencies.
- At this feasibility level of study, it is reasonable to accept that the effective unit cost of the materials transport to the island will be the lowest of the three systems considered to be viable for the project.

This then suggests that a unit cost of $4.83 per m3 is a reasonable assumption for the cost of transport of the material to the island location.

The reader is also cautioned that the costs presented in this section cover the transport of excavated material to the island and movement of the fill to the approximate grades indicated in the typical conceptual drawings. The costs of causeway breaches, completion of causeways for permanent use, small craft bridges, shoreline protection, infrastructure and development needs are all addressed later in this report.

12 ISLAND DEVELOPMENT OPTIONS

As noted earlier, the potential long term use options for the island covered in this study are:

- Port development/Maritime Center.
- Multi-use (residential, light commercial, resorts, recreational etc)
- Public Park
- No Development

12.1 Maritime Center

Artificial islands have been used for port terminal and maritime center development at a number of locations around the world. Two of the more well know port islands are Pier 400 at the Port of Los Angeles and Kobe Port in Japan. As a major intersection for shipping, Panama is clearly well positioned to create economic opportunities that can follow the provision of service or distribution facilities for the maritime sector.

In general terms, candidate uses for the marine terminal include:

- General Cargo Vessels
    - Containerized
    - Non – Containerized
- Liquid Bulk Carriers
    - Petroleum or non edible products
    - LNG vessels
    - Edible products
    - Fuel Bunkering barges
- Dry Bulks
    - Grain or edible products
    - Non-edible bulk products
- Cruise Ships
- Auto Carriers or Ro/ro[8] vessels
- Military Vessels
- Project Cargo or Heavy Lift vessels
- Logistics & Distribution Center
- Value Added Processing
- Commercial and Maritime Related support activities

[8] Roll on – Roll off

12.2 Multi Use Development Option

A second long term use for the island would be to offer it to a private sector developer for residential, commercial or recreational and tourist related activities.

This option offers the opportunity to build a world class waterfront neighborhood that would increase the economic opportunities in the area for service and other commercially related jobs. It would also provide a substantial return to ACP to offset the cost of the transport and construction of the island.

While the development elements of the completed island would probably be part of a Master Plan to be submitted by the selected developer, typical candidate activities on the island might include:

- high rise apartments
- single family homes
- stores/commercial developments
- park & recreational areas
- restaurants
- International class golf course & country club
- marina
- government offices
- churches
- hotels/resorts/conference center
- beaches
- wetlands/environmental zones
- pubic parking/bus terminal
- waterfront promenade and public access areas

12.3 Public Park

As noted earlier, the focus of any public reaction to the proposal to build the artificial island is more likely to be related to the long term use of the area rather than the construction of the island itself. In the event that neither of the first two options described above prove to be viable, or acceptable from an environmental, socio economic or public reaction standpoint, a third alternative would be to create an island that was available to the public as a recreational area, ecological reserve or nature park. This could take the form of a national park open to the public, either from water-only access or via a land

connection, restricted for use of research organizations such as the Smithsonian Tropical Research Institute (STRI)[9].

For the purposes of this study, it is assumed that the configuration and location of the island would generally follow the outline of the mixed use island, with potential minor modifications or grading of the fill to accommodate specific requirements.

Potential amenities that could be provided within the Park concept include:

- Nature trails or reserves
- Exercise pathways for jogging or skating
- Bike trails and off-road bike areas
- Public Beach
- Marina for day visits or overnight stays
- Camping area
- Waterfront Promenade
- Amphitheatre
- Fishing Pier

12.4 No development Option

Based on the findings of a recently completed report[10] on disposal options for the Pacific Side dredging and excavation projects, the Artificial island is one of only three potentially acceptable disposal sites that can accommodate all of the material to be removed from the Locks Excavation. The other prime candidate for receipt of the materials is an area of some 305 hectares, which is within the former US Department of Defense Firing ranges west of the Canal and currently off limits due to the existence of substantial quantities of unexploded ordnance (UXO).

A preliminary evaluation of UXO removal and site restoration costs indicates that the equivalent unit costs of placement of materials at the UXO site is slightly less than the cost of transport and placement at the Artificial island site. However, the use of the UXO site to receive this fill material is subject to resolution of an international dispute between Panama and the USA on this contentious matter, and might remove the site from consideration.

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[9] Plans to use dredged material to expand the Amador Causeway may impact the existing installations for the Smithsonian Tropical Research Institute. The island could offer an isolated location with minimal public access or disturbance.

[10] Pacific Side Excavation & Dredging Material Disposal Alternatives Evaluation, Moffatt & Nichol Engineers for ACP, March 2004

The third option proposed in the Disposal Study would involve the purchase of some 850 hectares of privately owned property some 20 km from the excavation at a site designated as El Arado. This option will cost significantly more than either the Artificial Island or the use of the UXO site.

As a final option, it is therefore suggested that the island could be used as a simple dump site, based on the outcome of final studies to select one or more preferred disposal sites for the excavated material. If overburden material was used to cap the rock, natural re-vegetation would occur over time, permitting the island to blend in to the natural landscape of the area.

12.5 Hydrodynamic Modeling

12.5.1 Alternatives Evaluated

Prior to developing concepts for any of the island alternatives, Hydrodynamic and Water quality impacts in the Gulf of Panama were studied for three island alternatives (Figure 12-1). Two of them situated at locations 1 (PS-0)[11] and 5 (PS-5) as presented in section 8.5.1 and Figure 8-10 of the Pacific Side Excavation & Dredging Material Disposal Alternatives report[12] (PSED2004) will hold the development or a marine center. The third alternative (MS-1) is also located at position 1 but in this case its size and layout would be suitable for the development of a mixed use commercial, residential and public access areas. The island would be connected to the mainland via a causeway, an open pile trestle or a combination of both. The access structure would be wider for the marine center than for the commercial residential development.

Due to the timetable for preparation of this report, it was necessary to run the hydrodynamic model early in the schedule, in order to test the impact of the causeway structures. Consequently, the consultants modified the orientation and location of the alternative locations for the maritime island slightly to provide improved wave protection and the two sets of alternatives do not completely match. However, the impacts of the minor changes in the alternatives do not affect the conclusions of the hydrodynamic model runs.

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[11] PS indicates “Preliminary Study”

[12] Pacific Side Excavation & Dredging Material Disposal Alternatives Evaluation, Moffatt & Nichol Engineers for ACP, March 2004.

12.5.2 Alternative PS-0

Alternative PS-0 is based on alternative P1-A described in the Preliminary Study of Island Development (PSID2001)[13] report. The island is located immediately due east of the flight path into Howard Air Force Base, and west of the explosive cargo anchorage area. Access to the island is via a causeway-trestle combination. The nearshore section will be an open piled trestle about 200 meters long designed to allow movement of littoral material along the shoreline and passage for marine life. At approximately the mid point of the causeway, and in sufficient water depth to permit the passage of small fishing vessels, a bridge about 50-meters long will be placed. The island has a constructed area of 350 Ha and includes a 3,400 meter long offshore breakwater.

12.5.3 Alternative PS-5

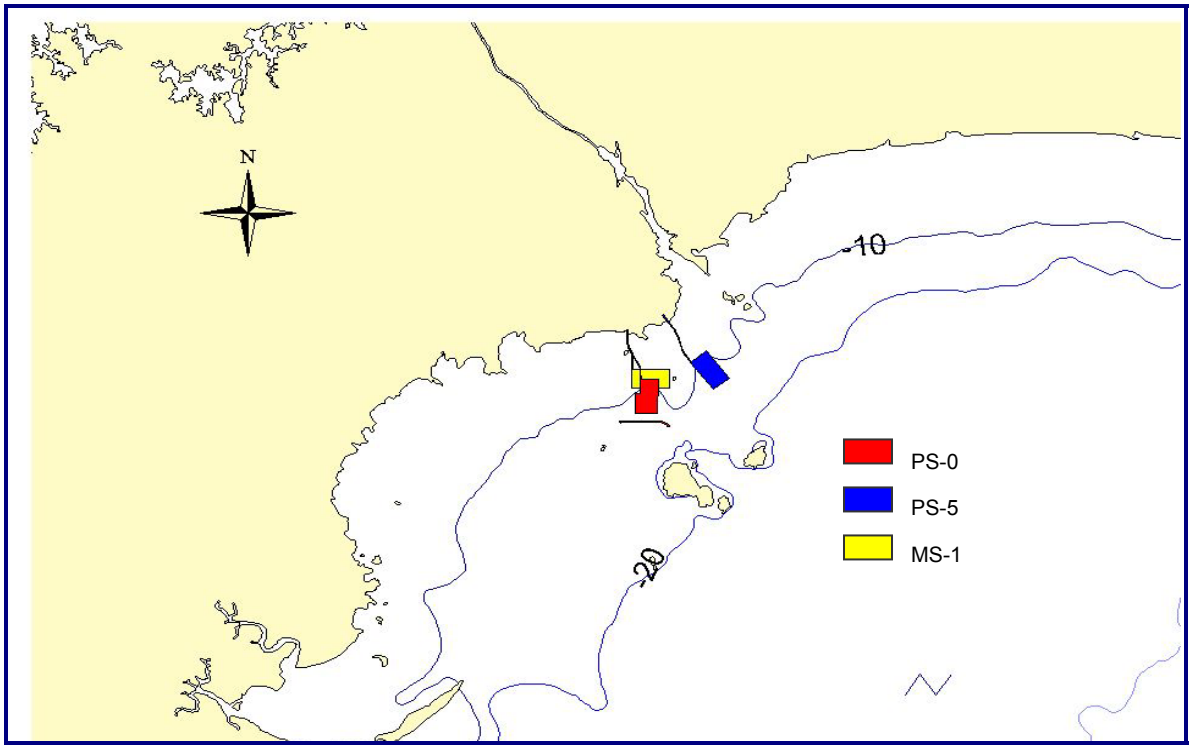
The second alternative is a variation of Alternative 5 (see report PSED2004), with the longest side of the artificial island oriented northwest to southeast. The connection to the mainland is aligned almost parallel to the Pacific entrance channel and the dimensions of the artificial island as well as the length of the causeway are similar to those for alternative PS-0

12.5.4 Alternative MS-1

Finally, the third alternative is a mixed use island located at the same site as alternative PS-0 but approximately 800 m closer to shore. In addition the longest side of the island has been oriented east to west.

[13] "Preliminary Study of Island Development at the Pacific Entrance of the Panama Canal", December 2001 by Moffatt & Nichol Engineers and Louis Berger Group for ACP

Figure 12-1: Alternative Island Locations for Hydrodynamic Model



12.5.5 Hydrodynamic impact assessment

A numerical model based on the existing conditions model described in the ECHM2002 Draft Report was developed for each island alternative: PS-0, PS-5 and MS-1. In addition three different possibilities for connecting the island to the foreshore, causeway (C), trestle (T) and a combination of both (H) were considered and simulated for each island alternative. Following is a description of how these different alternatives were implemented in the model.

Causeway Connection Alternatives

The three island alternatives were simulated with a causeway connection to the coast. PS-5 and MS-1 has been simulated with a completely closed causeway while PS-0 has two small openings in the causeway, following the description presented in the PSID2001 report.

Trestle

A connection between the island and the coast using an open trestle was also simulated. The width of the trestle is 55 m. for the commercial island alternatives PS-0 and PS-5 and around 20 m for the mixed use alternative MS-1. The considered layout of the piles

is 15.5' x 34' (4.72 m x 10.36 m) spacing using 26” (0.66 m) diameter piles. Model grid size is typically larger than the pile diameter, therefore it is normal modeling practice to include the influence of the piles on the hydrodynamics as an additional friction term in the model. This term produces the same effect in the flow (flow reduction) as the piles do and is typically implemented as additional bottom friction. Specifically, an equivalent bottom friction manning coefficient that accounts for both the natural bottom friction and the friction due to the piles, is calculated as follows. The flow resistance due to a jetty or a bridge is dependent on the blocking of the flow by the piles. For a row of piles perpendicular to the model x-direction the flow resistance is given by the following expression (Delft3D manual):

$$C_{loss,X} = \frac{1}{2} \frac{N_X \cdot C_{drag} \cdot d_{pile}}{\Delta y} \frac{A_{tot}}{A_{eff}}$$

where:

A_{tot} total cross sectional area
A_{eff} effective wet cross sectional area (A_{tot} minus area blocked by piles)
C_{drag} the drag coefficient of a pile (1.0 for smooth pile)
d_{pile} the diameter of a pile
N_X the number of piles in X-direction in the grid cell

The friction loss due to the piles is converted to manning friction coefficient. Values of the equivalent manning coefficient applied in the numerical model are presented in Table 12-1. Background manning coefficients are applied at every grid point of the model except those representing the trestle. The background coefficient is the same in both computational directions. The equivalent manning coefficient is smaller for the mixed use alternative MS-1 than for PS-0 and PS-5 due to the use of a narrower trestle.

Table 12-1 Equivalent Manning coefficients due to piles

Alternative	Background Manning coeff ($s/m^{1/3}$)	X-direction Manning coeff ($s/m^{1/3}$)	Y-direction Manning coeff ($s/m^{1/3}$)
PS-0	0.023	0.080	0.080
PS-5	0.023	0.080	0.080
Mixed-Use (MS-1)	0.023	0.054	0.054

Hybrid (combination of causeway and trestle)

The hybrid alternatives simulated as part of this work consist of a combination of causeway and trestle where the trestle section represents approximately one third of the total length of the connection to land. The trestle is distributed in two sections, one of 250 meters in the nearshore to avoid blocking of the flow in that area and a longer section in the area of largest flows located just north of the island. Table 12-2 presents the total length of the causeway/trestle alignment, the length of the two trestle segments and the percentage of open section for each alternative.

Note that the final causeway/trestle ratio should be optimized during the design phase of this project to obtain a cost efficient configuration with a relatively small disruption of the flow in the bay. This optimization could be done by performing a number of simulations for a set of different hybrid alternatives with different causeway/trestle ratios and distributions along the connection.

Table 12-2 Trestle length for hybrid alternatives

Alternative	Total Length (m)	Near Island trestle (m)	Shallow water trestle (m)	% of open section
PS-0	3750	1050	250	35
PS-5	3650	1025	250	35
Mixed-Used (MS-1)	3000	700	250	32

12.5.6 Description of Impacts

Comparison of model results for existing conditions and for the different alternatives was carried out for spring and neap tides, and for the four stages of the tide. A 14-day simulation period from 5/25/02 to 06/06/02 was selected because it includes both spring and neap tides.

Figure 12-2 and Figure 12-3 present flow patterns from the existing condition model during spring and neap tides respectively. Both figures include the flow patterns during four tidal stages: Low Water (LW), Peak Flood (PF), High Water (HW) and Peak Ebb (PE). Similar figures have been created for every simulated alternative and are included in Appendix H to this report. These figures show the differences in the magnitude of the velocities and the flow patterns for each simulated alternative at each stage of the tide.

A description of the impacts observed from each island alternative is presented in the following paragraphs.

Figure 12-2: Flow Patterns in Study Area – Neap Tides

Figure 12-3: Flow Patterns in Study Area – Spring Tides

Alternative PS-0

Model results show that the largest reduction in velocities caused by the construction of island alternative PS-0-Causeway (PS-0-C) is during neap tide. This option assumed a causeway breach at the shoreline and a mid causeway bridge for passage of small craft.

During this period the main flow direction is dominated by the Gulf of Panama Current. A disruption of the coastal current due to the causeway is observed at the four stages of the tide but especially during high water and peak ebb. This disruption is translated in a reduction of the velocity at the near shore from a range of 5-7 cm/s to 1-3 cm/s during high water and from 3-10 cm/s to 1-5 cm/s during peak ebb. North of the island the velocity was reduced from a range of 10-13 cm/s to values between 1-5 cm/s during high water. The flow is channeled through the area between the breakwater and Isla Taboga and also between the breakwater and the artificial island. This results in higher velocities distributed in a smaller area. During high water the maximum velocity increases in this area from 20 to 25 cm/s and during peak ebb from 32 to 35 cm/s. In addition, higher velocities are observed at the near coast passage and the bridge especially during high water (from 5 cm/s to 10 cm/s) and peak ebb (from 5 cm/s to 15 cm/s). This could be a potential cause for localized erosion around the piles and at the bridge channel. During spring tide the tidal flow dominates over the Gulf of Panama Current and the main flow direction at the island location is NNW during peak flood and SSW during peak ebb. A significant increase of velocities is observed around the tips of the breakwater (maximum velocity from 25 to 40 cm/s) and the NE tip of the island (maximum velocity from 20 to 30 cm/s) during these two tidal stages. These areas of higher velocities may require special provision for scour protection. During peak ebb it is also observed a decrease in the magnitude of the currents due to the causeway. The largest disruption of the coastal current is observed during high water with the maximum change observed from 17 to 5 cm/s. Also during this period high currents are observed between the breakwater and the artificial island and also at the northern passage and the bridge of the causeway. A general increase of the current magnitude, in the order of 4 cm/s, is also observed north of Isla Taboga.

Water flow is not blocked and directed south for alternatives PS-0-Trestle (PS-0-T) and PS-0-Hybrid (PS-0-H). As for alternative PS-0-C the largest impacts are also observed for neap tide but their magnitude is smaller. In both cases a velocity increase on the order of 5 cm/s is observed just north of the island. This increase is a consequence of the convergence of flow through the deepest open area along the trestle. Although the results from PS-0-T and PS-0-H are very similar, PS-0-H presents some blocking of the flow in the shallow water north of the island, where the longest causeway segment is located, with a reduction of the velocity from 5 to 2 cm/s.

Alternative PS-5

The island for alternative PS-5 is oriented parallel to the main flow during peak flood at spring tide. Specifically for A5-Causeway (A5-C), a large amount of flow is deviated towards the Panama Canal entrance producing a significant increase (5 to 7 cm/s) of the currents in the area near the island, but also between the island and the Amador causeway. During peak ebb at spring tide the island blocks the main flow direction which is towards south. In this case a significant reduction of the velocities, from 20 to 5 cm/s, is observed west of the island and an increase of the maximum velocity from 25 to 40 cm/s to the east.

During neap tide the main flow direction is dominated by the Gulf of Panama Current. A disruption of the coastal current due to causeway is observed during high water and peak ebb. Velocities are reduced in the area along the causeway from a range of 5-10 cm/s to 1-3 cm/s. The velocity reduction is observed west of the island as well as in the area between the island and the Amador causeway. During low water and peak flood the velocity reduction is smaller.

Similar results are observed for alternatives A5-Trestle (A5-T) and A5-Hybrid (A5-H) though the area influenced by the island and connection to the foreshore is significantly smaller than for A5-C. The blocking effect of the island on flow is still observed, but due to the trestle opening there is little or no impact in the area north of the island. In addition the impacts in the vicinity of the entrance channel are greatly reduced. Although the results from A5-T and A5-H are very similar, A5-H causes some blocking of the flow in the shallow water north of the island, where most of the causeway is located especially during peak ebb, producing changes in the velocities in that area in the same order than those observed for A5-C.

Mixed-Use Development Island (MS-1)

The footprint of the island for Alternative mixed-use (MS-1) intersects the peak ebb flow and to a lesser extent the peak flood. In particular, for alternative MS-1-Causeway (MS-1-C) this is translated into a reduction of the velocity magnitude north of the island in the order of 5 cm/s and a significant increase at the eastern edge up to a maximum velocity of 40 cm/s. During the stages of the tide when the Gulf of Panama Current is dominant (HW and LW during Spring Tide, and HW, LW and PF during Neap Tide) reduction from 6-9 cm/s to 1-3 cm/s and blocking of the flow is observed north of the island. For alternatives MS-1-Trestle (MS-1-T) and MS-1-Hybrid (MS-1-H) the impact of the island and the connection to the coast is small, especially for MS-1-T. In these two alternatives an important increase of the velocities from a maximum velocity of 13 cm/s to 25 cm/s at the north-west corner of the island is observed due to the convergence of flow through the deepest part of the connection alignment. In general, and because this location is closer to the coast, the magnitude of the flow affected by the construction is smaller than for PS-0 and PS-5 alternatives.

12.5.7 Summary of Hydrodynamic Impacts

- Any of the island alternatives will change the existing flows associated with the tidal and oceanic currents due to its location, size and geometry. These changes in the flow patterns are translated into a localized increase or decrease of velocities in the area around the island.
- In general, the impact of all the simulated alternatives on the hydrodynamic conditions of Panama Bay is relatively modest and limited to the immediate project vicinity. The largest changes in the currents are always observed around the island shoreline.
- The rubble mound causeway option produces the largest changes in the local current regimes. The blocking effect of the causeway forces the currents that normally flow north of the island to move to the south. Most of the blocking is observed on the near shore areas, but the velocities are very low under existing conditions, with typical values of 5 cm/s or less.
- The trestle and hybrid alternatives have lesser impacts than the causeway alternative, since they do not block as much of the flow north of the island. The trestle has virtually no impact on the current circulation patterns and the hybrid causeway/breach alternatives have a minimal impact during neap tide for high and low water. This then indicates that there would be a minimal disruption of the Gulf of Panama Current in the vicinity of the island
- Those alternatives that are located farther offshore (PS-0 and PS-5) produce the largest impact because they have a higher effect on the Gulf of Panama Current, again due to the length of the causeway and not necessarily related to island size.
- Alternative PS-5 produces some changes in current velocities at the Pacific entrance of the Panama Canal because of the channeling effect of the causeway in this area.
- Lesser impacts are observed at the alignment for PS-0 and MS-1. In this case there is minimal interference with the flow entering and leaving the Pacific entrance of the Panama Canal. In addition, the location of MS-1 with an open trestle has the least impact of all the options presented.
- Model results suggest that the shape of the island could be further optimized to avoid sharp corners that produce the highest localized changes in velocities when compared to the existing conditions case.

13 MARITIME RELATED DEVELOPMENT OPTION

13.1 Candidate Maritime Based Uses

At this time, ACP is in the process of reviewing a series of traffic forecast studies dedicated to the main categories of vessels indicated above. The results of these studies were not available to the consultants at the time of preparation of this report, but they will clearly provide a strong foundation for the selection of the preferred category and levels of maritime activity on the island.

For the purposes of this study, the following recommendations are based on a broad understanding of shipping patterns, world trade and technology trends in the shipping industry. More detailed assessments of throughput and classes of maritime activities will be required as the project moves into the detailed evaluation and design phases.

13.1.1 Fuel Storage and Transfer

Given the existence of the Trans-Isthmian pipeline, and the recent establishment of bulk transfer and bunkering installations on Taboguilla Island in Panama, it is not likely that the island is a prime candidate for Liquid bulk transfer, storage or distribution activities.

13.1.2 Cruise Ship Terminal

The island is unlikely to be major cruise Ship destination, since it would be separated from the main tourist attractions and distanced from Panama City. However, should there be difficulties in accommodating cruise ships at the Port of Balboa, Rodman or any of the newer installations now under consideration for the Amador area, the marine installations at a Port Island could certainly be used to receive passengers from cruise ships.

13.1.3 Container Terminals

According to ACP press releases, more container traffic than bulk cargo passed the Canal in 2003, for the first time since it opened in 1914[14]. With projected volumes of container traffic through the Canal expected to reach 11.8 million teus by 2025, the concentration of high volume container vessels at Panama then offers considerable potential for transshipment, value added or logistical services at the new Port Island.

[14] Journal of Commerce, January 2004

As container traffic continues to grow on the major trade routes, ship sizes have increased with the projected vessel capacity for the new locks project being on the order of 10,500 – 12,500 teu[15]. While these vessels represent a significant economy of scale in terms of operating costs, not all ports will be able to handle these large vessels and the capacity of the ships will exceed demand for all but the major consumption and distribution centers.

Panama has already become a major center for the transfer of containers from vessels on the major trade routes to the secondary distribution systems and this requirement is expected to grow as the ships get larger following the construction of the New Locks.

Ongoing studies for ACP will present forecasts of future container traffic, but if the rapid growth of traffic through the Manzanillo and Evergreen terminals on the Atlantic Coast is an indication of expectations, there will clearly be a need for major terminal capacity on the Pacific Side of the Canal to feed containers to the west coasts of Central and South America. While there are few limits to container terminal expansion on the Atlantic side, expansion in and around the Port of Balboa is much more complex. The Panama Ports Corporation is now implementing a major expansion project that is expected to increase the installed capacity to approximately 1.00 million teus per year[16], but future expansion beyond the limits of the ongoing Ports project is unlikely. Existing and expected future handling capacity of the existing container terminals on the Pacific and Atlantic sides is shown in Table 13-1 on the following page.

While it is not critical that a final decision be made on the detailed use categories for the maritime center at this time, the strongest expectation of interest for the port facilities will be for container ships, where the trend to the establishment of hubs, sub hubs and regional distribution centers now forms an essential element of the competition between the major ocean carriers. Coincidentally, this class of maritime activity traditionally generates the highest lease rates or revenues for Port authorities, although it must be recognized that port construction and development costs are also higher than bulk or other classes of cargo terminals.

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15 20 ft equivalent unit

16 According to press releases by Panama Ports Corporation, on completion of the expansion plan, the terminal at Balboa will feature 820 meters of quay, a draft of 16 meters, 16 hectares of container yard, eight "Super post-Panamax" quay cranes, and 21 yard cranes.

13.1.4 Other Maritime Related Activities

Distribution Center

At this time it is estimated that 73% imports to the Atlantic terminals are directly transshipped, 25% are drayed to the Cristobal Free Zone and 2% service local Panama demand. The existing system is based on Panamax vessel traffic and the capability of the Canal to accommodate Post Panamax vessels would almost certainly generate higher volumes of transshipment traffic. For the Pacific side, this traffic would primarily be to the west coasts of Central and South America, with perhaps some transfer to smaller vessels for subsequent Canal transit and service to Atlantic side destinations.

It is likely that major international retail and wholesale distribution companies will take advantage of an opportunity to store, inventory, manipulate and distribute to outlets in South and Central America and the Caribbean. Panama provides them the only location for economically servicing markets on both the Atlantic and Pacific and also provides a single regional location from which the final destination of the contents of containerized cargo can be determined with a minimum of ensuing transportation time. This allows retailers to adjust deliveries as close as possible to real time sales, thus minimizing shelf time and inventory costs.

Value added Facilities

Asian exports of consumer product components and finished goods are increasingly facilitated by the accomplishment of value-added activities in route. These activities include:

- Logistic services;
- Bar Coding and Scanning;
- Sorting and Labeling;
- Preparation and Insertion of Marketing Materials;
- Repacking / “Pick & Pack”;
- Kitting;
- Packaging Design & Manufacture;
- Manipulation;
- Repair;
- Internet Fulfillment;
- Special “Piece” Manipulation; and
- Storage.

Already Panama’s Cristobal Free Zone fulfills some of these functions for Asian and European exports to South America. While it is recognized that the traditional role of the Free Zone has changed as the South American economies have opened, future

activities will focus on Value added aspects of Atlantic-side transshipment containers and goods. A second facility is required to handle the main volume of Asian exports to countries on the West Coast of Central and South America.

This facility would not necessarily need to be located on the artificial island, particularly taking into account the location of the former Howard AFB close by. However, the tendency in logistics centers development has been to maintain the marine transfer, intermodal, distribution and value added facilities as close to each other to facilitate free movement of the goods and enable all operations to function efficiently within a duty free environment.

Table 13-1: Installed Capacity at Panama Container Terminals

Container Terminal	Imports	Exports	Loaded Total	Empties	TOTAL TEUs	Capacity	Utilization % of Cap.	Terminal Size (ha/ac) 2000	Terminal Size (ha/ac) Max.
Atlantic Side Terminals:									
MIT	501,743	522,222	1,023,965	307,189	1,331,154	1,500,000 [1]	89%	63/156	114/282
Colon	91,825	88,224	180,049	54,041	234,090	521,775 [1]	45%	25/62	72/178
Cristobal	84,299	80,994	165,293	49,588	214,881	1,500,000 [2]	14%	143/353	143/353
Sub-total	*677,867*	*691,440*	*1,369,307*	*410,818*	*1,780,125*	*3,521,775*	*51%*	*231/571*	*329/813*
Pacific Side Terminals:									
Balboa	90,499	96,951	177,450	76,050	253,500	253,500 [3]	100%	8.4/21	50/124
TOTAL	**768,366**	**788,391**	**1,546,757**	**486,868**	**2,033,625**	**3,775,275**	**54%**	**293/592**	**453/937**

Container Terminal	2000 Productivity / Acre (Lifts)	2000 Productivity / Acre (TEUs)	2000 Productivity / Hectare (Lifts)	2000 Productivity / Hectare (TEUs)	Maximum Productivity (TEUs/ha)	Maximum Capacity (TEUs)
Atlantic Side Terminals:						
MIT	5,079	8,533	12,577	21,129	20,871	2,379,294
Colon	2,234	3,775	5,541	9,364	20,871	1,502,712
Cristobal	360	609	779	1,503	10,435	1,492,205
Sub-total	--	--	--	--	--	*5,374,211*
Pacific Side Terminals:						
Balboa	7,143	12,071	17,857	30,178	20,871	1,043,550
TOTAL	--	--	--	--	--	**6,417,761**

Notes: 1) Capacity calculated at maximum productivity rate of 20,871 TEUs per hectare.
2) Capacity calculated at maximum productivity rate of 10,435 TEUs per hectare.
3) Capacity calculated at maximum productivity rate of 30,178 TEUs per hectare.

13.2 Functional Requirements

13.2.1 Ship Size Criteria

The completion of the Third Locks project will set a new Panama Canal standard for container and other ships. It therefore is reasonable to design the first phase of container facilities on the new island to that new size limit.

According to the Terms of Reference for the Third Locks Concept study, and preliminary dimensional criteria from the Harza and other studies used as a basis for this evaluation, the new locks will be designed to accommodate the following vessel dimensions:

- Length – 385.7 m
- Beam – 54.9 m
- Draft 15.2 m
- DWT – 105,000.

Table 13-2, presents a range of typical dimensions for existing, in building and potential future container ships. Using these parameters as general guidelines, the capacity of a container vessel, falling within the new Locks dimensional limits, will be on the order of 10,500 teu.

Table 13-2: Typical Dimensions of Existing and Future Container Vessels

Class of Vessel	DWT	TEU Capacity	Units. across deck	Length (m)	Beam (m)	Draft (m)
Line vessels						
1st generation		1,000		180	25	9
2nd generation		2,000		225	29	11.5
3rd generation		3,000	12	275	32	12.5
Panamax	70,000	4,000	13	294	32.6	12.5
Post-Panamax (1991)	75,000	4,400	16	275	39.4	12.5
Super Post Panamax	105,000	6,250 – 7,500	18	315	44	13.5 – 14.5
Mega - Ship1		9,200	19	346	46	14.5
Mega - Ship2	152,000	12,500	21	400	54.2	14.5
Malacca-max	242,000	14 - 18,000	24	400	60	21
Feeder vessels		300 -1,200		75 -130	13 -19	4.0 - 8.0
TOR - Locks Concept Study	105,000	10,500	21	385.7	54.9	15.2

13.2.2 Site Preparation

While the geophysical survey carried out in 2003 provided an understanding of the elevation of bedrock and the thickness of the soft sediments in the project area, additional borehole information is required to define the physical and strength characteristics of the soft material.

This information is critical to the computation of settlement rates for the island during and after construction, and also is required to provide a basis for the design of measures to accelerate or eliminate settlement.

However, there is a considerable body of research and experience on the construction of marine facilities over soft sediments, and it is possible to make an educated estimate of

the potential settlement and site preparation measures required for this feasibility level of analysis.

Based on the results of the geophysical survey, it can be seen that the average thickness of soft sediments in the study area vary from 2.00 to 7.00 m. Earlier work done by members of the consulting team for the Vacamonte Fishing Port project showed that the top 1.0 to 1.5 m of the soft material is semi-liquid with minimal shear strength and it is recommended that this material be removed prior to placement of any fill material. Preliminary computations then show that the likely settlement of the island with no settlement acceleration techniques, will range from 1.5 to 2.0 m where soft sediment depths are on the order of 7.00 m. Surcharging the island by approximately 3.0 m for at least 12 months will cause approximately 75% of this settlement to occur before removal of the surcharge load.

Where settlement may be a concern for structural stability of the island features or structures, the following site preparation steps are included in the cost estimates:

- Removal of 1.0 m of soft sediments prior to placement of fill
- Allowance for 1.0 to 2.0 m of long-term settlement of the island, depending on location
- Allowance for the placement of 3.0 m of surcharge load for a period of 12 months.

It should be noted that the settlement of the island will not impact the main berth areas which would be built on piles drilled into the bedrock and kept independent from the main body of the fill material.

13.3 Land Access Needs

13.3.1 Highway Access

Although the Port facilities will primarily function as a container transshipment station with minimal movement of containers outside the immediate port area, highway access is required to accommodate large vehicles, emergency vehicles, chassis and special project cargoes, in addition to normal daily traffic and bus services. Given the length of the causeway or trestle to the island, it is recommended that two highway lanes be provided in each direction, separated by a median and Jersey type barriers on each side.

Assuming 3.50 m lanes, 2.0 m shoulders and 1.0 m for the central median, the overall width of the highway corridor would be 19.5 m, taken to the center of the Jersey barriers on the outside of the corridor. This configuration will permit the passage of emergency or other vehicles around a stalled vehicle and exceeds the capacity requirements for the port and island development.

13.3.2 Rail Connection

Given the cost preference for rail transport of fill material to the island, it is reasonable to assume that the corridor and rail tracks from the Locks area to the island could then become a permanent feature of the project. If the system can be linked to the Panama Canal Railroad on the east of the Canal, interchange of containers and goods between the Pacific and Atlantic coasts could be facilitated.

The primary issue in the establishment of a permanent rail corridor will be the need to cross the Canal. At this time, the existing bridge at the Miraflores Locks is used occasionally by ACP staff and contractors to move materials and equipment across the Canal, and it is equipped to receive rail tracks. In general, the bridge is only opened when Canal traffic patterns are reversed between 12:00 and 1:00 pm on a given day.

Clearly this arrangement could also be followed for the movement of a container train from the island, since the level of traffic generated between the coasts is most unlikely to exceed one train per day.

However the bigger issue will be the cost of incorporation of a second bridge within the New Locks construction. While there are few operational difficulties associated with the addition of a bascule or rotating bridge to the New Locks, the cost of such a structure could easily exceed $55 million. This would be hard to justify on the basis of a single train per day.

It is therefore recommended that the initial planning elements of the Locks and the Island project include a permanent rail connection and a new bridge over the Locks, but no cost items should be allocated to this option at this time, except for the reservation of a corridor access for rail to the island and incorporation of rail yard areas in the island design.

As both the island and the Locks projects move forward, a separate analysis should be made of the need for permanent rail connection and the cost of provision of the facilities, in order to determine whether this capability should be included in the final projects.

In the event that rail is not used for the permanent connection, the alternative of draying the cross Isthmus containers or goods to the rail yards in the Albrook area is not considered to be a major cost or operational issue for the port operators.

At this time, it is therefore recommended that the conceptual design for the access to the island should include a 6.00 m corridor for the rail line.

13.3.3 Utility Corridor

Utilities required for the island include electrical power, cable communication, potable water, sewage handling and natural gas. Seawater to augment fire fighting would be an option for the maritime-use development.

Utilities would be delivered to the island in dedicated utility trenches in the rubble mound causeway option, or incorporated within the design of the breaches, trestles and bridge structure.

Specific utility requirement to support the different long term development options are presented later in this report. However, for initial sizing of the utility corridor, typical service needs include:

- Electrical Power
- Potable Water
- Fire water system (optional)
- Sanitary Sewer (from island back to mainland)[17]
- Ship liquid waste discharge pipeline (optional)
- Natural Gas (Optional)
- Oil lines
- Telephone, cable and other miscellaneous lines
- Space for Future expansion of services
- Service road access for maintenance

Consequently it is recommended that a 4.00 m wide utility vault should be provided for the island, together with a 2.0 m pipeline corridor and a 3.0 m access road. Overall width of the utility corridor is then assumed to be 9.0 m.

13.3.4 Pedestrian Access, Lighting and Landscaping

The access to the island also requires space for pedestrian access, assumed to be 2.5 m wide, areas for landscaping and a lighting corridor that would be located at the median between the highway corridors. These are likely to require an additional 7.0 m within the corridor limits.

13.3.5 Corridor Design Criteria

Based on this initial assessment of needs, the access structure connecting the maritime island to the shore side will require space to accommodate a 4-lane roadway, railroad, pedestrian access, a utilities corridor and room for landscaping.

Figure 13-1 shows the recommended allocation of space and overall width of the corridor considered necessary to service the maritime development proposed for the island.

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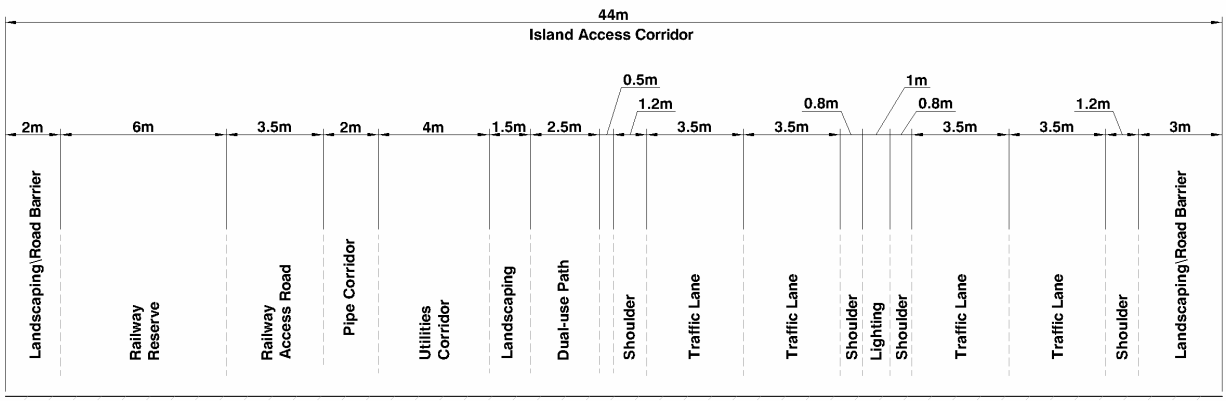
[17] Later discussion on waste water treatment refers.

Figure 13-1: Dimensions of Access Corridor Required for Maritime Development Option



In order to minimize the impact of the island construction on the local hydrodynamic regime, the causeway should impose the minimum impact on tidal currents and circulation within its area of influence. Consequently, cost estimates were prepared comparing the cost of an open piled structure with a rubble-mound type causeway that could be built from the material to be excavated from the locks. Based on the results of the hydrodynamic modeling, it is desirable to include breaches in the rubble mound causeway to improve the flow of tidal currents in the area. The length of the causeway will extend over 3.00 km from the shoreline and it is also recommended that a mid causeway passage be incorporated into the structure. In this way shrimp and other fishing craft and small boats navigating along the coast and to Vacamonte Port will not have to divert around the island. Consequently, these elements are then incorporated into the cost estimate for the rubble mound causeway alternative.

Table 13-3 shows the estimated cost of a 3.50 km access trestle constructed on an open piled concrete structure to the dimensions noted in Figure 13-1. It also includes a mid causeway bridge with a vertical clearance of 15 m above MHHW to permit the passage of small craft. The concept of a swing or lifting bridge was rejected due concerns over system reliability, high construction costs, manning and the costs of maintenance of the lifting gear.

A key question related to the construction of an open piled access trestle to the maritime island development relates to the design loading to be adopted for the structure. In the event that the contractor opted to use the trestle for construction access to the island, the excavated material could only be moved from the stockpiles to the island by rail or by trucks that meet the load criteria selected for the permanent use of the trestle.

Table 13-4 shows the estimated cost of the same access constructed as a rubble mound causeway with open piled trestle breaches at the shoreline and at the island, together with the mid causeway bridge noted above.

From the cost analysis it can be seen that the construction of an open piled trestle to permit the circulation of tidal currents in the area of the island will cost an order of magnitude higher than the use of excavated material in a rubble mound causeway, even including a bridge and 300 m of breaches in the rubble mound alternative. The difference of $75.26 million is a significant cost item.

Table 13-3: Estimated Cost of 3.5 km trestle for Maritime Island Concept

Description	Amount (US$2004)
Mobilization	***$1,500,000***
Trestle Structure	***$114,631,200***
Bridge for Small Craft Passage	***$6,097,791***
Miscellaneous	***$11,517,500***
Barrier Rails & Dividers	$1,012,500
Utility Vault	$1,725,000
Ballast & Rail track	$680,000
Lighting, striping, signage	$6,075,000
Landscaping	$2,025,000
Sub Total Estimated Construction Cost	***$133,746,491***
Add Contingencies @20%	***$26,749,298***
Total Cost of 3.5 km trestle & Bridge	**$160,495,789**

Table 13-4: Estimated Cost of 3.5 km causeway for Maritime Island Concept

Description	Amount (US$2004)
Mobilization	***$1,500,000***
Causeway	***$26,870,400***
200 m Trestle Structure at Shoreline	***$8,491,215***
100 m Trestle Structure at Island	***$4,852,123***
Bridge for Small Craft Passage	***$17,797,791***
Miscellaneous	***$11,517,500***
Barrier Rails & Dividers	$1,012,500
Utility Vault	$1,725,000
Ballast & Rail track	$680,000
Lighting, striping, signage	$6,075,000
Landscaping	$2,025,000
Sub Total Estimated Construction Cost	***$71,029,029***
Add Contingencies @20%	***$14,205,806***
Total Cost of 3.5 km Causeway & Bridge	**$85,234,835**

13.4 Cargo Handling Capacity

13.4.1 Containers

Container terminal capacity is a function of a number of operational or physical elements. The primary operation is ship to shore transfer, which is basically a function of crane availability and productivity. Yard capacity is the second element, and throughput is a function of cargo classification, container dwell time and characteristics of the containers. Finally, gate capacity or highway congestion can also control overall capacity of the container terminal.

In order to assess the functional requirements for a generic container terminal at the Artificial Island, the following parameters are assumed:

- At least70% of the containers will be transhipped
- Maximum vessel size will match the size limitations of the New Locks
- A maximum of five cranes will be assigned to a 10,500 teu main line vessel.
- A maximum of three cranes will be assigned to a feeder vessel (<4,500 teu)
- Each crane will average 50,000 lifts per year
- Each Terminal module will offer two berths for Post Panamax sized vessels

13.5 Marine Facilities

In order to develop the basic shape of the island for the location evaluation, a preliminary assessment of the cargo terminal size requirements is needed. The following sections generally describe the size of the container terminal modules that would respond to the demands of future Panama Canal traffic and world trade patterns.

13.5.1 Container Terminals

Since it is expected that a number of container carriers or operators would require separate terminals to handle their own demands, the development plan for the maritime island should incorporate independent container terminal modules of a size that are likely to be attractive to the private sector or private investor.

Berth Dimensions

Based on the vessel parameters above, the container terminal berths should be designed to accommodate a 386 m vessel, drawing 15.2 m fully loaded. A typical transshipment terminal will handle both the mainline and feeder vessels with priority for the main line vessels. If it is assumed that each module should be designed to receive one 6,500 teu ship and one 10,500 teu Super Post Panamax mainline vessel at the same time, the required total berth length is approximately 850 m. This terminal module

would then be adequate to handle two or possibly three existing Panamax vessels or a combination of main line and feeder ships.

Draft at the berth should be 16.75 m, sufficient to accommodate the design vessel indicated in section 13.2.1.

13.5.2 Value Added and Distribution services

For the purposes of this analysis, value-added, warehouse criteria have been based upon those used in Hong Kong, specifically from Sea-Land for its innovative facility there. In this view, a warehouse is composed of units, i.e., the smallest unit that may be leased to a single establishment. In terms on net spatial requirements, that is without truck access or parking or exterior equipment passageways, they constitute a space of 1,845 m^2 (equivalent to 19,859.4 sq. ft.). Table 13-5 gives the space/activity allocation accounted for by each unit.

Table 13-5: Space Allocation of a Unit

Activity	%	Sq. Meters Req'd
Distribution	10	184.5
Manipulation	10	184.5
Warehousing	75	1,383.8
Office	5	92.3
Total	**100**	**1,845.1**

Based on the Sea-Land experience in Hong Kong, an average container throughput for a 36,900 sq m building is expected to be on the order of 50,000 teus per year.

13.6 Navigation Access

13.6.1 Operational Criteria

In order to offer a high level of service to port users, the following navigation and channel operational criteria are considered essential to the efficient management of port traffic:

- Two way vessel traffic capability
- Unrestricted, 24 hour transit for all but the largest cargo vessels
- State of the art vessel traffic control system.

Along with the above, the following criteria were also assumed for the preliminary sizing of the navigation channel:

- Tug assistance will be provided for all vessel berthing operations
- Pilotage will be required for all vessels

13.6.2 Design Standards

The approach taken for the navigation channel analyses is based on the recommendations included in the following publications:

- Permanent International Association of Navigation Congresses (PIANC), International Commission for the Reception of Large Ships (ICORELS), "Optimal Layout and Dimensions for the Adjustment to Large Ships of Maritime Fairways," Report of Working Group IV, 1980.
- National Ports Council (NPC), "Port Approach Design- A Survey of Ship Behaviour Studies," London, U.K, 1975.
- US Army Corps of Engineers, "Hydraulic Design of Deep-Draft Navigation Projects, " EM 1110-2-1613, 1983.
- TERMPOL - Canadian Coast Guard (1977)
- US Navy, Naval Facilities Engineering Command, Design Manual DM-26.1 "Harbors," 1981.

Other pertinent publications are referenced in subsequent paragraphs where appropriate. However, the above references provide a sound planning basis for channel depth, channel width, and turning basin requirements.

13.6.3 Channel Depth Requirements

According to the U.S. Army Corps of Engineers publications, the required navigational channel depth relative to a referenced water level must take into consideration the following parameters:

- Loaded vessel draft including trim
- Squat
- Wave induced motions
- Safety Clearance
- Dredging Tolerance
- Advanced Maintenance Dredging

For the purposes of this study, all dredging depths and drafts are referred to Mean Lower Water Spring tidal elevations (MLWS) which is equivalent to 2.32 m below Precise Level Datum (PLD) as defined in the Panama Canal Clearance Diagram.[18]

Loaded Draft

For the purposes of this report, a fully loaded draft of 15.20 m, as noted in Section 13.2.1, has been used for preliminary planning purposes.

Squat

The position of a vessel's keel relative to the channel bottom will lower as the vessel speed increases. This phenomenon results when increased water velocities flowing past a moving ship hull produce a localized reduction in the elevation of the water surface. In general, squat is a function of the vessel speed, under-keel clearance, channel width, channel depth and vessel dimensions.

Wave-Induced Motions

The wave hindcast studies presented in Volume 1 indicate a maximum annual local wave height of 0.70 m with a 100 year maximum significant wave height of 1.80 m. Given the protection of the potential channel alignments by Taboga and Taboguilla islands, wave induced motion is therefore unlikely to exceed 1.0 m.

Safety Clearance

For a channel bed consisting of sand or silts, as indicated by the geophysical survey and existing data for the project location, a safety clearance of 0.6 m is considered to be acceptable.

Wherever possible, the alignment of the channel should be selected to avoid dredging in hard rock, in order to reduce project costs and also to permit lower safety clearance than for hard material. However, once the recommended alignment of the channel and island located has been selected, a detailed subsurface investigation program will be included within the overall site investigation for the project, in order to clearly identify the materials to be dredged and to check for the presence of rock layer(s) and potential hard spots within the channel area.

Dredging Tolerance

It is not possible to dredge to a uniform depth with a high degree of accuracy and the application of a dredging tolerance is widely accepted. Given the relatively open water conditions at the project site, an additional tolerance depth of 0.5 m should be included beyond the design dredge depth. The additional materials volume is not normally

[18] Panama Canal Clearance Diagram, Drawing Ref 6120-30C, Panama Canal Authority July 1999

included within the specified dredged volume calculations, but the dredging contractor will include an amount for over-dredge within the unit costs for the project.

Advanced Maintenance Dredging (AMD)

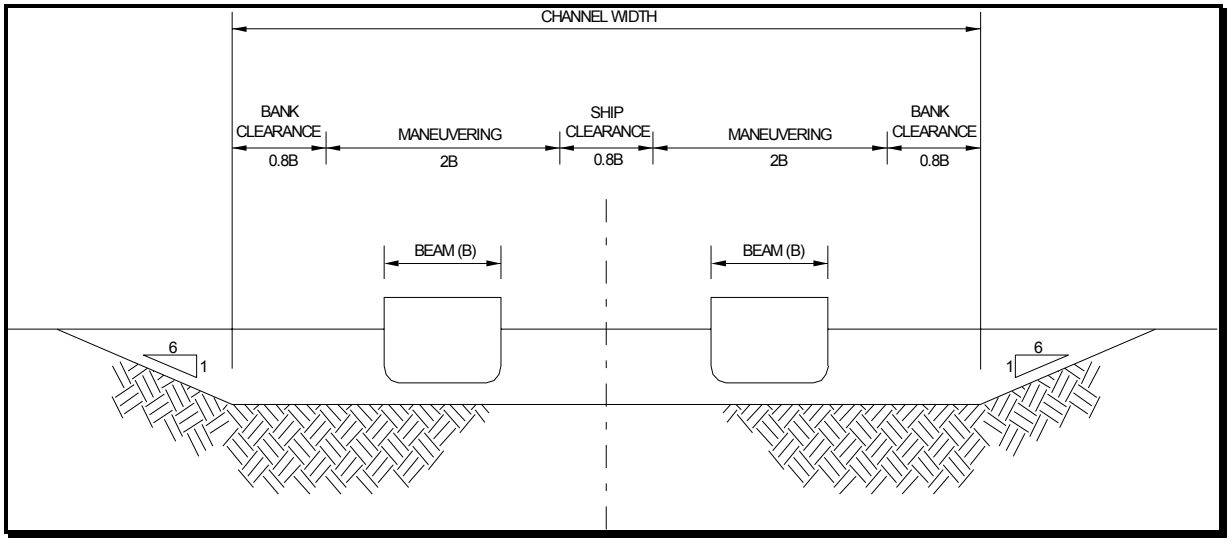
In areas prone to siltation, an additional depth can be added to the channel in order to allow for storage of accumulated sediment between maintenance dredging events. This approach prevents the premature loss of project depth and increases the length of time between dredging events.

Given the apparent stability of the bottom contours in the area and in the absence of any supporting data to the contrary, it is suggested that an allowance for AMD is not required at this stage.

13.6.4 Channel Width

The minimum width of a straight channel depends on the size and maneuverability of the vessel navigating the channel, the type of channel bank, the effect of other vessels in the channel and the effects of wind and currents. The width required takes into account space for a maneuvering lane, ship clearance and bank clearance.

Figure 13-2: Typical Width Dimensions of a Straight Dredged Channel



The Maneuvering Lane

The maneuvering lane must allow for the oscillating track of a maneuvering vessel. Generally, the width of the maneuvering lane will vary from 1.6 to 2.0 times the beam of the vessel depending on its controllability.

The Ship Clearance Lane

In a multiple lane channel, ship clearance lanes are normally taken as 80 percent of the design vessel beam.

Bank Clearance

A bank clearance width of 80% of the vessel beam is added to both sides of a channel.

13.6.5 Recommendations

Navigation access to the island is routed south of the existing Pacific and Explosives anchorages and north of Taboga Island. If it is assumed that passage of two mainline Post Panamax vessels is required, the channel would be 300 to 330 m wide to meet the various design standards.

However, there are a number of vessel passing or navigation options that would reduce the initial channel width and still provide a high level of service. As a port designed to handle both main line and feeder ships, it is suggested that one way traffic would be appropriate for mainline vessels, with two way traffic for ships below a given size limitation. It is also unlikely that the Pilots would permit two Super Post Panamax vessels to pass in the channel at the same time. Under these conditions, the initial channel width could then be reduced to approximately 250 m.

It is therefore suggested that the initial channel width should be set at 250 m, with potential for expansion later as traffic and financial resources permit. The initial channel depth is set at 16.75 m to accommodate a loaded vessel draft of 15.20 m, as indicated in the preliminary design parameters for the Third Locks project.

Future expansion could include widening and deepening of the canal to accommodate dry or liquid bulk or other vessels in the event that additional cargo consolidation or distribution facilities were developed on the island.

13.7 Development Concept

A generic layout for a maritime island development that responds to the functional requirements assessment is presented in Figure 13-3. The approximate area of the island required to meet this concept is 350 ha and it contains the following marine related elements:

- Three Container Terminal modules offering a total of 6 Super Post Panamax Berths
- A total container yard area of 155 ha
- Rail intermodal yard
- Area for future port development

- Space for logistics, commercial, customs services or value added development
- Circulation roads and parking areas.

Subsequent sections of this report examine various location options for the maritime development island. Specific marine terminal layouts are then developed in more detail at that time, in order to reflect the recommended location for the island.

Figure 13-3: Generic Concept for Maritime Island Cargo Terminals

13.8 Maritime Island Location Alternatives

13.8.1 Site Selection Methodology

There was little or no sub bottom information in the study area at the time of preparation of the Preliminary Island Report and a number of general assumptions were used to determine the optimum location for the Artificial Island. These included:

- An assumed depth of soft material of 7.0 m
- Preferred location of the island in 10 m (MLLW) of water would avoid dredging in rock and optimize the area of land generated by the project.
- All existing anchorages for vessels awaiting Canal transit should be avoided
- Sensitive environmental or tourism related areas should be avoided. These included Punta Bruja, Kobbe Beach and Veracruz Beach.
- Avoidance of the Obstacle Free Zone of the runway at the former Howard AFB.
- Avoidance of existing and potential sand extraction concessions north of Taboga Island.

The most critical unknown in the analysis was the depth and consistency of the sediments overlaying the known rock strata in the study area. The presence of multiple rock outcrops and small islands also indicated the likelihood of significant variations in the surface of the hard material.

Consequently the geophysical survey referenced in Volume 1 was contracted and undertaken in early 2003. The results of the survey provided a credible mapping of the rock threshold and determined the thickness of the overlying sediments of the entire area from the Canal to the western limits of the study area.

With the study results in hand, it was then possible to compute dredging and fill costs for a number of potential island locations, in order to select the optimum siting from a cost standpoint. For this second level of analysis, bottom line cost of each alternative was a function of:

- Length of navigation channel
- Characteristics of material to be dredged
- Depth of soft material to be removed or displaced by filling
- Transportation costs of material from shoreline to island location.
- Materials placement costs

For this study, computations were made of the generated island area, length of causeway and dredging requirements for navigation channels for five additional

alternative locations. Cost estimates were then prepared for each of these options, and the initial estimate for the site selected in the Preliminary study was also updated to reflect information gathered since the date of its completion.

Island fill and dredging quantities were computed using ground terrain model techniques and the hard materials thresholds indicated by the output from the geophysical survey. Based on the recommendations of the materials characteristics analyses, a compaction factor of 10% was also incorporated into the volume calculations for in-place quantity estimates.

The cost estimates for the site recommended in the Preliminary Report were also recomputed using this new information.

The options selected for the initial cost comparison are indicated in Figure 13-4. It is important to note that this first level of cost analysis is only relevant to island development for maritime development purposes. Since none of the other alternative long term uses will require a navigation channel for deep draft vessels, there are fewer constraints on the location and configuration of the island for the non-maritime related development options.

Figure 13-4: Alternative Locations Selected for First Cost Comparison

13.8.2 Site PS-0 (Location from Preliminary Island Study)

Project Description

Site PS-0 shown in Figure 13-4 is alternative P1-A described in the Preliminary Island Study report. The island is located immediately due east of the flight path into Howard Air Force Base, and west of the explosive cargo anchorage area. Based on the access corridor cost comparison presented in Section 13.3, access to the island is via a rubble mound causeway-trestle combination 3.80 km in total length originating at the eastern limit of Veracruz beach. The nearshore section will be an open piled trestle about 200 meters long designed to allow movement of littoral material along the shoreline and passage for marine life. At approximately the mid point of the causeway, and in sufficient water depth to permit the passage of small fishing vessels, a bridge about 50-meters long will be placed. A second breach approximately 100 m in length is also included at the causeway connection point on the island. The island has a constructed area of approximately 359 Ha.

Wave Protection

Based on the wave analyses undertaken for the preliminary study, it was considered that the container berths at this location would require protection by an offshore breakwater. The later analyses presented in Volume 1 of this report indicate that rotation of the island to offer better protection from the south west direction would achieve the same objective, but there are concerns regarding long period wave effects on the container berths, and these are discussed later in this report.

For the purposes of the cost comparison and given the uncertainties associated with the long period wave concerns, alternative PS-0 is included as an alternative for this later study.

Sand Concessions

According to records maintained by the Panama Maritime Authority (AMP), concessions have been granted, but not finalized for the extraction of sand at two locations in the general project area, as shown in Figure 13-4. The south eastern section of the island would impinge on the western parcel of the concession areas. The dredged channel also crosses the western sand concession at the mid point in the main berth approaches.

At this time, the details and duration of the concessions are not known, and it may be possible to work with the concessionaire to remove material from the impacted area prior to commencement of work on the dredged channel. However, it is clear that

adjustments may be required to the concession area or to the island location to respond to the potential conflict between the two projects.

Navigation Channel Dredging

Dredging costs for site PS-0 are estimated to be $41.1 million, with 16% of the total volume being in weathered or dense rock material. It is important to also note that the initial dredging computations reflect a project depth of 16.75 m. Future increases in vessel size could necessitate additional dredging to a depth of 18.5 m, all of which would be in dense rock.

Visual Impact

In general terms, it must be recognized that the construction and operation of container terminals on the island will not easily blend into the natural beauty of the area. The main areas of concern from a visual standpoint are those communities or areas of public use surrounding the project. Unfortunately, there are few measures that can be taken to improve the appearance of a container terminal, since the essentials of the facility are a large, flat rectangular development.

The primary viewpoint areas that would overlook the island include:

- Veracruz Community and Veracruz Beach (public beach, local community, weekend homes)
- Kobbe Beach (Restricted access beach area, potential resort development)
- Amador Causeway (popular exercise and public access area, restaurants, hotels, commercial development)
- Taboga Island (Public beach area, resort hotels, weekend homes, residences)

The strongest visual impact for site PS-0 will be from Veracuz Beach and also from the north shore of Taboga Island. In the event that the proposed resort hotel is constructed at Kobbe beach, the view of the working areas and container cranes is not likely to be welcomed.

Site PS-0 is located some 9.0 km from the Amador Causeway. If it assumed that a future Post Panamax container gantry crane will have an overall height of 75 m above the deck level, this would then represent a vertical view angle of 0.48 degrees above the horizon. Observations taken by the consultants from Amador Causeway indicate that the port facilities at Site PS-0 would not intrude significantly on the vista from this important public access area.

Proximity to Howard AFB.

As can be seen in Figure 13-4, almost all of Site PS-0 is beneath the outer corridors of the Obstacle Free Zone (OFZ) of the former Howard AFB main runway, but below the

vertical “air drafts” of the OFZ. The berths and container cranes are outside the OFZ and vertical clearances required under FAA advisory circulars for airport planning and operation are met with this option. As a maritime related development, the occasional passage of aircraft over the western edge of the island is not considered to be a major problem, in the event that the runway is re-activated at sometime in the future.

Cost Estimate

Cost estimates are presented for the base construction cost of a maritime based artificial island at the location under discussion. For the purposes of this initial site selection exercise, it has been assumed that then transportation costs of material from the Locks to each island site are the same for all alternatives and are not therefore relevant to the site selection analysis. Consequently, the cost estimate presents the following cost components of each of the island alternatives:

- Rubble Mound Access Causeway sized for Maritime Island Development
- Shoreline Breach of 200 m (Open piled trestle structure)
- Mid Causeway breach for passage of small craft if water depth exceeds 5.0 m MLLW
- Breach in causeway at island of 100 m (open piled trestle)
- Construction of rectangular shaped island to an elevation of 3.00 m above MHHW
- Wave protection structures and slope protection
- Dredged channel to berth areas, assuming initial channel width of 250 m, potential future depth 18.5 m, initial depth 16.75 m including tolerances etc.

The combined island construction costs for Site PS-0 are presented in Table 13-6, below.

Table 13-6: Combined Maritime Island Construction Costs - Site PS-0

Description	Estimated Cost (US$ 2004)
Transportation Costs	
Transportation to Island Site @ $4.83/m3 (note 1)	**$435,448,650**
Construction Costs	
Island Revetment	$14,691,000
Causeway Armor	$13,000,000
Causeway Bridge Approaches	$11,700,000
Shoreline Trestle	$8,492,000
Fishing Boat Bridge	$6,098,000
Trestle at Island connection	$6,369,000
Offshore Breakwater	$86,667,000
Total Construction Costs	**$147,017,000**
Dredging Costs	
Dredging in Soft Material	$16,492,600
Dredging in Weathered Rock (note 2)	$7,603,680
Dredging in Dense Rock	$17,049,000
Total Dredging Costs	**$41,145,280**
Sub Total	**$623,610,930**
Contingencies on construction at 20%	$37,632,456
Estimated Cost of Transport & Island Construction	**$661,243,386**

Note 1 – For the purposes of this initial site selection evaluation, transport costs for materials are considered to be similar for all alternatives at $4.83 per m3.

Note 2 - Costs do not include infrastructure or facilities development.

13.8.3 Site PS-1

Project Description

The location of Site PS-1 shown in Figure 13-4 is a development of alternative PS-0. However, the orientation of the berths has been changed to an east-west alignment to provide better protection against long period wave motion and eliminate the offshore breakwater. The island is located immediately due east of the flight path into Howard Air Force Base, and west of the explosive cargo anchorage area. Based on the access corridor cost comparison presented in Section 13.3, access to the island is via a rubble mound causeway-trestle combination 3.85 km in total length originating at the eastern limit of Veracruz beach. The nearshore section will be an open piled trestle about 200 meters long designed to allow movement of littoral material along the shoreline and

passage for marine life. At approximately the mid point of the causeway, and in sufficient water depth to permit the passage of small fishing vessels, a bridge about 50-meters long will be placed. A second breach approximately 100 m in length is also included at the causeway connection point on the island.

The island has a constructed area of approximately 402 Ha.

Wave Protection

Based on the wave analyses presented in Volume 1, there are concerns regarding long period wave effects on the container berths, and these are discussed later in this report. However, for the purposes of the site selection study, the island is located with the berths in an approximate east west alignment on the inshore face of the island to provide improved protection to the ship working area. At this feasibility level of analysis, it cannot be said with absolute confidence that this configuration will offer adequate protection against long period wave action, and the implementation of a detailed ship motion study would be a necessary and extremely important element of the next level of assessment of this option. However, a major advantage of this configuration is the expectation that the construction of an offshore breakwater can be avoided, thereby representing a significant cost saving on the project.

Sand Concessions

According to records maintained by the Panama Maritime Authority (AMP), concessions have been granted, but not finalized for the extraction of sand at two locations in the general project area, as shown in Figure 13-4. The south eastern section of the island would impinge on the western parcel of the concession areas. At this time, the details and duration of the concession is not known, and it may be possible to work with the concessionaire to remove material from the impacted area prior to commencement of work on the dredged channel. However, it is clear that adjustments may be required to the concession area or to the island location to respond to the potential conflict between the two projects.

Navigation Channel Dredging

Dredging costs for site PS-1 are estimated to be $136 million, with 40% of the total volume being in weathered or dense rock material. It is important to also note that the initial dredging computations reflect a project depth of 16.75 m. Future increases in vessel size could necessitate additional dredging to a depth of 18.5 m, all of which would be in dense rock.

ACP Anchorages & Spoil Dump Sites

SitePS-1 is clear of the ACP spoil site but the navigation channel to the island would cross the dump area. This would probably require a special cost item in the dredging

contract since it is understood that a considerable amount of concrete debris has been dumped in this area[19].

Visual Impact

Site PS-1 probably the least intrusive of all the alternatives in terms of visual impact. The strongest visual impact will be from Veracuz Beach and also from the north shore of Taboga Island. In the event that the proposed resort hotel is constructed at Kobbe beach, the view of the working areas and container cranes is not likely to be welcomed.

Site PS-1 is located some 9.0 km from the Amador Causeway. Hence the visual impact of the port from the Causeway is likely to be similar to that of Site PS-0, except that the container cranes and vessels would be less visible, due to the re-orientation of the berths.

Proximity to Howard AFB.

As can be seen in Figure 13-4, approximately 50 percent of Site PS-1 is beneath the Obstacle Free Zone of the former Howard AFB main runway. However, vertical clearances required under FAA advisory circulars for airport planning and operation are met with this option. As a maritime related development, the occasional passage of aircraft over the western edge of the island is not considered to be a major problem, in the event that the runway is re-activated at sometime in the future.

Cost Estimate

The combined transportation and island construction costs for Site PS-1 are presented in Table 13-7, below.

[19] The geophysical survey and side scan work undertaken in January 2003 reveals the extent and elevation of apparent deposits of concrete beams and material in the Spoil Ground area.

Table 13-7: Combined Maritime Island Construction Costs - Site PS-1

Description	Estimated Cost (US$ 2004)
Transportation Costs	
Transportation to Island Site @ $4.83/m3	**$435,448,650**
Construction Costs	
Island Revetment	$15,075,000
Causeway Armor	$10,800,000
Causeway Bridge Approaches	$11,700,000
Shoreline Trestle	$8,492,000
Fishing Boat Bridge	$6,098,000
Trestle at Island connection	$6,369,000
Total Construction Costs	**$58,534,000**
Dredging Costs	
Dredging in Soft Material	$20,208,000
Dredging in Weathered Rock (note 2)	$29,713,800
Dredging in Dense Rock	$86,063,750
Total Dredging Costs	**$135,985,550**
Totals	**$629,968,200**
Contingencies on construction at 20%	$38,903,910
Estimated Cost of Transport & Island Construction	**$668,872,110**

13.8.4 Site PS-2

Project Description

Site PS-2 moves the island eastwards and slightly inshore, with the intention of reducing the length and costs of the dredge channel. The generated area of the island at this location is computed to be 378 ha, with a causeway length of 4.45 km. The connection to land from the island could be taken from the same location as Site PS-1, or alternatively moved eastwards to the area of Palo Seco, subject to an analysis of the hydrodynamic impacts on Kobbe Beach.

Wave Protection

As for Site PS-1, the berths would be well protected from direct wave action, but long period waves should be investigated before a commitment is made to this option.

Sand Concessions

The eastern Sand concession area falls within the island limits and also impacts the navigation channel. Selection of site PS-2 would therefore involve negotiations with AMP and the concession holders.

Navigation Channel Dredging

Dredging costs for site PS-2 are estimated to be $111 million, with approximately 75% of the total volume being soft material.

ACP Anchorages & Spoil Ground

The access channel to Site PS-2 crosses the southern limit of the Pacific Anchorage, west of the Canal, as shown earlier in Figure 13-4. However, this is not expected to be a serious impediment to the project as few vessels normally anchor in the area of the potential conflict. The island and part of the access channel is located above the designated ACP spoil ground and removal of some of the concrete debris should be anticipated within the dredging works. This debris could probably be dumped within the body of the island relatively easily.

Visual Impact

Although some 1.5 km closer, there is little difference between the visual impacts of Sites PS-1 and PS-2 from the Amador Causeway. However, the island would have a significant visual impact when viewed from Kobbe Beach and also from the north slopes of Taboga Island. Impacts from Veracruz and Veracruz beach areas are less severe than for site PS-1.

Cost Estimate

The combined island construction costs for Site PS-2 are presented in Table 13-8, below.

Table 13-8: Combined Maritime Island Construction Costs - Site PS-2

Description	Estimated Cost (US$ 2004)
Transportation Costs	
Transportation to Island Site @ $4.83/m3	**$435,448,650**
Construction Costs	
Island Revetment	$14,685,000
Causeway Armor	$14,140,000
Causeway Bridge Approaches	$11,700,000
Shoreline Trestle	$8,492,000
Fishing Boat Bridge	$6,098,000
Trestle at Island connection	$6,369,000
Total Construction Costs	**$61,484,000**
Dredging Costs	
Dredging in Soft Material	$16,952,600
Dredging in Weathered Rock (note 2)	$25,194,000
Dredging in Dense Rock	$69,002,500
Total Dredging Costs	**$111,149,100**
Totals	**$608,081,750**
Contingencies construction at 20%	$34,526,620
Estimated Cost of Transport & Island Construction	**$642,608,370**

13.8.5 Site PS-3

Project Description

Site PS-3 moves the island eastwards and slightly inshore, reducing the length and costs of the dredge channel. The generated area of the island at this location is 378 ha, with a causeway length of 4.6 km. The connection to land from the island is moved eastwards to the area of Palo Seco.

Wave Protection

As for Site PS-2, the berths would be well protected from direct wave action, but long period waves should be investigated before a commitment is made to this option.

Sand Concessions

The eastern Sand concession area falls within the island limits and also impacts the navigation channel. Selection of site PS-3 would therefore involve negotiations with AMP and the concession holders.

Navigation Channel Dredging

Dredging costs for site PS-3 are estimated to be $66 million, with approximately 75% of the total volume being soft material.

ACP Anchorages & Spoil Ground

The access channel to Site PS-3 crosses the southern limit of the Pacific Anchorage, west of the Canal, as shown earlier in Figure 13-4. However, this is not expected to be a serious impediment to the project as few vessels normally anchor in the area of the potential conflict. The island and part of the access channel is located above the designated ACP spoil ground and removal of some of the concrete debris should be anticipated within the dredging works.

Visual Impact

There is little difference between the visual impacts of Sites PS-2 and PS-3 from the Amador Causeway. However, the island would have a significant visual impact when viewed from Kobbe Beach and also from the north slopes of Taboga Island. Impacts from Veracruz and Veracruz beach areas are less severe than for site PS-1 and PS-2.

Cost Estimate

The combined island construction costs for Site PS-3 are presented in Table 13-9, below.

Table 13-9: Combined Maritime Island Construction Costs - Site PS-3

Description	Estimated Cost (US$ 2004)
Transportation Costs	
Transportation to Island Site	**$435,448,650**
Construction Costs	
Island Revetment	$14,550,000
Causeway Armor	$14,260,000
Causeway Bridge Approaches	$11,700,000
Shoreline Trestle	$8,492,000
Fishing Boat Bridge	$6,098,000
Trestle at Island connection	$6,369,000
Total Construction Costs	**$61,469,000**
Dredging Costs	
Dredging in Soft Material	$13,742,700
Dredging in Weathered Rock (note 2)	$13,035,000
Dredging in Dense Rock	$38,812,500
Total Dredging Costs	**$65,590,200**
Totals	**$562,507,850**
Contingencies on construction costs at 20%	$25,411,840
Estimated Cost of Transport & Island Construction	**$587,919,690**

13.8.6 Site PS-4

Project Description

Site PS-4 rotates option PS-3 to provide better wave protection to the main berthing area. The generated area of the island is 364 ha, with a causeway length of 4.45 km. The connection to land from the island is at Palo Seco, close to the Long Stay Hospital.

Wave Protection

As for Site PS-3, the berths would be well protected from direct wave action, but long period waves should be investigated before a commitment is made to this option.

Sand Concessions

The eastern Sand concession area falls within the island limits and also impacts the navigation channel. Selection of site PS-4 would therefore involve negotiations with AMP and the concession holders.

Navigation Channel Dredging

Dredging costs for site PS-4 are estimated to be $55 million, with approximately 75% of the total volume being soft material.

ACP Anchorages & Spoil Ground

The access channel to Site PS-4 crosses the Pacific Anchorage. This would require relocation or displacement of approximately 30 % of the capacity of the anchorage. The island and part of the access channel is located above the designated ACP spoil ground and removal of some of the concrete debris should be anticipated within the dredging works.

Visual Impact

There is little difference between the visual impacts of Sites PS-3 and PS-4 from the any of the view point locations identified earlier in this section

Cost Estimate

The combined island construction costs for Site PS-4 are presented in Table 13-10, below.

Table 13-10: Combined Maritime Island Construction Costs - Site PS-4

Description	Estimated Cost (US$ 2004)
Transportation Costs	
	$435,448,650
Construction Costs	
Island Revetment	$14,524,500
Causeway Armor	$13,528,000
Causeway Bridge Approaches	$11,700,000
Shoreline Trestle	$8,492,000
Fishing Boat Bridge	$6,098,000
Trestle at Island connection	$6,369,000
Total Construction Costs	**$60,711,500**
Dredging Costs	
Dredging in Soft Material	$12,258,520
Dredging in Weathered Rock (note 2)	$10,913,280
Dredging in Dense Rock	$31,935,000
Total Dredging Costs	**$55,106,800**
Totals	**$551,266,950**
Contingencies on construction costs at 20%	$23,163,660
Estimated Cost of Transport & Island Construction	**$574,430,610**

13.8.7 Site PS-5

Project Description

Site PS-5 moves the island as close to the Canal as possible, in an attempt to minimize the cost of the navigation channel. The generated area of the island at Site PS-5 is computed to be 386 ha. Connection to the shore side would be to the Palo Seco area via a 3.3 km causeway, which is the shortest of all the alternatives considered for the maritime development option.

Wave Protection

Site PS-5 is probably the best protected area for container operations, since it is well protected from all directions except the east, where wave heights are minimal.

Sand Concessions

Site PS-5 is clear of the Sand concession areas.

Navigation Channel Dredging

Dredging costs for site PS-5 are estimated to be $24.8 million, with approximately 90% of the total volume being soft material.

ACP Anchorages & Spoil Grounds

This alternative sits within the ACP spoil grounds and also falls within the designated Explosives Anchorage. The location of the navigation channel to Site PS-5 is such that relocation of the Explosives Anchorage would be a necessary component of this alternative.

Visual Impact

The construction of the maritime development island at Site PS-5 would have a high visual impact on the Amador area as it would sit in the center of the view westwards from the Causeway. Impacts from Kobbe beach would be less severe and the island would be well hidden from the Veracruz Community and beach areas.

Cost Estimate

The combined island construction costs for Site PS-5 are presented in Table 13-11, below. From the table, it is clear that PS-5 is the most cost effective of the three alternatives, mainly because of the relatively low dredging costs ($24.8 million). At an estimated cost of $533 million (for the transportation, island construction and dredged channel), it is almost $140 million less expensive than Site PS-1 and some $95 million less costly than alternative PS-0 presented in the Preliminary Island Study report.

Table 13-11: Combined Maritime Island Construction Costs - Site PS-5

Description	Estimated Cost (US$ 2004)
Transportation Costs	
Transportation to Island Site	**$435,448,650**
Construction Costs	
Island Revetment	$14,079,000
Causeway Armor	$9,942,000
Causeway Bridge Approaches	$11,700,000
Shoreline Trestle	$8,492,000
Fishing Boat Bridge	$6,098,000
Trestle at Island connection	$6,369,000
Total Construction Costs	**$56,680,000**
Dredging Costs	
Dredging in Soft Material	$13,319,700
Dredging in Weathered Rock (note 2)	$6,208,200
Dredging in Dense Rock	$5,255,000
Total Dredging Costs	**$24,782,900**
Totals	**$516,911,550**
Contingencies on construction costs at 20%	$16,292,580
Estimated Cost of Transport & Island Construction	**$533,204,130**

13.8.8 Comparison of Construction Costs - Maritime Development Island

The major variable in the cost of construction of the maritime island at each location alternative is clearly the cost of the navigation channel to the marine terminals. Dredging costs for the initial dredging of the navigation channel to a depth of 16.75 m and a width of 250 m vary from $136 million closest to the former Howard AFB to $25 million for the easternmost site located approximately 1.5 km from the Pacific Entrance Channel to the Canal. The major variable in the cost of dredging for the alternatives relates to the need to remove significant quantities of rock to achieve the design depth. This also indicates that future dredging will be entirely in rock, with consequent higher costs for the locations having the longer navigation channel lengths.

From this initial cost assessment, locations closest to the Panama Canal are then the most favored from a cost standpoint, assuming always that the island will be used for maritime related development. In order to simplify the next level of analysis of the location study, sites PS-2 and PS-4 are dropped from further consideration since sites PS-1, PS-3, PS-5 and site PS-0 characterize the range of options sufficiently well.

13.9 Preferred Location for Maritime Development Island

Based on the assessment presented in this section, there is no single alternative that is clearly preferred for the maritime development island project. In pure cost terms, location PS-5 is the most economic, by a factor of almost 20% or $112 million, when compared to location PS-0 at $661 million. However, Site PS-5 is very close to the Amador Causeway and would undoubtedly have a significant impact on the views from this very popular location. A second issue would be the potential for excessive ship motion at the berth faces from the wake of vessels entering and leaving the Canal Pacific Entrance Channel. Finally, the construction of an artificial island at site PS-5 would require the displacement of the Explosives Anchorage, and it is not clear at this time where the facility would be relocated.

Site PS-3 falls midway between the extremes in terms of cost and visual impacts. However the causeway connection to the island would be close to Kobbe beach and the island is located in the area of one of the two sand concessions assigned to a private company.

Sites PS-0 and PS-1 are the most expensive of the three sites to develop, but also have the least potential visual impact. The issue of proximity to the runway Obstacle Free Zone must also be taken into account for both alternatives, but is not a fatal flaw.

Selection of the most cost effective site would indicate a clear preference for Site PS-5, but there are severe concerns that this option would create significant opposition from special interest groups and the public in general. Site PS-0 or PS-1 are likely to be much less controversial, but the additional cost burden may damage financial viability.

Site PS-3 represents a middle ground in the analysis. It is mid way between the cost extremes, mid way in visual impacts and avoids the Howard AFB Obstacle Free Zone. With some minor adjustments to refine the requirements for dredging in hard materials, it could well represent an acceptable compromise for the maritime development option for the Island.

The comments on the expected visual impact of the maritime related development at each location represent the consultant's opinion of likely reaction to the project and are not based on any formal discussions with interested parties or public action groups. However, in the final analysis, public reaction to the project will probably be the major factor in the selection or rejection of the final location for maritime related development and it is not possible in this feasibility study to make a recommendation on the preferred alternative.

14 MULTI USE DEVELOPMENT

As can be seen from the foregoing sections, there are a number of concerns that could arise from a proposal to use the artificial island for maritime development purposes. The three primary areas of concern are:

- Public Reaction based on visual impact of the island and facilities
- Operational concerns posed by potential incidence of long period waves
- Financial viability of the location most likely to be acceptable to the public.

Unfortunately, there is little that can be done to improve the appearance of a container terminal. It is essentially a flat, rectangular structure, with large cranes reaching some 75 m above the deck level. Any departure from the basic dimensions of the terminal can lead to serious deficiencies in operational productivity and detract from the financial viability of the facility.

On the other hand, there are a number of advantages associated with the use of the island for non commercial maritime development. Location is not a major factor in the cost of the island since it does not require a deep draft navigation channel. Land access requirements are less stringent and the shape and profile of the island can be adjusted to match the surrounding landscape and features.

Finally, the multi-use concept by its nature will provide public access to the island, which could contain parks, beaches, recreation areas, restaurants etc, all of which would enhance its acceptance by the local communities.

14.1 Development Concept

Ideally, the development of the space created by the Multi-use island concept would be determined by a private sector developer, in similar fashion to the Punta Pacifica development now being undertaken in the Paitilla area of Panama City. ACP would move material to the island and format the fill to the approximate shapes agreed as part of the permitting process. ACP would invite proposals from the private sector for development of the island, which would involve a fee payment or lease arrangement for the land generated by the project. The proposed level of private investment in public access areas could play an important part in the selection of the developer for the project

The selected developer would then prepare a Master Plan to meet agency, ACP and community approval, building and marketing the island according to its own program.

Clearly this approach would lead to a variety of development proposals for the island, and anything presented in this report can only give a general indication of what might be possible. However, in order to provide a basis for evaluation of the option, tentative suggestions are presented in this report to give an indication of how the island might look and what type of development might be accommodated within the land created by the excavated material.

14.1.1 Location Options

As noted earlier, location of the multi use island is not a critical issue from a cost standpoint, and the following criteria can be used to determine the ideal location.

- The land connection should link to the most economic transportation system
- Visual Impact on local communities should be minimized
- The location of the island in shallow water will increase the useful area of land created.
- Short distances from land to the island will reduce causeway or trestle costs
- Environmentally sensitive areas should be avoided.

Based on these criteria, there are essential two basic locations for the multi-use island. It can be to the west as shown in Figure 14-1, where it would have the least impact on the views from the Amador Causeway or Taboga. Assuming that the island would be profiled with a maximum elevation of some 15 – 20 m above MHHW, it is estimated that approximately 350 to 400 ha of land would be generated by the excavation material at this location. Causeway length would be on the order of 2.0 to 2.5 km, depending on the island configuration.

However, the western half of the island is under the Howard AFB Obstacle Free Zone. While the future of the former air base is still not clear, there are possibilities that the area could be used for air cargo distribution centers, aircraft maintenance or as a pilot training center. Proposals have also been floated to move the Albrook General Aviation facilities to Howard.

Under any of these options, the arrival and departure of large or small aircraft over the multi use island would be a highly negative element that would seriously detract from the value of the properties and the willingness of the community to invest in the development. It is therefore critical that a definite decision be taken on the future of the Howard base before this location could be selected.

Figure 14-1: West Location for Multi-use island

Figure 14-2 shows an alternative location for the island on the east of the study area. This location would avoid the potential concerns related to the Howard AFB OFZ, but the places the island firmly in view of the Amador Causeway. Given that the multi-use will have a much more attractive appearance than the maritime development option, this may or may not be a concern to the public and the investors in the Amador projects.

However, the location and height of the island at this location will have a definite impact on the views from the Causeway and public reaction must be tested before any decision can be taken on this option.

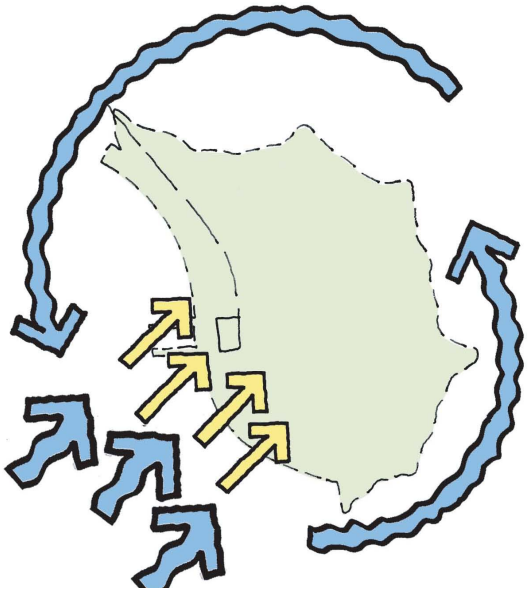
Figure 14-2: East Location for Multi - Use Island

14.1.2 Island Development Framework

This project offers the opportunity to provide a world class development in a beautiful environment. The shape of the island and the interrelationship between all of the development elements is then critical to the overall success of the venture. At this conceptual planning level, the following driving forces are considered to be important.

Island Shape

The multi-use island should blend with the natural beauty of the area. The most dominant features in this study area are the islands surrounding the project site. The shape and general profile of the artificial island should then be in harmony with the islands of Taboga, Taboguilla, Venado, Tortola and Tortolita.



Wind and waves from the southwest provide a generative force that influence the form of the island. The island's initial contact with the waves requires a structured edge which is articulated in form of sweeping arcs. As the waves swirl around the island towards the east, the edge transitions into a ragged composition of peninsulas and coves.

Figure 14-3 shows the approximate shape and general contours of an island considered to meet the objectives set out above.

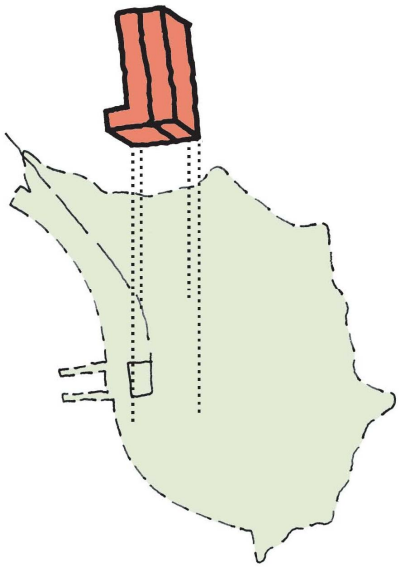
Figure 14-3: Suggested shape and Profile of the Multi-Use Island

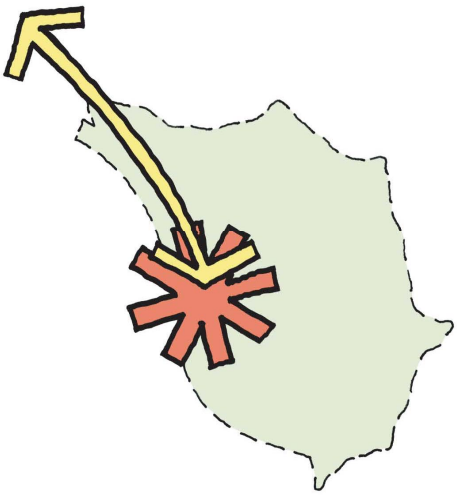
Development Concept

Within the space generated and shaped as note above, the following design elements are considered to be central to the attractiveness of the development;

Arrival on the island

After crossing the causeway, one drives along a tree-lined boulevard which leads directly to the town square. The square is developed in the local tradition of parks and provides a space for visitor recreation and large civic gatherings.



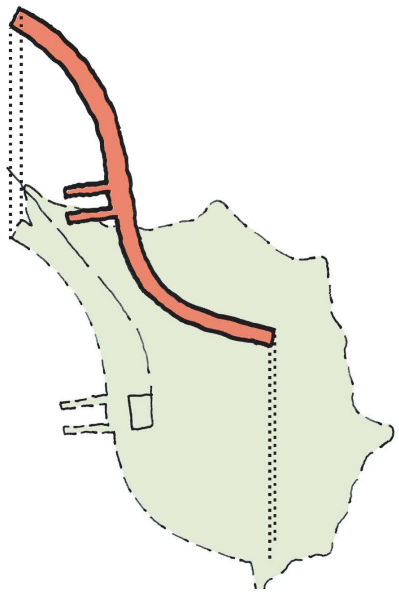


Commercial Core

Surrounding the town square is the commercial core which creates a town center for the island. The core provides local and visitor services and generates activity around the square. A secondary Main Street is found in the center of the core with shops, restaurants, and other amenities. Commercial office space is provided above the retail space and located in areas off Main Street.

Waterfront Promenade

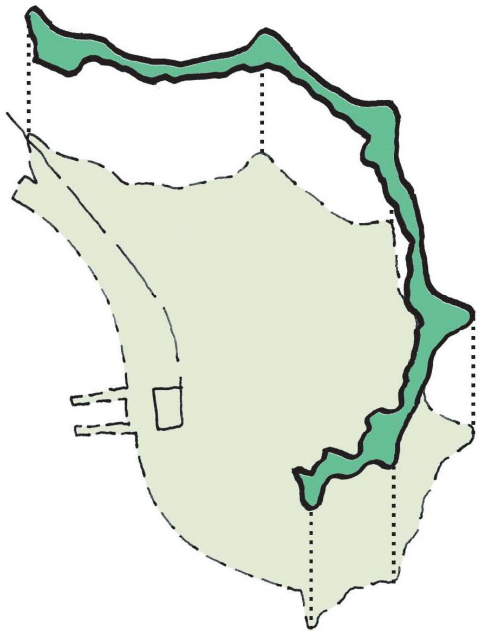
On the western edge of the island, a waterfront promenade structures the island. Hotels and resorts follow a gentle arc around a long stretch of beach facing the Gulf.



Continuing along the promenade toward the south, apartment buildings form another arc, offering views in multiple directions towards the Gulf. Centrally located to the promenade is a marina which provides additional vitality to the urban core.

Residential developments

The island is designed with the least developed areas on the eastern edge with the waterfront park, gradually progressing with more development as one moves west to the resorts and promenade edge. More developed areas share a relationship with the open sea, while less developed areas are engaged with views to and from the urban development of Panama City and the islands along the Amador Causeway. Residential areas are set at the highpoint of the island to provide opportunities for views to the sea and to take advantage of the sea breezes.



Waterfront park and golf course

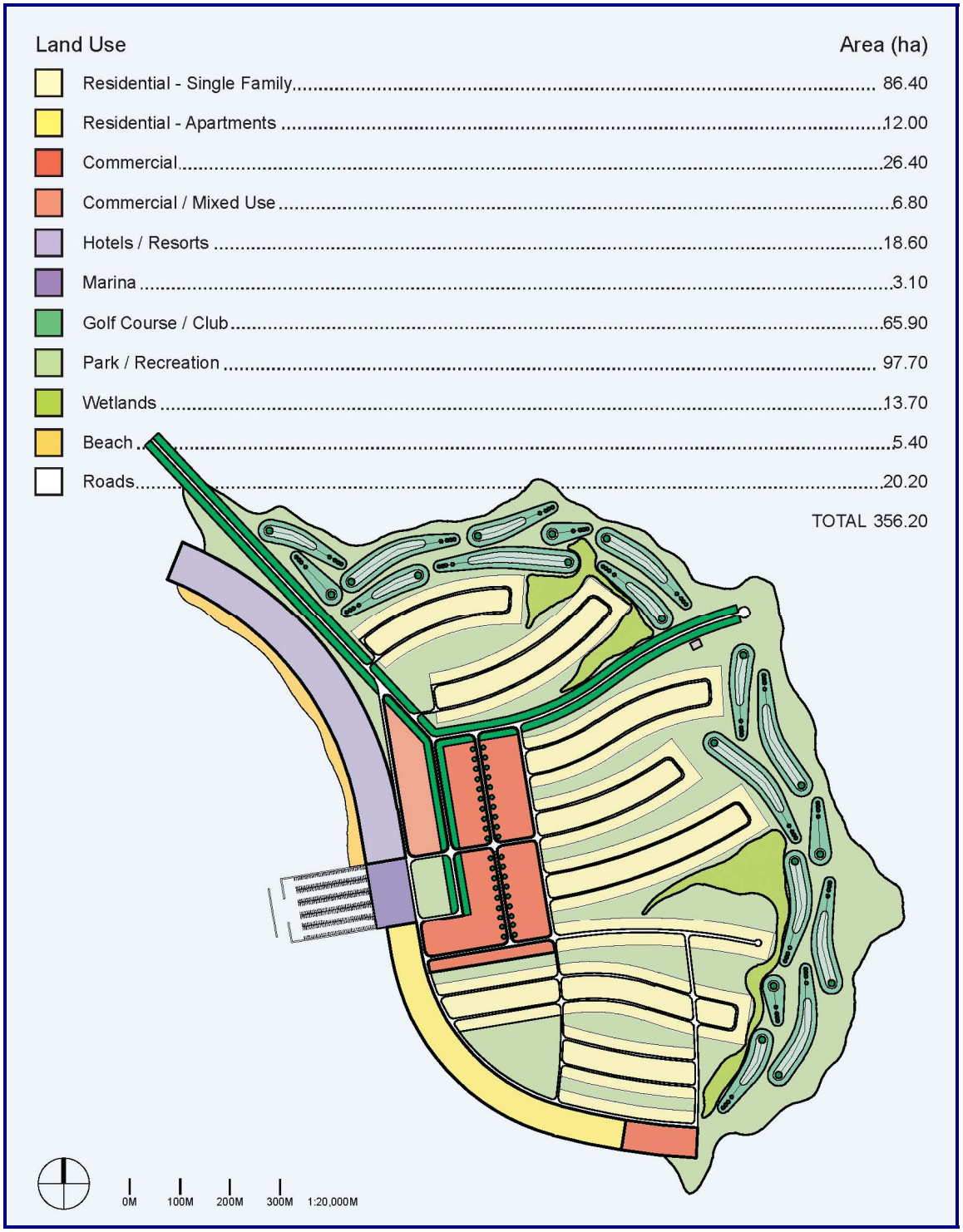
Fingers of parkland offer opportunity for recreation as well as a place for storm drainage collection and cleansing. This intricate landscape system of park, storm drainage, and wetlands forms a framework for the residential development. This framework creates a sustainable environment befitting the residents of an island.

A tree-lined avenue branches from the main boulevard, leading to the eastern edge of the island. Along the avenue, one finds the golf course which wraps around

the residential development. The 18-hole course has a lush and diverse landscape and offers views to Panama City. Beyond the golf course, lies a waterfront park which sits above the sea, framing the island as well as buttressing the land from the waves. The park connects with the waterfront promenade providing continuous public recreation and access along the entire perimeter of the island.

Using these planning philosophies, a conceptual layout for the multi-use island is shown in Figure 14-4.

Figure 14-4: Conceptual Layout of Multi-Use Development



14.1.3 Landside Access

As noted earlier, the length of the land connection for the multi use island is much shorter than the maritime development option, since it is possible to construct the island in much shallower water without severe cost penalties. Access demands are also less stringent than the commercial maritime development since traffic volumes would be much lower and the permanent rail connection offers no value to the development.

Given the concerns over water circulation presented earlier in this document, an evaluation of the comparative costs of an open piled trestle and a rubble mound causeway was warranted.

Figure 14-5 and Figure 14-6 show typical sections for an open piled trestle and rubble mound causeway to provide land access to the multi-use island. The width of the access is reduced to 21.4 m and design loadings for the trestle are less stringent than those that would be assigned to the maritime development structure.

Figure 14-5: Typical Section of Open Piled Trestle Sections for Multi-Use Island

Figure 14-6: Typical Section of Rubble Mound Causeway for Multi-Use Island

Cost Comparison

The 21-m wide structure shown in Figure 14-5 will consist of a 3-lane roadway and a dual use path supported by 4-pile bents spaced at 10 m on center. From Table 14-1, it can be seen that the total cost of the structure is $42.70 million. However, it should be noted that the cost of the trestle could be absorbed by the island developer once filling is complete, since the transport contractor would probably opt to build a temporary causeway from excavated material in order to construct the island. This would be quicker and cheaper to build than the piled structure, and there would be no concerns over damage after five years of passage of the high capacity dump trucks and heavy construction equipment. On completion of the island fill, the temporary causeway would be removed and the material placed on the island.

Table 14-1: Estimated Cost of Open Piled Trestle to Multi Use Island

Item	Cost
Piles	**$8,990,460**
HP 14x117 Piles	$1,737,890
Load Test	$40,640
PDA Dynamic Test	$42,875
Pile Cutoff	$66,517
Drill & Socket Piles	$7,102,538
Deck	**$26,563,796**
CIP Concrete Topping	$5,168,948
Concrete Closure Slab	$2,044,651
CIP Concrete Bent Caps	$5,423,158
P/C P/S Panels	$13,000,778
Barrier Rails	$589,991
Traffic Divider	$336,270
TOTAL	**$35,554,256**
Contingencies at 20%	**$7,110,851**
Estimated Cost of Trestle	***$42,665,107***

From Table 14-2 it is seen that the cost of the rubble mound causeway with breaches is $13.97 million, significantly less than the cost of the open piled trestle, primarily due to the fact that the fill material for the main sections of the causeway is supplied at no cost. However, the difference in overall cost is not considered to be a fatal flaw in the event that objections are raised to the use of the rubble mound structure.

Table 14-2: Estimated Cost of Rubble Mound Causeway to Multi Use Island

Description	Cost
Rubble mound causeway	$6,086,000
200 m trestle at shoreline	$3,702,200
100 m trestle at Island	$1,851,100
TOTAL	**$11,639,300**
Contingencies at 20%	$2,327,860
Cost of Causeway with breaches	**$13,967,160**

14.1.4 Infrastructure

Given the myriad of potential development options that could be used for the multi-use island, it is not possible or practical to attempt to forecast utility needs beyond a simple listing or required services.

These are expected to include:

- Electrical power
- Cable communication
- Potable water
- Fire fighting water system
- Sewage handling
- Natural gas supply if available

Utilities would be delivered to the island in dedicated utility trenches in the causeway/trestle access structures. Once on the island, utility distributions would follow standard distribution patterns following system regulations for private development in Panama. However, as a prestigious and new development, it is expected that all utilities would be placed underground.

14.2 Cost Estimates

A combined estimate for the transport and construction of the multi-use island is presented in Table 14-3. Since the costs of both the east and west option are essentially similar, this estimate can be taken to apply to all location alternatives. It should be noted that an allowance has been added for the removal of 1.0 to 2.0 m of soft material from the island footprint prior to filling, in order to reduce the potential settlement

of the filled structure. This may or may not be required for all island development options, but should be included in the potential costs of the island alternatives until such time that the detailed geotechnical analyses indicate otherwise. Settlement of the No Development option is not critical and this item is not included in the cost estimates for this alternative.

Table 14-3: Cost Estimate - Multi-Use Development Option

Description	Estimated Cost (US$ 2004)
Transportation Costs	$435,448,650
Construction Costs	
Island Revetment	$7,525,000
Rubble mound causeway	$6,086,000
Trestle at shoreline	$3,702,200
Trestle at Island	$1,851,100
Dredging Costs	
Dredging in Soft Material	$6,129,260
Totals	**$460,742,210**
Contingencies on construction costs at 20%	$5,058,712
Estimated Cost of Transport & Island Construction	**$465,800,922**

14.3 Conclusions

The additional costs of construction of the multi use island are relatively modest at approximately 5% of the transport cost of the material. These costs might be reduced further if the private developer was required to build the causeway breaches once filling of the island was completed. Savings might also be effected on the wave protection elements if the final shoreline protection work was incorporated into the developer's work program.

Clearly the multi-use option poses fewer aesthetic and cost challenges than the maritime development option. It also offers greater flexibility in location, shape and final size which then permits consideration of many options for its final size, location and development configuration.

14.4 Hybrid Alternative

As can be seen from the foregoing discussions, the following issues have been identified relative to the maritime development and multi use island concepts.

- The least cost maritime island is closest to the Panama Canal Pacific Entrance
- This location has a severe visual impact on the Amador Causeway
- The west location for the multi-use option has the least visual impact
- This proximity of the west location to the former Howard AFB aircraft arrival and departure patterns is a potentially serious concern
- The west location for the multi use island has a visual impact on the Amador Causeway, which may or may not generate public opposition to the project
- Locations for either island in front of Kobbe beach and close to Punta Bruja are likely to generate significant opposition.

One of the marine disposal options tested as part of the Pacific Side Disposal Alternatives Study was the construction of a peninsular in the Palo Seco area. Long term development could be either maritime or multi use, as indicated in Figure 14-7. While there were concerns over the habitat and ecological values of the on-shore areas and shoreline, the environmental impact of the alternative was not considered to be a fatal flaw in the proposal. The layout presented in Figure 14-8 then addresses these concerns by providing separation of the maritime development from the mainland.

The fundamental criteria used to determine the configuration of this option was that the marine terminal or multi-use development should only extend to a point where the views from the Amador Causeway were not obstructed. Unfortunately, the shallow water in the area indicated that the peninsular option would only hold 32.4 million m3 of material, which was insufficient to meet the full project requirements.

However, there may be significant cost savings on the project if the multi use island concept was moved to the area of the peninsular and incorporated with a maritime development at the Palo Seco location.

Figure 14-9 shows a tentative location for the hybrid development, which could possibly fulfill the requirements of the excavation project needs and provide maritime, commercial and residential type development opportunities.

Figure 14-7: Maritime or Multi Use island Concepts for Palo Seco area

Show both drawings from Disposal Study here on the same page

(Figures 8-8 and 8-9)

Figure 14-8: Modified Maritime Development Concept at Palo Seco

Figure 14-9: Hybrid Maritime-Mixed Use Development Concept at Palo Seco

15 PUBLIC PARK

15.1 Development Concept

While the Amador Causeway development has been extremely popular, the range of recreational activities offered to users of the area are somewhat restricted due to the configuration of the Causeway. However, some of those concerns may be addressed if the causeway is widened to approximately 250 m, as currently under discussion by ARI and other interested public agencies.

The artificial island project offers an opportunity to build a public access experience that would supplement and enhance the Amador development, such that the two areas would not be competing for the same clientele.

Amador is now well known for its restaurants, marinas, shopping arcades, hotels and the conference center, as well as the recreational areas for joggers and cyclists. It is therefore recommended that the commercial elements of the Amador development would be minimized at the island park, which could follow the example of the highly successful Stanley Park in Vancouver BC.

In this way, the island would offer the same recreational activities as Amador, but restaurants would be of a more rustic nature and the parks would be designed to enhance the family experience. The development of the island also offers the potential to create a series of pocket beaches that would enhance the public access areas, linked with a waterfront promenade that ringed the island shoreline.

Finally, the provision of a day marina for small craft, with a fishing pier, water taxi service and an overnight camping area would enhance the marine recreational facilities in the area and supplement the amenities provided at Taboga.

Figure 15-1 shows a development concept for the Public Park development option. One of the first things to note is that the island is in the same location and has the same shape as the mixed use option. This is intentional, in that the permitting for both options can then follow the same paths, with the final decision as to the permanent use of the island being then simply related to public acceptance and financial issues.

This also provides a fall back position for ACP in the event that developer interest was not forthcoming for the multi-use or maritime development island options.

Figure 15-1: Concept for Public Park Development Option

15.2 Cost Estimates

A combined estimate for the transport and construction of the public park development option is presented in Table 15-1. Note that the public access elements of the project are not included in the estimate, although it is unlikely that the private sector could be persuaded to provide more than modest investments in the commercial elements of the development. The costs of these elements of the project are presented later as part of the section addressing the main design features of the option. It should be noted that the revetment costs are higher for this option than the Multi-use island since larger lengths of the shoreline would be protected as part of the basic island development.

Table 15-1: Cost Estimate – Public Park Development Option

Description	Estimated Cost (US$ 2004)
Transportation Costs	**$435,448,650**
Construction Costs	
Island Revetment	$14,524,500
Rubble mound causeway	$6,086,000
Trestle at shoreline	$3,702,200
Trestle at Island	$1,851,100
Dredging Costs	
Dredging in Soft Material	$6,129,260
Totals	**$467,741,710**
Contingencies on construction costs at 20%	$6,458,612
Estimated Cost of Transport & Island Construction	**$474,200,322**

15.3 Conclusions

The costs of the basic construction of the public park option are the same as the multi-use alternative since the footprint and location of each of the islands is essentially the same. However, for the public park option, the public access elements of the project will need to be provided by the public sector or by ACP, since the funding of these facilities is unlikely to be of interest to the private sector. There is a possibility that central government could provide the funding for the parks and public access areas, but this cannot be assumed at this stage of the analysis.

The incremental costs of the park facilities can therefore be likened to a community benefit project, sponsored by ACP or one of the public agencies in Panama, in the event that this option was considered to be the preferred long term use for the artificial island.

As for the multi-use option, the public park concept poses fewer aesthetic and cost challenges than the maritime development option. It also offers greater flexibility in location, shape and final size which then permits many options for its final development configuration.

16 NO DEVELOPMENT OPTION

16.1 Concept

In the event that funding was not available for the public park option, and private sector interest in the multi use or maritime development concepts was not forthcoming, the island could be used a simple materials disposal site, but shaped to match the local surroundings.

It follows that the location and general shape of the island under this scenario would essentially be the same as the multi-use or public park concepts. In the event that a decision was made to proceed with the maritime use island and the project sponsors were unable to complete the project, it would be more difficult to restructure the island to blend in with its surroundings, due to the flat, rectangular nature of the port development complex.

As a no development option, this alternative would be left as an island, and any temporary access structure would be removed on completion of the fill work. This would then resolve any long term concerns over the impact of the island on the local current and sedimentation regimes.

16.2 Cost Estimates

The cost of transport and construction of the no-development option are presented in Table 16-1, below.

As can be seen from the estimate, this option represents the minimum cost alternative for the island and is then the most comparable option with the disposal options presented in the Disposal Options Report.

Table 16-1: Cost Estimate for No Development Option

Description	Estimated Cost (US$ 2004)
Transportation Costs	$435,448,650
Construction Costs	
Remove temporary Causeway	$750,000
Shoreline Protection	$7,262,250
Place overburden material over surface	$350,000
Totals	**$443,810,900**
Contingencies on construction costs at 20%	$1,672,450
Estimated Cost of Transport & Island Construction	**$445,483,350**

16.3 Summary of Alternatives Evaluation

The intention of this section has been to present an across the board evaluation of the cost of moving the material from the excavation to the island location and providing the basic elements that will permit development under each of the long term options examined.

Alternative locations, long term development options and the estimated costs of transport and construction for the artificial island were examined in order to provide an assessment of the likely costs to ACP, of the basic development of each of the options.

Consequently, the cost elements presented in this section only include those items considered to be directly related to the proposed long term use, such as causeway breaches, dredged channels for maritime use and shoreline protection. At this time, the report does not examine the requirements and costs of infrastructure or post construction developments, such as marine terminals, roads, utilities etc. These are discussed in detail in Section 10 of this report.

Table 16-2 presents the summarized transport and island construction costs for all of the alternatives analyzed in this section. Alternative location options that characterize the range of alternatives for the maritime island are reduced to three, from the original list of six, in order to simplify the comparison.

From the table it is seen that the lowest cost option having a potential for added value is likely to be the Multi-use island, primarily due to the reduced causeway length and costs and the elimination of the dredging costs when compared to the maritime options. It is also considered that the developer will build the final elements of the causeway, provide

its own shoreline treatment and re-grade the island, all of which would reduce the ACP elements of cost.

The no-development option offers the lowest overall costs, although it is essentially the same island as the Multi-use or Public Park option. The reduced costs in this case are primarily the result of the elimination of shoreside access once the island fill is completed.

It is important that no judgment be made as to the preferred island option at this stage. All alternatives except the no development option require additional infrastructure in order to support the proposed long term use, and these are compared with the potential added value for each scenario in subsequent sections of this report.

As also noted in the previous discussion on visual impacts, public reaction to the project may well be the determining factor in the selection of the preferred option, and at this feasibility level of study, no conclusions can be made in this respect at this time.

However, the analysis does provide a comparison of the island option against the UXO or other materials disposal sites proposed in the Disposal Options Report. According to Table 7-18 of the Disposal report, transportation costs for the UXO site are estimated to be $292 million, with site preparation and restoration costs estimated at $21.3 million if the entire site is used for fill. This then indicates a total cost of $313 million for materials disposal to the UXO sites, compared to the no-development island option at $445 million.

The difference between the two costs then represents the first element of the amount that must be recovered by added value, community benefits or economic benefits at the island site. The second element of cost in this assessment is the added investment required above the basic island construction, which included the provision of infrastructure, marine or other facilities and public access components of the island.

Table 16-2: Summary of Transport & Island Construction Costs - All Options

Description	Maritime Development Locations			(Multi Use) MS-1	Public Park (PP-1)	No-Dev (ND-1)
	PS-0 (Prelim Study)	PS-3	PS-5			
General Data						
Island Area (ha)	358.5	378.0	385.7	350.0	350.0	350.0
Causeway Length (m)	3,800	4,600	3,270	2,030	2,030	
Transportation Costs						
Transportation to Island Site	**$435,448,650**	**$435,448,650**	**$435,448,650**	**$435,448,650**	**$435,448,650**	**$435,448,650**
Construction Costs						
Island Revetment	$14,691,000	$14,550,000	$14,079,000	$7,525,000	$14,524,500	$7,262,250
Causeway & Armor	$13,000,000	$14,260,000	$9,942,000	$6,086,000	$6,086,000	
Causeway Bridge Approaches	$11,700,000	$11,700,000	$11,700,000			
Shoreline Trestle	$8,492,000	$8,492,000	$8,492,000	$3,702,200	$3,702,200	
Fishing Boat Bridge	$6,098,000	$6,098,000	$6,098,000			
Offshore Trestle	$6,369,000	$6,369,000	$6,369,000	$1,851,100	$1,851,100	
Breakwater	$86,667,000					
Remove Temporary Causeway						$1,100,000
Total Construction Costs	**$147,017,000**	**$61,469,000**	**$56,680,000**	**$19,164,300**	**$26,163,800**	**$8,362,250**
Dredging Costs						
Dredging in Soft Material	$16,492,600	$13,742,700	$13,319,700	$6,129,260	$6,129,260	
Dredging in Weathered Rock **	$7,603,680	$13,035,000	$6,208,200			
Dredging in Dense Rock	$17,049,000	$38,812,500	$5,255,000			
Total Dredging Costs	**$41,145,280**	**$65,590,200**	**$24,782,900**	**$6,129,260**	**$6,129,260**	
Sub Totals	**$623,610,930**	**$562,507,850**	**$516,911,550**	**$460,742,210**	**$467,741,710**	**$443,810,900**
Contingencies on construction	$37,632,456	$25,411,840	$16,292,580	$5,058,712	$6,458,612	$1,672,450
Transport & Island Construction	**$661,243,386**	**$587,919,690**	**$533,204,130**	**$465,800,922**	**$474,200,322**	**$445,483,350**
Equiv. Cost per m2 of Island	$184	$156	$138	$133	$135	$127
Equiv. Cost per m3 of material	$7.57	$6.73	$6.10	$5.33	$5.43	$5.10

17 ENVIRONMENTAL ASSESSMENT

17.1 Methodology

The assessment methodology presented in this section closely follows the approach used in the Disposal Options[20] study and also relies heavily on the data collected for the marine options addressed in that project.

Impact significance was assessed using ANAM's (Vicente Conesa Fernández – Vitora[21]) recommended methodology based on the preparation of a Significance Matrix using a multi criteria approach. Elements that constitute the matrix include the following:

- Sign (+/-)
- Degree of Perturbation (DP)
- Risk of occurrence (RO)
- Extension (EX)
- Duration (D)
- Reversibility (RV)

Sign (+/-): Impact sign refers to the beneficial or prejudicial character of the different Project actions on environmental elements.

Degree of Perturbation (DP): Refers to the degree of disturb the action causes over a particular environmental factor in the specific field of occurrence. It ranges between 1-12 where 12 correspond to a total destruction situation and 1 is a minimal effect.

Risk of Occurrence (RO): Refers to the frequency of the effect, whether cyclical or recurrent, unpredictable or constant along time. Continuous effects are assigned a value of 4, periodical is 2, and 1 to those of irregular or discontinuous occurrence.

Extension (EX): Refers to the theoretical area of influence of the impact related to the Project overall area (% of impacted area). If the action produces a spot effect, the impact is considered localized (1). If the impact has an influence over the project, it is considered total (8); intermediate situations correspond to partial impacts (2) and extensive impacts (4).

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[20] Pacific Side Excavation & Dredging Material Disposal Alternatives Evaluation, Moffatt & Nichol, March 2004 (Final Report)

[21] "Guía Metodológica para la Evaluación del Impacto Ambiental", 2nd. Ed. Madrid, 1995", by Vicente Conesa F.

Duration (D): Refers to the period until the affected environmental factor would return to the initial condition either by natural or corrective measures. If the effect lasts less than one year, it is considered that the action produces a short effect (1); between 1 and 10 years, it is considered permanent (4).

Reversibility (RV): Refers to the possibility of return to the initial conditions previous to the action by natural means. A short term is assigned a value of 1; mid term is 2, and irreversible effects are assigned a value of 4.

The significance of the impact (IS) results is then: IS = + / - (PD+RO+EX+D+RV)

For situations in which no significant impacts were identified, a nil condition (zero value) was adopted. Table 17-1 shows the Impact Significance Ranking system.

Table 17-1: Environmental Impact Significance Classifications

SIGN		**DEGREE OF PERTURBATION (DP)**	
Beneficial Impacts	+	Low	1
Negative Impacts	-	Medium	2
		High	4
		Very high	8
		Total	12
EXTENSION (EX)		**DURATION (D)**	
Spot	1	Brief	1
Partial	2	Temporary	2
Extensive	4	Permanent	4
Total	8		
Critical	12		
RISK OF OCCURRENCE (RO)		**IMPACT SIGNIFICANCE (IS)**	
Irregular or discontinued	1	The significance of the impact varies between 5 and 36. Scores between 29 and 36 are considered very high; high between 23 and 28; medium between 17 y 22; low between 11 and 16, and very low between 5 and 10.	
Periodical	2		
Continuous	4		
REVERSIBILITY (RV)			
Short term	1		
Middle term	2		
Long term	4		

17.2 Common Impacts

Many of the anticipated impacts of the island construction are common to all alternatives. In particular, the island footprint is essentially the same size for all alternatives and the sub bottom materials, water quality, sediment characteristics and habitat are relatively similar across all of the locations evaluated in this report.

To simplify the evaluation, these common elements of the impacts are addressed first, followed by a brief discussion related to each of the island options.

17.2.1 Characterization of Study Area

The general area for the Artificial Island stretches from the runway of the former Howard AFB to the edge of the Palo Seco peninsula close to the Pacific Entrance to the Panama Canal.

All these areas have been investigated in the past due to their rich mollusk communities. Among those studies Aviles (1975) and Aguila et al (1978) have studied the sandy-muddy bottoms of these areas and identified economically important bivalve species such as *Protothaca asperimma* and *Mytella guyanensis*.

Mangrove communities in the area of influence of the study area include those at Veracruz, Balboa, Farfan River, and some scattered populations around the Palo Seco/Farfan Peninsula.

D'Croz (D'Croz et al, 1994) and Gomez (Gomez et al, 2000) conducted studies in the vicinity of Melones Island, which is approximately 6 km south of the island study area and 2 km west of Howard AFB. Gomez indicated that near this island the zooplanktonic organisms showed increased densities which can be attributed to hydrographic conditions such as local eddies.

In fact, zooplankton samples taken during these studies showed the highest biomass in the area of the Artificial Island.

17.2.2 Water Quality

Panama Bay falls under the influence of northern winds that blow over the Isthmus with greater intensity during the dry season and induce water from the bottom of the sea to flow up to the surface (Kwiecinski & D´Croz, 1994). This season is characterized by its low water temperatures, elevated salinity, high concentration of nutrients, and strong reduction in clarity and reduced value in dissolved oxygen (Smayda, 1966; Forsbergh, 1969; D´Croz *et al*., 1991), as a result of great biological productivity (Kwiecinski *et al.*,

1975). In the rainy season, the drainage from the rivers and streams produces an increase in the water temperature, reducing the salinity and elevation of nitrates and silicates. (Kwiecinski & D´Croz, 1994).

East of the Pacific Entrance to the Canal, Panama Bay constitutes the most severe case of marine contamination in the country, due to the discharge of over 40 million tons of untreated sewage and storm waters per year. In some areas levels of fecal coliforms are 500 times higher than those established for water consumption and public recreation, and 50 times higher for the proliferation of wild life (D´Croz *et al*., 1991).

The waters west of the Canal entrance are much less contaminated since they are protected by Amador Causeway, which imposes an influence on the regional current regime. Outflow from the Canal also acts as a barrier between the two water bodies.

While it is not considered that any of the island development options will have significant negative impacts on water quality in the study area, the planning and design of the facilities should include self contained waste water treatment systems, pollution controls for berthed vessels, compliance with international (MARPOL) regulations on discharge of ballast waters and the partial treatment of storm water runoff from the marine and development zones.

17.2.3 Habitat Loss

Results from biological surveys conducted during the PSED2004 study showed that the area of the Artificial Island was among the most diverse sites in benthonic organism contents[22]. The Shannon's Index of diversity for this site was 2.888 within a range of 1.236 and 2.998. However, the density of organisms was not high (615 per m^2) when compared to coastal samples (average 1547 organisms per m^2). The most abundant of these organisms was the group Annelida, with 96 species collected, and representing 69.57% of the total. The deposition of excavation material in this area will affect bottom type and change the associated biological communities.

Artisan fishery is an important economic activity for the locals. Species more frequent are: jurel (*Trachurus trachurus*), sierra (*Thyrsites atun*), pargo (*Pagrus pagrus*), corvina (*Argyrosomus regius*), mero (*Epinephelus sp*.), róbalo (*Centropomus spp*.), among others, being fished less than one kilometer away from the coast of Taboga on bottoms with some rocky outcrops present. Lobsters, octopus and other marine organisms are also taken in the rocky areas close to the coast.

While the island will effectively reduce the sub tidal area by some 350 ha, the soft sediments are not a prime habitat for the species noted above. The island will also require armor protection around its perimeter, which will introduce a strip of intertidal and

[22] As compared to other marine disposal sites presented in the PSED2004 report

sub-tidal habitat to the area. Based on an average perimeter of 7.00 km and a depth of 10 m below MLLW, the island will create approximately 8.00 ha of new intertidal habitat and 11.00 ha of sub tidal habitat for the species that are common to the project area.

However, the other important activity in the area is the shrimp fishery and it is common to see local vessels trawling for shrimp in the area of Tortola and Tortolita islands. The areas east of this location are less favored due to the presence of rock outcrops, debris in the ACP Spoil Grounds and the presence of the Panama Canal Pacific Anchorages.

The coastal shrimps collected in the shallow waters include white, tití, carabalí, and red, all of which can be found in water depths of less than 100 m.

While there are no figures on the extent of the fishing grounds for shallow water species noted above, the loss of some 350 ha of the shrimp grounds represents a significant negative impact for those alternatives falling within the prime fishing areas. These impacts are then mainly associated with the maritime island projects to the west of the site. For the maritime island options, the area of the lost habitat is increased, as the fleet will not be permitted to fish within the navigation access channels to the marine facilities.

17.2.4 Biota Loss

None of the project alternatives are expected to have a negative impact on flora since the bottom sediments in the study area do not support any marine growth.

However, care must be taken to protect the sensitive shoreline areas from spills, waste water direct discharge or increased sedimentation from the island and causeway construction.

The analysis of both plankton and benthos samples taken for the PSED2004 study showed the marine areas in front of the Palo Seco Peninsula have the highest diversity and abundance of organisms. The highest biomass (dry ash) of zooplankton among all 6 sampling stations was found in Palo Seco. In general, biomass volumes were also among the top three sample stations in total abundance and third highest in fish egg and larvae abundance.

Shannon's Index of diversity for this area had two values: those on the shoreline averaged 1.740, and Site 2 in front of Palo Seco showed the highest biodiversity index with a value of 2.998.

Phtyoplankton studies showed Coscinodiscus spp with the highest occurrence frequency in Site 2 (night and day samples). The occurrence of this organism is associated with seasonal upwelling and it is a source of food for other trophic levels such as fish. Consequently, the presence of a high benthic biodiversity, high zooplankton and phytoplankton biomasses, and fish larvae in these coastal waters suggest the presence of a high productive area in the vicinity of Palo Seco peninsula, Kobbe and Punta Bruja.

17.2.5 Hydrodynamic Modification

The hydrologic model developed for this alternative showed a minor change in the distribution and speed of currents with the construction of an artificial island and associated land connection. Some of the changes will involve an increase in current velocities in areas located in between the proposed artificial island and Taboga Island during certain tidal cycles, and the potential for eddy formation on the western side of this structure. From the environmental point of view, the access road to the artificial island may create conditions similar to those created by the Causeway to Flamenco Island, unless sufficient "openings" or water passages are provided as part of the design.

Although the current velocity changes predicted by the hydrodynamic models may not have a significant direct effect on large pelagic organisms, it may have an effect on phtyo- and zooplankton concentrations in certain areas and subsequently on the spatial distribution of higher levels of the trophic chain such as fishes. Due to this potential impact to bio-productivity, it is recommended that in-depth environmental assessments be implemented in order to effectively estimate the extent of the impacts on the aquatic habitat and biota of the area.

17.2.6 Air Quality

No measurements of air quality were taken as part of the Disposal study, but it can be assumed that contaminants are minimal in the study area. Construction of the island will produce temporary emissions of dust and care should be taken during the transport and placement process to maintain sufficiently high water content of the fine rock and overburden material to prevent impacts on Kobbe, Veracruz and the surrounding areas.

Emissions from the developed facilities will be controlled by the class of activity proposed. While none of the proposed uses can be considered to be major pollutants, traffic levels for the maritime island and vessel emissions will be higher than for the other options. The multi-use island would rank second in this respect, followed by the park and no development options.

17.2.7 Noise Pollution

As for the air quality assessment, the maritime island is likely to have the most significant impact on noise levels, mainly from the commercial traffic transiting the causeway. Impacts from the multi use option would be the next level and noise from the public park concept would be minimal, unless it included an open air theater or performance facilities.

17.2.8 Spills and Accidents

Container terminals are considered to be one of the least damaging waterfront cargo facilities in terms of pollution or hazard risks. However, as noted above, all bunkering operations should follow established procedures and conform to US Coastguard, MARPOL and Panama national standards.

Transit of vessels to and from the marine terminals should also conform to ACP regulations and also be coordinated with operations controls for vessels entering and leaving the Canal. It is assumed that this control will be achieved by the inclusion of the maritime center into the marine traffic control system now in place for Panama Canal traffic.

17.2.9 Cultural and Archaeological Resources

Some 50 km of former dry land along the southern shore of Panama have been inundated by rising seas since the end of the Pleistocene era. Relatively intact Pre-Columbian sites may well be located offshore in the Gulf of Panama. Their degree of presentation would depend on various factors, such as the speed of inundation, nature of overlying sediments, strength and variability of local currents, etc. However, this inundated zone is so vast that experts believe that the study area is unlikely to contain

uniquely significant sites that would merit the extraordinary effort needed to properly excavate them.

Nevertheless, it should be noted that the “San Jose,” a Spanish treasure ship that sank in 1631 has been discovered recently near the Islas de Perlas and other ships following the same route from the Peruvian ports may have gone down closer to shore. Lost gold-laden vessels have doubtless been the subject of both documentary research and exploratory dives for more than 300 years. However, vessels laden with more mundane cargoes, which have not been so strenuously sought after, may also lie undiscovered on the sea bottom. Side-scan sonar surveys conducted by ACP as part of the geophysical survey carried out in early 2003 did not reveal signs of any potential wreck sites, but more detailed survey should be undertaken once a preferred location has been selected for the island.

17.3 Summary of Common Impacts

Table 17-2 presents the estimated environmental impacts that can be considered as common to all alternatives. At this feasibility level of study, all of these impacts may be considered as pertinent to the Direct Impact Areas (DIA)s. Additional field measurements and environmental evaluation would be required to expand the assessment to identify and include the Indirect Impact Areas (IIA)s.

From the table, it can be seen that the overall average impact of the basic island construction is computed to be “very low”. However, there is no weighting applied to the various impact categories and it the position taken by many permitting or environmental entities is that the presence of any one significantly negative and important impact is sufficient to classify the entire project by that rating. In the case of the impacts common to all of the island alternatives, the two most important negative impacts are likely to be the loss of some 375 ha of sub tidal area and the impact of the modified local current regime on the local shorelines within approximately 3 km of the island.

Table 17-2: Summary of Direct Environmental Impacts from Island Construction Common to all Development Options

Potential Impacts	Impact Significance						
	Degree of Perturbation (DP)	Risk of Occurrence (RO)	Extension (EX)	Duration (D)	Revers-ibility (RV)	Total	Impact
Habitat Loss							
Sub Tidal Zones /1	-8	-4	-4	-4	-4	**-24**	High
New Intertidal Zones /2	-4	-4	-4	-4	-4	**-20**	Medium
Biota Loss /1	-8	-4	-4	-4	-4	**-24**	High
Water Quality /3	-2	-2	-2	-4	-4	**-14**	Low
Hydrodynamic Modification /3	-8	-4	-2	-4	-4	**-22**	Medium
Air Quality /3	-1	-1	-2	-1	-1	**-6**	Very Low
Noise Pollution /4	-1	-1	-2	-2	-1	**-7**	Very Low
Cultural & Archaelogical	-1	-1	-1	-2	-4	**-9**	Very Low
Spills & Hazard Risk /4	-2	-1	-2	-1	-1	**-7**	Very Low
Average	**-3.89**	**-2.44**	**-2.56**	**-2.89**	**-3.00**	**-14.78**	**Low**

1 - From Footprint of Island and Causeway

2 – New Intertidal Zone Created by island and Causeway construction. Assumes rip-rap construction on 1V:2.5H slopes

3 - Does not consider long term use of island. See later discussion

4 – From Construction activities only. Covers land connections and island construction

17.4 Mitigation Alternatives - Common environmental impacts

As can be seen from Table 17-2, the most significant negative environmental impacts from the island and causeway construction will be the loss of approximately 375 ha of sub tidal habitat below the new structures. The primary activity expected to be negatively impacted by of this loss of habitat is likely to the shrimp fishery. This loss will not be offset by the new intertidal habitat to be created from the rip rap protection around the island and causeway, since this new intertidal and sub tidal area will mainly provide a new habitat for bottom fish species.

Mitigation action for the lost sub tidal habitat should therefore primarily address the concerns or needs of commercial shrimp fishery. Given the extent of the fishing grounds and the difficulty of implementing projects to enhance the shrimp habitat, it would appear that the preferred means of mitigation will involve some form of compensation or assistance to the recognized industry representatives, in the form of management assistance, species management or research efforts, or other initiatives aimed at enhancing the existing fishing grounds, improving product quality control or increasing the general value of the industry.

There are no applicable precedents as to the actual form and amount of compensation that would be appropriate for this action, but one form of computation might involve the assessment of the production value of the lost area, compared with the total area of the fishery or fisheries covered by the Panama based shrimp fishing fleet.

All of the other impacts identified in Table 17-2 are considered to be short term, related to the construction, or not sufficiently significant to warrant direct mitigation measures.

17.5 Site Specific Impacts

As noted earlier, the most significant environmental impacts of each island option will vary according to the long term use concept for each location and island configuration.

The following discussion focuses on the specific impacts of each of the maritime and non–maritime long term development options. Mitigation suggestions are made for each alternative.

As for the common impacts presented above, this level of assessment is focused primarily on the Direct Impacts of the various development options, which at this feasibility level of assessment are considered to be:

- the sea bed under the footprint of the island and connecting structures
- the transportation corridor from the locks to the island
- Shorelines, beaches or marine habitats within the area of influence of the hydrodynamic regime which might be modified by the island construction
- Shorelines, beaches, land areas or marine habitats which may be directly impacted by the long term use designation for the artificial island

It should be noted that the discussion of those impacts, such as habitat loss, that are common to all island alternatives are not discussed in the following paragraphs. However, they are an important element of the overall environmental analysis of each development option and are included in the summary tables for each alternative.

17.5.1 Maritime Development Sites

The environmental impacts of the long term development concepts proposed for the maritime development options are relatively consistent for all locations. The primary design and use features that are particular to the maritime development options, and of interest for the environmental assessment are:

- The causeway connecting the island to the shoreline is a hybrid structure primarily constructed from rock with a 200 m breach at the shoreline, a mid span bridge and a 100 m breach at the connection to the island.
- The shoreline and island breaches are constructed as a trestle structure on piles.
- The primary use for the island will be for container receipt, transshipment and transfer of some units to Panama
- Future maritime uses might include tanker berths, bunkering or other activities. Tankage for this type of facility would probably be located on land in the Howard area.
- The island will also contain value added or commercial installations to support the main container terminals and other marine installations.
- If justified by demand, a rail service may be implemented and connected to the Panama Canal Railroad using the construction corridor from the Locks excavation to the island.
- All marine activities and installations will be designed and built according to acceptable international standards, ACP requirements and Panama national regulations or controls.

Water Quality

The primary factor that could lead to deterioration in the water quality around the island is storm drainage run off from the extensive paved areas and unlawful discharge of ballast water or liquid wastes from visiting vessels.

As part of the basic design of the island, all drainage outlets from the container terminals should be equipped with oil water separators and strict controls should be implement to ensure that all sanitary sewage is taken to a water treatment plant.

The terminals should be required to offer ballast and liquid waste collection services in accordance with IMO or MARPOL convention requirements and this control should also be extended to the navigation approaches to the island.

Hydrodynamic Modification

There are a number of location options for the maritime island, varying from option PS-0 or PS-1 in the west to locations within 1,000 m of the Canal Pacific entrance.

As the closest option to the Veracruz beaches, the construction of the island at the west locations may create a shadow effect on this area and more detailed study is required in the event that Options PS-0, PS-1 or PS-2 are selected as the preferred disposal site. According to the model runs presented earlier in this report, the inclusion of the 200 m shoreline breach in the causeway will play a major role in maintaining the flow of sand from the east to the west and the Veracruz beaches. However, the form of the beach and the presence of significant sand deposits west of Veracruz indicate that the major source of material for these popular beaches is from Punta Chame to Vacamonte, in which case, the impact of the island is likely to be minimal or very local.

Options PS-3 and PS-4 are likely to have a lesser impact on the Veracruz beaches, but may reduce tidal currents and circulation in the Kobbe Beach area.

Option PS-5 will have a similar effect and was shown in the model to marginally increase flow velocities in the Canal Entrance, due to the channelling effect created by the Amador Causeway and the proposed Island Causeway.

At the EIA phase of the project, more detailed evaluation of the impacts of the hydrodynamic modification should be undertaken, once the preferred location and long term use option have been determined.

Air Quality

Based on the existing operations at the Manzanillo Container terminal on the Atlantic side, approximately 70% of all containers are transhipped and do not leave the terminal. The remaining boxes are moved to the Free Zone, with some 5% of all containers destined for Panama City and domestic markets[23].

Since it is expected that the Pacific Side container terminals on the island will operate in a similar fashion, it can be argued that 30% of all containers would be moved by truck or train from the island yards to shoreside destinations. It then follows that the air quality concerns would primarily be related to this truck traffic. Within the terminals, containers would probably be moved by Rubber Tired Gantry (RTG) equipment, but each terminal would also have approximately 15 tractor units to support the container transfer operations. Air quality impacts of this and other port traffic can be reduced somewhat by the use of LPG fuel or other low emissions options. However the presence of the island some 3 km offshore is probably sufficient to ensure that the air quality of the surrounding areas will not be adversely impacted by the maritime use of the created areas.

The air quality impacts of the maritime use option are consistent for all of the locations discussed in this report.

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[23] Informal conversations with Manzanillo terminal management, October 2002

Noise Pollution

Port operations normally continue uninterrupted for 24 hours and 365 days per year. However, most yard transfer operations are limited to normal working hours and days to limit overtime and other special payments.

As noted above, the main noise impacts of the port are likely to be associated with the truck or train traffic along the causeway and the road that will connect to the InterAmerican Highway. These concerns can be reduced by limiting night time truck traffic in the event that local residents complain over noise levels outside reasonable working hours.

As for the Air quality impacts discussed earlier, the impact of any noise pollution from the island does not vary according to the location, since all alternatives are some three to five kilometres from potentially impacted communities.

Spills and Accidents

Ship collision and spills are a major concern at all port installations. In general terms, the use of the island to receive and handle container ships poses far less risk than tankers or other more hazardous cargoes. However, Panama has adopted the MARPOL 73/78[24] Convention regulations and the relevant procedures should be strictly followed for bunkering and other operations and contingency plans will be required in the event of accidents or spills. These will include the availability of oil control booms, clean up equipment and emergency teams, all of which are currently available at the ACP installations, the Port of Balboa and other maritime locations in Panama.

Visual Impact

Visual Impacts are not specifically considered to be environmental concerns but are likely to play a large part in the acceptance of the Panamanian population and ANAM of a particular development option or island location.

In terms of visual impact, the container terminals cannot be considered to be compatible with the existing beaches and shoreside developments and the visual impact of the port and ships may be a cause for community concern. At many locations around the world, container and other maritime terminals are located close to residential or urban areas without major concern, but in most cases, the ports were there first and the residential development followed. Proposals for new maritime development projects in previously undeveloped areas can often give rise to community objections and it is difficult to gauge the strength of this potential opposition.

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[24] International Convention for the Prevention of Pollution from Ships, 1973 as modified by the protocol of 1978.

However, it is reasonable to assume that the visual impact of the development of a container terminal at the project location might give rise to objections from local communities or special interest groups.

While the west locations for the island may give rise to objections from the communities in the Veracruz area, the east locations may generate concerns from developers and users of the Amador Causeway. At this time, it is not possible to gauge the level of potential impact for these two groups, and it has been assumed that the overall impact of the visual quality of the maritime island is the same for all alternatives.

Mitigation Measures

As noted earlier, the primary impact areas are related to habitat loss from the lost area below the island and causeway footprint. However, the development of the island at any of the alternative locations could potentially be mitigated by projects to enhance the local beaches, environmentally sensitive areas or important habitats. Potential areas for mitigation include:

- Veracruz beach enhancements or improved shoreside facilities
- Restoration of contaminated intertidal areas used by migrating birds in the Rodman Area
- Protection of the Dry Forest at the shoreside of Palo Seco, as identified in the PSED2003 report.
- Enhancement of the protected areas at Punta Bruja
- Community benefit projects, such as a road link from Veracruz to the Vacamonte highway.

Summary of Environmental Impacts for Maritime Island Options

The assessment of environmental impacts of the island project cannot be presented in detail until a decision is made as to the preferred long term use since the character of the final use of the island is probably the major factor controlling the environmental impact. Clearly this is a major project and the full EIS process covering extensive site studies, risk analyses, mitigation recommendations and environmental control systems must be undertaken as the next phase of the project.

Table 17-3 presents a preliminary summary of expected impacts based on the site characterization studies prepared for the PSED2004 report and the analysis of the alternative sites and maritime use concepts presented in this report. It is by no means exhaustive, but gives a general indication of those options considered to be environmentally favored or otherwise at this feasibility level of assessment.

It should be noted that the Environmental Impacts for Air quality, Noise Pollution, Spills and Hazard Risk and Visual impact shown in Table 17-3 will not coincide with those

previously indicated in Table 17-2, since the former are relevant to the long term use of the island and the latter are only pertinent to the island construction operations.

As for the common impacts presented in the previous section, no weighting has been applied to the negative and positive impacts presented in this table. In the event that the island project is moved ahead to the EIA phase, it is critical that all of the assessment parameters be evaluated and agreement should be obtained with ANAM and other interested parties on the relative importance of each one of the assessment categories.

Table 17-3: Summary of Environmental Impacts – Maritime Development Sites

Site	Description	Potential Impacts	Impact Significance						
			DP	RO	EX	D	RV	Total	Impact
PS-0	Maritime Center - Prelim Report	Habitat Loss							
		Sub Tidal Zone	-8	-4	-4	-4	-4	-24	High
		Inter-Tidal Zone	-4	-4	-4	-4	-4	-20	Medium
		Biota Loss	-8	-4	-4	-4	-4	-24	High
		Water Quality	-2	-2	-2	-4	-4	-14	Low
		Hydrodynamic Modification	-8	-4	-2	-4	-4	-22	Medium
		Air Quality	-4	-4	-4	-4	-4	-20	Medium
		Noise Pollution	-4	-4	-4	-4	-4	-20	Medium
		Cultural & Archaeological	-1	-1	-1	-2	-4	-9	Very Low
		Spills & Hazard Risk	-8	-1	-4	-4	-4	-21	Medium
		Visual Impact	-8	-4	-4	-4	-4	-24	High
		Average						**-19.80**	**Medium**
PS-3	Maritime Center - Mid Location	Habitat Loss	-8	-4	-4	-4	-4	-24	High
		Sub Tidal Zone	-8	-4	-4	-4	-4	-24	High
		Inter-Tidal Zone	-4	-4	-4	-4	-4	-20	Medium
		Biota Loss	-8	-4	-4	-4	-4	-24	High
		Water Quality	-2	-2	-2	-4	-4	-14	Low
		Hydrodynamic Modification	-8	-4	-2	-4	-4	-22	Medium
		Air Quality	-4	-4	-4	-4	-4	-20	Medium
		Noise Pollution	-4	-4	-4	-4	-4	-20	Medium
		Cultural & Archaeological	-1	-1	-1	-2	-4	-9	Very Low
		Spills & Hazard Risk	-8	-1	-4	-4	-4	-21	Medium
		Visual Impact	-4	-4	-2	-4	-4	-18	Medium
		Average						**-19.20**	**Medium**
PS-5	Maritime Center - East Location	Habitat Loss	-8	-4	-4	-4	-4	-24	High
		Sub Tidal Zone	-8	-4	-4	-4	-4	-24	High
		Inter-Tidal Zone	-4	-4	-4	-4	-4	-20	Medium
		Biota Loss	-8	-4	-4	-4	-4	-24	High
		Water Quality	-2	-2	-2	-4	-4	-14	Low
		Hydrodynamic Modification	-8	-4	-2	-4	-4	-22	Medium
		Air Quality	-4	-4	-4	-4	-4	-20	Medium
		Noise Pollution	-4	-4	-4	-4	-4	-20	Medium
		Cultural & Archaeological	-1	-1	-1	-2	-4	-9	Very Low
		Spills & Hazard Risk	-8	-1	-4	-4	-4	-21	Medium
		Visual Impact	-8	-4	-4	-4	-4	-24	High
		Average						**-19.80**	**Medium**

Notes:

DP – Degree of Perturbation, RO – Risk of Occurrence, EX – Extension, D – Duration, RV – Reversibility

17.5.2 Non-Maritime Use Concepts

Multi-use Concept

As for the maritime use option, there are a number of potential alternative sites for an island that would support residential, commercial and other non-maritime options. For the purposes of this environmental overview, it has been assumed that the most likely location will be as indicated in Figure 14-1, due south of Punta Bruja.

Specific design features that are particular to the Multi-use concept are:

- The island is closer to the shoreline than the Maritime Option
- The connection to the land would be over an open piled trestle structure, which does not require breaches for water circulation
- Storm water run off from the island will be filtered through drainage and sedimentation ponds
- The island configuration will be modified to reduce impacts on the hydrodynamic regime.
- No dredged channels are required for large vessel navigation

Water Quality

The primary factor that could lead to deterioration in the water quality around the island is storm drainage run off from the shorefront developments and paved area. As noted above, the preliminary concept for the island assumes the incorporation of storm water collection lagoons within the recreational development areas, which is expected to limit the discharge of contaminated run-off into the water around the island.

It is therefore anticipated that the Water Quality impacts of the multi-use option can be classified as low.

Hydrodynamic Modification

While it is clear that the insertion of an island structure into the area will undoubtedly influence the local current circulation regime, the multi use concept does not have the same restrictions or impacts as the maritime island.

The configuration of the island can be tailored to reduce the impacts on the local current regime and the open piling on the land connection will play a major role in the reduction of the impacts. However, as for all of the options presented in this report, more detailed evaluation of the impacts of the hydrodynamic modification should be undertaken at the EIA phase of the project, once the preferred location and long term use option have been determined.

Air Quality

While there may be some local degradation of air quality on the island due to vehicular traffic, the air circulation in the area is good and the regular sea breezes will ensure minimal or no adverse impacts on the surrounding communities.

Noise Pollution

Minimal negative impacts on the environment are expected from noise, since traffic levels are likely to be low. Potential adverse impacts may occur if the island development incorporates recreational features, such as amphitheatres or other concert presentation parks.

Spills and Accidents

As a primarily residential development, no significant spill or hazard impacts are expected for the multi-use option. However, it has been assumed in the design of the island that all sanitary sewage will be piped to a shoreside treatment plant with the treated effluent to be discharged into the local waters. Care should be taken during the design phase to ensure that the system overflow provisions are included to prevent accidental discharge of untreated sewage into the waters along Veracruz beach and in front of the many environmentally sensitive shoreline areas along the study area.

Visual Impact

While the visual impact of a developed residential island in the study area is much less than the impact of the container terminals and shipping facilities, the project may give rise to objections from the communities in the Veracruz area and generate concerns from developers and users of the Amador Causeway. At this time, it is not possible to gauge the level of potential impact for these two groups. However, for the purposes of this analysis, it is assumed that the proposal to build the multi-use island will generate concerns over the visual impacts.

Mitigation Measures

As for the maritime use option, the preferred mitigation possibilities to offset the impacts of the development of the multi-use island include projects to enhance the local beaches, environmentally sensitive areas or important habitats.

However, the island can also include a number of features to that will enhance the sensitive areas within the area of influence of the project. In addition to the opportunities presented in the previous section, mitigation or enhancement projects on the multi use island may include:

- The use of soft material from the dredging operations to constructed contained marsh land or intertidal habitat area to attract migratory birds.
- Construction of sandy beaches to generate habitat for molluscs and other intertidal dwelling species
- Development of parks to provide tree cover or habitat for birds.

Summary of Environmental Impacts for Multi Use Island Option

Table 17-3 presents a preliminary summary of expected impacts of the Multi-Use island based on the site characterization studies prepared for the PSED2004 report and the concepts presented in this report.

As for the impacts presented in the previous sections, no weighting has been applied to the negative and positive impacts presented in this table. In the event that the island project is moved ahead to the EIA phase, agreement should be obtained from ANAM and other interested parties on the relative importance of the assessment categories.

However, at this feasibility level, it is considered that the overall environmental impacts of the concept are low, with the exception of the loss of habitat under the footprint of the island. As for the maritime option, this may be partially offset by the generation of intertidal habitat in those areas where rip-rap protection is to be provided to the filled areas. However, given the nature of the island development and the type of causeway to be used for the project, the potential area of new intertidal habitat will be much less than that provided for the maritime island options.

Table 17-4: Summary of Environmental Impacts – Multi-Use Development Option

Potential Impacts	Impact Significance						
	DP	RO	EX	D	RV	Total	Impact
Habitat Loss							
Sub Tidal Zone	-8	-4	-4	-4	-4	-24	High
Inter-Tidal Zone	-4	-4	-4	-4	-4	-20	Medium
Biota Loss	-8	-4	-4	-4	-4	-24	High
Water Quality	-1	-2	-2	-4	-4	-13	Low
Hydrodynamic Modification	-2	-4	-2	-4	-4	-16	Low
Air Quality	-1	-1	-1	-4	-4	-11	Low
Noise Pollution	-2	-1	-2	-4	-4	-13	Low
Cultural & Archaeological	-1	-1	-1	-2	-4	-9	Very Low
Spills & Hazard Risk	-2	-1	-2	-4	-4	-13	Low
Visual Impact	-4	-4	-4	-4	-4	-20	Medium
Average						**-16.30**	**Low**

Notes: DP – Degree of Perturbation, RO – Risk of Occurrence, EX – Extension, D – Duration, RV – Reversibility

Public Park Concept

The configuration and location of the Public Park island is expected to be similar to the Multi-Use concept. Specific design elements that are particular to the Public Park concept and important to the Environmental Assessment include:

- No residential or significant commercial development
- Creation of parks, tree cover and enhanced shoreline features
- Narrower causeway, constructed on open piled trestle
- Opportunities to incorporate features to encourage migratory species or develop land or marine habitats.

Water Quality

As a public access location, restrooms and other conveniences will be located on the island. It will also have some commercial and administrative facilities, all of which will generate liquid wastes. The volume of waste products is unlikely to justify the installation of a water treatment plant and it is expected that holding tanks would be installed for collection by tanker trucks for disposal onshore or at an approved facility.

The final concept to deal with sanitary sewage and other liquid waste products will be developed during the design phase of the project, but it is critical that no discharge of untreated liquid wastes should be permitted for the island. If these guidelines are followed, it can then be assumed that the impact of the public park island concept on water quality will be low.

Hydrodynamic Modification

The hydrodynamic impact of the public park concept is similar to that of the multi-use island since the location and configuration of the two concepts is similar.

Air Quality

No adverse air quality impacts are expected from the alternative

Noise Pollution

Noise impacts from the Public Park concept are likely to be low. However, it is quite probable that recreational or concert events might be hosted on the island, in which case there may be cause for concern over occasional noise levels. Restrictions should be placed on the timing of any noise producing events.

Spills and Accidents

No significant spills or accidents are expected for this alternative

Visual Impact

The visual impact of the island is essentially limited to the insertion of a new land mass into the vista from Veracruz or the Kobbe areas. No impacts are expected from the Amador or Taboga areas since the island is well distanced from these popular locations.

The design of the island should be developed to reflect the shape and form of the other marine features of the bay, with no intrusion of high rise buildings or unnatural structures that would be visible from the surrounding communities.

Mitigation Measures

As for all other options the primary impact areas are related to habitat loss from the lost area below the island and causeway footprint. The public park concept would have no commercial pressure for added value from the created area and as such offers the potential to incorporate features that enhance its ecological value. These might include:

- Nature reserve
- Planting of selected flora species to encourage the establishment of permanent or migratory birds or mammal populations, possibly through import of species to the park areas

- Creation of intertidal habitats.
- Construction of shorefront features of ecologically educational interest to visitors.

Summary of Environmental Impacts for Public Park Option

Table 17-3 presents a preliminary summary of expected impacts of the Public Park concept.

At this feasibility level, it is considered that the overall environmental impacts of the concept are very low and offset almost entirely by the potential to create new habitats and ecologically interesting areas on the park.

Table 17-5: Summary of Environmental Impacts – Public Park Option

Potential Impacts	Impact Significance						
	DP	RO	EX	D	RV	Total	Impact
Habitat Loss							
Sub Tidal Zone	-8	-4	-4	-4	-4	-24	High
Inter-Tidal Zone	-4	-4	-4	-4	-4	-20	Medium
Biota Loss	-8	-4	-4	-4	-4	-24	High
Water Quality	-1	-1	-1	-2	-4	-9	Very Low
Hydrodynamic Modification	-2	-4	-2	-4	-4	-16	Low
Air Quality	-1	-1	-1	-2	-4	-9	Very Low
Noise Pollution	-1	-1	-2	-1	-2	-7	Very Low
Cultural & Archaeological	-1	-1	-1	-2	-4	-9	Very Low
Spills & Hazard Risk	-1	-1	-2	-1	-4	-9	Very Low
Visual Impact	-1	-2	-2	-4	-4	-13	Low
Average						**-14.00**	**Low**

Notes: DP – Degree of Perturbation, RO – Risk of Occurrence, EX – Extension, D – Duration, RV – Reversibility

17.5.3 No Development Option

The no development option is essentially a version of either the Multi-use or Public park option in terms of location and general format. The island would be used as a simple dump site with some grading to blend in to the marine landscape of the area. At a later date, it is possible that the island could be developed, but for the purposes of this assessment, it is assumed that it will remain uninhabited with no permanent connection to the shoreline.

Specific features of the island that are particular to the no-development option are:

- Any temporary land connections will be removed on completion of the disposal operation
- Rip rap protection will be provided on the circumference of the island to prevent loss of fill material.
- Overburden from the Locks excavation will be used for surface cover to encourage natural revegetation.

The environmental impacts of the no development option are therefore the same as the common impacts indicated earlier in Table 17-2. Long term impacts are limited to the loss of sub tidal habitat and some modification of the hydrodynamic regime. Short term impacts are related to the transport of materials, either by barge or over a landside corridor, dust, noise, turbidity and other construction related activities.

Mitigation Measures

As a simple disposal site, it is not expected that significant mitigation measures would be required to meet agency or community concerns over this project. However, in the event that mitigation is required, the most likely candidates would be selected habitat enhancement projects at Rodman or other locations, and possible compensation for the loss of shrimp fishery area below the island footprint.

17.6 Summary of Environmental Impacts

17.6.1 Impacts Assessment

The major issue related to the assessment of environmental impacts from the various long term development options or locations for the Artificial island is the classification and prioritizing of the assessment categories. All of the island options will lead to the reduction of the sub tidal habitat in the area by approximately 375 ha, which may be partially offset by the creation of intertidal habitats by a number of approaches.

Water quality, air quality and other impacts are relatively low, and in most cases can be offset by regulation, design features or operational controls.

However, the reaction of the public and interested parties to the visual impact of the various alternatives is a potential cause for concern. While it is accepted that a number of artificial islands have been built around the world with little or no controversy, other proposals have generated spirited opposition that blocked construction for a considerable period of time. Fill projects in Panama at Punta Pacifica and in front of the Avenida Balboa have generated significant objections, while work along the Amador causeway is proceeding without any apparent opposition.

It is therefore important that some sort of public relations or public involvement campaign is included in the next phase of the Artificial Island project, in order to gauge the potential public reaction to the visual and other impacts of the various long term development options and island locations presented in this report.

17.6.2 Impact Mitigation

In order to prepare a meaningful environmental mitigation plan, extensive discussion is required with all interested and involved parties such that a consensus may be obtain on the focus of the mitigation package. This may involve creation of new habitat, community benefit projects, restoration of degraded or contaminated resources or direct financial assistance to groups.

At this feasibility level of project assessment, it is too early to enter this type of discussion forum, since the fundamental objective of the study is to examine the artificial island concept and assist ACP with a decision on it attractiveness from a financial, logistical and strategic standpoint.

However, it is important that an allowance is included in the project costs for mitigation, in order to present a realistic expectation of overall project costs. This approach was also followed in the assessment of disposal sites in the PSED2004 report. The inclusion of mitigation costs in both studies then assists with an equitable comparison of costs from the alternatives presented in both studies.

At this time, it is suggested that the most realistic approach to the computation of mitigation costs is to link them to the perceived environmental impact level as developed in this section. Based on an informal assessment of typical mitigation costs for marine projects, it would appear that the application of the percentage based mitigation costs shown in Table 17-6 would be a reasonable allowance at this time.

Table 17-6: Suggested Mitigation Allowances for Alternative Island Concepts

Negative Impact Level	Percentage Added to Cost Estimate
Very Low	0.50%
Low	0.75%
Medium	1.00%
High	1.25%
Very High	1.50%

18 SOCIO ECONOMIC ASSESSMENT

18.1 Common Impacts

As for the environmental assessment presented in the previous section, several of the socio economic impacts and benefits of all of the island alternatives are similar. These are then addressed first, followed by a short discussion on each of the development options and locations.

Due to the preliminary nature of this study, no contact has been made with the public or interested agencies or groups to support or confirm the comments presented in this section. The anticipated reactions to the alternative locations for the island are supported by anecdotal information and informal comments received by the consultants during the preparation of this study.

18.1.1 Fishing Industry

The fishing industry and all related commercial and industrial activities are an important sector of the Panamanian economy, constituting the second largest export activity. In 2001, Panama exported 110,105 metric tons of fish products generating $320 million. Ten percent (10%) of the total national export of fish products comes from artisan fishing, a low investment activity common in communities in Bique Bay,

Industrial fishing which produces the remaining 90% of national fish exports is the major economic activity in the Port of Vacamonte. The port manages 4,100 fishing boat calls per year and has generated an average of $60 million per year in the last ten years.

Artisan Fisheries

Artisan fishing takes place close to shore, and for this reason, communities dependent on artisan fishing might be negatively impacted by the location of the island and the access road unless provisions are made to prevent obstacles to shoreline navigation by small craft.

Much of the artisan fishery is focused on bottom species or gill netting, and the construction of the island is unlikely to have an adverse effect on commonly used fishing sites, such as, Melones, off Taboga Island and on the fish population itself.

The placement of rock armor material on the slopes of the island may also enhance the habitat for species such as corvina, red snapper and other rock fish[25].

Industrial Fisheries at Vacamonte

The major industrial fisheries and the processing companies located at Port Vacamonte and Taboguilla Island will not be affected by the project since the larger vessels involved in industrial shipping operate in open waters far from the coast.

Shrimp Fishery

The largest number of vessels using the Port of Vacamonte are engaged in the shrimp fisheries and the inshore area west of the Canal Pacific entrance is a popular fishing area for these vessels.

The loss of some 400 ha of the local fishing area represents approximately 7% of the bottom habitat in this segment of the shrimp fishery and it is expected that some form of mitigation or compensation may be requested for this reduction in the overall fishing grounds area for this important economic activity.

18.1.2 Real Estate Values

Depending on the final location of the island, the value of land and real estate in Taboga Island and the Amador Causeway, might be adversely affected. Opposition to the construction of the island and its long term use could come largely from Panama City residents who own weekend houses at Taboga Island and owners of hotels, restaurants, and shops on the Amador Causeway.

18.1.3 Tourism

The location and appearance of the maritime center might have an impact on real estate, tourism and related activities in those communities overlooking the island project.

The Amador Causeway is an area of high tourist importance in Panama City. A $70 million government program is underway to provide the region with common areas, a cruise ship port, a golf course land fill and other amenities listed in Table 18-1. As of the end of 2002, it was reported that $32 million of the total has been invested in the area. Over the next 20 years private investors are expected to contribute an additional $330 million in projects involving large parking areas, marinas, golf courses, malls, five star hotels, restaurants, residential areas and museums.

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[25] Informal surveys taken at the Port of Vacamonte shortly after construction of the breakwater showed a significant population of corvina and rock fish species within weeks of construction.

Investors and local government officials alike might present strong opposition to the construction of a maritime related island that can be seen from the Amador Causeway as this will reduce the attractiveness of the area, and could even lead some investors to rescind plans for prospective projects.

Table 18-1: Investment Program for Amador Causeway Area (1996 – 2020)

No.	PROJECTS	Investment (Mil. $ US)
	Public Investment: 1996-2000	
1	Common areas	26.8
2	Cruise ship port	21.4
3	Golf course Land Fill	7.2
4	Sea Front Pedestrian Area	2.6
5	War Museum	1.1
6	Trolley Service/Welcome Center	1.2
	Sub-Total Public Investment	**60.3**
	Phase I: 2000-2010	
7	Golf Course	33.6
8	Commercial Development	32.1
9	Naos Hotel	33.6
10	Grand Amador Hotel	48.6
11	Panama Bay Restaurant	1.2
12	Yacht Club	1.7
13	Marina	3.0
14	Seafood Restaurants	0.5
	Sub-Total Phase I	**154.3**
	Phase II: 2010-2020	
15	Hotel de la Calzada	36.4
16	Hotel de la Plaza	36.4
17	Hotel de Golf	24.3
18	Country Club – Restaurant	2.6
19	Tennis Club	1.4
20	Commercial Development (2)	32.1
21	Hilltop Villas	19.1
22	Marina (2)	3.0
23	Touristic Villas	25.4
	Sub-Total Phase II	**180.7**
	TOTAL	**395.3**

Taboga Island, like the Amador Causeway, is also an area attractive to tourists. It is among areas included in Zone 8 of the IPAT Master Plan, a program that fosters investments oriented towards enhancing the recreational potential and natural beauty of

a region. Currently, Taboga Island has several projects in the planning stages for the small island El Morro and Finca I Perez behind the Taboga Hotel. Residents from Panama City also have second houses on Taboga Island which they frequent primarily during the dry season. Owners of hotels, restaurants, residential and recreational properties will be affected by the location of the maritime center as the touristic appeal of the island will decrease if the maritime center is visible from the location of these establishments.

While Kobbe Beach is not currently a tourist attraction that can be compared to the Amador Causeway development or Veracruz beach, the Authority of the Interoceanic Region (ARI) predicts Kobbe Beach to offer great tourism potential. According to ARI projections, Kobbe Beach will be designated a "mixed land use area", combining urban and tourist activities. Some potential projects in the area's future include resort-like hotel developments with recreational and residential facilities. With these plans in the works, the construction of the island may generate opposition from ARI and potential developers at Kobbe Beach.

18.2 Maritime Island

18.2.1 Impact Assessments

Taboga and Taboguilla Islands

Depending on the final location selected, the maritime development center could have a range of positive and negative effects on the communities of Taboga and Taboguilla Islands.

While the construction of the maritime facility could have a negative impact on some of the economic sectors that are important to the local economy of these two islands, it could also help diversify their economy by providing employment opportunities whether they be in the actual construction of the island and access road or in the job opportunities developed by the maritime installations on the artificial island.

Bique Bay and Veracruz

As discussed earlier, artisan fishing could be adversely affected by the impact the construction of the artificial island may have on the marine ecosystem of the beaches and consequently the fish species. Since small scale seafood traders depend on the catch resulting from artisan fishing, the maritime center would also negatively impact this group of workers. However, as mentioned above, the construction of a maritime center could also be a source of employment for residents and have a positive impact on the local economy by providing a more stable means of employment over the long term. The

prospect of new jobs would likely outweigh the negative impacts in these communities, especially since employment opportunities are very limited.

Port of Vacamonte

The Port of Vacamonte has generated an average income of $60 million per year in the last ten years. The loss of approximately 7% of the local area used for shrimp trawling will have a modest impact on the fishery. However, the industrial fishing sector is well established and not likely to be affected by the construction of the island.

Amador Causeway

The Amador Causeway is an area of high touristic importance in Panama City. The construction of port terminals directly in front of the Causeway (Alternatives PS-4 and PS-5) is likely to meet with spirited opposition from interest parties and the public in general and this might be considered to be a fatal flaw for this location, in spite of the fact that it is the most cost effective of all of the maritime development locations.

The impact of the new short and long term jobs arising from the development of the new port facilities at the locations close to the Causeway is not significant enough to counteract the expected negative visual impacts on this important recreational and tourism resource.

For this reason, the construction of the maritime island will most likely find the highest opposition in this area.

Kobbe Beach

Locations PS-0, PS-3 and possibly PS-4 are most likely to generate significant opposition from potential developers and interested agencies responsible for Kobbe Beach area. It may be argued that those alternatives with causeway connections east of the beach area will have an impact on water circulation and water quality in the beach area but the strongest impact would be the visual effect of the berth structures and container cranes some 3 km off shore and in full view of the beach users.

18.2.2 Impact Classifications

Four criteria were selected in order to determine the degree of socioeconomic impact that communities or economic sectors may suffer. The degree of negative impact per criterion and community or economic sector was defined at the quantitative level according to four different values, each one corresponding to a qualitative category: 0=Null, 1=Low, 2=Medium, and 3=High.

The four evaluation criteria selected are:

A. Physical impact

B. Direct economic impact

C. Indirect economic impact

D. Hedonic Value

Next, every variable was weighted, giving a higher value to criteria Physical Impact and Direct Economic Impact with a weighted value of 33.33% than to Indirect Economic Impact and Hedonic or (Property Value), which were weighted at 16.7%. This approach is taken since any impact on the first two criteria will affect the other two, but not the opposite. Therefore, A) and B) are the most determinant criteria, with C) and D) being of secondary importance.

The following process was applied for potentially affected community or economic sector: first, it was considered in what degree each variable would be affected and a quantitative value was assigned (either 0, 1, 2 or 3). The weighting factor considered for each variable was applied and an average established for all impacted communities.

A socioeconomic index (ISE) was elaborated, aiming at measuring the level of socioeconomic impact that would be originated in a certain community or economic sector. An average ISE per island alternative was obtained out of the ISE values for the communities or economic sectors involved.

Finally, the ISE values are converted to a ten point system.

Table 18-2: Index used for Socio Economic Classification

ISE value	Level of Impact	Ten point Classification
0	Nil	0
0.01 – 1	Low	2
1.01 – 2	Medium	6
2.01 – 3	High	10

Table 18-3 suggests that the maritime development center will have a strong socioeconomic impact on surrounding communities, particularly Amador Causeway. The Port of Vacamonte will be the least affected of the communities considered.

Table 18-3: Socio Economic Impacts of Maritime Development Center

Affected Community	Impacts/Weight factors				Total Impact (ISE)	Classification of Impact
	Physical	Dir. Economic	Ind. Economic	Property Values		
	33.33%	33.33%	16.67%	16.67%		
Ave. - all Communities					**2.07**	**High**
Taboga	*2*	*2*	*3*	*2*	*2.17*	*High*
Taboguilla	*2*	*2*	*1*	*1*	*1.67*	*Medium*
Bique Bay	*3*	*2*	*1*	*1*	*2.00*	*High*
Veracruz	*3*	*3*	*1*	*1*	*2.33*	*High*
Vacamonte	*1*	*1*	*1*	*1*	*1.00*	*Low*
Amador Causeway	*3*	*3*	*2*	*2*	*2.67*	*High*
Kobbe Beach	*3*	*3*	*2*	*2*	*2.67*	*High*

18.3 Multi Use Island

The socio-economic impacts of constructing the multi-use island will most likely not be as numerous nor will they affect as many social and economic sectors as those resulting from the maritime center development island. The main effect of the multi-use island will be on the fishing industry, namely on the artisan fishing community. As discussed in section 18.1.1, communities where artisan fishing is an important part of the economic sector may be affected if the construction of the island and the access road alters the beaches used by artisan fishermen and/or the population of aquatic life. Since the multi-use island will contain residential and commercial developments rather than container terminals and other maritime facilities, it will most likely be an aesthetically pleasing view from the Veracruz area and Taboga Island, reducing concerns over real estate property values in the area. In actual fact, the development of the multi –use island could well enhance local real estate values due to the proximity of the public access areas, commercial developments and recreational facilities that could be provided.

Taboga and Taboguilla Islands

Unlike the construction of the maritime development center, the construction of the multi-use island could encourage the existing tourism on Taboga Island. The multi-use island will consist of a combination of commercial, residential and public access developments. Some potential land uses include a golf course, marina, hi-rise apartments, upscale single family homes, stores, restaurants, hotels and resorts, parks and beaches. Such land uses will attract tourists and residents of Panama City to the artificial island who can then take advantage of the tourist opportunities at Taboga Island as well due to the proximity between Taboga and the artificial island.

In addition to promoting tourism in Taboga Island, the multiple developments at the multi-use island alternative will present many employment opportunities for residents of Taboga and Taboguilla Islands.

Bique Bay and Veracruz

Due to their dependence on artisan fishing, Bique Bay and Veracruz could be negatively affected by the construction of the multi-use island. However, as mentioned in the previous paragraph, employment opportunities on the artificial island or in its construction will produce jobs that could prove beneficial to the residents of Bique Bay and Veracruz. The added population on the new island also presents additional opportunities for area businesses to expand markets for fresh fish, produce and other important consumables.

Port of Vacamonte

The economic activity at the Port of Vacamonte is unlikely to be adversely affected by the construction and long term development of the mixed-use island.

Amador Causeway

If well planned, the multi-use island alternative will create an aesthetically pleasing landscape which will be well distanced from Amador Causeway. The primary area of concern from investors in the Causeway projects will be competition from the island. This may be addressed within the terms of reference for the Island Master plan by limiting those facilities that will compete directly with the Amador projects. In general terms, the mixed-use island could increase tourism for the Amador Causeway and surrounding areas in Panama City by attracting more tourists to the region.

Kobbe Beach

The impact of the multi-use island would be significantly less than the maritime center, although some concerns may arise due to its proximity to the beaches. In particular care should be taken to ensure that no liquid wastes are discharged from the island.

Impact Classification

The socioeconomic classification for the multi-use island alternative are shown below in Table 18-4. It is expected that the multi-use island will have a moderate impact on the neighbouring communities, with the areas most affected being Kobbe Beach, Taboga and Taboguilla Islands and the Amador Causeway.

Table 18-4: Socio Economic Impacts of Multi-Use Island

Affected Community	Impacts/Weight factors				Total Impact (ISE)	Classification of Impact
	Physical	Dir. Economic	Ind. Economic	Property Values		
	33.33%	33.33%	16.67%	16.67%		
Ave. - all Communities					**1.02**	**Medium**
Taboga	*2*	*1*	*1*	*1*	*1.33*	*Medium*
Taboguilla	*1*	*0*	*0*	*0*	*0.33*	*Low*
Bique Bay	*2*	*1*	*1*	*0*	*1.17*	*Medium*
Veracruz	*1*	*1*	*1*	*0*	*0.83*	*Low*
Vacamonte	*1*	*0*	*1*	*0*	*0.50*	*Low*
Amador Causeway	*2*	*2*	*1*	*1*	*1.67*	*Medium*
Kobbe Beach	*2*	*1*	*1*	*1*	*1.33*	*Medium*

18.4 Public Park

The creation of a public park on the artificial island can be considered as a community benefit project and as such care must be taken to ensure that it imposes no negative socio economic impacts on the surrounding areas.

If care is taken to provide recreational resources that supplement the attractions at Taboga, Amador or Veracruz beach, the parks and facilities could enhance the overall attractiveness of the shoreline from Palo Seco to the town of Veracruz.

The development of the park and island could well enhance local real estate values due to the proximity of the public access areas and recreational facilities that could be provided.

Taboga and Taboguilla Islands

The park may attract tourists and residents of Panama City to the artificial island. The economy of Taboga could derive benefits from the establishment of the park, particularly if a waterborne link is provided between the two areas.

Bique Bay and Veracruz

Employment opportunities on the artificial island or in its construction will produce jobs that could prove beneficial to the residents of Bique Bay and Veracruz. The recreational visitors to the parks and features on the new island also present opportunities for area businesses to expand markets for fresh fish, produce, food kiosks and other products.

Port of Vacamonte

The economic activity at the Port of Vacamonte is unlikely to be adversely affected by the construction and long term development of the island as a public park.

Amador Causeway

The park alternative for the island will be well distanced from Amador Causeway. The primary area of concern from investors in the Causeway projects will be competition for the recreational features and business at Amador. This may be addressed by providing an experience at the island that is fundamentally different from that offered at Amador. In general terms, the parks on the island could be developed for longer term stays, with adequate parking, fishing piers, public beaches and other activities that cannot be provided at Amador.

Kobbe Beach

The impact of the park island is not likely to damage the viability of existing or proposed developments associated with Kobbe beach. Since the short causeway connection to the island will have breaches at the shoreline and at the island, there are no significant concerns related to water circulation or water quality that might impact the beaches at Kobbe.

Impact Classification

The socioeconomic classification for the public park island alternative is shown below in Table 18-5. It is expected that the parks will have a minimal impact on the neighboring communities, and on balance, should provide positive socio economic benefits to the area and to Panama. If the public perception of this project does not meet these goals, there is little justification in proceeding with this alternative.

Table 18-5: Socio Economic Impacts of Public Park Island

Affected Community	Impacts/Weight factors				Total Impact (ISE)	Classification of Impact
	Physical	Dir. Economic	Ind. Economic	Property Values		
	33.33%	33.33%	16.67%	16.67%		
Ave. - all Communities					**0.48**	**Low**
Taboga	*1*	*1*	*1*	*0*	*0.83*	*Low*
Taboguilla	*0*	*0*	*0*	*0*	*0.00*	*Null*
Bique Bay	*0*	*0*	*0*	*0*	*0.00*	*Null*
Veracruz	*0*	*1*	*0*	*0*	*0.33*	*Low*
Vacamonte	*0*	*0*	*0*	*0*	*0.00*	*Null*
Amador Causeway	*1*	*1*	*2*	*1*	*1.17*	*Medium*
Kobbe Beach	*1*	*1*	*1*	*1*	*1.00*	*Low*

18.5 No Development Option

The no-development option would essentially add another island to the group of islands located within the study area, and the basic design intent is that the new land mass should blend in with the natural beauty of the area.

Impacts on surrounding communities

The presence of another uninhabited island north of Taboga is not likely to have any impact on the residents or visitors to the area, except perhaps during the construction process.

Classification of Impacts

The socioeconomic classifications for the no development alternative are shown below in Table 18-6. The uninhabited island should pose no impacts on the neighboring communities, except during the construction period.

Table 18-6: Socio Economic Impacts of No Development Option

Affected Community	Impacts/Weight factors				Total Impact (ISE)	Classification of Impact
	Physical	Dir. Economic	Ind. Economic	Property Values		
	33.33%	33.33%	16.67%	16.67%		
Ave. - all Communities					**0.19**	**Low**
Taboga	*1*	*0*	*0*	*0*	*0.33*	*Low*
Taboguilla	*0*	*0*	*0*	*0*	*0.00*	*Null*
Bique Bay	*0*	*0*	*0*	*0*	*0.00*	*Null*
Veracruz	*1*	*0*	*0*	*0*	*0.33*	*Low*
Vacamonte	*0*	*0*	*0*	*0*	*0.00*	*Null*
Amador Causeway	*0*	*0*	*0*	*0*	*0.00*	*Null*
Kobbe Beach	*1*	*1*	*0*	*0*	*0.67*	*Low*

18.6 Summary of Impacts

It is recognized that the final location of the island will play a significant role in the determination of socio economic impacts, regardless of class of long term use proposed. However, the analyses presented in this section give a general indication of the likely reaction to each of the development classes proposed in this report. In this respect, the maritime option is likely to provoke the strongest reaction, followed by the multi-use option and then the public park and no development scenarios.

However, based on the preliminary evaluations and assessments undertaken for this study, it is considered that the Artificial Island project will have the following socio economic impacts on the surrounding communities:

Maritime Use Concept..... High

Multi Use Development ..... Medium

Public Park Concept..... Low

No Development Option..... Low

19 DESIGN OF MAIN FEATURES

19.1 Basis for Assessment of Design Features

To this point in the report, all analyses have been concentrated on the location, configuration of the artificial island under different long term development scenarios. However, in order to provide a realistic comparison with other materials disposal alternatives presented in the Disposal Options Report, the cost analyses have been restricted to the transportation of material to the work site and the basic project elements that are specific to a particular location or proposed land use.

In this next section the financial implications of the long term development options for the island are examined and compared. In this way, the additional investment in infrastructure or other works can be tested against the value added potential in order to evaluate the potential financial return on long term use alternatives that go beyond the simple disposal of the excavated materials.

The specific additional expenditures associated with each of the development options vary considerably, and the return on the investment will also vary according to the level of infrastructure provided by the project sponsor. For the purposes of this report, the cost of the base infrastructure is presented, regardless of the responsibility for the costs involved.

Based on this premise, the added investment components of each of the long term use options are likely to include, the following items. Those cost elements to have the potential for funding or provision by the private sector are shown in italics:

- Maritime Development Option
    - Navigation Channel (included in base costs presented in Section 13.8.8)
    - Causeway breaches and bridge (included in base costs presented in Section 13.8.8)
    - Highway access, paving and causeway surface construction
    - Island Highway network system
    - Utilities and distribution network
    - *Marine Structures*
    - *Container Terminal Paving, buildings and Gates*
    - Rail connections and circulation on the island

- Multi-Use Development
    - *Causeway breaches and bridge (included in base costs presented in Section 13.8.8)*
    - *Highway access, paving and causeway surface construction*
    - *Island Highway network system*
    - *Utilities and distribution network*

- Public Park
    - Causeway breaches and bridge (included in base costs presented in Section 13.8.8)
    - Highway access, paving and causeway surface construction
    - Island Highway network system
    - Utilities and distribution network
    - Public Parks and *recreational facilities*

- No Development Option
    - As its title implies, no additional investment would be made for this option, beyond the provision of shorefront armor materials to prevent loss of fill material into the water column. The cost of this item and the removal of the temporary causeway on completion of construction were included in the costs presented in Section 13 of this report.

19.2 Maritime Development

19.2.1 Marine Terminal Modules

A modern import/export style container terminal will handle approximately 394 teus per m of berth per year[26], while the berths at a transhipment terminal such as that expected for the Artificial Island could handle up to 1,000 teu/meter/year.

The original site proposed in the Preliminary Island report and three of the five sites evaluated in 13.8 are shown in Figure 19-1.

Figure 19-2 and Figure 19-3 show conceptual layouts for maritime development at Site P1 and PS-5. Both sites offer the potential to construct a total of three modern state of the art container transshipment terminals capable of handling the largest vessels that will be able to transit the Canal once the New Locks are constructed.

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[26] One-Stone report on container terminal capacity, World Cargo News, Jan 2004

Figure 19-1: Location of Potential Sites for Maritime Development Option

Terminal Throughput

The volume of material available to construct the island at either of the two locations will be sufficient to create a rectangular island with a total berth length of 2,400 m. As noted earlier, container terminal throughput will depend on the lesser of berth transfer or yard capacity. For the purposes of the computation of the capacity of a single container terminal module, berth throughput can be assessed on a random arrival basis, using average crane productivity standards as a benchmark value. If it is assumed that a maximum of five cranes will be used to work one of the Post Panamax vessels[27], with two feeder ships being handled at the same time, a total of eight cranes would seem reasonable for this class of transshipment module. Assuming a net productivity of 30 to 35 moves per hour, and an annual level of use of 2,500 hours per crane, the target berth/crane capacity of each terminal module will be approximately 650,000 lifts, or equivalent to 950,000 teus[28], including empties. Total throughput capacity of the fully developed island with three container terminals will therefore be on the order of 2.85 million teus per year.

Using the output from the M&N QuickTerm model, each container transshipment module will require a yard area of 47.6 ha, plus the berth area of some 3.00 ha, for a total of 51.00 ha per unit. Each terminal module will have a static holding capacity of 30,159 teus, necessitating 18,106 ground slots.

Non-containerized Cargo

Based on the tentative container terminal layout shown in Figure 19-2, approximately 64 ha of the island will also be available for other cargoes as demand dictates. Since the capacity of a cargo terminal varies widely according to the type of cargo being handled, there are no real rule of thumb indicators for non-containerized cargo capacity on the island. However, the following guidelines for different types of cargo give an indication of the potential throughput that might be realized from the area available:

Non Containerized general cargo (break bulks)..... 2.0 million tons per year

Liquid Bulks (Fuel products, bunker storage)..... >10.00 million tons per year

Dry Bulks (Fertilizers, miscellaneous bulks)..... 5.0 – 10 million tons per year

Automobiles or ro/ro..... 625,000 vehicles per year

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27 At the Port of Singapore, up to five cranes regularly work Post Panamax vessels at this time.

28 Assumes 40% of all containers are 40 ft units

Figure 19-2: Maritime Related Island Development at Site PS-0

Figure 19-3: Maritime Related Island Development at Site PS-1

Figure 19-4: Maritime Related Island Development at Site PS-4

Figure 19-5: Maritime Related Island Development at Site PS-5

19.2.2 Island Infrastructure

The level of interest in the investment in Port facilities from potential container terminal operators and carriers will vary according to the expected volume and business, perceived financial and political risk and the installed capacity at the Port of Balboa. However, it is expected that the Pacific side container terminals now under expansion will face a capacity crisis by the time the island project is completed. In this case, it is not unreasonable to expect that a potential container terminal operator would be willing to finance and provide the basic permanent installations required to meet its operational needs. As for the other concessions granted in Panama, these investments would include the cost of berth structures, yard and pavings, internal utilities within the container yard, gatehouse, buildings and equipment. However, it is considered unlikely that the private sector would be willing to take responsibility for the island infrastructure and the extension of the utility networks to the island, unless a Port Society was formed to manage the concessions and operate as the island administrator.

The first level of additional investment over the basic transportation and island construction costs therefore involves the provision of these basic essential elements of the maritime development island. These include:

- Completion of Highway Access (pavement along causeway sections)
- Utilities
- Landscaping/Mitigation
- Public Access areas
- Security Installations and fencing

The requirements, recommendations and cost of the dredged channel and turning basin for the port was addressed earlier as part of the island location studies and will not be repeated here. Requirements and costs for the causeway breach structures and the mid causeway bridge were also presented as part of the initial cost assessments and are not repeated in the following sections.

The development concept for the maritime island assumes that the rail line installed for materials haulage will later be used to link the island with the Panama Canal Railroad yard in the Albrook/Balboa area. For this to happen, rail bridges will be required at the existing Miraflores and the new Locks. The cost of these links has not been included in the infrastructure cost estimates at this time, pending a decision on the viability of the bridge links and its potential impact on Panama Canal operations.

Infrastructure costs are divided into three Phases, to support an incremental demand and island development strategy. The three phases of Infrastructure development include:

- **Phase 1** – Completion of access road on causeway, main lighting, power, water and utilities to island, first level of internal road systems, public access areas, parks and landscaping, dredging of 225 m wide channel to first container module.

- **Phase 2** – Extension of highway and utility networks, expansion of dredged area to accommodate second container terminal

- **Phase 3** - Extension of highway and utility networks, expansion of dredged area to accommodate third container terminal. Possible expansion and deepening of navigation channel.

Land Access

Based on the cost comparison between and open piled and closed causeway connection and taking into account the results of the hydrodynamic model, it is recommended that the land access to the maritime develop would be via a causeway-trestle-bridge combination.

Rubble Mound Causeway

The design of the rubble mound causeway was presented earlier in Section 13 and will not be repeated here.

Trestle Sections

The standards and codes used to design the two trestle sections and mid causeway bridge are the same as those used for the design of the berth and listed in the previous paragraphs. In addition to dead, live, vehicle, and seismic loads, railroad loads were also considered using the AREA Manual for Railway Engineering. A 200-m open pile trestle will be located near the shoreline designed to permit movement of littoral material along the shoreline and offer a passage for marine life. A second breach 100 m long would be constructed at the connection of the causeway to the main body of the island.

The trestle sections for the maritime island will have a 41.3-m wide deck constructed from prestressed precast concrete panels supported on square prestressed precast concrete piles longitudinally spaced at 10 m on center as shown in Figure 19-6. At approximately the mid-point of the causeway a 100-m bridge will be constructed to permit the passage of small fishing vessels. The 3-span bridge will have two 25-m spans and one 50-m span in the center to permit fish passage, current circulations and

also permit small craft to navigate along the coastline without having to cross the main navigation channel to the Port. A single span bridge was considered but the causeway slope obstructed the desired 50-m horizontal channel clearance. The bridge will consist of AASHTO prestressed girders with variable height supported on cast-in-place concrete columns, which in turn will be supported by square prestressed precast concrete piles. The remainder of the access road will be made of a 56.2-m wide causeway consisting of a quarry run core and armor stone placed on a 1:2 slope along the sides of the core as shown in Figure 19-7.

Figure 19-6: Maritime Island AccessTrestle - Typical Section

Figure 19-7: Maritime Island Access Causeway - Typical Section

Figure 19-8: Maritime Island Fishing Boat Bridge – Elevation & Section

Figure 19-9 : Maritime Island Fishing Boat Bridge Approaches - Elevation & Section

Utilities

Overview

Utilities for the maritime development island would include electrical power, cable communication, potable water, sewage handling and natural gas. Seawater to augment fire fighting would be the preferred option for the maritime-use development, due to the high volume of water required in an emergency situation. However, the need for frequent tests and maintenance would eliminate it from consideration for the remainder of the island.

Utilities would be delivered to the island in dedicated utility trenches in the causeway. Once on the island, utility distributions would follow standard distribution patterns following normal methods for development in Panama. However, as a maritime related development, all power and telephone lines would be laid underground to avoid accidental contact with high vehicles, port equipment and general aesthetics.

Electrical Power

High voltage power cables would be installed in the causeway utility trench to bring power to a sub station on the island. The shore connection point and capacity is undetermined at this stage of study, so it is assumed that an adequate service connection will be made available at the shore by the utility agency.

For the maritime development, a maximum power load of 10 MVA may be required to operate the electrical container cranes, bulk conveyors, pumps, motors, etc. that will be required. Power would be delivered from shore at 12,000 volts or higher, and a distribution loop (underground) at this voltage would loop the island. Transformer substations should drop the voltage to the appropriate level required by the user, 4160 for container cranes, 480 volt for conveyors and pumps, lighting, etc. Metering will probably be done at each business property line, but this will depend on whether or not the utility supply company acquires and maintains the system.

Communications in the form of some combination of cable, conventional telephone and fiber optic service would be provided in the causeway trench, but would require adequate separation or shielding from the high voltage power.

Potable Water

Potable water would be delivered from shore in a pipeline located in the utility trench. As with the electrical power, the capacity and connection point on shore is undetermined at this time.

The maritime development will require potable water for administration buildings, commercial buildings, restrooms, miscellaneous wash down hoses, and fire water. Daily consumption will be low, on the order of 50,000 gallons/day (35 GPM), but

instantaneous demand for fire protection will be high at 12,000-16,000 GPM. To meet this need, a 20-inch to 24-inch supply main from shore and a similarly sized loop around the island is required. The use of seawater for fire protection of the marine terminals would reduce the size and cost of the potable water system and also provide a dual system in the event that one or the other was overstressed during an emergency event.

Sewage Treatment Options

Sewage collected on the island can be taken to a treatment plant on the island, or pumped to a sewage treatment plant on shore. The first option would be less expensive since all treatment would be local, but this system uses up limited island area and creates the possibility of undesirable odors. The shore side facility, if it is reasonably near the causeway to shore intersection, only requires the addition of a lift and pump station on the island and a pipeline to the shoreline. The pipeline would probably be in the order of 6 to 8 inches in diameter depending on population density. The shore side facility may also be less expensive since more space should be available for treatment ponds and sludge basins.

Storm Water Drainage

Given the high intensity of rain storms in Panama, it is not considered practical to provide treatment for the storm water discharge from the island. However, the marine terminals would be required to have oil water separator systems and all outlets from the island would have catchment basins and grilles to prevent discharge of solids, debris or litter into the Bay.

Natural Gas

If available in Panama, natural gas is needed in the maritime-use development for material processing, water heaters, incinerators, etc. The demand should be low overall with a 6-inch high-pressure line probably adequate. For the mixed-use development demand may be slightly higher due to more water heaters and stoves in the residential and commercial areas. As with any utility planning a careful study of land use is needed to determine demand. If for some reason natural gas is not available reasonable close to the causeway on shore, bottled propane can serve as the alternate fuel source, but is more expensive and less versatile from a distribution standpoint.

Wave Protection Requirements

Wave protection requirements for the maritime island vary according to the type of structure and its exposure. Site PS-0 has an offshore breakwater to protect the main container berth area and also to permit the construction of future berths for non-container vessels on the south face of the island. All of the other locations evaluated in

this report have protection to the berth areas from the orientation of the marine terminal area and do not require the breakwater. Wave protection is also required to the exposed faces of each of the island locations and causeway options. Finally armor stone protection is required below the berths to prevent loss of material by ship wash action.

Design Wave Height

According to the analysis presented in Section 7.1 of Volume 1, the significant wave height (Hs) of the 100 year deepwater wave in the project area is computed to be 3.6 m. However, this is reduced to 0.7 m with a 17 second period at the study site, which supports the concerns over the incidence of long period waves in the area. Then design wave for breakwater and shoreline protection is then a function of the local wave regime, which was modeled on the basis of wind records and fetch distance. This second level of analysis indicates that the 100 year return local wave has an Hs of 1.8 m and a period of 4.1 seconds. This is then taken as the design wave height for incidences from the east, south and west of the project area.

Since all of the alternative locations for the maritime island are within a distance of approximately 6 km, the only real differentiation between wave protection needs will be the influence of the islands of Taboga and Taboguilla, and the orientation of the berth structures.

For the purposes of this conceptual analysis, and taking into account the mild wave climate in the area, it has been assumed that wave conditions will be similar for all of the island locations and configurations, with the noted exception of the breakwater structure proposed for alternative PS-0

Wave Protection Recommendations

According to the Shore Protection Manual[29], which is taken as the primary guideline document for the design of rubble mount structure protection, rock armor protection size is a function of specific gravity, slope, acceptable damage criteria and the return period selected. Given the importance of wave protection to expensive installations within a port area, a return period of 100 years is normally selected as a basis for design.

Adjustments to the ideal slope of a structure can also assist with the reduction of armor stone size where conditions are relatively severe. However the optimum slope for any rock armoured coastal structure is close to the natural angle of repose of the fill, which for quarry run material, will normally fall between 1 vertical to 1.75 or 2.0 horizontal.

For the island project, wave conditions can be classified as mild and the design size for armor stone falls well within the size of rock likely to be available from the excavation

[29] Shore Protection Manual, US Army Corps of Engineers, 2001

sites. Table 19-1 shows the recommended armor stone sizes and layer thicknesses for the protection to the different elements of the island structures presented in this report.

Table 19-1: Wave Protection Specifications

Island Component	Side Slope	Armor Stone W50 (tonnes)	Layer thickness (m)
Offshore Breakwater			
Exposed Face and crest	1V:2.5H	1.00	1.50
Breakwater Head	1V:2.5H	2.00	2.00
Inside face	1V:2.0H	1.00	1.50
Causeway			
East facing slopes	1V:2.0H	1.00	1.50
West facing slopes	1V:2.0H	1.00	1.50
Revetments to Island			
South Facing slopes	1V:2.0H	1.00	1.50
Other slopes	1V:2.0H	0.10	0.75
Revetments below berths	1V:1.75H	0.10	0.75

Note: W50 represents the weight of 50% of the primary armor stone. Maximum and minimum size for rock is 2.25 x W50 and 0.30 x W50 respectively. Size of rock in second layer of armor is 10% x W50 of primary armor.

Ship Motion Evaluation

As noted earlier, the incidence of a 17 second wave from the south west gives rise to concerns over ship motion, as it does for many of the ports on the Pacific Coast of North and South America. While this problem is not a major concern for bulk or other classes of vessels, it creates significant difficulties for container vessels, due to the high transfer

rate requirements for the ship to berth transfer. Continuous ranging of the vessel at the berth makes it more difficult for the crane operator to accurately place the spreader bar onto the container, which in turn can have a dramatic effect of crane productivity. Other ports subject to this problem also experience accelerated fender damage due to the high longitudinal loads that are imposed on the energy absorption units, which are mainly designed to resist forces perpendicular to the berth.

The evaluation of long period waves is very specific to a particular site and requires intensive local data collection and measurement, which is beyond the scope of this study. Unfortunately, the problem cannot be easily resolved since long period waves can penetrate narrow openings in breakwaters, as at the port of San Antonio in Chile and other locations.

It is strongly recommended that no decision be taken on the development of container berths at any of the sites evaluated until this phenomenon has been fully evaluated. As at Pier J in the Port of Long Beach, this problem can lead to the abandonment[30] of the facility and could be a serious impediment to the success of the maritime island development concept if not fully evaluated and addressed.

19.2.3 Cost Estimates – Phased Infrastructure Development

Table 19-2 shows the estimated costs necessary to provide the infrastructure required to enable maritime development to take place on the artificial island. In order to simplify the analyses, Location PS-3 is taken as a basis for the costs, since it represents a mid point in the likely range of costs of the maritime island and might also be considered to be the least controversial of the locations. For details of the estimates, the reader is referred to Appendix I of this report.

[30] After extensive data collection and modeling, additional breakwater arms were constructed outside the entrance to this terminal, which is inside the main breakwaters of the Long Beach-Los Angeles port complex. While the breakwaters did reduce the severity of the problem, the high handling rates of the modern container cranes could not be achieved at this berth and the facility has now been closed as a container terminal.

Table 19-2: Basic Infrastructure Costs – Maritime Island Alternative PS-3

Item	Estimated Cost - (US$ 2004)			
	Phase 1	Phase 2	Phase 3	Total
Mobilization	750,000	500,000	200,000	1,450,000
Roads and Paved Areas				
Road Access on Causeway	3,150,000			3,150,000
Island Circulation Roads	2,475,000	1,350,000	900,000	4,725,000
Paved areas and public parking	1,800,000	1,800,000	900,000	4,500,000
Utilities				
Marine Terminal Power Supply	12,000,000	2,000,000	1,000,000	15,000,000
Island Power Supply	7,000,000			7,000,000
Island Power Network	3,000,000	2,000,000	1,000,000	6,000,000
Lighting	1,500,000	600,000	500,000	2,600,000
Communication Systems	2,000,000	800,000	500,000	3,300,000
Potable water supply	1,500,000	950,000	350,000	2,800,000
Sea water fire system to terminals	3,500,000	2,000,000	2,000,000	7,500,000
Fresh water fire system to island	7,500,000	1,500,000	500,000	9,500,000
On Shore Waste Water Treatment Plant	3,000,000			3,000,000
Island Waste collection system	1,500,000	1,200,000	1,000,000	3,700,000
Storm Water Drainage System	4,375,000	700,000	350,000	5,425,000
Public Area landscaping	750,000	500,000	200,000	1,450,000
Security and Fencing	350,000	150,000	50,000	550,000
Sub Total	**$56,150,000**	**$16,050,000**	**$9,450,000**	**$81,650,000**
Contingencies at 20%	$11,230,000	$3,210,000	$1,890,000	$16,330,000
Estimated Infrastructure Cost	**$67,380,000**	**$19,260,000**	**$11,340,000**	**$97,980,000**

Marine Terminals - Structures

Assuming that the port terminals will be used to accommodate the largest container vessels able to transit the Canal following the completion of the new Locks, a preliminary berth design was undertaken and cost estimates developed for the marine structures.

Based on the parameters discussed in section 13.5 for existing and future container traffic, the container terminal should be designed to accommodate a 386 m vessel, drawing 15.2 m fully loaded. Assuming a terminal module designed to receive one 9,200 and one 10,500 TEU mainline vessels at one time, this then indicates a module berth length of 850 m with a draft of 16.75 m.

The design of the berth involves the consideration of several loads in accordance with the following references, standards and codes:

- American Concrete Institute,*Building Code Requirements for Structural Concrete and Commentary, (ACI 318-02), 2002*

- American Association of State Highway and Transportation Officials (AASHTO), *Standard Specifications for Highway Bridges*, 16th Edition, 1996, with 1997, 1998, 1999 Modifications
- ANSI/ASCE-7-98, Standard, Minimum Design Loads for Buildings and Other Structures, 1998
- Military Handbook – *Piers and Wharves* (MIL-HDBK1025/1)

Structure

Typical structural loads, such as, dead, live, vehicle and seismic loads were considered. In addition to these loads, vessel berthing forces and mooring forces defined by the design vessel under consideration were applied to the analysis. The loads caused by container cranes were also identified as indicated below.

Design Criteria

Design vessel

The design vessel to be considered for berths Terminal will be a container ship with a capacity of between 9,000 to 10,500 TEU. It will have a length of 386 m and a fully loaded draft of 15.2 m.

Vertical live load

The wharf should be designed to accommodate a uniformly distributed live load of 1000 pounds per square foot (psf) distributed to produce maximum stress. The trestle and bridge will be designed for 640 psf, sufficient to accommodate the passage of heavy port equipment, special project cargos on flat bed multi-wheeled trailers, containers and container chassis and mobile cranes broken down for transport over public highways.

Container crane

The Post Panamax crane envisaged for the terminals will have a 100 ft rail gauge and an operating vertical wheel load of 237 kips at 5'-0" spacing for an equivalent uniform load of 47.40 kip per foot. Lateral (perpendicular to rail) and longitudinal (parallel to rail) components of the 100-foot gauge container crane may be taken as 5% and 10% respectively of the total lifted load plus the dead load of the crane, both applied one-half to each of the two runways or crane girders.

Vehicle load

In accordance with AASHTO Standard Specifications for Highway Bridges for an HS 20-44 truck or equivalent loading. Vehicle impact is included in accordance with MIL-HDBK 1025/1 requirements. When an HS 20-44 load is applied the uniform live load will be removed.

Vessel Berthing

Vessel berthing force is based on the design vessels defined above, with berthing energies calculated based on vessel displacement, and a berthing velocity of 15 cm/sec and angle of approach of 10 degrees. Berthing energies are calculated in accordance with MIL-HDBK1025/1. Longitudinal component of berthing force with a 33 percent allowable stress increase for berthing forces only.

Mooring Forces

Mooring force are applied to the breasting and spring lines of the fully laden controlling design vessel under a 60 mph wind velocity. Vertical line angles typically range from 15 degrees below horizontal to 45 degrees above horizontal.

Seismic loads

For the conceptual analyses the lateral load due to a seismic event is considered to be around 10% of the structure weight plus 25 percent of the deck live load.

Figure 19-10 depicts a berth design that meets the functional requirements and design criteria outlined above. The structure consists of a 40-m wide structure with 20-in. square prestressed- precast concrete piles spaced at 4.8 m on center. The cost of this structure would be approximately $67,100 per meter of length.

Figure 19-10: Typical Cross Section at Container Berth

Container Yards and Facilities

Each container module will be a self contained unit, although all terminals would probably share the primary security check point and rail yard connections. A typical container terminal yard area will contain the following components:

- Entrance complex
- Maintenance and Operations Buildings
- Gatehouse and security control points
- Paved area appropriate to yard equipment needs
- Fire fighting system
- Storm water drainage system
- Electrical Sub Station
- Power to container crane berths and yard area
- High mast lighting
- Employee facilities
- First aid and emergency assistance stations

19.2.4 Container Terminal Cost Estimate

Assuming a typical container module of 860 m x 600 m as shown in Figure 19-3, the estimated cost of construction of each unit are presented in Table 19-3. The costs of gantry cranes and yard equipment have not been included in the estimate, since it is considered reasonable that they would be provided by the terminal operator, except for the unlikely case that ACP or a Panama public agency elected to operate the terminal directly.

Table 19-3: Estimated Construction cost of Container Terminal Module

Item	Estimated Cost - (US$ 2004)
Mobilization	500,000
Site Work and regrading	2,000,000
Container berths	50,575,000
Entrance Complex	800,000
Maintenance Building	600,000
Operations & Employee Building	625,000
Container Yard Paving	38,250,000
Internal Power Systems to berths	400,000
Terminal Power network	250,000
Lighting	1,275,000
Communication Systems	250,000
Potable water supply	785,000
Sea water fire system to terminals	1,650,000
Storm Water Drainage System	150,000
Security and Fencing	100,000
Sub Total	**$98,210,000**
Contingencies at 20%	$19,642,000
Estimated Cost of Container Module	**$117,852,000**

19.3 Multi Use Island

As noted earlier, the concept of the multi–use island envisages that a private developer would take over responsibility for the provision of all infrastructure and construction on completion of the basic island construction work. However, in order to obtain an understanding of the level of infrastructure investment that this approach might entail, Table 19-4 shows the estimated cost of the typical infrastructure costs that might be needed for a private developer to commence marketing the building lots on the island. The investment is shown in two phases based on an assumption that the project sponsor would wish to delay as much of the investment as possible until a reasonable cash flow was obtained from the initial sale of lots on the island.

Table 19-4: Basic Infrastructure Costs – Mixed Island Alternative

Item	Estimated Cost - (US$ 2004)		
	Phase 1	Phase 2	Total
Mobilization	250,000	75,000	325,000
Roads and Paved Areas			
Road Access on Causeway	765,000		765,000
Island Circulation Roads	843,750	843,750	1,687,500
Paved areas and public parking	450,000	450,000	900,000
Utilities			
Island Power Supply	7,000,000		7,000,000
Island Power Network	2,000,000	1,000,000	3,000,000
Lighting	750,000	350,000	1,100,000
Communication Systems	200,000	100,000	300,000
Potable water supply	1,500,000	650,000	2,150,000
Fresh water fire system to island	4,500,000	1,500,000	6,000,000
On Shore Waste Water Treatment Plant	5,000,000		5,000,000
Island Waste collection system	1,750,000	300,000	2,050,000
Storm Water Drainage System	4,375,000	700,000	5,075,000
Beach Creation	2,400,000	450,000	2,850,000
Public Area landscaping	1,250,000	1,250,000	2,500,000
Sub Total	**$33,033,750**	**$7,668,750**	**$40,702,500**
Contingencies at 20%	$6,606,750	$1,533,750	$8,140,500
Estimated Infrastructure Cost	**$39,640,500**	**$9,202,500**	**$48,843,000**

19.4 Public Park Option

19.4.1 Facilities

As a community benefit project, the Public park concept cannot be financed or provided by the private sector. Although it is not suggested that ACP would fund and build the parks and island features, it might be possible for the project to be sponsored by Panama government or international agencies, based on the benefits that the public access areas would bring to the city and area.

Without extensive feedback from interested agencies and parties, it is not possible to present a firm recommendation for the park concept and costs. However, given the extensive investments in the Amador Causeway, it is suggested that the island parks would have a different flavor and offer an alternative experience, such that the two community areas could supplement each other and enhance the overall recreational attractiveness of the area. Given that the estimated size of the island will be approximately 350 ha, it is considered that the following features could be accommodated within the island footprint.

- Public Beach
- Parks and trail System
- Waterfront Promenade area
- Intertidal shoreline habitat areas
- Parking for vehicles and buses
- Concession Areas for restaurants and small stores
- Special interest areas (butterfly park, aviary, tropical nursery etc)
- Restrooms and Picnic areas
- Amphitheatre for open area performances

19.4.2 Utilities

Essential utilities would be provided on the island, to include:

- Power
- Lighting
- Potable water
- Fire protection System
- Communications
- On-island water treatment plant

- Storm water drainage system

19.4.3 Estimated Costs

Table 19-5 presents the estimated costs of the infrastructure and facilities that might be offered on the public park concept island. The estimate is presented as a one time investment, in order that the full range of recreational and public facilities would be provided at the outset.

Table 19-5: Basic Infrastructure Costs – Public Park Alternative

Item	Estimated Cost - (US$ 2004)
Public Beach	1,750,000
Parks and trail System	1,000,000
Waterfront Promenade area	850,000
Intertidal shoreline habitat areas	250,000
Parking for vehicles and buses	450,000
Concession Areas for restaurants and small stores	300,000
Special interest areas (site preparation only)	150,000
Restrooms and Picnic areas	175,000
Amphitheatre for open area performances	300,000
Power supply, sub station & network	750,000
Lighting	500,000
Potable water	350,000
Fire protection System	450,000
Communications	125,000
On-island water treatment plant	750,000
Storm Water Collection & Discharge	100,000
Public Area landscaping	250,000
Sub Total	**$8,500,000**
Contingencies at 20%	$1,700,000
Estimated Infrastructure Cost	**$10,200,000**

20 SUMMARY OF COST ESTIMATES

In order to evaluate the value added potential of each alternatives, the cost estimates for each of the alternatives are broken down into the base costs for materials transport and deposition on the artificial island and those discretionary or additional costs that must be applied before any added value or community benefit can be derived from the long term use envisaged.

A third level of investment then applies to those costs that might reasonably be provided by a private sector developer taking full or partial responsibility for a specific long term development option.

The following cost summary is therefore classified as:

- Transportation Costs
- Essential infrastructure Costs
- Environmental Impact Mitigation Allowance
- Discretionary infrastructure costs
- Discretionary Development Costs

Table 20-1: Summary of Island Costs including Discretionary Investments - Phase 1

Investment Category	Maritime Development Options			Multi Use	Public Park	No Development
	PS-0	PS-3	PS-5	MS-1	PP-1	ND-1
Phase 1						
Transportation Costs	435,448,650	435,448,650	435,448,650	435,448,650	435,448,650	435,448,650
Essential infrastructure Costs						
Breakwater & Wave Protection	121,629,600	17,460,000	16,894,800	9,030,000	17,429,400	8,714,700
Causeway & Breaches	54,790,800	56,302,800	51,121,200	13,967,160	13,967,160	
Dredging	49,374,336	78,708,240	29,739,480	7,355,112	7,355,112	
Base Infrastructure	67,380,000	67,380,000	67,380,000		10,200,000	1,320,000
Impact Mitigation Allowance	7,286,234	6,552,997	6,005,841	3,493,507	3,633,002	3,341,125
Discretionary infrastructure costs*						
Roads, Utilities, Beaches, public areas				*39,640,500*		
Discretionary Development Costs						
Container Terminals (2)	*235,704,000*	*235,704,000*	*235,704,000*			
Sub Total	**$971,613,620**	**$897,556,687**	**$842,293,971**	**$508,934,929**	**$488,033,324**	**$448,824,475**

Note: Discretionary Costs refer to the facility and other development projects that the private sector might be expected to undertake.

Table 20-2: Summary of Island Costs including Discretionary Investments (Phases 2 & 3)

Investment Category	Maritime Development Options			Multi Use	Public Park	No Development
	PS-0	PS-3	PS-5	MS-1	PP-1	ND-1
Phase 2						
Essential infrastructure Costs						
Extend Road Network	4,380,000	4,380,000	4,380,000			
Extend Utilities	13,560,000	13,560,000	13,560,000			
Landscaping etc.	1,320,000	1,320,000	1,320,000			
Discretionary infrastructure costs						
Extend Road Network				1,642,500		
Extend Utilities				5,520,000		
Landscaping etc.				2,040,000		
Discretionary Development Costs						
Third Container Terminal	117,852,000	117,852,000	117,852,000			
Sub Total	**$137,112,000**	**$137,112,000**	**$137,112,000**	**$9,202,500**		
Phase 3						
Essential infrastructure Costs						
Extend Road Network	2,400,000	2,400,000	2,400,000			
Extend Utilities	8,640,000	8,640,000	8,640,000			
Landscaping etc.	300,000	300,000	300,000			
Discretionary infrastructure costs						
Extend Road Network						
Extend Utilities						
Landscaping etc.						
Discretionary Development Costs						
Sub Total	**$11,340,000**	**$11,340,000**	**$11,340,000**			

Table 20-3: Summary of Island Costs – All Phases

Investment Category	Maritime Development Options			Multi Use	Public Park	No Development
	PS-0	PS-3	PS-5	MS-1	PP-1	ND-1
Materials Transportation Costs	435,448,650	435,448,650	435,448,650	435,448,650	435,448,650	435,448,650
Impact Mitigation Allowance	7,286,234	6,552,997	6,005,841	3,493,507	3,633,002	3,341,125
Essential Infrastructure Costs	323,774,736	250,451,040	195,735,480	30,352,272	48,951,672	10,034,700
Discretionary Infrrastructure Costs				48,843,000		
Discretionary Development Costs	353,556,000	353,556,000	353,556,000			
Total Project Costs	**1,120,065,620**	**1,046,008,687**	**990,745,971**	**518,137,429**	**488,033,324**	**448,824,475**

21 VALUE ADDED ASSESSMENT

The cost estimates presented in the previous sections indicate that the transportation of materials and basic construction of the artificial island will cost approximately $130 million more than the placement of material at the UXO site, as presented in the PSED2004 report. Although it is recognized that there are significant unknowns over the cost of the site clearance and restoration of the UXO areas, the overall difference in costs between the options is significant and it is not expected that the gap will close as more detailed analysis is undertaken.

The respective base transportation and infrastructure development costs of the UXO sites, open water disposal and the various island options are as shown in Table 21-1, below

Table 21-1: Comparison of Basic Island Costs with UXO site

Description	UXO Site	No Development Option	Open Water Disposal
Site Preparation/Prelims	$2,363,790		
UXO Clearance	$11,724,306		
Transportation	$292,102,200	$435,448,650	$457,987,400
Site Restoration	$4,761,323	$10,034,700	
Mitigation	$2,497,338	$3,341,125	
Total Cost	**$313,448,956**	**$448,824,475**	**$457,987,400**
Equivalent Cost per m3	$3.48	$4.98	$5.08

Perhaps more importantly, the use of the UXO site or any other land based disposal option provides no added value. In comparison, the island project offers the opportunity to not only add value to the project, but to also generate long term economic benefits in terms of employment opportunities, enhance regional land values and community access to the public facilities to be included within the project.

In order to develop an assessment of the viability of the value added island options, it is then reasonable to first use the costs of the UXO site as a benchmark to test the value added options for the Artificial island.

The second level of analysis must then consider the financial risk associated with the added infrastructure costs required to make the island ready to be developed or marketed to the private sector.

Finally the island developer or private sector user must also provide essential infrastructure in order to generate revenue or sales of the generated land. Depending on the class of long term development proposed, these costs may or may not be borne by the private sector, but the allocation of these investments then impacts the value of the land or lots and may change the viability of the project.

This section then examines a range of potential income or sales that might be derived from the value added options. It is not an exhaustive analysis and due to the confidential nature of this study, cannot present any detailed assessment of the potential market for any of the options. Therefore it can only be used as a first level evaluation of the potential viability of the value added concept, which must be further tested in the event that a decision is made to pursue the artificial island concept further.

21.1 Maritime Terminal Development

Private sector involvement in modern high volume container terminal development is undertaken by not more than eight to ten international companies and vessel operators. Typical operating companies are HIT and SSA, both of which have port concessions in Panama at this time. Others include P&O and the CSX groups. Vessel operators that also build or operated container terminals include Maersk SeaLand, Evergreen and Hanjin, among others.

21.1.1 Concession arrangements

Most new container construction outside the US is implemented under concession agreements between private sector investors and regional or national government entities. The Manzanillo, Evergreen and Panama Ports Company concessions in Cristobal and Balboa are recent examples of these arrangements.

There are essentially three approaches to container terminal development. Each has varying degrees of risk for the concession holder and owner, with consequent variations in investment costs and revenue.

- Build, operate and transfer (BOT) Full concession, where the concession holder builds and operates the terminal for a specific period, usually on the order of 25 to 35 years, with the facility ownership returning to the landlord on completion of the concession term. This is closest to the Panama model.
- Operating Concession – The landlord builds the permanent installations, and possibly provides gantry cranes. The concession holder operates the terminal

using its own yard equipment and personnel. Duration of agreement can be five to 20 years.

- Owner Operation. The project sponsor builds and operates the terminal, often with concessions for special services, such as stevedoring, tugs etc.

As noted above, in South America and Asia, the BOT approach is far more common, as governments move away from public support for infrastructure projects. This is probably the most logical approach for this project, and follows the models of the Manzanillo, Evergreen and Balboa container terminals.

The most common system in the US is the landlord/lease system, whereby the container terminal will be constructed by the port agency or public entity. This is mainly the result of significant public financing and funding for port projects.

21.1.2 Potential Income Expectations

Container Terminals

Concession fees and lease rates for container terminals vary widely, dependent on the level of facilities or infrastructure provided by the owner, market conditions and political risk. As one of the prime locations for container traffic, Panama is well positioned to take advantage of its position and enhance its standing as a distribution point. This market may well improve following the move to larger container ships once the Canal expansion program is complete, as many of the existing ports will not be able to accommodate the larger vessels and local markets will be too small to justify direct calls on all but a few locations.

The most simplistic approach to projecting income from container terminals and other cargo operations is probably the simple lease system, where an operator leases the terminal on an area or throughput basis. As noted above, lease rates vary widely according to market conditions and competition for terminal capacity, but in general terms, a typical lease on a developed terminal, excluding equipment, buildings and cranes, will be between $75,000 and $275,000 per ha per year.

Direct comparison of the container terminal costs with other leases on a simple cost basis can be misleading, since throughput and revenue potential will vary considerably. For example, US west coast terminal throughput is often close to 10,000 teus per hectare per year, while throughput at transshipment terminals such as Manzanillo or HIT in Panama is on the order of 20,000 teus per hectare. Ports such as Singapore and Hong Kong claim throughputs of 30,000 to 50,000 teus per hectare. These all speak directly to the amount a private operator is willing to pay for a terminal.

However, it is understood that the existing Panama Ports expansion at Balboa represents the final capacity increment that will be physically possible on the Pacific side. It can be argued that the maritime island project will be an attractive investment by the time the island construction is completed, since the installed capacity at Balboa would be absorbed by that time.

A lease rate of $200,000 per ha would then generate $10.00 million per container terminal or a total of $30.00 million per year, assuming that the project owner installs the berths, pavings and utilities for each of the terminal modules.

Another approach is to evaluate the concession fee that a private port operator would be likely to pay for a greenfield site, that requires significant investment, such as the Manzanillo, Balboa and Evergreen terminals.

It is reported that typical operating costs at a modern container terminal are on the order of $45 to $75 per teu handled, including empty units. Rates to customers for transshipment container moves off and onto a vessel vary from $60 to $90. Concession fees vary widely but fall normally between 7.5 and 15 % of the customer cost.

Applying this very crude comparison for Panama indicates that each terminal could be expected to generate some $4.25 million per year in concession fees if the terminal operator took responsibility for the construction of the marine facilities, equipment etc.

The project sponsor might therefore expect to generate $12.75 million per year in concession fees from the three container terminals if the private sector undertook the responsibility for all construction within the terminal limits.

Value added and Distribution Facilities

Typically each developer or tenant in the VAD area will wish to build its own complex or facility on leased or purchased land.

A detailed study is required to determine a typical range of lease or sale costs that would apply to this project. However, potential lease rates for prime waterfront development ready sites will normally range from 8.0 to 12.0% of appraised value per year. This then translates to a low of $30,000 to as much as $120,000/ha/year, depending on location, market potential and level of demand.

The maritime island is expected to have some 120 ha of land available for value added or other commercial activities, which translates to approximately 80 ha of directly marketable area. The application of a lease rate of $75,000 per ha would then generate approximately $6.0 million in revenues.

An informal telephone survey of appraised land values in Panama was undertaken for this project to give an indication of potential sales costs for lots on the mixed use island. The survey indicates that developable land in Panama for industrial or non prime area

activities ranges from a low of $10 per m2 in Veracruz to $50 per m2 in the more desirable locations.

It appears reasonable to assume that the value added parcels on the island will be an attractive investment once the container terminals are established, and the equivalent total income that might be derived from the sale of the 80 ha area would be $40.0 million.

The island will also offer approximately 50 ha of space for non containerized marine terminals, support facilities and other commercial businesses. Taken on a simplistic area comparison, the marketable portion of this area could generate approximately $3.00 million per year in lease income or $20 million in one time sale costs.

Summary – Maritime Island

In summary, the potential income from the marine terminals and value added development on the island could be as shown in Table 21-2.

Table 21-2: Estimated Annual Lease or Sale Revenues from Maritime Development Project

Annual Income ($ 2004)	Lease		Sale	
	Greenfield	Developed	Greenfield	Developed
Container Terminals (3)	$12,750,000	$40,000,000	n/a	n/a
Value Added Lots		$6,000,000		$40,000,000
Miscellaneous development		$3,000,000		$20,000,000

As a lease based project, the potential income from the maritime island must be set against the capital investment costs over an extended period of time, unlike the multi use concept which can be viewed as a sales venture.

Table 21-3 presents a preliminary cash flow model covering the lease income from a BOT concession for the three container terminals and the lease of the back up lands. It assumes that the basic island infrastructure would be provided by the project sponsor. As can be seen from the Net Present Value (NPV) columns, the net cash flow from the development and leasing of the island for Maritime use has a negative NPV of $428.9 million at year 2030, as compared to the UXO site with a negative NPV of $259.70 million. This then implies that the long term use of the island for maritime purposes is unattractive financially, and can only be justified in terms of strategic development strategy, economic benefits or creation of economic opportunities for Panama.

Table 21-3: Estimated Cash Flow from Maritime Island Development ($Millions)

Year	Investments ($ millions)			Income ($ millions)				Net Cash Flow	UXO Site
	Transport & Island Construction	Infra-structure	Total	Container Terminals	Value Added Area	Other	Total		
2007	72.57		72.57					(72.57)	(52.24)
2008	74.39		74.39					(74.39)	(53.55)
2009	79.53	19.37	98.90					(98.90)	(54.88)
2010	84.79	104.15	188.94					(188.94)	(56.26)
2011	86.91	108.73	195.64					(195.64)	(57.66)
2012	89.08	10.43	99.51					(99.51)	(59.10)
2013		10.69	10.69					(10.69)	
2014				10.10	3.57	1.78	15.45	15.45	
2015				10.36	3.66	1.83	15.84	15.84	
2016		14.16	14.16	10.62	3.75	1.87	16.24	2.07	
2017				10.88	3.84	1.92	16.64	16.64	
2018				11.15	6.15	3.08	20.38	20.38	
2019				17.15	6.30	3.15	26.60	26.60	
2020				17.58	6.46	3.23	27.27	27.27	
2021				18.02	6.62	3.31	27.95	27.95	
2022				18.47	6.79	3.39	28.65	28.65	
2023				18.93	6.96	3.48	29.37	29.37	
2024				19.40	7.13	3.57	30.10	30.10	
2025				19.89	7.31	3.66	30.85	30.85	
2026				20.38	7.49	3.75	31.62	31.62	
2027				20.89	7.68	3.84	32.41	32.41	
2028				21.41	7.87	3.94	33.22	33.22	
2029				21.95	8.07	4.04	34.06	34.06	
2030				22.50	8.27	4.14	34.91	34.91	
NPV	**$377.65**	**$220.11**	**$567.04**	**$146.82**	**$54.89**	**$27.45**	**$138.12**	**($428.92)**	**($259.70)**

Note: Assumed discount rate is 7.5%, assumed Inflation rate is 2.5% per year.

While it is recognized that the numbers presented in Table 21-3 are extremely crude, the first impression is that the maritime development option does not represent an attractive investment for ACP. However, according to economic benefits studies[31] for other projects, the establishment of the marine and commercial operations on the island could generate over 4,000 employment opportunities and significant indirect benefits.

[31] The MARAD Port Kit Model, version 2000, US Department of Commerce.

21.2 Multi Use Development Concept

Although a private sector developer of the multi use island might be willing to lease lots for commercial or other activities, the most likely scenario is that all parcels would be sold. The developer would provide the basic island infrastructure and might also be involved in the construction of homes etc, but this income would not accrue to ACP or the project sponsor and does not form part of the added value evaluation.

The subsequent analysis therefore examines the potential amounts a client would expect to pay for land parcels on the island. In order to test the overall viability of the project, the infrastructure costs, developer concession fees and island construction costs must be subtracted from this amount.

As note earlier, the consultants carried out an informal evaluation of appraised land values in Panama to provide a basis for estimating the potential cost of various land uses on the mixed use island. As can be seen from Table 21-4, there is an extremely wide variation in costs, from as little as $10.00 per m2 in the Veracruz area or outside Panama City, to $750 per m2 for upscale single family home waterfront developments such as the Punta Pacifica project.

It is also important to recognize that the informal assessment of real estate prices does not take into account the market conditions or level of demand for property in Panama. While the values indicated in Table 21-4 are representative of typical market prices at this time, they do not reflect demand in each of the locations shown

Table 21-4: Current Appraised land Values in Panama

Location	Current Market Value ($/m2)
Punta Pacifica	$750.00
Vista Mar (prime lots)	$250.00
Vista Mar (duplex lots)	$180.00
Amador (sea view)	$475.00
Taboga (Prime lots)	$200.00
Taboga (Sea view)	$100.00
Taboga	$50.00
Veracruz (non waterfront)	$10.00

Table 21-5: Potential Sale costs of land on Mixed Use Island

Class of Development	Total Area (ha)	Unit Cost ($/m2 2004)	Marketable Area (ha)	Income ($ 2004)
Residential Prime Lots	86.40	$750.00	20.00	$150,000,000
Residential general lots		$550.00	45.00	$247,500,000
Residential Apartment buildings	12.00	$850.00	9.60	$81,600,000
Commercial	26.40	$75.00	15.84	$11,880,000
Commercial/Mixed Use	6.80	$75.00	5.10	$3,825,000
Hotels/Resorts	18.60	$450.00	9.30	$41,850,000
Marina	3.10	$25.00	2.79	$697,500
Golf Course & Country Club	65.90	$15.00	65.90	$9,885,000
Parks, beach, roads etc	137.00	n.a	102.75	
Totals	**356.20**		**276.28**	**$547,237,500**

Potential Income to ACP from Mixed use development

The island development and infrastructure costs, developer fees, profit and taxes must be deducted from the overall income expectations in order to determine the income ACP might receive from the private sector developer selected to complete the multi use island project.

From Section 14, it was seen that the base costs associated with the mixed use island are as follows:

Transportation, Island construction and causeway $465,800,922

Impact Mitigation Allowance $3,493,507

Infrastructure to support development (all phases) $48,843,000

Total costs before sale of lots $518,137,429

If it is assumed that a developer "fee" for the right to market the island would be on the order of 10 % of the amount received from the sale of the lots, plus the cost of infrastructure, it could be argued that the potential income to ACP from the project might be on the order of $450 million. Dependent on the level of demand and phasing of

development, the multi use island therefore appears to be a business venture that could potentially defray part of the costs of materials disposal for the Locks project. If it is further assumed that the cost of disposal to the UXO site can be “discounted” from the total cost of the island project, this then increases the financial benefits of the option to ACP by some $130 million.

Table 21-6 presents a tentative cash flow and NPV analysis for the use of the island for mixed development. As noted above, the cash flow projections assume that the private developer will be responsible for the installation of all but the basic infrastructure, with the fees payable to ACP reduced to compensate for these costs.

From the table, it is seen that the potential NPV of the multi use development is negative $80.11 million, as compared to negative $259.70 million for the UXO site.

This then implies that the use of the island for residential and other developments could conceivable contribute approximately $180 million to the cost of the Locks projects if the sales of the lots reached the values indicated in Table 21-5, and demand was such that absorption of all of the marketable areas was achieved within a ten year period.

These are both very ambitious assumptions and given the large amounts of land available in Veracruz and the surrounding areas, there are no real assurances that the island would be a successful venture as a real estate development.

Clearly, it would be important that more detailed evaluation of the property market would be necessary before ACP should make a commitment to invest in the additional costs required to prepare the island for the Mixed Use development option.

Table 21-6: Estimated Cash Flow from Multi-Use Island Development Option

Year	Investments ($ millions)			Income	Net Cash Flow	UXO only
	Transport & Island Construction	Infra-structure	Total			
2007	72.57		72.57		(72.57)	(52.24)
2008	76.13		76.13		(76.13)	(53.55)
2009	79.78	31.88	111.66		(111.66)	(54.88)
2010	81.77	43.76	125.53		(125.53)	(56.26)
2011	83.82		83.82	30.19	(53.63)	(57.66)
2012	85.91		85.91	61.89	(24.02)	(59.10)
2013				63.44	63.44	
2014				97.53	97.53	
2015		11.49	11.49	99.97	88.48	
2016				68.31	68.31	
2017				70.02	70.02	
2018				71.77	71.77	
2019				73.57	73.57	
2020				75.40	75.40	
NPV	**$372.89**	**$76.77**	**$437.31**	**$357.20**	**($80.11)**	**($259.70)**

Note: Analysis taken to 2020 since it is assumed that all available property would be sold within ten years of island construction

22 CONSTRUCTION PLANNING

22.1 Maritime Island

22.1.1 Materials Transportation & stockpiling

As indicated in Section 10, rail transport would appear to be the favored transportation alternative for the artificial island project. Construction sequencing will therefore form a critical element of the Locks and Island project, particularly as the transportation corridor and system will need to be fully operational at the commencement of excavation work on the Locks project.

A second key consideration is the movement of the material from the shoreline to the island itself. During the initial stages of the work, the causeway access will need to be constructed and this would most probably be achieved by dump trucks rather than rail cars, necessitating storage areas as indicated in the earlier analyses.

Once the causeway is complete, and a loop dike or embankment is constructed at the island site, the trains can then move directly to the dump areas, eliminating the need to double handle the material at the shore side.

For the purposes of cost estimating for this study, separate unit costs have been developed for these two materials delivery scenarios.

22.1.2 Construction Phasing

Based on the considerations presented above, the main steps in the island construction sequencing are as follows:

1. Rail corridor earthworks, bridge construction and stream crossings
2. Delivery of rail, locomotives and equipment
3. Construction of rail lines, stockpile yards and receiving areas
4. Delivery of first phase materials to shore side stockpile area
5. Construction of causeway and temporary crossings at breaches
6. Construction of materials retaining dikes and train loops on the island
7. Dumping of material
8. Grading and compaction of material
9. Shoreline protection to exposed locations
10. Construction of breaches, bridge and expansion of causeway to full width
11. Construction of Island infrastructure and facilities

22.1.3 Island Construction

As noted above, the most cost efficient materials delivery system to the island will be to move trains directly from the Locks site to the island and side dump material where required. As the island grows, rail lines can be shifted to new work faces to open up new delivery areas.

The most common form of island construction normally involves the construction of perimeter dikes or berms, which then contain finer materials used for the main body of the fill. Given the very high percent of rock to be excavated from the Locks project area, this requirement is not so critical for the Artificial Island project, as the rock material does not require retaining dikes for structural support.

However, the large quantity of rock does pose other problems, mainly related to the development of buildings and marine facilities on the island. The main berths will be open piled structures that will be drilled into the bed rock underlying the soft sediments. The types of piles envisaged will not be able to penetrate fill material having rock particles that are larger than 150 mm in diameter, without damage or displacement, so the entire berth area must be kept clear of rock material and only contain fill that is compatible with the pile driving requirements.

Small buildings on the island can be constructed on raft foundations but if settlement of the soft sediments is an issue, piled foundations may be necessary for taller buildings, again indicating that rock cannot be placed in these areas.

Finally, utility corridors within the island should be clear of large rock pieces for ease of excavation at a later date.

Materials Selection & Placement

To meet these requirements, it is recommended that as much of the underwater fill be composed of rock as the excavated quantities permit, and filling above high water should either be from overburden material or screened rock having a maximum size of 150 mm.

In this way, compaction of the upper layers will be facilitated and there will be a minimal impact on subsequent construction tasks as the long term development program for the island takes effect.

22.1.4 Project Implementation Schedule

Figure 22-1 incorporates the key construction elements and sequencing issues into a five year excavation plan for the Locks Project. While the Gantt chart indicates a start date for excavation in early 2008, this has not yet been confirmed by ACP or its consultants. The date indicated in Figure 22-1 therefore represents the earliest date that

work on the Locks excavation could proceed, based on the steps considered to be necessary to finalize the selection, location and configuration of the disposal option. In this respect, it is seen that work on the access corridor should commence at least one year in advance of the commencement of excavation work in order to ensure that the materials removal and delivery systems are ready to receive material when required. Assuming that it will take one year to prepare the EIS or EIA for the island project and causeway connection, and to complete the final designs and contract documents, this then indicates that a decision to proceed with the island project would be needed some three years before commencement of work on the Locks.

Figure 22-1: Implementation Schedule for Maritime Island Option

22.1.5 Construction Packaging

Clearly the construction of the island will represent a major contract covering some six to seven years of activity. This study has shown that a rail transport system appears to be the most cost effective means of moving the material from the Locks to the work site. However different international contractors may have a preference for alternative delivery systems, based on availability of equipment, familiarity with other systems or other considerations. One of the fundamental rules in construction contracting is that the project owner should define the end result required and not impose unnecessary restrictions on the methods used. It is therefore suggested that contractors be allowed to propose their preferred method of transport of the materials, within reasonable limitations of time, environmental impact avoidance, interference with Panama Canal operations and other critical issues.

22.2 Multi Use Island

22.2.1 Construction Planning

Construction planning for the multi-use island will follow the same general principles as the maritime development island, with the exception that a developer should be selected early in the process. In this way, the island shape and profile can be adjusted or configured to suit an agreed Master Plan for the long term development, which would form an important part of the developer selection process.

A second advantage of the early commitment is that it would give ACP the opportunity to switch to the public park or no-development options in the event that developer proposals were not forthcoming or did not meet ACP, ANAM or public community expectations.

22.2.2 Implementation Schedule for Multi Use Island

Shows the implementation schedule for the multi-use island concept. While the construction and permitting elements of the project are similar to the maritime use concept, the selection of the private developer is critical to the project success and is therefore initiated early in the implementation process.

Figure 22-2: Implementation Schedule for Multi-Use Island Option

22.3 Public Park

The construction sequencing for the public park option follows closely on the schedule for the multi-use island, except that ACP would probably choose to evaluate the interest in the private sector multi-use concept before moving to consideration of the public park option.

The time lost in this process would be recovered by a shorter permitting and public input period, since the park concept is more likely to be acceptable to the permitting agencies and public in general.

22.4 No Development Option

Construction sequencing and processes for the no development option will also closely follow the schedules for the multi use and public park alternatives, with the exception that no infrastructure would be provided on completion of the fill. In addition, a period of approximately three months would be added to the program on completion of the island construction for removal of the temporary causeway in the event that the contractor elected to use a land based transport system for the project.

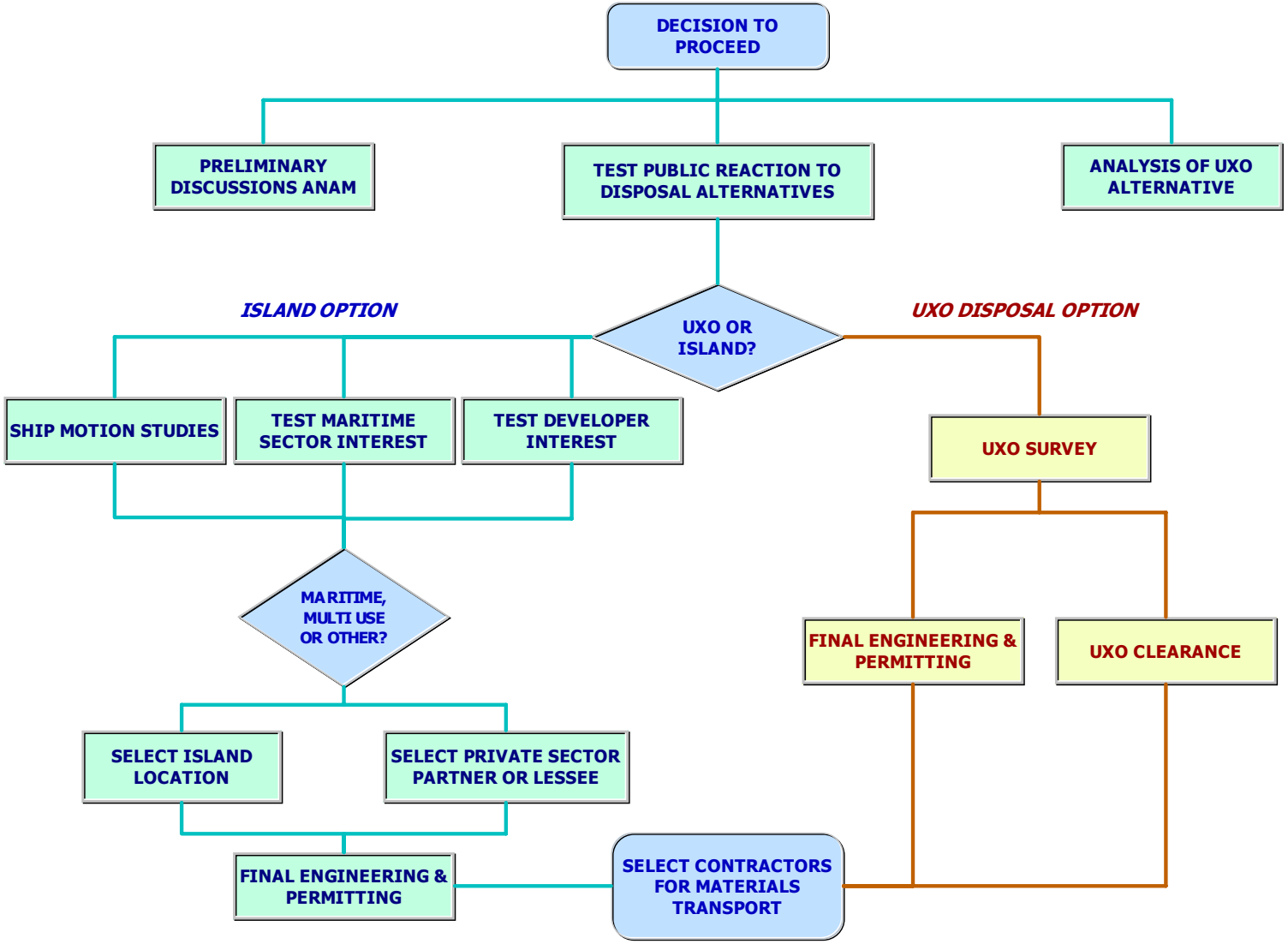
23 SELECTION OF PREFERRED ALTERNATIVE

The selection of a preferred alternative for the island project will be the result of a series of steps that will involve the permitting agencies, market evaluations of demand, analysis of the UXO site disposal alternative, high level government decisions, public reaction and detailed financial or value added assessments.

While the consultant can express opinions and show likely costs of each of the alternatives, key issues such as the public reaction to a long term use alternative or island location proposal cannot be resolved without direct communication and a public awareness campaign.

The steps required to reach a final decision on the location, configuration and long term use for the island are presented in Figure 23-1 below and were also incorporated into the Implementation schedules for the main alternatives presented in the previous section.

Figure 23-1: Decision Tree for Selection of Disposal Option



24 CONCLUSIONS & RECOMMENDATIONS

Probably the most important conclusion from this study is that there is no single location or long term use option for the island that sets it clearly apart from all the others.

The second most important conclusion is that the cost estimates indicate that the use of the artificial island as a simple disposal site is expected to be more expensive than the placement of material at the UXO area. However, given the large volumes of material involved, a modest shift in the transport costs of either alternative could readily tilt the scales of the evaluation in the other direction.

It therefore follows that the artificial island concept remains a valid option for placement of the excavated material from the Locks project. However, it is beyond the capability of the consultant or even ACP to select a preferred option at this time. Public perception of the project will be critical to its success or otherwise and seemingly attractive development options could well fall by the wayside as a result of objections from special interest groups or the public in general.

In terms of costs, it would seem that all of the maritime development options are not attractive to ACP as a financial venture, unless demand for the container terminals drives private sector offers above those considered to be standard for the industry. Given Panama's strategic location and the prospects for value added and distribution activities in the area, this may not be an unreasonable expectation. However, the market can only be tested once serious proposals are made for the maritime facility concessions.

The consultants also remain concerned over the potential disruptive effects of long period waves on container berths built at any of the location alternatives. This issue has the potential to be a fatal flaw in any container related maritime development proposal and must be thoroughly investigated before any decision can be taken to move ahead with construction of the container terminals.

The Mixed use development option seems on first analysis to be a more attractive venture from a financial viewpoint, particularly if ACP could hand the entire development responsibility to a private sector operator once the basic island construction is complete.

If successful, the Multi Use island development could effectively reduce the Locks excavation costs by approximately $190 million. However, there is a considerable risk attached to real estate development and given the high cost of the Canal Expansion project and in particular the Locks project, this may not be an additional cost that ACP wish to take on at this time.

The Public Parks concept represents a middle ground that might be considered to be mitigation or a community benefit from ACP to the people of Panama. However, the added cost of some $150 million over the UXO site is significant and would be difficult to justify in light of the high overall cost of the Locks project.

Finally, the No development option is essentially a fall back position in the event that the UXO or a cheaper disposal option cannot be made available in time for the excavation work on the Pacific Side locks. Although more expensive than the UXO site, it is cheaper than open water disposal and it would not be unrealistic to place the material at the island location and investigate mixed use value added options, or even the Park alternative at a later date. In essence, ACP could place the material at the site and then hand over development rights to a private sector entity as a concession, or offer it to Central government for development.

However, as noted above, this option would only be exercised if all other land based or less expensive disposal options were unavailable for the Locks project.

It is also clear from the results of the Disposal Study that ACP requires clarification of the preferred disposal option for the Locks project as soon as possible. Given the uncertainties noted above, it is recommended that the next steps in the selection process should be:

- Begin public discussions and presentations on the range of options for the Artificial Island Project
- Commence discussions with ANAM on the range of options and preferences for the island project
- Undertake high level discussions with the major carriers and terminal operators over the potential level of interest in the maritime development option
- Initiate informal discussions with leading private sector developers in Panama and internationally over the potential prospects for the mixed use island
- Evaluate Panama government and public interest in the Public Park concept
- Undertake more detailed studies of the UXO sites to determine risk and costs of the use of this site.
- Commence discussions with government on the political implications of use of the UXO sites for materials placement
- Commence discussions with ANAM on the use of the UXO area for disposal

Assuming that these steps would take from six to twelve months to complete, ACP will then be in a position to make a firm strategic decision on the preferred option for disposal of the material from the Locks project.

With the results of the UXO site analyses in hand, the market and public reaction to the Artificial island sites and long term uses can then be re-evaluated and a business decision taken on the preferred option for disposal of the Locks materials.

If the decision favors the Artificial Island project, the formal environmental and engineering studies can commence in earnest at that time, hopefully with the prior support of the private sector, public at large and interested agencies in local, regional and national government.