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Proposed Cruise Berthing Facility, Grand Cayman

Environmental and Engineering Consultancy Services

Environmental Statement

Non-Technical Summary - DRAFT

June 2, 2015
12214.101

Innovation, Excellence & Service

Proposed Cruise Berthing Facility, Grand Cayman

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Non-Technical Summary – DRAFT

Prepared for

Ministry of District Administration Tourism & Transport and The Port Authority of the Cayman Islands

Prepared by

Baird

W.F. Baird & Associates Coastal Engineers Ltd.

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12214.101

SECTION I - NON-TECHNICAL SUMMARY

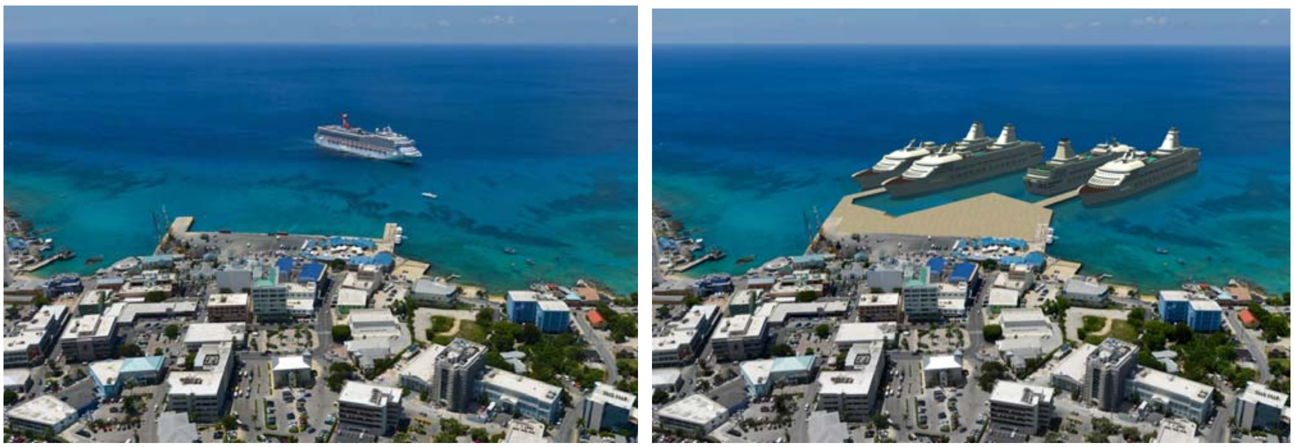
TABLE OF CONTENTS

List of Acronyms

AGRRA	Atlantic and Gulf Rapid Reef Assessment
Baird	W.F. Baird & Associates Coastal Engineers Ltd.
CBF	Cruise Berthing Facility
CIG	Cayman Islands Government
DOE	CIG Department of Environment
EAB	CIG Environmental Advisory Board
EIA	Environmental Impact Assessment
ES	Environmental Statement
GTH	George Town Harbour
GTRP	George Town Revitalization Program
IMO	International Maritime Organization
MM	Mott MacDonald
MMM	MMM Group Ltd.
MPA	Marine Protected Area
MSL	Mean Sea Level
NGO	Non-Governmental Organization
NOAA	U.S. National Ocean and Atmospheric Administration
NRA	National Roads Authority of Cayman Islands
RIAM	Rapid Impact Assessment Matrix
OBC	Outline Business Case (PricewaterhouseCoopers, October 2013)
ORIA	Owen Roberts International Airport
PACI	Port Authority of the Cayman Islands
PTB	CIG Public Transport Board
PwC	PricewaterhouseCoopers
RFP	Request for Proposals
SC	CIG Project Steering Committee
SOC	Strategic Outline Case (CIG Project Steering Committee, April 2013)
SWI	Smith Warner International Ltd.
TEMN	Technological & Environmental Network Ltd.
ToR	Final EIA Terms of Reference
WHO	World Health Organization
7MB	Seven Mile Beach

1.0 BACKGROUND

Grand Cayman is one of the few islands in the Caribbean where cruise ships must still tender their passengers ashore. Tendering involves the transfer of cruise passengers between ship and shore using small vessels. In order to improve the quality and safety of the cruise passenger experience and maintain market share, the Cayman Islands Government (CIG) is considering the development of a new cruise berthing facility in George Town Harbour. The proposed project would include a dredged berthing area and piers providing berths for four large cruise ships, with additional reclaimed land for landside facilities.



Downtown George Town and George Town Harbour – Existing Conditions and Proposed Project

The proposed project has a long history, with numerous studies having been undertaken by various groups dating back to 1994. Most recently, the CIG has overseen the completion of the following studies: Strategic Outline Case (CIG Project Steering Committee, April 2013); Concept Study (Mott MacDonald, October 2013) and Outline Business Case (PricewaterhouseCoopers, October 2013). In May 2014, the CIG retained W.F. Baird & Associates Coastal Engineers Ltd. (Baird), in association with Smith Warner International Ltd. (SWI), Technological & Environmental Network (TEMN) and The MMM Group (MMM), to undertake environmental and engineering studies for the proposed cruise berthing facility. The resulting Environmental Impact Assessment (EIA) study is now complete, and is documented in the Environmental Statement.

1.1 Project Need

Tourism is an important component of the Cayman Islands economy, representing 24% of the Gross Domestic Product and providing significant employment and entrepreneurial opportunities for residents (Strategic Outline Case, 2013). Approximately 85% of visitors to the island arrive by sea, predominantly by cruise ship. It has been noted that in recent years Cayman has been gradually losing market share in the Caribbean region. Based on feedback from the cruise industry, it was identified in the SOC that this declining trend is likely to continue unless a berthing facility is constructed to facilitate the movement of passengers to and from the cruise ships.

Presently, cruise ship passengers arriving at Grand Cayman are transferred ashore by means of small craft ("tendering"). As noted in the OBC, while the existing tendering service at GTH is rated very highly in the industry, tendering itself is considered to be a "high-risk, negative passenger experience by cruise lines and passengers alike". Another important consideration is that, due to inefficiencies associated with tendering, visitors may have to wait for long periods to come off the ships, and also have to queue and return to their vessels at a much earlier time than if berthing facilities were available. This limits the time that passengers have available to enjoy and experience the Cayman Islands.

Other jurisdictions in the Caribbean region have developed dedicated cruise berthing facilities in order to capture a greater share of cruise tourism, and to meet the needs of larger vessels, such as the relatively new *Oasis* and *Quantum* class vessels. Due to their size, these larger vessels are not well suited for tendering operations. Grand Cayman is one of the few remaining major cruise destinations without berthing facilities (OBC, 2013).

Available information suggests the potential for the declining trend in cruise traffic and market share to continue, with resultant impacts on the tourism sector and economy of the Cayman Islands, unless significant investment is made in port infrastructure improvements. The CIG expects that the proposed cruise berthing facility in George Town Harbour will strategically place the Cayman Islands in an enhanced position to maintain and/or increase its share of the growing cruise market in the Caribbean region.

1.2 Scope of Environmental Impact Assessment

Concurrent with the recognition of the need for improved cruise facilities, the CIG recognized that significant port infrastructure improvements may result in significant environmental impacts, in particular to the surrounding marine environment, as well as socio-economic impacts. In response to these issues, the CIG commissioned the present EIA study, as defined in the *Final EIA Terms of Reference* (MM, 2013). In general terms, the EIA study included a comprehensive assessment of baseline conditions and the evaluation of potential impacts of project development within fifteen different areas/topics of consideration. Specific activities undertaken to complete the EIA included the following:

- Comprehensive stakeholder engagement and public consultation process;
- Definition of baseline site and environmental design conditions, including evaluation of natural hazards;
- Development and assessment of alternatives;
- Assessment of benthic habitat and marine ecology;

- Modeling and analyses of coastal processes, sediment transport and water quality;
- Identification and assessment of anticipated environmental impacts and socio-economic impacts related to project development;
- Consideration of climate change effects throughout all aspects of the EIA;
- Identification and assessment of possible mitigation measures to reduce adverse impacts;
- Application of the Rapid Impact Assessment Matrix (RIAM) method to more objectively assess the potential impacts of the project, as well as the anticipated benefits of proposed mitigation measures;
- Preparation of an Environmental Management Plan (EMP) to guide construction of the facility.
- The EIA was carried out in accordance with the Terms of Reference that were approved by the CIG's Environmental Advisory Board (EAB).

2.0 SUMMARY OF SITE AND ENVIRONMENTAL CONDITIONS

The CIG previously identified George Town Harbour as the preferred site for the proposed cruise berthing facility. As directed by the CIG, the Environmental Impact Assessment study focused on alternatives for the George Town Harbour site; as such, no other sites were considered as part of this study.

Comprehensive investigations were undertaken to assess existing site and environmental conditions, including review of previous studies, completion of specialized field investigations and application of empirical and numerical models. These investigations provided a comprehensive understanding of baseline conditions, including the identification of specific site opportunities and constraints. These were key considerations in the development and assessment of alternatives for the proposed project, and in the assessment of potential environmental and socio-economic impacts of project construction and operations.

Figure 2.1 presents an overview of the existing site conditions, and highlights key features of the site, including the bathymetry, coral reefs, ship wrecks and existing port facilities.

Figure 2.1 Overview of Existing Site Conditions

3.0 ANALYSIS OF ALTERNATIVES

The development and assessment of various alternatives for the proposed cruise berthing facility was a critical predecessor to the EIA. The starting point for this exercise was the preferred project layout developed in the Concept Study (MM, 2013) and incorporated in the Outline Business Case (PwC, 2013). Review of this project layout identified two key concerns:

- Cut/fill balance – the volume to be dredged from the seabed was much greater than the volume needed to reclaim land, therefore requiring the disposal of a significant volume of dredged material;
- Impact on coral - the project footprint (dredging) overlays a significant area of healthy coral reef to the north of the project site (Cheeseburger/Soto's Reef).

The spatial extent and volume of dredging, the potential requirement for offshore disposal of excess dredged materials and the associated potential negative impacts (both direct and indirect) on the coral reefs in this area were deemed to be critical considerations with respect to the anticipated impacts of project construction on the natural environment. In response to these concerns, a number of alternative layouts were developed with the objective being to reduce the spatial extent and volume of dredging, and/or to reduce the requirement for offshore disposal, thereby reducing negative impacts on the marine environment.

The evaluation of project alternatives included their assessment and ranking using numerous evaluation criteria. These criteria were grouped into the following general categories:

- Project functionality;
- Environmental impacts;
- Socio-economic impacts.

This evaluation led to the development of an optimized project concept, as presented in Chapter 4.0. The optimized project layout provides a significant reduction in environmental impacts (as compared to the OBC layout) associated with reductions in the project footprint and dredging and disposal volumes, as summarized below:

- Total project footprint - 22% reduction;
- Dredge footprint - 39% reduction;
- Footprint on reefs - 38% reduction;
- Dredge volume - 54% reduction;
- Disposal volume - 71% reduction.

The optimized project layout also provides improved functionality for both cruise and cargo operations due to the larger land reclamation area (approximately double that of the OBC layout), extensions to the north and south dock walls, a new mixed-use berth and a second RO/RO ramp. Figure 3.1 provides a comparison of the OBC layout (PwC, 2013) and the optimized EIA layout.

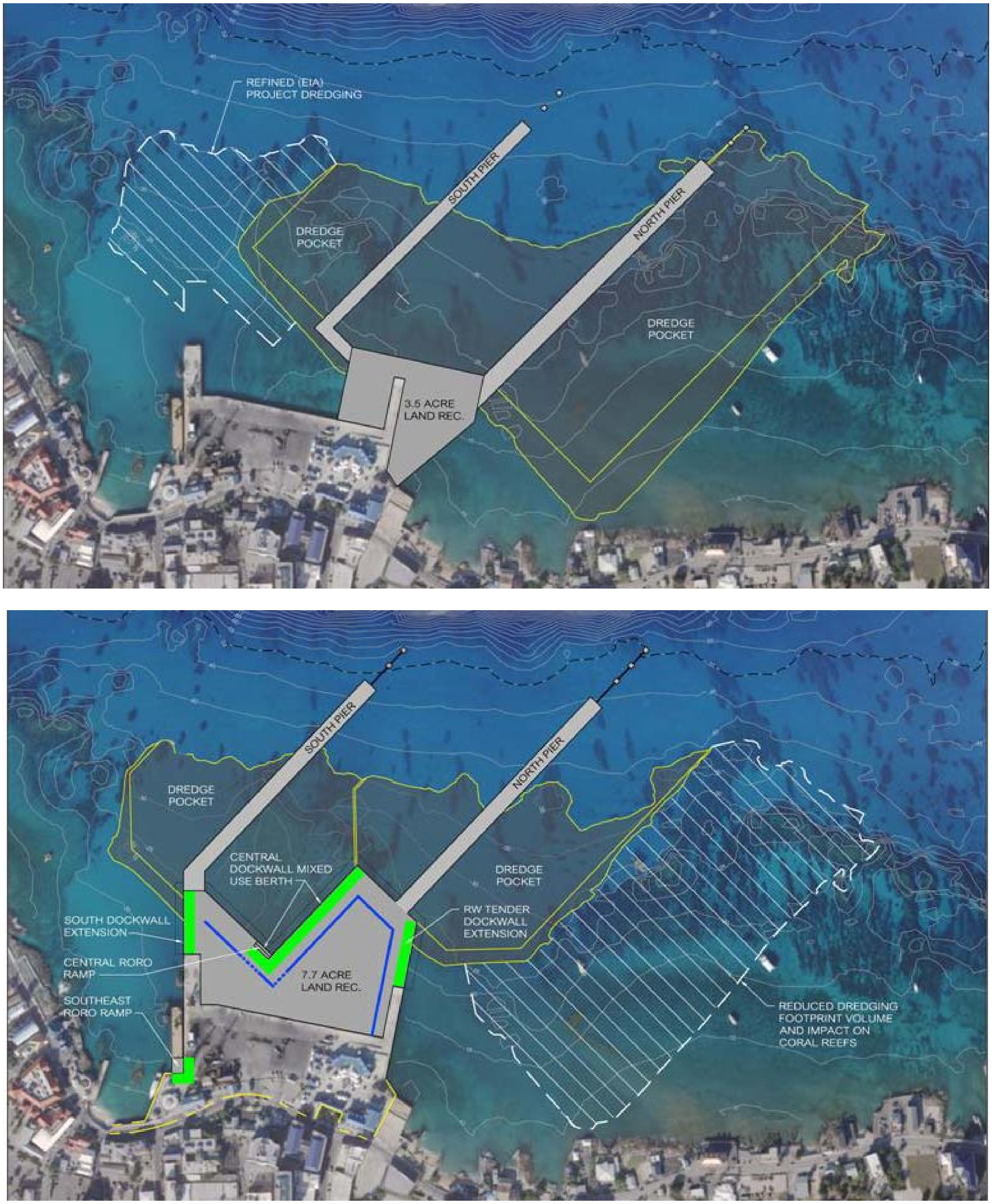


Figure 3.1 Comparison of OBC Layout (top) and Optimized EIA Layout (bottom)

4.0 PROPOSED PROJECT

4.1 Project Overview

The analysis of alternatives led to the development of an optimized concept layout for the proposed cruise berthing facility that provides a balance between functional and cost considerations, with reduced environmental impacts as compared to the OBC layout presented in the Final EIA Terms of Reference. The optimized concept layout is shown in Figure 4.1 and Figure 4.2 (on the following pages), and includes the following key elements:

- Dredging of berth pockets for cruise vessels to depths of 35 ft and 36.5 ft below mean sea level (MSL) for the south and north pier berths respectively. The total dredge volume will be approximately 333,000 yd^3 (255,000 m^3).
- Two piers with berths for four large cruise ships (two suitable for *Oasis* class vessels). The piers have nominal lengths of 1000 ft (305 m) and a width of 60 ft (18 m). The pier structure will likely consist of a concrete deck supported by concrete piles with a bent spacing of approximately 30 ft (9 m). There are a total of 366 piles in the conceptual design, each 3 ft (1 m) in diameter with an approximate length of 120 ft (37 m). It is anticipated that the piles will be driven, socketed and anchored into the seabed. Each pile bent will be made up of a cast-in-place concrete cap with pre-cast concrete deck panels spanning between bents. A cast-in-place wear surface will be constructed on top of the deck panels. The piers have an elevation in the order of 10 ft (3 m) above MSL.
- Mooring dolphins (three at north pier; two at south pier) are proposed at the outer end of the piers. The concept design for the dolphins assumes 10 foot diameter steel monopiles, each 140 ft (43 m) long, each driven, socketed and anchored into the underlying seabed.
- Approximately 7.7 acres (3.1 ha) of new land will be created using approximately 164,000 yd^3 (125,000 m^3) of the dredged materials. The remainder of the dredged materials (169,000 yd^3, 130,000 m^3) will likely be disposed of offshore. The perimeter of the reclamation area will consist of a vertical bulkhead wall composed of continuous pipe piles, topped with a concrete cap. The top of the cap is anticipated to have an elevation of 10 ft (3 m) above MSL. The piles will have a length of approximately 100 ft (32 m).
- A 460 ft (140 m) quay wall for smaller cruise ships and Roll-On/Roll-Off (RO/RO) cargo vessels will be constructed, along with a 250 ft (76 m) extension to the north tender dock and a 310 ft (95 m) extension to the south cargo dock.
- A new RO/RO ramp will be built in the centre of the reclamation area (between the piers) with a width of approximately 75 ft (23 m) in order to accommodate RO/RO cargo vessels.
- The old RO/RO ramp near the NorthTerminal will be reconstructed in order to accommodate aggregate barges.

- Basic landside improvements will consist of a hardscape promenade around the outside of the land reclamation area, a wave/flood protection wall, site grading/drainage and basic servicing. Additional landside development may follow, but was not included in the scope of this study.
- The hardscape promenade and wave/flood wall will be designed to resist severe wave overtopping and limit site flooding during storms.
- The outer portion of the land reclamation area will be sloped seawards for direct drainage of stormwater into the sea, while the remainder will slope eastward to a new stormwater drain. The drain will discharge to the sea at the northern and southern edges of the reclamation area. Catch basins will be constructed at each end of the drain to trap sediments and debris.

Two of the existing offshore vessel anchorage points nearest the project site will be removed. After construction, the port will be able to accommodate four vessels at berth and two vessels at anchorage. When more than six cruise ships arrive at Grand Cayman (at present, this occurs only 10 to 15 days per year), the additional vessels will need to remain offshore on power.

The total project footprint will be approximately 32.5 acres (13.2 ha), including 23.5 acres (9.3 ha) for dredging, 7.7 acres (3.1 ha) for the reclamation area, and 1.8 acres (0.7 ha) for the piers beyond the dredging extents.

Figure 4.1 Rendering of Optimized Concept Layout

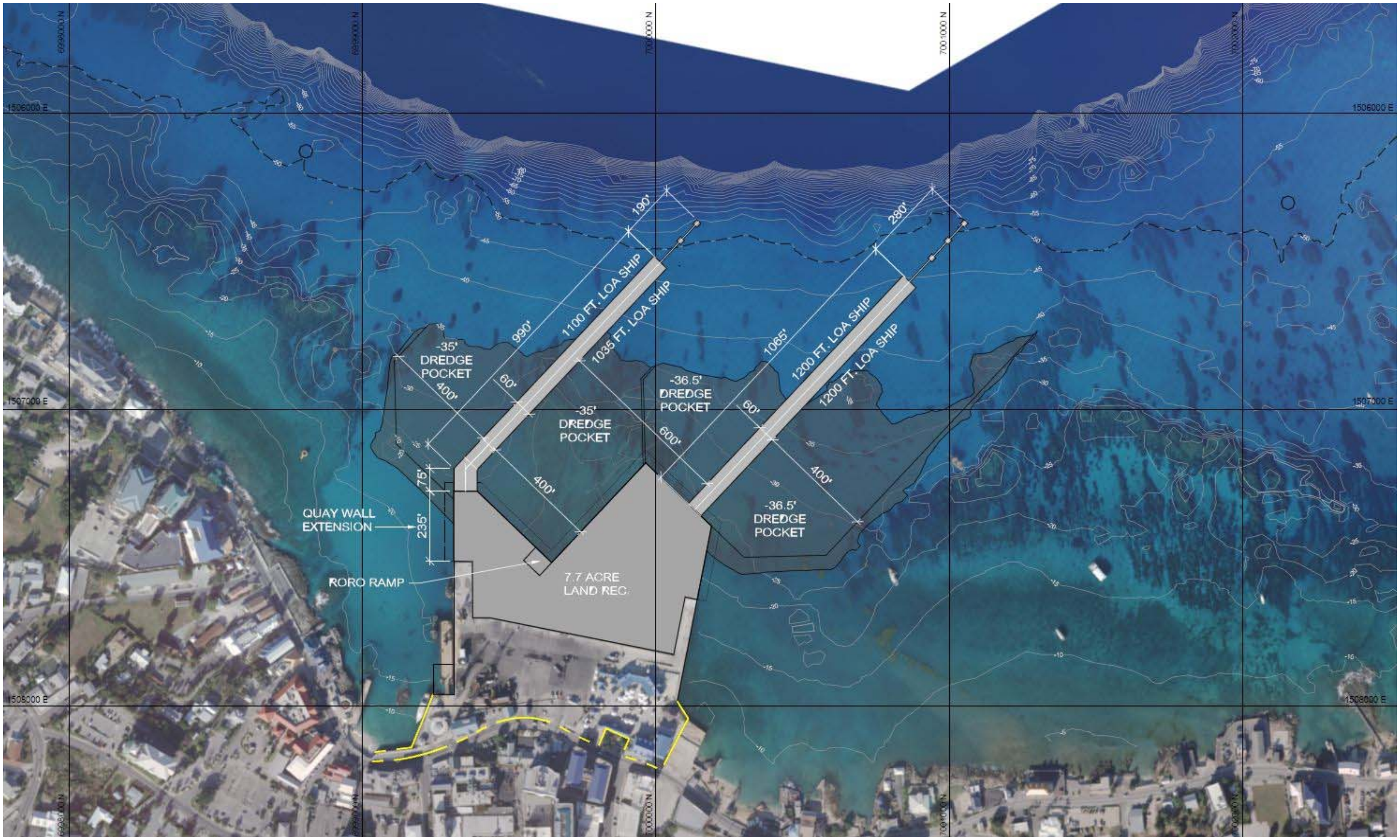


Figure 4.2 Plan View of Optimized Concept Layout

4.2 Construction Schedule

The overall project construction schedule is estimated at 30 to 36 months. This includes 2 to 4 months for dredging the berth pockets and filling the land reclamation area, with the duration of these activities dependent upon the dredging methodology (as discussed below).

4.3 Dredging Operations

Based on a review of available information regarding the subsurface conditions, it is anticipated that either hydraulic or mechanical dredging may be feasible for this project. Hydraulic dredging would likely be undertaken using a large cutter suction dredge (CSD), while mechanical dredging would likely be undertaken using a large backhoe dredge (BHD). Figure 4.3 presents photographs of a CSD and BHD.

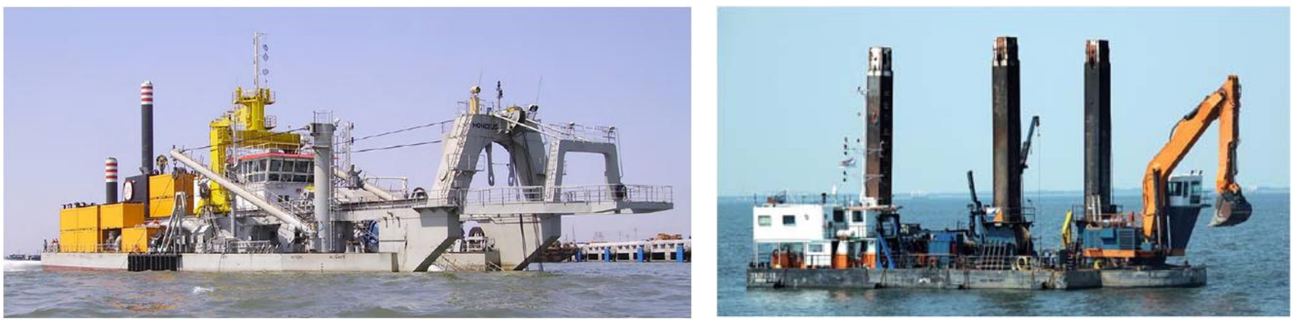


Figure 4.3 Cutter Suction Dredge [left] and Backhoe Dredge [right]

A cutter suction dredge is a dredge that has a large rotating cutter head that is lowered to the seabed to loosen the sediment. The sediment and seawater is then sucked up by means of a suction inlet pipe adjacent to the cutter head, and the resulting slurry is pumped to the reclamation area or disposal site. Hydraulic dredging with a CSD is a relatively fast operation, but generates large volumes of water (dredge slurry may be 5-25% solids, depending on the nature of the material being dredged). The estimated duration of a CSD operation for this project is in the order of 4 to 6 weeks. The primary sources of turbidity created by a CSD are the cutter head on the seabed and suspended sediment in the process water discharged from the reclamation area.

Mechanical dredging involves the use of a clam shell or bucket that is lowered to the seabed to "grab" the soils. The material is then lifted through the water column and placed into a barge for transport to/disposal at the reclamation area or offshore disposal site. Mechanical dredging is generally slower then hydraulic dredging (estimated duration in the order of 12 to 16 weeks for this project), but does not generate large volumes of water. The primary source of turbidity is at the dredge itself, as the bucket is pulled up through the water column.

Discussions with several dredging companies have indicated that a mechanical dredging operation would likely be employed for this project given the volume and type of material to be dredged. In addition, the environmental impacts associated with dredging are expected to be less with a mechanical dredging operation. As such, mechanical dredging is recommended for this project.

Regardless of the dredging method and equipment adopted, best practice generally involves the use of real time monitoring and adaptive management techniques to minimize turbidity and sedimentation associated with dredging, reclamation and disposal operations. Proposed turbidity and sedimentation thresholds have been developed and are included in the draft Environmental Management Plan (EMP), which is included as Section III of the Environmental Statement. Should monitoring detect turbidity or sedimentation levels in excess of the specified threshold conditions, the Contractor would be required to adjust, modify or cease operations.

Finally, it is noted that the absence of a comprehensive subsurface investigation at the project site represents an uncertainty with respect to the size and type of dredge required. Additional subsurface investigations are recommended to address this uncertainty.

4.4 Dredged Material Disposal

The excess volume of dredged material that cannot be placed within the reclamation area is estimated to be in the order of 169,000 cubic yards. Various options may be feasible for the disposal of excess dredged material, including disposal/dumping at an offshore location and/or disposal at an onshore location.

Offshore disposal for a mechanical dredging operation (BHD) would likely utilize a barge operation, while offshore disposal for a hydraulic dredging operation (CSD) could use a barge operation or a floating pipeline. The excess dredged material would be dumped in large water depths (> 1000 feet) more than 1.25 miles west (offshore) of the project site in order to limit the impacts of the disposal operation on the nearshore environment.

Onshore disposal would likely be more complicated and expensive than offshore disposal, but could provide the opportunity to process the material for sale as fill in the future. Onshore disposal is more likely to be a viable option with a mechanical dredging operation (BHD) than with a hydraulic dredging operation (CSD), as dealing with the huge volumes of water generated by a CSD would be a particular challenge.

5.0 STAKEHOLDER ENGAGEMENT AND PUBLIC CONSULTATION PROCESS

The EIA study included a comprehensive stakeholder engagement plan and public consultation process. This involved online and in-person surveys with local business stakeholders and households, as well as meetings and discussions with representatives from various industry groups, various CIG Departments and Authorities, and local Non-Governmental Organizations. The table below identifies stakeholders included in the consultation process undertaken for the EIA study. A public meeting reporting the preliminary findings of the EIA and soliciting comments from the public will be incorporated in the final ES.

Table 5.1 Summary of Stakeholder and Public Consultations Undertaken for EIA Study

Stakeholder Group	Description of Stakeholders	Number of Participants
General Public	Households George Town (167); West Bay (64); Bodden Town (60); North Side (9); East End (8)	308
Business Stakeholders	Tender boat operators (Captains and Linesmen)	12
	George Town Business Operators	16
	Water Sports operators (Independent)	11
	Transportation service providers	5
	George Town Dive Shops	9
Industry Groups	Chamber of Commerce	62
	Land & Sea Cooperative	1
	Cruise Lines (Carnival, Disney, Norwegian and Royal)	4
Cayman Islands Government	Port Authority of the Cayman Islands (PACI)	1
	National Roads Authority (NRA)	1
	Department of Tourism	1
	Department of Planning	1
	Department of the Environment (ongoing involvement)	1
	Cayman Islands National Museum	1
Non-government Organizations	Cayman National Trust	1
	Cayman Eco	1

Public perception of project impacts during construction was mainly negative, with concerns primarily related to the potential for negative impacts on environmental receptors and businesses that are vulnerable due to their dependence on the natural environment. Positive benefits identified were primarily related to construction jobs and value added to the economy. The proportion of stakeholders citing negative impacts during project construction was higher (37%) than those citing positive benefits (30%). A total of 24% saw the project has having no effect, while 9% did not respond.

The general public perception of impacts in the operational phase was generally positive (42%). The negative impacts (21%) were identified as being associated with the coral reefs, the tender operation, traffic in George Town and potential loss of the existing ship wrecks.

Stakeholders' perceptions of impacts during project operations were varied. The perception of marine-based businesses (such as dive shops) was generally negative due to potential negative impacts on their operations associated with destroyed and/or damaged reefs in George Town Harbour, and increased travel times to sites in the harbour due to the presence of the piers. The perception of land-based businesses and households was generally more positive, with job opportunities, local business opportunities and a boost to the local and national economy being identified as benefits associated with project operations.

6.0 NATURAL HAZARDS ASSESSMENT

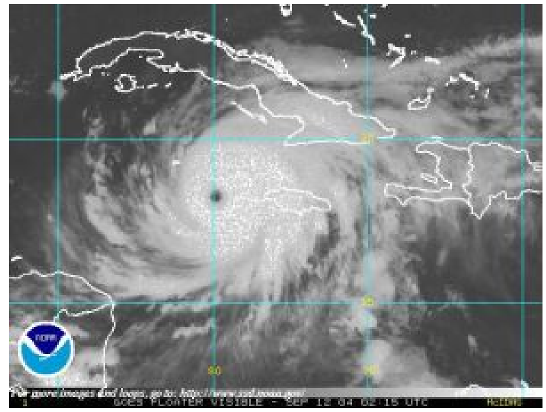


Figure 6.1 Hurricane Ivan over the Cayman Islands (Source: NOAA)

The Cayman Islands are vulnerable to a number of natural hazards, including hurricanes, earthquakes and tsunamis. A review and assessment of these natural hazards was undertaken to determine the potential risks and implications of each on the proposed project, including the influence of climate change effects.

Study tasks included:

- Computer modeling of hurricane-generated waves and storm surge at the project site (see Figure 6.2);
- Evaluation of seismic hazard in Grand Cayman based on available technical literature and databases;
- Assessment of tsunami hazard based on available technical literature; and
- A site-specific study of climate change effects.

6.1 Project Impacts

Hurricanes, earthquakes and tsunamis have the potential to cause severe damage to the project, as well as other infrastructure on the island, possibly resulting in an extended period of time during which the project would be non-functional (i.e. during repair/reconstruction efforts), with the potential for significant negative impacts on the economy of the Cayman Islands. As such, it is critical that the planning and design of the project consider the extreme conditions associated with natural hazards. Figure 6.2 shows an example of hurricane-generated nearshore wave patterns for existing conditions and after construction of the CBF.

One specific hazard associated with seismic activity that is of particular concern is "liquefaction" of the soils at the site. Liquefaction occurs when saturated or partially saturated soils are subject to dynamic loading (such as from an earthquake), and begin to behave like a liquid. The resulting damage to marine structures can be substantial.

As noted in the CIG draft Climate Change Policy (2011), small island developing states, such as the Cayman Islands, are particularly vulnerable to the effects of future climate change. Climate change effects do not have the same potentially devastating impacts on the cruise berthing facility, but are certainly an important consideration in its planning and design. Specifically, increasing air temperatures, changing precipitation patterns, increasing frequency and intensity of extreme storm events and sea level rise are expected over the life of the facility. The design and construction of the project must be resilient to such future changes.

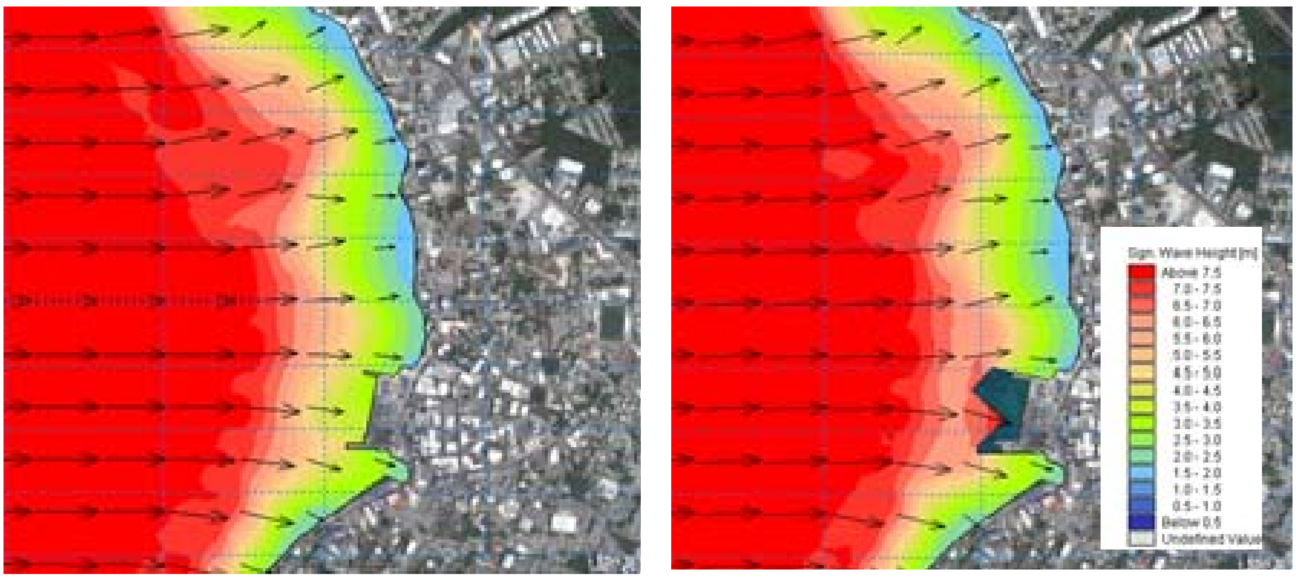


Figure 6.2 Significant Wave Height for Severe Hurricane Event from the West [Existing (left) and Proposed (right)]

6.2 Mitigation Measures

Recommended mitigation measures to address the effects of natural hazards and climate change include the following:

- *Design phase* – complete additional engineering investigations to better define subsurface conditions, seismic risks and extreme wave loads on key project elements (piers, shoreline protection and land reclamation area), and incorporate this information into the final design.
- *Construction phase* – require Contractor to develop a construction sequence/schedule that limits exposure of partially completed works during the hurricane season, and to develop a Disaster Management Plan for implementation in response to approaching hurricanes.
- *Operation phase* – develop a Disaster Management Plan, including links to hurricane and tsunami warning systems.
- *Climate change* – incorporate allowances for sea level rise, increased storm intensity and rainfall into the design of project infrastructure (piers, shoreline protection and storm water drainage system).

7.0 GEOLOGY AND SOILS

A review and assessment of available information on regional geology and soil conditions at the project site was undertaken. The available information indicates that the subsurface conditions at the project site consist of calcareous soils, including an intermittent presence of loose sand over cemented materials (calcarenite or limestone).

The nature of the geology and soils at the site is very important in the design and construction of the cruise berthing facility from a number of aspects:

- The methodology (type of equipment) and rate at which dredging can be performed.
- The dredged material disposal methodology.
- The percentage of fine material in the seabed soils affects the size and concentration of suspended sediments in the plume generated by the dredging process.
- The risk for liquefaction during an earthquake, and the design measures need to counteract this effect.
- The rate at which sediment infilling of berth pockets could occur and the resulting maintenance dredging that will be required.

7.1 Project Impacts and Mitigation Measures

The available subsurface information is insufficient to support detailed design of the project. In particular, more reliable information is required to support an assessment of the following key issues:

- Extent of loose sediment over cemented materials, and strength of cemented materials;
- Selection of suitable dredging equipment, and associated production rates and costs;
- Ability to drive piles, and assessment of alternative methods to provide tensile capacity to resist extreme wave uplift loads on piers;
- Seismic risk, in particular for land reclamation area (liquefaction potential).

As such, it is recommended that additional site-specific subsurface investigations be undertaken, including geophysical and geotechnical investigations, as well as a probabilistic seismic hazard assessment study.

8.0 WAVES, SEDIMENT TRANSPORT AND FLOODING RISK

The proposed CBF has the potential to affect wave action and sediment transport along the coast, and may also have an impact on the risk of coastal flooding. A comprehensive review and assessment of coastal processes was undertaken to assess these issues, including the following:

- Wind and wave climate (offshore and at the project site);
- Tides and water levels (regional and at the project site);
- Sediment transport along the West coast (including Seven Mile Beach and George Town Harbour);
- Sediment infilling of the dredged basin;
- Flooding risk and inundation along George Town's waterfront.

Key tasks included review of previous studies, data and information, a comprehensive field data collection program and extensive empirical and numerical modeling of key processes, in particular nearshore waves, hydrodynamics and sediment transport associated under existing and proposed conditions.

8.1 Project Impacts

The anticipated impacts of the proposed project on coastal processes are summarized below:

- Localized changes to nearshore wave conditions are expected, including the following:
    - Reduced wave action along the shorelines to the north and south of the project due to the sheltering effect of the larger land reclamation area, as shown in Figure 8.1.
    - Increased wave action in the area to the immediate west (offshore) of the project due to wave reflections from the vertical quay walls around the expanded land reclamation area. These reflected waves will have a limited effect on the berthed cruise ships.
- An assessment of flooding risk due to the overtopping created by hurricane waves was undertaken for existing conditions and with the proposed CBF constructed. Figure 8.2 shows inundation levels assuming the nearby passage of a hurricane with a 1 in 50 year return period. No difference in flood levels was identified outside the port area or within the existing port lands. The conceptual design of the new land reclamation area includes a wave/flood wall to limit flooding of the site.
- No significant sedimentation of the dredged berthing area is expected under typical conditions.

- Significant sedimentation of the dredged berthing area may occur during hurricanes. Computer simulations were completed for Hurricane Fox (1952), which had northerly track when it passed just west of Grand Cayman Island. These simulations showed a sedimentation volume in the order of 3,000 yd^3, with sedimentation depths in the order of 1 to 5 feet along the side slopes of the dredged basin. Sedimentation rates, volumes and depths will vary depending on the proximity (track) and severity (intensity) of the hurricane. It is possible that maintenance dredging may be required to restore the design dredge depths following a severe hurricane.
- The project will not result in any significant impact on Seven Mile Beach, as no significant sediment transport occurs between George Town Harbour and Seven Mile Beach.

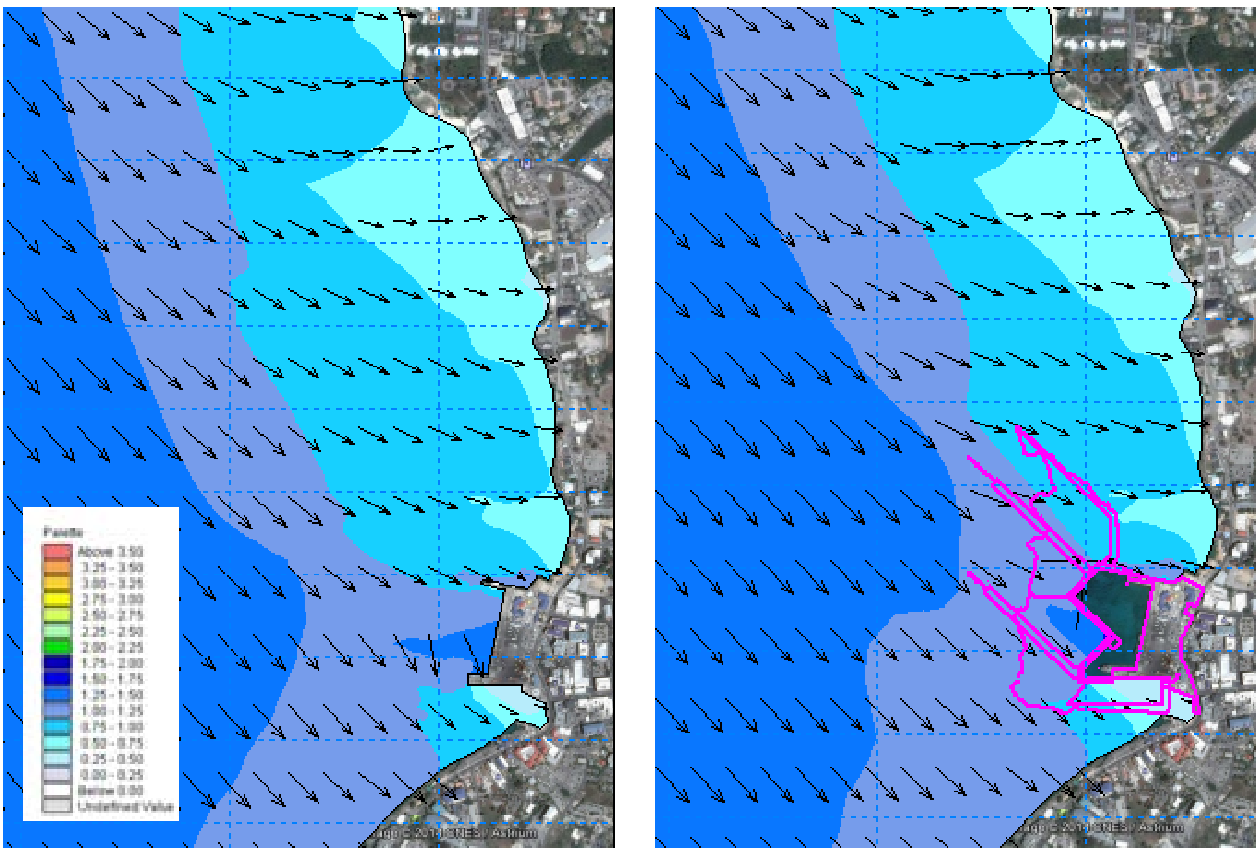


Figure 8.1 Wave Action during Typical Nor'wester – Existing Conditions (L) and Proposed Project (R)

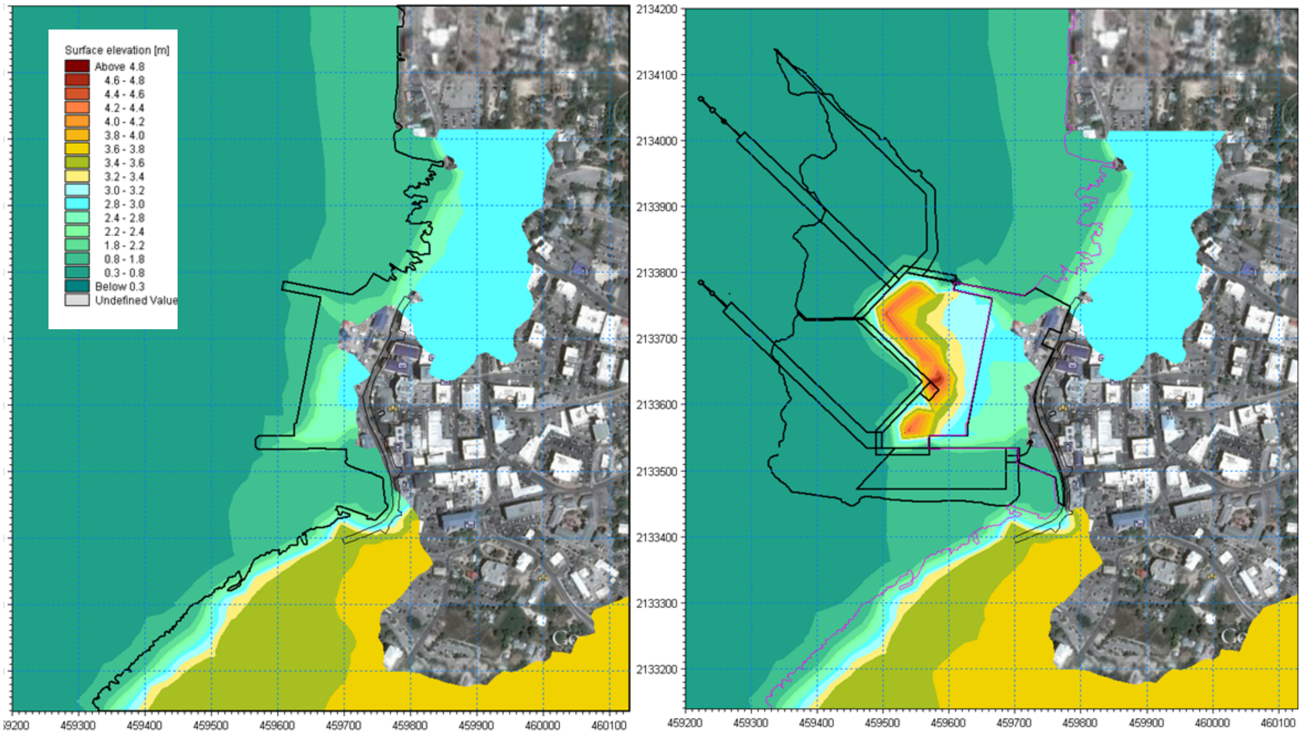


Figure 8.2 Flooding Risk from Hurricane Waves – Existing Conditions (L) and Proposed Project (R)

8.2 Mitigation Measures

As noted above, the proposed project is not expected to increase wave action along the adjacent shorelines nor the risk of flooding of George Town. The conceptual design of the new land reclamation area includes a wave/flood wall to limit flooding of the project site itself due to wave overtopping during Nor'westers and hurricanes.

The effects of sediment infilling (and required maintenance dredging) can be mitigated to some degree by over-dredging of the berth area. Specifically, the berth area could be initially dredged to a depth greater than required to accommodate the cruise ships, thereby providing additional capacity to accumulate sediment before maintenance dredging is needed.

9.0 NEARSHORE CURRENTS AND TURBIDITY

A comprehensive set of studies was carried out to assess the impact of the proposed CBF on the following processes:

- Nearshore currentspatterns and magnitude ("hydrodynamics").
- Dredge plumes: the creation of suspended sediment plumes during dredging, land reclamation and disposal operations, including at the dredger itself and at the discharge locations (land reclamation area and offshore disposal site). Two different types of dredging operations were examined: (1) hydraulic dredge (CSD) and (2) mechanical dredge (BHD).
- Sediment re-suspension: the re-suspension of seabed sediments associated with vessel traffic, particularly propeller/thruster generated flows during berthing and de-berthing.

The investigation involved completion of baseline current measurements at four different locations near the project site, analyses of historical turbidity measurements by the DOE, computer modeling of dredging operations (both sediment extraction and disposal), and computer modeling of sediment re-suspension by cruise ships. The baseline measurements showed that current patterns are relatively complex but small in magnitude. Natural turbidity in George Town Harbour is generally very low (turbidity < 4 NTU, suspended sediment concentration < 2 mg/l), but elevated turbidity levels may persist for a few days during Nor'westers (turbidity ~ 15 NTU; suspended sediment concentration ~ 10-20 mg/l). In general, corals are negatively impacted by extended exposure to suspended sediment concentrations (SSC) in excess of 10-20 mg/l.

9.1 Project Impacts

The anticipated impacts of the proposed project on nearshore currents and turbidity are summarized below:

Construction Phase

- Project construction will result in elevated turbidity and sedimentation levels in George Town Harbour, in particular during dredging and land reclamation works.
- Figure 9.1 shows the maximum estimated extent of the turbidity plume at the seabed generated by a mechanical dredging operation (i.e. BHD) at the project site. The plume extent is based on a 24-hour rolling average of suspended sediment concentration (SSC) over an assumed 90 day (three month) period of dredging operations.
- Figure 9.2 shows the maximum estimated extent of the turbidity plume at the surface generated by barges dumping dredged material 0.6 miles offshore (west) of the project site. Again, the plume extent is based on a 24-hour rolling average of suspended sediment concentration (SSC) over an assumed 90 day (three month) period of disposal operations.

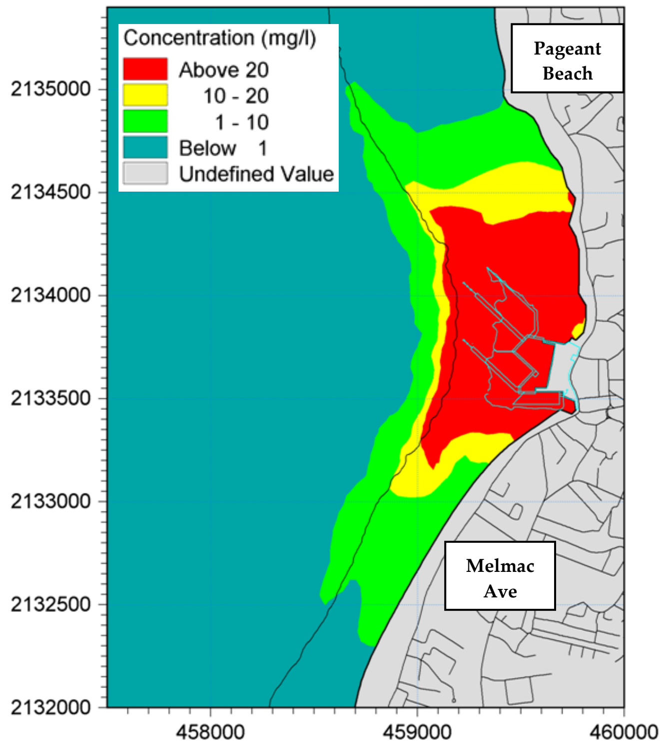


Figure 9.1 Maximum Seabed Turbidity Plume Generated by Mechanical Dredging Operation (24 hr Rolling Average)

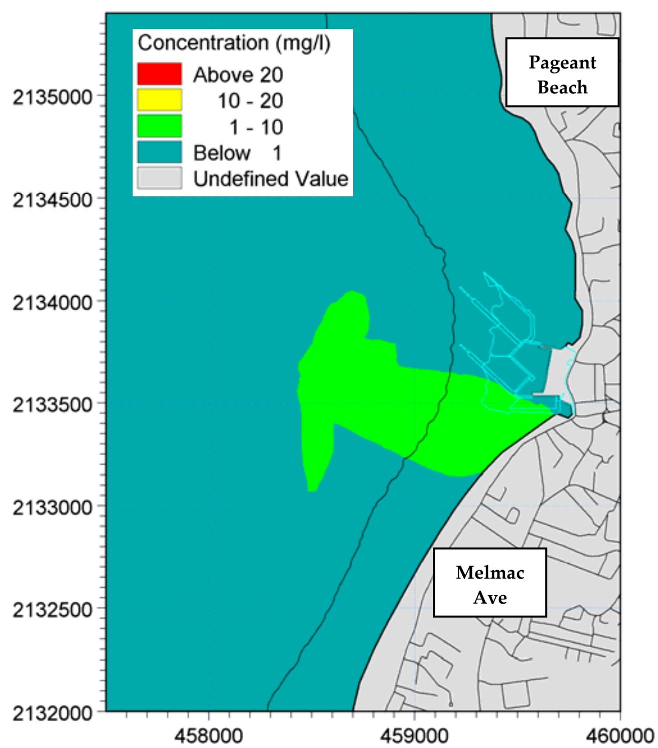


Figure 9.2 Maximum Surface Turbidity Plume Generated by Barge Disposal Operation 0.6 miles Offshore (24 hr rolling average)

Operation Phase

- The project will result in reduced circulation in George Town Harbour, particularly when cruise ships are berthed. Based on computer model simulations, the percentage of time that "calm" conditions are experienced adjacent to the dredged basin is approximately doubled (29% to 46% of the time) when a cruise ship is berthed at either the north or south pier. The influence of the project diminishes with distance; at 0.6 miles north or south, there was no signficant difference in the currents from baseline conditions.
- Berthing and de-berthing of cruise ships at the new facility will result in elevated turbidity and sedimentation levels in George Town Harbour due to "sediment re-suspension" associated with the flows generated by the ships' propellers and thrusters. For example, Figure 9.3 shows the results of computer model simulations of a turbidity plume generated by the bow thrusters of a cruise ship berthed at the north pier during typical northerly flowing currents.
- It is anticipated that the effects of sediment re-suspension (i.e. turbidity plume size and severity) will diminish with time due to the cumulative effects of multiple ship berthings resulting in localized deepening and loss of the finer sediments within the dredged basin.

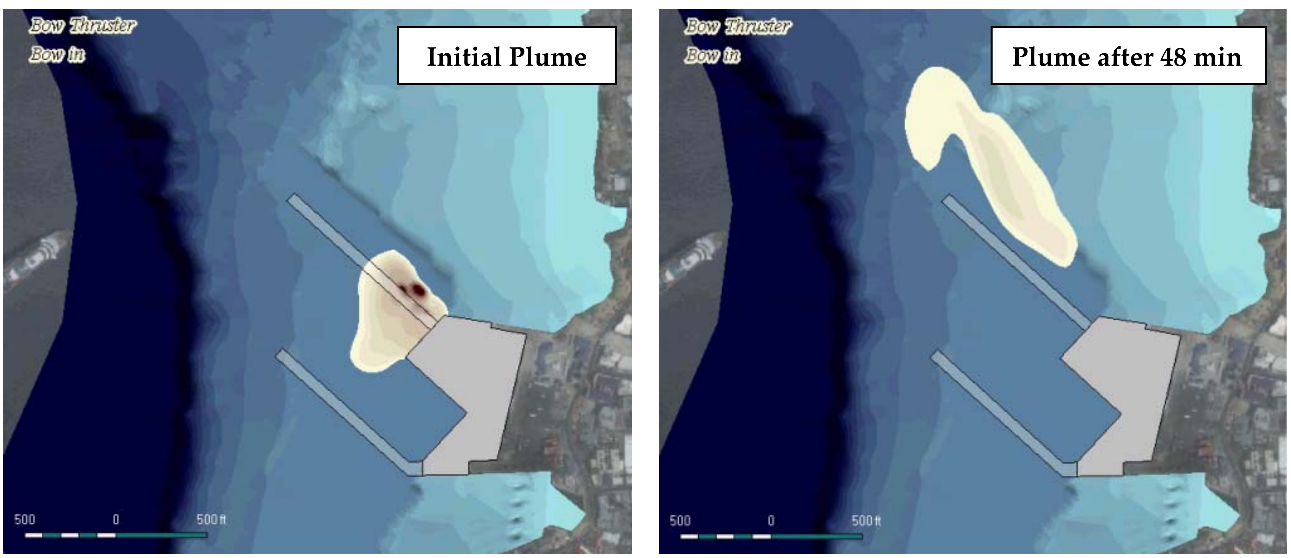


Figure 9.3 Computer Model Simulation of Sediment Plume Created by Cruise Ship Bow Thruster

9.2 Mitigation Measures

Possible mitigation measures to address the impacts of the project on turbidity and sedimentation levels in George Town Harbour are summarized below:

- Turbidity and sedimentation during dredging and construction will be monitored and controlled through the implementation of a comprehensive Environmental Management Plan (EMP), which includes the following key aspects:

- Definition of allowable turbidity and sedimentation levels in critical areas (adjacent to coral reefs), and response protocols in the event of these levels being exceeded.
- Contractor to incorporate Best Management Practices (BMPs), including the use of turbidity barriers and adaptive management of dredging and construction operations.
- Comprehensive monitoring of turbidity, sedimentation, coral health and fish populations, including real-time monitoring of turbidity as input to adaptive management of dredging and construction operations.

- Turbidity and sedimentation during operations could be mitigated by one or more of the following measures:
  - "Vacuum" removal of fines from dredged berthing area after primary dredging.
  - Install seabed stabilization/protection in critical areas to reduce or eliminate the effects of propellor-induced sediment re-suspension.
  - Implement operational controls, including limits on vessel approach speed and power application during berthing/de-berthing.

10.0 SEDIMENT AND WATER QUALITY

An assessment of baseline conditions for sediment and water quality was completed, including a review of intermittent water quality data collected by the DoE since 2000, and the collection and testing of sediment and water quality samples for this study. Test results were compared to relevant international guidelines for key parameters, and no significant concerns were identified. The excellent water quality (and lack of contaminants in the samples) reflects the absence of any significant sources of pollutants in the project area.

Sample Setup in the Laboratory

One area of concern noted in the baseline data was the increase in phosphate levels noted in measurements available from 2000 (DoE) and 2014 (this study). This issue can be addressed through the implementation of appropriate guidelines and policies by the CIG.

10.1 Project Impacts

Potential impacts of project construction and operations on sediment and water quality are summarized below:

- The materials to be dredged are considered to be “clean”, and suitable for use as fill or for open water disposal;
- Elevated turbidity levels are expected during dredging and construction, and also during operations, as discussed in Chapter 9;
- Increased risk of spills and pollution/contamination during construction;
- Potential release of waste, fuel and bilge water by vessels during operations; and
- Increased surface runoff from expanded land reclamation area.

10.2 Mitigation Measures

Construction phase impacts can be effectively mitigated through the implementation of various practices, as defined in the Environmental Management Plan (EMP). The risk of pollution by marine traffic can be mitigated through enforcement of International Maritime Organization (IMO) and MARPOL Convention guidelines, standards and regulations. Mitigation measures to address the risk of elevated turbidity and sedimentation levels during construction and operations are summarized in the preceding Chapter. Phosphate levels may be reduced during operations through the implementation of controls on the importation of phosphate containing detergents and fertilizers, for example.

11.0 STORM WATER

Storm water runoff into the sea from the port area can result in poor water quality. The proposed project includes 7.7 acres of new land area, which represents a two-fold increase in the rainfall catchment area of the port. A drainage master plan has been developed for the project that would help to mitigate adverse impacts to the existing catchment area and the nearshore environment. This work was conducted in accordance with the CIG Ministry of Planning Storm Water Management Guidelines (June 2006), and took into account potential changes in rainfall intensity and frequency due to climate change.

11.1 Project Impacts

Potential project impacts related to storm water include increased runoff of storm water into the sea (with potential adverse impacts on water quality) and increased risk of flooding of adjacent landside areas. A review and assessment of the local watershed and historical rainfall records was undertaken to define baseline conditions. This information was utilized as input to watershed hydrological and hydraulic analyses to support the development of a conceptual drainage master plan for the project in order to mitigate potential adverse impacts associated with storm water. The storm water drainage master plan is described in Chapter 13.0 of the Environmental Statement.

11.2 Mitigation Measures

The proposed storm water drainage master plan was designed to accommodate the 25 year rainfall event; this event is double the intensity required by local (NRA) guidelines, thereby providing resiliency for the effects of climate change. Key aspects of the proposed drainage system include:

- Storm water from the existing catchment area (port lands and Harbour Drive), as well as a sizeable portion of the new reclaimed land area, will flow into a box drain running north-south across the port. Storm water on the westernmost portion of the reclaimed area will flow directly into the sea.
- The storm water drain will discharge into the sea through catchment boxes at the northern and southern limits of the project. The catchment boxes are intended to capture sediments and debris prior to discharge.
- Sink wells will be drilled at various points along the drain and around the land reclamation area to capture low flow discharges.

Computer modeling of storm water runoff under existing and proposed conditions demonstrated that implementation of the proposed storm water drainage master plan as part of the proposed project will result an improvement relative to existing conditions.

12.0 AIR QUALITY AND GREENHOUSE GAS EMISSIONS

A comprehensive field monitoring program was undertaken as part of the EIA study to define baseline conditions for air quality and Greenhouse Gas (GHG) emissions, including three months of continuous measurements at seven locations around George Town. Key pollutants of interest included nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon dioxide (CO_2) and airborne fine particles (PM_{10}). The baseline measurements demonstrate that existing air quality generally meets relevant international standards for ambient air quality.

Regarding baseline conditions, the primary source of air pollution on Grand Cayman is vehicular traffic. As noted in the traffic study, vehicular traffic is expected to increase regardless of whether or not the proposed cruise berthing facility is constructed. Although the volume of emissions from cruise ships are significantly higher, the impact of ship emissions on the island is naturally mitigated by the prevailing Easterly (offshore) trade winds.

12.1 Project Impacts

Regarding the construction phase, key sources of air-borne pollution will include construction equipment (marine and landside) and construction site dust emissions. Mitigation of these emissions requires that the Contractor be required to implement relevant and achievable "best practices", such as those defined in guidelines such as *"The Control of Dust and Emissions from Construction and Demolition: Best Practice Guidance"* published by the UK's Greater London Authority (2006).

Regarding the operation phase, the potential impacts of the project on air quality and greenhouse gas emissions was developed by estimating potential sources of air-borne pollutants, including cruise ships, tender traffic and landside traffic. Empirical estimates were developed for a "typical busy day" under existing conditions (four *Dream* class ships at the offshore anchorages) and with the proposed cruise berthing facility in operation (four cruise ships at berth, including two *Dream* class ships and two *Oasis* class ships, with two more *Dream* class ships at the remaining offshore anchorages). The results are summarized below:

- Cruise ships - 64% increase in emissions (six ships rather than four);
- Tenders - 29% decrease in emissions (two ships offshore rather than four);
- Vehicles - 5% increase in emissions (increased bus/taxi traffic for excursions).

As noted above, these estimates are based on a "typical" busy day. The increase in emissions associated with cruise ships is significant; however, the effect of cruise ship (and tender) emissions on the island is naturally mitigated by the prevailing Easterly (offshore) trade winds. Detailed quantification of the impacts on air quality and GHG emissions would require numerical modeling of the dispersion of air-borne pollutants; this effort was beyond the scope of the EIA study.

12.2 Mitigation Measures

The implementation of sulphur standards adopted by the International Maritime Organization (IMO, 2008; Annex VI of MARPOL) is expected to significantly reduce the impact of shipping (including cruise ships) on air quality by 2020. Other mitigation measures are also possible to reduce emissions from cruise ships, but would require co-operation of the cruise lines.

13.0 NOISE AND VIBRATION

The purpose of the noise and vibration assessment is to consider the potential effects of the project on individuals within the vicinity of the CBF. A field monitoring program was undertaken as part of the EIA study to define baseline conditions for noise, with one week (seven days) of continuous noise measurements collected at four locations in the George Town area, as shown in Figure 13.1. Existing noise levels were generally found to be within relevant standards (World Health Organization, WHO) for day time and night time at all four locations.

Figure 13.1 Baseline Noise Measurement Locations

13.1 Project Impacts

The potential impacts of project construction and operations on noise levels were estimated by completing model simulations for these two phases. For the construction phase, the primary impact is likely to be pile driving operations, with the possibility of noise levels exceeding the WHO guidelines and being an annoyance. Dredging operations, which are expected to run 24/7 for two to four month period, and increased truck traffic through George Town (particularly overnight), may also be an annoyance. With the exception of the area immediately surrounding the project site, the model simulations suggest that the increase in noise levels during construction will generally be less than 3 dB. In addition, the model simulations suggest that the increase during operations will generally be less than 1 dB. As a change of less than 3 dB is imperceptible to the human ear, these changes are deemed to be insignificant.

Regarding vibrations, the most prevalent and powerful sources of construction vibrations are blasting, pile driving and dynamic compaction. Blasting is not anticipated to be required for this project. Vibrations associated with pile driving and dynamic compaction have the potential to be annoying/disruptive to people/businesses in the vicinity of the works, and may also cause settlement and structural damage.

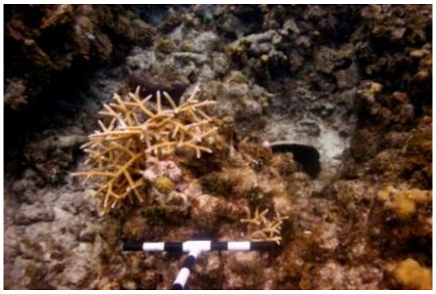
13.2 Mitigation Measures

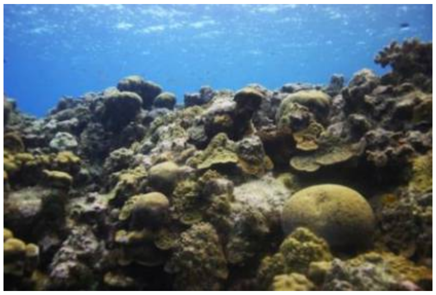
Suggested measures to mitigate the effects of noise and vibration during construction include the following:

- Define allowable working hours, and restrict operations for the most offensive operations (i.e. pile driving and dynamic compaction) to day time only;
- If practical, use quieter piling techniques, such as vibratory hammers or presses;
- Provide screening (noise barriers);
- Undertake structural condition assessments of buildings within 500 feet (150 m) of the project site likely to be affected by vibrations (to provide a baseline against which damage claims, if any, can be assessed);
- Measure noise and vibration during construction at buildings within 330 feet (100 m) of the proposed pile driving area. The measurements should start in advance of construction in order to establish reference levels.
- Implement a community information and liaison program to advise/forewarn of upcoming construction activities, particularly those likely to be most disruptive to residents and businesses in the vicinity of the project.

14.0 MARINE ECOLOGY

A comprehensive review and assessment of the marine ecology within George Town Harbour was undertaken in order to define baseline conditions, and to assess the potential impacts of project construction and operations on these conditions. Baseline conditions were defined through the collection, review and assimilation of relevant data collected by the DoE, review of previous studies by others, and field data collection at fourteen sampling sites (coral, algae and fish community structure). The baseline conditions in George Town Harbour are highlighted below:





- The nearshore reefs show signs of anthropogenic stress, but are in generally good condition, particularly in the Caribbean context.
- Clear water and lack of fishing pressure allow for the proliferation of healthy coral cover, including two species listed as "Critically Endangered" (*Acropora cervicornis* and *Acropora palmata*) and four other species listed as "Threatened" *(Orbicella annularis, Orbicella faveolata, Orbicella franksi* and *Mycetophyllia ferox*).
- The reefs include both patch and spur & groove formations, with the latter creating a network of grottos and tunnels that form a complex habitat that supports a diverse assemblage of hard and soft corals, sponges and fish species.
- The nearshore reefs are ecologically significant as a habitat, and form a critical part of the marine ecosystem and the Marine Protected Area on Grand Cayman Island.
- The nearshore reefs are economically significant to the Cayman Islands, as they represent an important component of the water sports industry (snorkelling and diving) that brings cruise and overnight tourists to the Cayman Islands.

The development of the proposed project will have significant negative impacts on the marine ecology within George Town Harbour, in particular the coral reefs and associated habitat surrounding the project site. In general, these impacts are directly related to the areal extent of the project and the volume of dredging, and the operation of large cruise ships in the nearshore area. Key ecological impacts would include coral destruction, habitat fragmentation and reduced biodiversity. The anticipated impacts of project construction and operations on marine ecology are summarized in Sections 14.1 and 14.2 respectively, and in Figure 14.1. In addition, the development of the proposed project would result in socio-economic impacts associated with the loss of marine ecosystem goods and services; these impacts are discussed in Section 18.

14.1 Project Impacts - Construction Phase

- Direct impact on (destruction of) approximately 15 acres (6 hectares) of coral reefs and associated marine habitat within the project footprint (refer to Figure 14.1 on following page).
- Indirect impact (increased stress on and degradation of) additional 15-20 acres (6-8 hectares) of coral reefs and associated marine habitat located within approximately 650 ft (200 m) of project footprint due to the elevated turbidity and sedimentation levels, particularly during dredging and land reclamation works (refer to Figure 14.1 on following page).
- Elevated risk of spills and pollution associated with construction traffic, material storage and operations, and site runoff.

Possible mitigation measures to address the anticipated impacts of project construction on marine ecology are summarized in Section 14.3.

14.2 Project Impacts - Operation Phase

- Sediment re-suspension caused by cruise ship traffic to and from the facility will result in elevated turbidity and sedimentation levels on adjacent reefs (refer to Figure 14.1 on following page).
- Increased runoff, with associated increase in sediments and other pollutants.
- Increased risk of pollution due to accidental discharges and spills (cruise ship sewage, bilge water, etc.).
- Increased risk of introduction of invasive species from ballast water.
- Turbidity and sedimentation associated with maintenance dredging operations (if required).
- Increased risk of marine incidents, and associated potential for damage to nearshore reefs.
- Reduced use of anchors at offshore mooring locations, with associated reduction in damage to reefs in these areas.

Possible mitigation measures to address the anticipated impacts of project operations on marine ecology are summarized in Section 14.3.

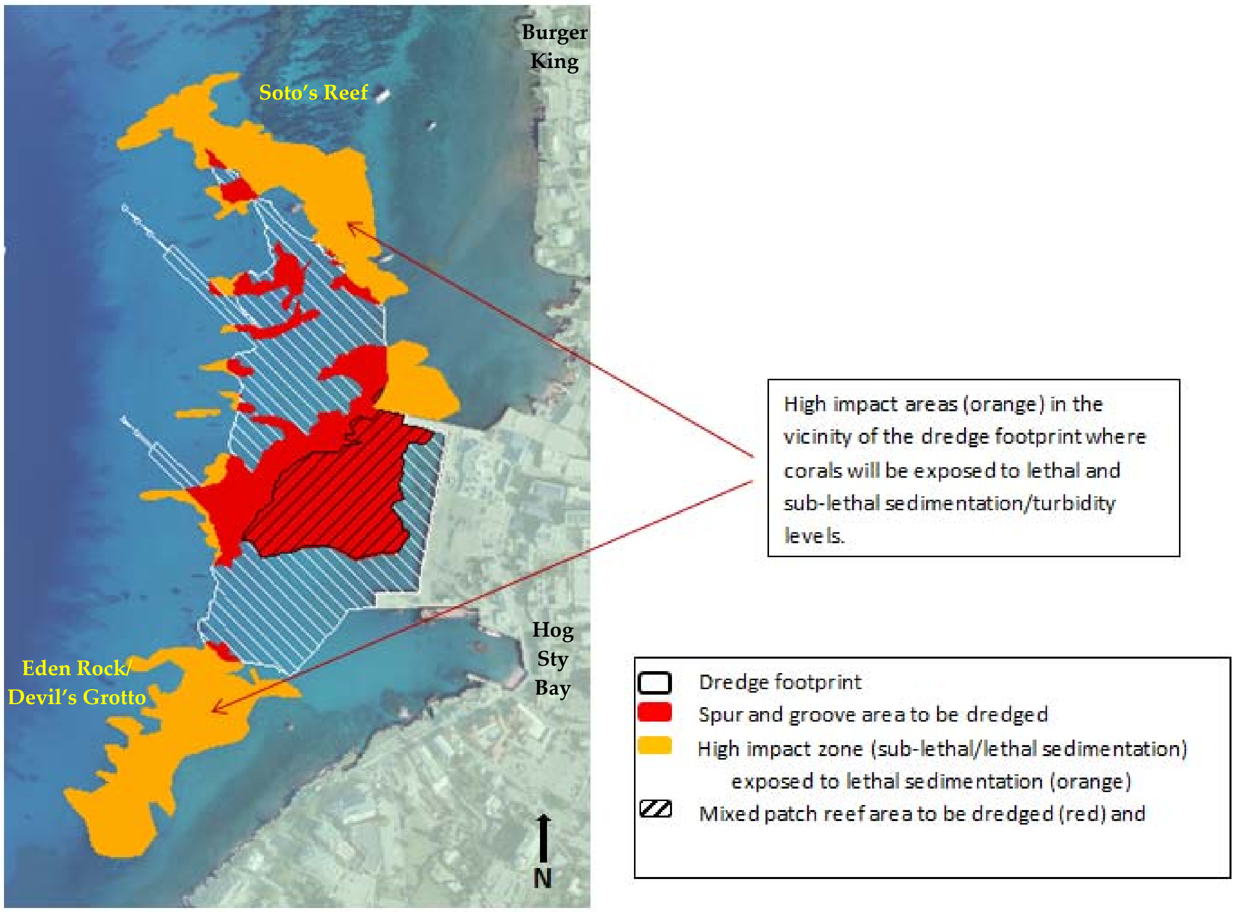


Figure 14.1 Estimated Spatial Extent of Direct and Indirect Impact Zones on Coral Reefs

14.3 Mitigation Measures

14.3.1 Coral Relocation Program

If the project proceeds, it is recommended that a significant coral relocation program be designed and implemented. The overall objective of the coral relocation program would be to mitigate/compensate for habitat destruction caused by the project. The specific objectives, scope and cost of the coral relocation program have not been defined at this time, and require discussion with the CIG and DoE. The following points provide some context regarding the possible scope and cost of a coral relocation program.

- A coral relocation program will not achieve "no net loss", and success is not guaranteed.
- Typically, the recipient site would be selected based on providing similar characteristics (substrate, water depth, exposure to waves and currents, pH, DO, salinity, etc.). For this project, consideration should also be given to address habitat fragmentation, specifically to restore "functional connectivity" between the reefs to the north and south of the project.

- The cost of coral relocation programs undertaken for other projects in the Caribbean and elsewhere varies from US$250 to $1,800 per square meter (CI$20 to $140 per square foot). Previous court cases in the Cayman Islands, as well as guidelines included in the Florida Coral Reef Protection Act (2009) have defined a value in the order of CI$1,000 per square meter (CI$90 per square foot) of damaged reef.
- The proposed project footprint covers 15 acres (650,000 square feet) of coral reef, with this area being more or less evenly split between patch reefs and spur and groove formations. The spur and groove formations include significant three-dimensional features with high vertical relief and rugosity.
- It is anticipated that coral colonies within the patch reefs area would be relocated using conventional “harvesting” methologies, including the removal, transport and reattachment of individual colonies by divers.
- Regarding the larger spur formations, it is anticipated that specialized methods, including the use of marine consturction equipment, would be developed to facilitate the movement of large segments of "intact" spurs, as this is likely to be more efficient/effective method, and also retains the 3D "rugosity" of the original habitat.
- Relocation of the *Balboa* shipwreck should be considered as part of the coral relocation program (also refer to Chapter 15).

Based on the information presented above, the estimated cost of a full coral relocation program for this project would be in excess of $CI13M. Should the project proceed, the objectives, scope and budget for the coral relocation program would require further discussion with the CIG and DoE.

14.3.2 Mitigation Measures – Project Construction

A comprehensive Environmental Management Plan (EMP) will be implemented during project construction, including the following key aspects:

- Define allowable turbidity and sedimentation levels in critical areas (coral reefs), and response protocols in the event of these levels being exceeded.
- Require Best Management Practices (BMPs), including the use of turbidity barriers and adaptive management of dredging and construction operations;
- Comprehensive monitoring of turbidity, sedimentation, coral health and fish populations, including real-time monitoring of turbidity as input to adaptive management of dredging and construction operations.

Other mitigation measures that may be considered to limit impacts on marine ecology during the construction phase include the following:

- Restrict dredging to May-July to avoid coral spawning season (Sep-Oct and Mar-Apr) and periods of elevated sea surface temperatures (Aug-Oct) when corals are at greatest risk of bleaching (also if possible avoid peak cruise/tourist season from December to April).
- "Vacuum" removal of fines from dredged berthing area after primary dredging.
- Install seabed stabilization/protection in critical areas.
- Incorporate a suitable drainage system in the project design (a storm water master plan has been developed as part of the EIA - refer to Chapter 11).

14.3.3 Mitigation Measures – Project Operations

- Implement operational controls, including limits on vessel approach speed and power application during berthing/de-berthing, Monitor for compliance with IMO and MARPOL regulations, standards and guidelines for ship-generated pollution in Cayman waters.
- Establish funding for mitigation of damage to marine ecology, perhaps through assignment of a proportion of project-generated revenue to support coral restoration projects in the area.
- Provide suitable tugs to respond to emergency situations (i.e. loss of power or steerage).

15.0 CULTURAL HERITAGE

The Cayman Islands has a rich natural and cultural heritage that is both marine and terrestrial in origin. The archaeological and cultural heritage resources existing within the project area (George Town Harbour and downtown George Town) were defined using both primary and secondary data collection. The key cultural heritage sites/features identified through this research include two ship wrecks in George Town Harbour (the *Balbao* and the *Cali*), Fort George, Hog Sty Bay, the National Museum, Elmslie Memorial Church and various monuments erected in the study area. In addition, maritime architecture and shipbuilding heritage were identified as important cultural "themes."

15.1 Project Impacts

The anticipated impacts of the construction and operation of the proposed project on cultural heritage are summarized below:

- The *Balboa* shipwreck is located within the footprint of the proposed project, and will be lost unless it is relocated.
- The *Cali* shipwreck will not be directly impacted by the project, but may be indirectly impacted by turbidity plumes during dredging and operations, with potential degradation of the adjacent marine habitat and the quality of diving/snorkeling.
- Access to/use of Hog Sty Bay may be limited/restricted during construction.
- The risk of damage to buildings and monuments is low.
- Project operations are anticipated to result in additional income potential to buildings and monuments from guided tours; there is also the potential to expand the inventory of cultural heritage artifacts.

15.2 Mitigation Measures

Impacts related to the *Balboa* can be mitigated by relocating the wreck to a new site; this could result in a positive impact due to increased accessibility to this feature (i.e. if it is re-located to a site where day time dives are possible). Relocation of the *Balboa* should be considered as part of the coral relocation program, as discussed in Chapter 14. Mitigation measures to address turbidity plumes during construction and operations are also discussed in Chapter 14.

In addition, further communication with stakeholders and the general public on the potential impacts of the project on cultural heritage assets, and the specific mitigation measures to be taken is recommended. Finally, communications with stakeholders and the general public should be continued through the construction phase to advise of upcoming activities, and to minimize the potential for upset associated with disruption to typical activities (socio-economic issues are addressed later in this document).

16.0 PEDESTRIAN AND VEHICULAR TRAFFIC

A comprehensive transportation study was undertaken to assess pedestrian and vehicular traffic in downtown George Town, including an assessment of existing (baseline) conditions, expected growth in baseline conditions without the proposed project, and the additional growth/impact on pedestrian and vehicular traffic associated with the proposed project. The study focused on three impact areas, including Harbour Drive, the Inner Cordon and the Outer Cordon, and included consultation with the National Roads Authority (NRA) regarding their priorties for road network improvements, and the Ministry of Planning (MoP) regarding their ongoing efforts related to the George Town Revitalization Plan (GTRP).

Baseline conditions were defined through review of historical information and previous study reports provided by the NRA, and field measurements and observations of pedestrian and vehicular traffic and parking utilization at numerous locations within the study area. This information was used to set up and calibrate a traffic model for baseline conditions. This calibrated model was then used to estimate the impacts of growth in baseline conditions, the additional impacts of the project, and alternative mitigation strategies to reduce the impacts of increased traffic on commuters and tourists.

Considering baseline conditions, Harbour Drive is a key corridor for morning, mid-day and evening commuter traffic, and also handles overnight commercial traffic travelling between the port and the inland Cargo Distribution Centre. High levels of pedestrian traffic on cruise days create pedestrian and vehicular conflicts along Harbour Drive, resulting in congestion, delays and risk of accidents. The model simulations demonstrate that the expected growth in vehicular traffic (without the project) will result in increased congestion, with a significant negative impact on the pedestrian level of service, commute time and risk of delays and accidents.

16.1 Project Impacts

Construction of the proposed cruise berthing facility will result in additional congestion due to construction traffic to and from the project site. Considering the operation phase, increased cruise ship traffic anticipated in response to the development of the project is expected to result in higher pedestrian traffic and parking requirements (more tour staffing and transit), with increased congestion and pedestrian-vehicle conflicts, particularly on Harbour Drive. However, the project is not expected to have a significant impact on the volume of vehicular traffic.

Schematic Diagram of Pedestrian Prioritization at Intersection of Harbour Drive and Fort Street

16.2 Mitigation Measures

Construction phase impacts can be mitigated through the planning and implementation of a traffic management plan. For example, the traffic management plan might include temporary restrictions and alternative routes for pedestrians and commuter traffic, approved routes and time of day restrictions for construction traffic, and a monitoring and maintenance plan to identify and repair damage caused by construction traffic. Tour staging is expected to be re-located to the nearby Tower Lot site during construction activities.

Considering the operation phase, modeling of various improvements identified in the NRA's Priority for Road Network Improvements and the MoP's George Town Revitalization Plan were shown to substantially mitigate key issues associated with the growth in traffic expected regardless of whether or not the cruise berthing facility is implemented.

Additional mitigation measures were also identified to provide increased priority for pedestrians and reduced vehicular traffic in downtown George Town, with the model results demonstrating improvements to both the pedestrian level of service and travel times for commuters.

Options to implement full pedestrianization of Harbour Drive and one-way traffic (both northbound and southbound) were evaluated and found to cause significantly more delays than the scenario where Harbour Drive remains as a two-way traffic conduit.

Implementation of the various improvements and mitigation measures is not dependent upon the development of the cruise berthing facility; however, should the CBF project go ahead, an integrated approach involving various CIG entities will be required to manage/mitigate potential impacts associated with multiple construction and improvement projects in the George Town area.

17.0 CRUISE AND CARGO OPERATIONS

The existing port facility in George Town Harbour serves both cruise and cargo operations, with both being essential to the economy of the Cayman Islands. The harbour area is congested, with marine traffic, includingcruise, tender and cargo vessels, as well as recreational/water sports activities. Similarly, the landside area (port lands and adjacent downtown area) is also congested.

A comprehensive review and assessment of existing cruise and cargo operations was undertaken to establish baseline conditions, including review of data provided by PACI and discussions with PACI management. In addition, historical data available from various sources were reviewed, with these data being used to project future trends in cruise and cargo traffic for the port. Key findings related to cruise/tender and cargo operations include the following:

Existing Port Facilities

- The continuing trend to use larger cruise ships (> 4,000 passengers) in the Caribbean region presents added challenges for tendering, with at least one cruise line choosing to have its largest vessels skip Grand Cayman on its Western Caribbean itineraries.
- The existing tender fleet has a maximum capacity in the order of 4,500 to 6,500 passengers per hour, depending on the passenger management strategies adopted by the cruise ships).
- The existing tender operation is susceptible to the weather, in particular strong winds and rough seas associated with Nor'westers; PACI records indicate an average of 4% of calls are relocated to Spott's Landing, with an additional 4% of calls missed entirely.
- Cruise operations take place during the day, while cargo operations take place at night; this effectively separates cruise and cargo operations.
- Cargo traffic is expected to continue to increase at a rate in the order of 5% per year.
- Cargo ships calling at Grand Cayman are limited to about 500 TEU ("twenty foot equivalent units") in size due to the physical constraints of the existing facility (length of South cargo dock and depth alongside it). This is a small ship even by Caribbean standards.
- It is anticipated that the cargo port will reach its physical capacity within 10 to 20 years.

17.1 Project Impacts

17.1.1 Construction Phase

The anticipated impacts associated with the construction of the proposed cruise berthing facility on cruise and cargo operations are summarized below:

- Intermittent disruptions to cruise/tender and cargo operations (marine and landside).
- Intermittent disruptions to recreational and water sports activities in GTH.
- Intermittent limitations/restrictions on access to certain marine and landside areas.
- Increased marine traffic and risk of marine incidents.

17.1.2 Operation Phase

The anticipated impacts associated with the operation of the proposed cruise berthing facility on cruise and cargo operations are summarized below:

- Increased cruise traffic is expected upon project completion (1-3% per year, as per OBC).
- No significant chanage in passenger disembarkation rate (the estimated peak disembarkation rate with four cruise ships at berth is 5,500-6,500 passengers per hour; this is similar to the capacity of the existing tender operation).
- Increased passenger time onshore, albeit with a significantly longer walk to Harbour Drive.
- Reduce downtime due to inclement weather (average of 1-3% considering the range in ship sizes expected to use the new berthing facility, as compared to average of 8% for the existing tender operation, including 4% missed calls plus 4% diverted to Spotts Landing).
- The requirement for tendering will be significantly reduced by the new facility. However, tendering will still be required on busy days when more than four cruise ships call at George Town; the final concept layout does not provide a sheltered tender landing facility, so the tender operation will continue to be subject to the weather.
- The final concept layout will increase the port's capacity to handle cargo, due to a longer/deeper South cargo dock, a new RO/RO ramp and increased land area.
- Cruise operations will continue by day, with cargo operations to continue by night, thereby maintaining the current separation of these operations.
- Additional operational support will be required for the new facility, including pilots and line handlers, as well as landside operations and management/administrative staff.
- Navigation of large cruise ships to and from the berthing facility will increase the risk of marine incidents (more traffic and closer proximity to the reef).

17.2 Mitigation Measures

17.2.1 Project Design

- Navigation simulations should be undertaken to estimate safe operational limits for the facility, and to define requirements for navigation aids.

- A comprehensive landside master plan is required to define the facilities and infrastructure necessary to support progressive growth in cruise and cargo traffic and operations at the new facility (refer to Figure 17.1 below).

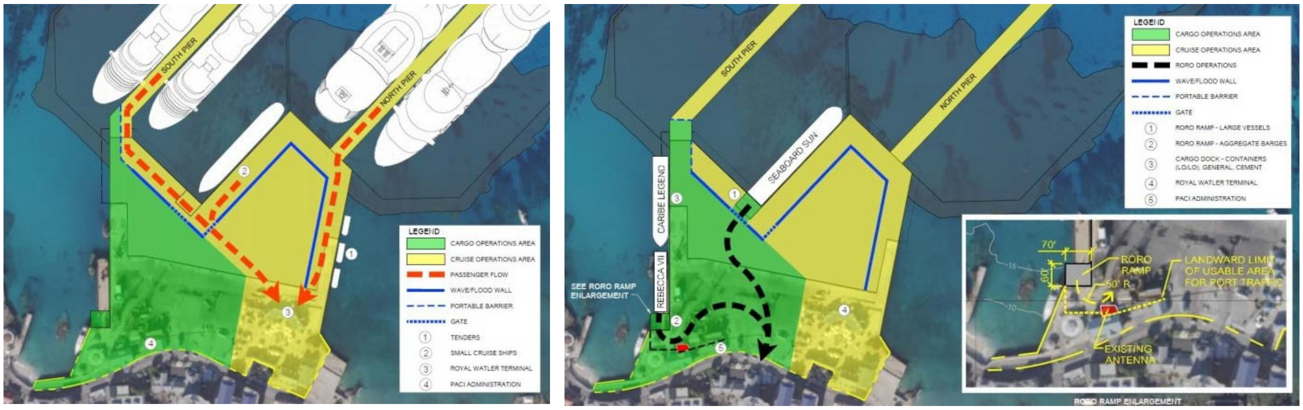


Figure 17.1 Schematic Diagrams of Cruise (left) and Cargo (right) Areas and Flows at Proposed Facility

17.2.2 Construction Phase

- It will be important to maintain tender operations throughout the construction period.
- Careful planning and coordination between PACI and the Contractor will be required to maintain cruise, tender and cargo operations throughout construction. This will be an important consideration in the development of the construction sequencing plan.
- Notices to Mariners and temporary navigation aids will be required.
- Specific requirements for the protection of the natural environment within and around the project site are defined in the Environmental Management Plan.
- The Contract Documents should define requirements related to work area limits, time of day restrictions on operations, construction access routes and staging/storage areas, and protection of existing structures and facilities.

17.2.3 Operation Phase

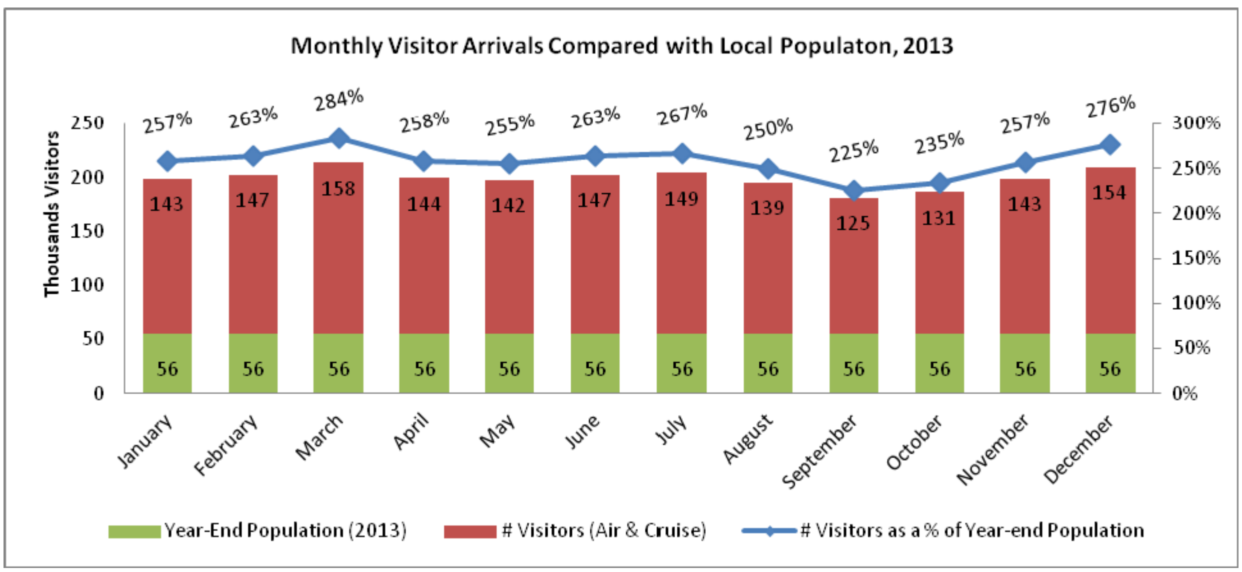
- Suitable navigation aids will be required to support safe navigation.
- A landside master plan is required to guide the future development of the expanded land reclamation area; the CIG should prioritize landside improvements, with phased implementation to enhance the facility while maintaining safe and efficient operations.
- The CIG and/or PACI will need to obtain the additional resources necessary to operate the new facility, including:
- Management, operations and administrative staff for marine and landside cruise and cargo operations;

- Suitable tug(s), pilot boats and crews and line handlers.
- Consider replacement of outdated cargo handling equipment (crawler cranes) with more efficient equipment (rubber tired mobile cranes) to improve the efficiency of operations and reduce wear and tear on the dock surface.

18.0 SOCIO-ECONOMIC AND BUSINESS DISTRICT IMPACT ASSESSMENT

The socio-economic impact assessment, which incorporated the business district impact assessment, included desktop research, observations and consultations with stakeholders. Data sources included census of population and housing, economic reports and tourism, energy, water supply and physical planning statistics from the CIG's Economic and Statistical Office (ESO). Stakeholder consultations were undertaken to ascertain their awareness of the proposed project, their perceptions on the potential impacts of the project on their communities/groups, socio-economic factors, cultural/heritage, landscape and the natural environment.

The population of the Cayman Islands was estimated at 55,691 at the end of 2013, with 28,423 (about 50%) residing in the George Town District. Tourism is the second largest contributor to the gross domestic product (GDP) of the Cayman Islands, with monthly air and cruise visitor arrivals exceeding the local population throughout the year. In 2013, there were a total of 1.7 million visitors to the Cayman Islands (1.4 million by cruise and 345,400 by air – see figure below), spending an estimated CI $496 million; this represents approximately 14% of the GDP of the Cayman Islands ($3.7B in 2013). Approximately CI $115M of the total spending, or 23%, was associated with cruise ship passengers.



A key finding of the EIA is that the marine resources in GTH have a significant economic value. A preliminary estimate of this economic value has been developed by assessing the ecosystem goods and services provided by the marine resources within GTH, including tourism and recreation, shoreline protection, primary production and fisheries. The estimated total economic value of the goods and services provided by the marine resources in GTH is in the order of CI$19-22M/year, with this value being dominated by tourism and recreation, in particular watersports activities in GTH (snorkelling, diving, etc.). The estimate is based on a combination of direct data collection and literature-derived values, and is subject to some uncertainty due to various assumptions required to develop the estimate.

Project construction and operation will result in damage to the marine ecosystem within GTH, with associated adverse impacts on the goods and services provided by the marine ecosystem. Revenues generated by watersports businesses which rely on tourism and recreation opportunities provided by the marine resources within GTH will also be adversely affected. However, it is anticipated that these adverse impacts will be offset, to some degree, by the diversion/displacement of activities from within GTH to other locations and/or activities/attractions in George Town and around Grand Cayman Island. It is recommended that the OBC be updated to reflect these and other socio-economic impacts identified in the EIA.

The anticipated socio-economic impacts associated with the construction and operation of the proposed cruise berthing facility are summarized below.

18.1 Project Impacts - Construction Phase

18.1.1 Positive

- Macro-economic benefits to the Cayman Islands:
    - Estimated CI$150M contribution to GDP from capital expenditures related to project construction over a three year period);
    - the OBC (PwC, 2013) estimated 490 FTE (full time equivalent) employment opportunities will be available during construction. The project will require administrative staff, labourers, divers, skilled tradesmen, project management, engineers, foremen and operators, amongst other positions. To the extent that local expertise is available, the labour force will benefit.
- Micro- economic benefits to the Business District:
    - Increased sales and revenues for some businesses, in particular food and beverage services and accommodation from influx of workers;
    - Increase employment opportunity for local residents.

18.1.2 Negative

- Intermittent disruption to both cargo and cruise operations. Potential for cumulative macro-economic impact.
- Increased risk for marine incidents (accidents and injuries) in the harbour.
- Reduced access to the harbour for diving, snorkelling and other water-based activities, with possible displacement of some GTH businesses.
- Public health and safety risk to visitors and residents from reduced water quality.

- Estimated economic loss in the order of CI$6.5-9M/year (based on current spend rates) related to direct and indirect impacts on marine ecosystem goods and services within GTH caused by project construction, in particular due to the loss of coral reefs and associated business for local watersports operators, plus indirect impacts to employees' incomes and purchasing power. This corresponds to an estimated economic loss in the order of CI$16-27M over the anticipated 2.5 to 3 year period of construction. As noted above, these estimates are based on a preliminary marine resource valuation, and are subject to some uncertainty. Also, these estimates do not consider the anticipated diversion/displacement of activities from within GTH to other locations and/or activities/attractions in George Town and around Grand Cayman Island.
- Reduced revenue from goods and services in the business district if the number of visitors to the business district declines due to cumulative impacts of project construction.
- Increase in vehicular and pedestrian traffic and congestion due to movement of construction materials and equipment on and off site.
- Temporary nuisance vibrations, noise and air pollution in George Town.

18.2 Project Impacts - Operation Phase

18.2.1 Positive

- Macro-economic benefits to the Cayman Islands:
    - As per Outline Business Case (PwC, 2013), net benefits are estimated to be CI $245M (net present value) and 1,000 FTE in person years assuming 1% per annum growth in cruise visitors over an assumed 20-year economic lifespan of the project. Net benefits increase to CI $1,196M assuming 3% per annum grown over 20 years.
- Micro-economic benefits to the Business District:
    - Increased sales and revenues. Non-marine commercial stakeholders in George Town reported sales CI $1,992,000 per annum (seven respondents), 51% of which was attributed to cruise visitors.
- Reduced tender traffic will reduce the risk of marine incidents (accidents and injuries).

18.2.2 Negative

- Increased vehicular and pedestrian traffic in George Town will reduce the level of service for pedestrians and increase congestion on the roads.
- Project will reduce/eliminate access to some snorkeling and diving sites in George Town Harbour, and will increase travel time to others (due to the need to go around the piers).
- Increased resources will be required to cope with increased visitor volume and mitigate negative impacts, including upgrades to landside infrastructure (i.e. roads, services and

tourist attractions), insurance for the new facility, emergency services including health care and fire, etc.

- Estimated economic loss in the order of CI$6.5-9M/year (based on current spend rates) related to direct and indirect impacts on marine ecosystem goods and services within GTH caused by the project, in particular due to the loss of coral reefs and associated business for local watersports operators, plus indirect impacts to employees' incomes and purchasing power. Assuming 1-3%/year growth in cruise passenger traffic over the 20 year life of the project (as per the OBC), this corresponds to an estimated economic loss in the order of CI$100-165M over the 20 year life of the project (range in net present value assuming a 3.5% discount rate). As noted above, these estimates are based on a preliminary marine resource valuation, and are subject to some uncertainty. Also, these estimates do not consider the anticipated diversion/displacement of activities from within GTH to other locations and/or activities/attractions in George Town and around Grand Cayman Island.
- Loss of income for tender operators estimated at CI$0.3M/year, with associated impacts on quality of life for more than 40 households (this issue was considered in the OBC).
- Increased volume in cruise tourism may deter stay-over visitors from visiting George Town on days when ships call; as stay-over tourists spend more than three times what cruise visitors spend, this suggests the potential for significant, long-term negative impacts, particularly given the limited carrying capacity of certain natural attractions, such as Stingray City.

The estimated economic losses presented above represent the anticipated project-related impacts resulting from the direct loss of a natural resource (coral reefs) which is essential to the watersports industry in GTH, as well as the indirect impacts to employees' incomes and purchasing power. It is noted that the estimated economic losses are based on a preliminary marine resource valuation derived from current spend rates, and are subject to some uncertainty. Further analyses are required to adjust the estimated losses to reflect the Gross Value Added (GVA) to the overall economy of the Cayman Islands, and also to account for the anticipated diversion/displacement of businesses from within GTH to other locations and/or activities/attractions in George Town and around Grand Cayman Island. It is recommended that the OBC be updated to reflect these and other socio-economic impacts identified in the EIA.

Mitigation measures to address socio-economic impacts are presented below. Additional mitigation measures related to impacts on marine ecology, air, noise and water pollution, and landside traffic are discussed elsewhere.

18.3 Mitigation Measures

18.3.1 Construction Phase

- Continuous and comprehensive coordination between Contractor and PACI to minimize disruption to existing cruise/tender and cargo operations (both marine and landside).

- Traffic management plan to minimize impacts on vehicular and pedestrian traffic (for example, schedule materials deliveries during off-peak commute and visitor times to minimize impacts on the local community).
- Make provisions for tendering service during construction and after construction.
- Relocate *Balboa* to new location within GTH where day time access for snorkeling and diving is possible; a wreck relocation plan will be required.

18.3.2 Operation Phase

- Make provisions for tendering service during the operational phase.
    - Develop/implement a program to mitigate livelihood impacts amongst particularly vulnerable groups (such as tender crews), including the following:
    - Undertake needs assessment:
    - Define process for accurately identifying those directly impacted;
    - Work in a collaborative and inclusive manner to develop strategies to minimize socio-economic impacts;
    - Consider the need to compensate persons who will have income and revenue loss;
    - Provide assistance with identifying and establishing alternative livelihoods and revenue streams where appropriate; this may require skills training and professional development.
- Additional and ongoing communication with stakeholders and the general public regarding the potential negative and positive impacts of the proposed project will be very important, including consideration of the following factors:
    - There were some views that there is insufficient information available on the full scope and potential impacts and benefits of the project;
    - Given the cultural and socio-economic significance of the sea to the Cayman Islands, and the potential for negative impacts, it is critical that alternative scenarios (with, without, alternate locations, etc.) be clearly presented to the public and stakeholders (i.e. in layman's terms).
    - Justification for the preferred option and mitigation strategies should also be presented.

19.0 LANDSCAPE AND VISUAL IMPACT ASSESSMENT

A comprehensive review and assessment of the natural and built landscape was conducted as part of the EIA in order to define baseline conditions, and to assess the potential landscape and visual impacts of the proposed cruise berthing on the George Town area. The study included a land use survey, spatial analysis of views from selected observation points, and renderings for various project layout alternatives for perspectives selected to match photographs of existing conditions from specific street level vantage points. A photograph taken from the Appleby Centre (provided by IRG Ltd.) was also used to develop aerial oblique renderings of selected concepts for comparison with existing conditions.

Grand Cayman is generally flat, with an average elevation of approximately 6 ft above sea level. The flat relief of the island gives it a low visual profile. The port lands and downtown George Town are slightly more elevated than the surrounding areas, with the most significant features in the project area being the coastline and the nearshore and fringing reefs that surround the West Coast of the island. The existing land use in the study area is primarily commercial and institutional (government and administrative offices), with localized residential areas to the north and south of the central business district. The buildings within 1,600 ft of the project site are large in scale and height compared to buildings beyond. The flat relief coupled with the high buildings within the business district limits visibility of the coast to people in the buildings located along Harbour Drive and the coastline. Further, the existing anchorages are relatively close to the coast, so visibility is further restricted when cruise ships are moored in GTH.

The anticipated landscape and visual impacts associated with the construction and operation of the proposed cruise berthing facility are summarized below. Renderings comparing existing and proposed conditions from different vantage points are provided at the end of this Chapter.

19.1 Project Impacts - Construction Phase

- Visibility of the proposed project activities will highest for areas along Harbour Drive and the coastline.
- Views of the sea will include construction and dredging equipment.
- Elevated turbidity levels during the dredging program (~2 to 4 month duration) will impact aesthetics, and will restrict the ability to snorkel and dive.
- No land use impacts are expected, as activities are limited to the existing port area.

19.2 Project Impacts - Operation Phase

- Views with cruise ships in port will not be significantly impacted.
- The additional land area created by the project represents an opportunity to develop enhanced cruise terminal facilities and amenities, and to improve the visual landscape and aesthetic value of the facility.
- The additional land area will provide increased capacity for both cruise and cargo operations, and will facilitate more efficient operations.
- The project is expected to increase the value of other property along the waterfront.

19.3 Mitigation Measures

- The negative visual impacts associated with construction are temporary and unavoidable. Ongoing communication and involvement of stakeholders and the general public will increase the understanding of negative visual impacts during construction, and should reduce complaints.

Figure 19.1 Renderings of Existing and Proposed Conditions as viewed from Appleby Tower, George Town

Figure 19.2 Renderings of Existing and Proposed Conditions as viewed from North Church Street, George Town (Burger King) [Existing, top; Proposed CBF, bottom]

Figure 19.3 Renderings of Existing and Proposed Conditions as viewed from North Church Street, George Town (Fish Market) [Existing, top; Proposed CBF, bottom]

Figure 19.4 Renderings of Existing and Proposed Conditions as viewed from South Church Street, George Town [Existing, top; Proposed CBF, bottom]