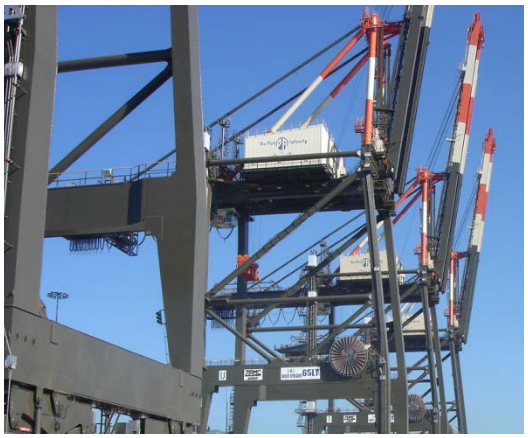
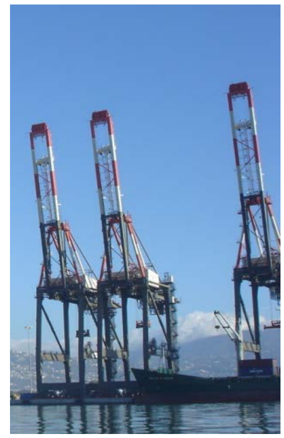
Report

Environmental Impact Assessment of the Development of Infrastructure Capacity at Kingston Harbour: Channel Upgrade & Fort Augusta Development





PREPARED FOR MOTT MACDONALD AND THE PORT AUTHORITY OF JAMAICA

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REPORT

ENVIRONMENTAL IMPACT ASSESSMENT OF THE DEVELOPMENT OF INFRASTRUCTURE CAPACITY AT

KINGSTON HARBOUR: CHANNEL UPGRADE & FORT AUGUSTA DEVELOPMENT

PREPARED BY: TEMN LTD.

FOR MOTT MACDONALD AND

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1. EXECUTIVE SUMMARY

Need for the Project

This environmental impact assessment is carried out in respect of the proposal by the Port Authority of Jamaica (PAJ) to deepen the Port Bustamante Basin, and to deepen and widen areas of the Ship Channel to accommodate larger container vessels. The PAJ intends to use some of the dredged material to reclaim land adjacent to Fort Augusta for future development as a container terminal.

The PAJ dredging project is intended to improve KCT's competitive advantage and enable the port to serve as a trans-shipment hub for draught-restricted ports of the US East and Gulf Coast. When completed, the channel will accommodate vessels with an approximate capacity of 13,000 TEUs with a maximum draft of 15.2 meters, a maximum ship length of 366 meters and beam of 48.8 meters.

Overview of Project Activities

Estimated total volume to be dredged is 15.7 million m^3 broken down as follows:

- Maintenance dredging - 0.5 million m^3
- Capital dredging – 15.2 million m^3

Specific activities proposed to be undertaken include:

1. Maintenance and capital dredging 15.7 million cubic metres of material from the ship channel and Port Bustamante, and using as fill for berth construction;
2. Construction of reclamation bunds;
3. Construction of 1,000m of berth;
4. Procurement of fill material for reclamation works by dredging the areas identified;

5. Reclamation of Fort Augusta peninsula with 4.0 million m^3 of borrow material to produce approximately 50 hectares of container storage areas and berth apron;
6. Disposal of material either not suitable or not required for the reclamation works.

The reclamation will be carried out in such a manner that fill material is contained within adequate temporary bunds formed as the work progresses. This is to include the formation of containment bunds around the perimeter of the reclamation area prior to commencement of filling.

Scope of the EIA

The limit of the assessment extends a radius of 2Km, an area that includes for the purpose of the socioeconomic impact, the communities of Greenwich/Newport West, Port Royal, Portmore, Passage Fort and Portsmouth. Physical/chemical and biological baseline evaluation focused on the area in the vicinity of Fort Augusta proposed for reclamation, as well as the wider Kingston Harbour.

The environment within the zone of influence is described in terms of physical/chemical, biological and socioeconomic attributes. This has included an evaluation of water quality, coastal ecology, ocean dynamics and socioeconomic factors (public perception, land use, cultural aspects).

Physical Environment

The physical environment is evaluated in terms of water quality, sediment quality and coastal dynamics. The water quality assessment is based on data collected on July 20, 2012 for the current EIA and on prior data collected for the unpublished 2006 EIA and data collected during prior dredge monitoring. The current sampling effort focused on establishing monitoring baseline conditions for basic water quality indicators including suspended solids/turbidity, dissolved oxygen, temperature, salinity and heavy metals. Available data from previous work indicated levels of the trace metals chromium and lead in water and sediment that were well within the normal range.

Coastal dynamics investigation focused on acquisition of hydrodynamic field data within the greater Kingston Harbour and in the vicinity of the Fort Augusta expansion area. This was carried out between September 28 and September 30, 2012. Field observations and measurements indicate that the shoreline to the west, and down drift of the proposed Fort Augusta expansion area, is severely eroded with apparent damage to existing infrastructure. Given the persistent westward longshore sand transport and wave forcing, the construction at Fort Augusta will likely further reduce sand supply from the east and therefore worsen the shoreline state along the section of the beach to the west.

Assessment of the fate of dredged material is based on the result of previous work done to quantify the parameters of such a release in the 2002 capital and maintenance dredging operation in Kingston Harbour using the STFATE model. STFATE was used to simulate short and long-term fate of dredged material due to dredging disposal operations and environmental processes.

The model predicts the distribution of dredged material through the water column and bathymetric distribution of dredged material on the seabed on the basis of individual disposal loads. The STFATE accounts for various parameters including the type of disposal vessel, physical properties of the water column, and material properties.

Ecology

The main focus of the ecological survey was to quantify the spatial extent of seagrass beds and to identify the presence/absence of ecologically or commercially important species of fauna found in or immediately adjacent to the Fort Augusta reclamation site. Aerial and marine (benthic) surveys were conducted in July and August of 2012. Despite the degraded conditions, the Bay has been and continues to serve as the main nursery area for shrimp within the harbour. From aerial surveys, seagrass areas in the vicinity of the proposed reclamation are estimated at 3.2Ha. Most of the seagrass beds between Port Henderson and Fort Augusta are found within a 50 - 150 m band from shore at a depth of <2m. Further from shore, the sediments are primarily fine sand, mud and silt. The area is impacted by chronic sedimentation.

Kingston Harbour supports recreational, subsistence and commercial fisheries. Fisheries resources include shrimp, conch, lobsters, coastal pelagics (herring, sprat, etc.), reef and reef associated finfish (snapper, parrot etc.) and the now rare, larger pelagic fish such as dolphin, kingfish, mackerel and jacks. The most notable habitats for fishes are the mangrove and seagrass beds adjacent to Port Royal and along the outer (western) harbour. There are numerous fish species associated with the Port Royal mangroves and adjacent seagrass beds including the sea bream (*Archosargus rhomboidalis*), family Sparidae, silverside (Atherinidae), dusky anchovies (Engraulidae), mackabacks (Gerreidae), porcupine fishes (Diodontidae), parrotfishes (Scaridae) and wrasses (Labridae).

The six designated fishing beaches within the immediate vicinity of the proposed development area were visited and interviews conducted with fishermen to collect data pertaining to fish and shrimp landings as well as the presence/absence of exotic/ protected/endemic species such as dolphins, crocodiles, etc. Many of the fishermen interviewed, fished only within the confines of Kingston Harbour, however many expressed that this was becoming an increasing challenge due to a steady decline in fish stocks. This has forced them to venture outside the harbour to deeper waters and to areas near Hellshire to the south-west, Lime Cay to the south-east, St. Thomas, St. Elizabeth and even as far as Pedro Cays. Twenty nine species of common and rare fish were identified in catches at the five beaches surveyed.

Socioeconomics

The socioeconomic impact assessment (SIA) examines the socioeconomic, cultural setting of the study area and identifies potential impacts of the proposed development. The SIA study area includes areas within a 2 km radius of the proposed dredge and reclamation sites. Impacts are assessed at the micro (local), regional (parish) and macro (national) levels. The SIA is based on desktop research and a socioeconomic and perception survey. Data sources include census data from the Statistical Institute of Jamaica (STATIN), the Jamaica Survey of Living Conditions (JSLC), the Economic and Social Survey of Jamaica (ESSJ), EIA reports that were previously conducted within the area, and results of the socioeconomic and perception survey.

The impact on cultural heritage was assessed through reference to the Jamaica National Heritage Trust list of designated sites and the distance of these sites from the proposed project site.

The existing land use for this SIA study area was determined through the review of satellite imagery of Jamaica and topographic maps. Field verification of land uses were made during visits to the various communities. Parcel data for the SIA study area was obtained from the National Land Agency (NLA) and ESRI ArcGIS was used to produce the map and analyse the distribution of land uses.

Environmental Impact

Assessment An assessment of the overall project alternatives and analyses of the potential environmental and social impacts identified for phases during and after construction are presented within the framework of the study disciplines outlined in the Terms of Reference, namely:

Physical/Chemical,

Biological/ecological,

Sociological and

Economic/Macroeconomic.

The definitions for these are as follows:

Physical/chemical	Covering all physical and chemical aspects of the environment, including finite (non-biological) natural resources, and degradation of the physical environment;
Biological/ecological	Covering all biological aspects of the environment, including renewable natural resources, conservation of biodiversity, species interactions pollution of the biosphere;
Socioeconomic	Covering all human aspects of the environment, including social issues affecting individuals and communities; together with cultural aspects, including conservation of heritage, and human development;
Macroeconomic	Covering macroeconomic consequences of environmental change, both temporary and permanent, within the context of the project activities.

Impacts identified for each environmental component (Physical/Chemical, Biological/ecological, Socioeconomic/cultural and Macroeconomic) are evaluated using the rapid impact assessment matrix (RIAM) method (Jensen, 1998). The assessment is provided for each project alternative, including the "without-project" scenario and the desired alternative.

Environmental Score/Range Value

Activity/Discipline	Existing		During Construction		Post Construction	
Parameter	ES	RV	ES	RV	ES	RV
Physical and Chemical Components	***-32***	***0***	***-119***	***-5***	***-112***	***-2***
Hydrology (Ground and Surface water)	0	0	0	0	0	0
Coastal Dynamics	-32	0	-32	0	-98	0
Marine Water Quality Impacts	0	0	-36	-4	-14	-2
Gaseous emissions	0	0	-30	-4	0	0
Occupational	0	0	-7	-1	0	0
Noise	0	0	-7	-1	0	0
Solid Waste Management	0	0	-7	-1	0	0
Biological and Ecological Component	***0***	***0***	***-94***	***-5***	***-117***	***-5***
Terrestrial	0	0	-12	-2	-35	-3
Marine/Benthos	0	0	-82	-5	-82	-5
Sociological and Cultural Components	***-14***	***-2***	***0***	***0***	***103***	***4***
Economic and Operational components	***0***	***0***	***-87***	***-5***	***186***	***5***
Overall Scores	-46	-4	-300	-5	60	4

For the overall Assessment, the various environmental score (ES) values are grouped into ranges and assigned alphabetic or numeric codes for ease of comparison. The assessments are made for impacts identified for the period during dredging and reclamation activities. The existing conditions provide the baseline for future assessments. The ES values for each of the four environmental components (Physical/Chemical, Biological/ecological, Socioeconomic/cultural and Macroeconomic) are determined for the period during and after implementation of the project.

The Environmental Score/Range Values are explained in the following table.

Environmental Score (ES)	Range value (RV) (Alphabetic)	Range value (RV) (Numeric)	Description of Range Value
72 to 108	E	5	Major positive change/impact
36 to 71	D	4	Significant positive change/impact
19 to 35	C	3	Moderate positive change/impact
10 to 18	B	2	Positive change/impact
1 to 9	A	1	Slight positive change/impact
0	N	0	No change/status quo/not applicable
-1 to -9	-A	-1	Slight negative change/impact
-10 to -18	-B	-2	Negative change/impact
-19 to -35	-C	-3	Moderate negative change/impact
-36 to -71	-D	-4	Significant negative change/impact
-72 to -108	-E	-5	Major negative change/impact

From the analysis, implementation the project is expected to have a major negative impact during construction, some of which will be temporary. Some impacts can also be mitigated. Implementation of the project, while having localised negative physical and biological impacts, will have significant positive socio-economic impacts.

Physical/chemical Impacts

Water Quality

The main water quality impact expected is the increase in suspended solids at the site to be dredged as well as possible transportation of this suspended matter to adjacent/down-current areas. This increase in TSS/turbidity is expected to be temporary and levels are expected to return to background shortly after cessation of the dredging event(s). The sediment to be dredged is not adjudged to be toxic based on previous examination as well as the fact that the source of the sediment is from the surrounding watershed within which the main activities are residential, commercial, agricultural and to a much lesser extent industrial. A return to baseline conditions for water quality shortly after cessation of the dredging and reclamation works is expected. The proposed method for the reclamation works should ensure that impact to turbidity level in the vicinity will decrease once the retaining works are completed.

Results from previous dredge monitoring indicate that effects of the dredging were localised and confined to the dredge site. The effect was not noticeable at sampling locations in relatively close proximity to the north, northeast and southwest of the dredge site.

Analyses for trace metals arsenic, copper, chromium, lead, mercury, nickel, tin, vanadium, and zinc indicate levels of these in sediment and water samples that are well below EPA criteria for wildlife. Elutriate tests conducted indicated that these trace metals are not released from sediment to the water column.

Coastal Dynamics

Wave Modelling

The CMS-Wave modelling results suggest that the proposed Fort Augusta expansion will have negligible influence on the overall wave conditions in the greater Kingston Harbour. Wave reflections from the vertical seawall will not significantly influence wave conditions at the project site. The major influence of the expansion will be the wave sheltering to the west. While reducing the overall incident wave energy to the west of the proposed structure, the expansion will create a large gradient of wave height, and therefore wave energy. The wave-energy gradient will induce a gradient in longshore sand transport to the west. The transport gradient will likely induce beach erosion in areas with less sediment input than output. This will add to the already stressed condition along the shoreline west of the proposed reclamation.

Current Modelling

The CMS-FLOW model, reproduced the observed conditions reasonably well and has proven to be accurate for the study of the flow patterns in Kingston Harbour and the proposed Fort Augusta expansion site. Overall, the proposed expansion has little influence on the flow patterns even at local scales. The flow modelling illustrated an ebb-domination pattern along the project shoreline. This ebb domination, in addition to the highly oblique waves generated by the easterly wind, contributed to the beach erosion along the section of shoreline to the west of the proposed expansion. It is recommended that shore protection measures be developed to protect the shoreline west of the expansion site from further erosion due to the proposed modification.

Fate of Dredged Material

During reclamation, whether by ‘rainbowing’ or pipeline discharge, there is risk of an effluent with a high concentration of suspended solids returning to the nearshore waters. Based on the FATE model, as fines are disposed at the 1000m contour (deep water disposal site), a turbidity plume will form as the material disperses and sinks. Monitoring of previous operations of disposal at the 1000m contour indicates all traces of the plume vanish about twenty minutes after release from a hopper barge. Given the general good clarity of these deep waters, the disappearance of the plume indicates that rapid sinking into the abyss occurs along with dispersion. Thus this operation has been deemed to have negligible impact on the environment.

Biological/ecological Impacts

Potential terrestrial impacts during construction are negligible since the site is already degraded from longstanding construction activities such as Fort Augusta itself as well as other beach front developments, some of which have been abandoned. The proposed terminal construction will destroy the existing beach habitat west of Fort Augusta but the ecological impact to the terrestrial environment in the immediate area of the development should be minor.

Potential marine impacts due to construction activities can arise from runoff water that contains construction related sediment. The construction related discharges are not likely to be significant provided appropriate containment measures aimed at reducing runoff/sediment from construction activities are put in place.

The most significant potential marine impacts include:

- loss of seagrass habitat in the immediate reclamation and donor site areas;
- loss of other associated fauna such as urchins and conch unless these individuals are specifically removed prior to the commencement of dredging/reclamation activities;

- loss of feeding, and nursery habitat for turtles, fishes and the loss of important shrimping grounds on the western side of the harbour;
- decreased floral and faunal diversity within the harbour ecosystem;
- decreased longshore drift of sediment to beaches downcurrent of the development area.

Biological Impacts after the Dredging

Potential terrestrial impacts at the immediate development site are negligible since the site is presently degraded. Activities such as improper management and/or storage/removal of construction debris could create breeding sites for pests and also lead to blockage of storm water drainage channels.

Potential marine impacts due to operational activities are considered to be significant because of the increased risk of release of petroleum products and re-suspension of sediment due to an increase in maritime activity. This is expected to exacerbate the impact to an already impacted harbour ecosystem and the presence of immediately adjacent wetland habitat which appears to be at least intermittently used by crocodiles. Given the proximity to the entrance to the harbour, the potential also exists for these petroleum products to be carried out of the harbour and impact reef systems immediately downstream or into Hunts Bay depending on the tidal cycle. The reefs in this area are already highly stressed by excess nutrients and suspended solids in the water coming from Kingston Harbour.

Mitigating the compounded impacts from existing stress and additional stress from construction, release of petroleum-based toxins into the system and elevated sedimentation/turbidity will be of critical importance to the survival of both harbour and reef systems. Since the benthos inside Hunts Bay is anoxic from chronic organic pollution and high sedimentation levels, serious consideration must be given to protecting and where possible, rehabilitating, existing nursery and shrimping grounds that are not directly impacted by harbour construction and operations.

The approach to the identification of candidate sites for seagrass replanting will be guided by a desk study to establish areas of seagrass coverage in Kingston Harbour and environs (if necessary) over the last 10 to 15 years. This information would be evaluated in conjunction with critical physical parameters including light, temperature, turbidity/TSS, salinity and wave energy to identify sites where transplantation is likely to be most successful.

Mitigation for the loss of shrimp habitat would be based on a detailed study to establish a relationship between the use of available habitat types and locations at various stages in the animal's life cycle. Information on sediment types (incl. organic matter), the distribution of surface sediments and shrimp population distribution from long term catch data would be required. With this information the significance of the area lost by the current development, to the population's viability can be better assessed. The scope of the area for targeted interventions could include initiatives within Hunts Bay such as:

i) deepening portions of the Bay to provide optimal depth for seagrass replanting which in turn would provide suitable habitat for proliferation of the shrimp population;
ii) local/land-based initiatives to reduce sediment and solid waste load in storm run-off into Hunts Bay or into the main Harbour to reduce impact on the Port Royal mangroves.

Socioeconomic & Cultural Impacts

During Dredging & Reclamation

Potential land use impacts from dredging activities will be indirect as the activity will be confined to the sea. Reclamation of land along the Fort Augusta peninsula will increase land surface area of the country. The reclaimed land is proposed for terminal and container storage. Land use impacts will also occur if land disposal is the option chosen to dispose of dredge material not used for reclamation on land. Land use impacts will be direct, short and long term and significant.

Traffic impacts will be as a result of the movement of workers to and from points of access to project activities. This will be in the vicinity of the reclamation site on the landward side as well as at the port, due to movement on and off dredge vessels. Vehicular traffic will mainly affect the Portmore Causeway/Highway 2000 and exits providing access to the KCT, and Marcus Garvey Drive.

Marine traffic will be impacted. There will be minor increase in traffic due to the presence of dredging vessels in the harbour. The channel is also used by other marine interests such as the Petroleum Corporation of Jamaica, which also has vessel calls for delivering petroleum and products for refining. Other interests in the inner harbour (northeast) such as the Cement Company, Jamaica Aggregates and operators of small boats such as the fishing interests may also be affected. However proposed dredging activities will be scheduled around the activities of current harbour users. As such traffic impacts during this project phase will be short-term and minor.

Employment Opportunities

It is anticipated that approximately 200 jobs will be created during the construction phase. Opportunities will also be created for divers, environmental experts, surveyors, truck drivers, heavy equipment operators and casual labourers. In addition, business opportunities will be created for quarry operators for the supply of boulders required for the reclamation.

Community Development/Recreation Impacts

Recreation impacts may occur as a result of dredging. Recreational use of beaches within the area was identified as one of the main activities for residents in the study area. Beaches were also identified as a natural resource and asset to the community. Sediments from dredging may impact water quality at these beaches. Contaminants in sediments are evaluated in the water quality and coastal dynamics sections.

Perceived impacts of the proposed dredging were mainly negative. The perceived impacts included pollution of the harbour and marine resources; loss of recreational resources (beaches); destruction of fisheries and shrimp grounds; loss of livelihoods for fishing interests; increase in traffic; and noise. Fishing interests within the harbour opined that fisheries recovery from previous dredging activities in the harbour took anywhere from four to ten years.

Positive impacts identified included employment opportunities; business and community development and associated benefits of reduced crime.

Macroeconomic Impact

The dredging/reclamation activities will have broader macroeconomic impact. In addition to the creation of employment, the project will demand goods and services from other sectors of the economy, namely, quarrying and transportation. This is expected to stimulate activities in these sectors which will have a possible impact on national output.

Post Dredging & Reclamation

After reclamation of new land, there will be an increase in land asset. This is a positive significant long-term impact.

Traffic impacts post dredging and reclamation, will be negligible on land. Marine traffic will increase with the capability of the channel to accommodate larger vessels in addition to current traffic. Traffic impact on land will be insignificant. Impact from increased harbour traffic will be positive, significant and long-term as project and national development goals are met.

Post dredging/reclamation impacts on community development would be long-term as a result of employment and associated benefits to the wider community.

Macroeconomic

The project is a national goal included in Vision 2030 – Jamaica National Development Plan and the Medium Term Socio-Economic Policy Framework 2009-2012. The project aims at giving the country strategic competitive advantage as a trans-shipment point for cargo within the region (Caribbean and Latin America) and to take advantage of the widening of the Panama Canal to accommodate larger vessels. This will positively impact the industry which contributed 11.2% to GDP and 10.7% to goods and services production at a value added of $104,937 million (current prices) in 2011.

An estimated 68.7% of the persons surveyed were in support of the proposed project. 68% of persons surveyed deemed the proposed project as being 'important' or 'very important', while 22.7% of respondents viewed the project as not being important. The remaining respondents had no response.

83% of all respondents felt the project would create some form of employment opportunity for persons living within close proximity to the project site or those within surrounding within the surrounding environs. Only 8% of respondents indicated that the project would have a largely negative effect on employment, while an estimated 5% felt there would be no employment opportunities created. Youth employment was considered a major potential impact of the proposed development, which some respondents felt would result in a reduction in crime.

Mitigation of Impacts

Mitigation of Physical/Chemical Impacts

Water Quality

It is recommended that the dredging and filling operation be contained to minimise sediment transportation to adjoining areas. Effectiveness of containment strategies should be verified by monitoring of water quality at sensitive areas and/or areas down-current of the dredging and filling sites.

Specifically, consideration should be given to:

- Deployment of silt screen around the construction/working face of the containment bund until the reclamation berm is finished such that the quality of the water exiting the reclamation is similar to the quality of the water in the adjacent location;
- At a minimum, fortnightly aerial monitoring of the movement of the dredge to and from the disposal site;
- Development of a water quality monitoring programme around the dredge and fill sites for suspended solids, Turbidity and DO during and after the dredging. This would be carried out weekly for the first month and fortnightly for subsequent months until the reclamation berm has been completed.

Once the containment bund is in place, risk of sediment coming from the reclamation will be minimised, as placement of material will be within the bund. Any overflow water will go into settlement ponds, with weirs to prevent silt returning into the sea.

Water quality monitoring programme should be carried out weekly during the dredging, and should be supplemented by weekly aerial observations. Aerial observations and ground monitoring should be coordinated to occur simultaneously as far as possible.

Coastal Dynamics

Given the persistent westward longshore sand transport and wave forcing, the expansion at Fort Augusta will likely further reduce sand supply from the east with implications for the state of the shoreline west of the proposed reclamation. As discussed in the wave modelling results, the construction of the Fort Augusta expansion will result in a rather strong gradient of the wave energy, which may subsequently result in additional stress to the beaches to the west.

Overall, the proposed expansion has little influence on the flow patterns even at local scales. The flow modelling illustrated an ebb-domination pattern along the project shoreline. This ebb domination, in addition to the highly oblique waves generated by the easterly wind, contributed to the beach erosion along that section of shoreline to the wet of the proposed expansion. It is recommended that some shore protection measures be developed for the shoreline west of the proposed expansion to mitigate against further erosion due to the proposed shoreline modification.

Alternative 1

A beach nourishment project could be implemented to restore the severely depleted beach to the west of Ft. Augusta land reclamation area with a re-nourishment cycle of approximately every five years.

The nourishment could take advantage of the dredged sediment from the channel deepening. In addition to sub-aqueous disposal of the dredged material, a small portion of the dredged material could be disposed along the shoreline west of the proposed reclamation to restore the severely eroding beach. Based on the above sediment budget analysis, the restored beach should last for at least 5 years before a re-nourishment project would need to be considered.

Alternative 2

Deposit suitable dredged material at the northeast corner of the proposed reclamation and allow the natural coastal processes to distribute the material westward over time.

Ecology

The mitigation plan should be implemented through a joint programme between the PAJ, Fisheries Division and UWI, Centre for Marine Sciences. It is recommended that the plan address direct impacts from the dredging and reclamation activities through a mix of interventions. The area proposed for reclamation (R4) is a known shrimp habitat shrimp habitat whose function will be lost due to the development. The mitigation of this loss will be carried out through the replanting of the removed seagrass at suitable sites. The replanting must be carried out bearing in mind the need to assess the specific importance of the area to be lost, to the life cycle of the shrimp. The detailed seagrass mitigation plan is presented at **Appendix 5.**

Recommended mitigation for the construction of the “reclamation” area and the widening of the nearby channel include:

- Initial dredging to a slightly greater depth than absolutely necessary thereby reducing the need for maintenance dredging;
- Careful mapping of seagrass areas to be directly affected by the dredging/reclamation and replanting as required by NEPA to compensate for possible mortality. The approach to the identification of candidate sites for seagrass replanting will be guided by a desk study to establish areas of seagrass coverage in Kingston Harbour and environs (if necessary) over the last 10 to 15 years. This information would be evaluated in conjunction with critical physical parameters including light, temperature, turbidity/TSS, salinity and wave energy to identify sites where transplantation is likely to be most successful;

The following specific measures are recommended to address impact to shrimp/fish ecology:

- Development of suitable habitat to increase population size available for harvesting. Creating viable alternative fishing sites through habitat enhancement. This will be achieved in part through the replanting of seagrass;

- Use of artificial reefs which have been scientifically proven to create viable habitat for fisheries, and have been successfully deployed in many fisheries globally;

- Identification of suitable sites for habitat creation and mitigation in consultation with the Fisheries Division.

Socioeconomics

Fishing Interests/Other Harbour Users

Negative socioeconomic impact on the fishing community will be mitigated through the joint programme between the PAJ and Fisheries Division. Users of the harbour need to be aware of planned activities and alternatives available and/or recommended for them. This is especially necessary during dredging activities. Using appropriate tools to control sediment plumes and pollution will reduce impact on fisheries.

Based on consultation with the Fisheries Division the following specific measures are recommended to address impact to fishers:

- Clear demarcation of restricted areas to reduce conflict with fishers and reduce damage to fishing gear. Consultation and communication at all stages of project planning and implementation will increase awareness, reduce conflict and also minimise physical damage to gear;

- Establishment of a fund to compensate for verifiable loss of fishing gear, disruption in activity and other operational losses associated with the dredging reclamation activities. This fund could be used to finance a mix of activities including but not necessarily limited to:

  - Purchasing motorised craft for leasing or granting to displaced fishers who have successfully completed training in operating these crafts;

- Making payments to those directly affected;
- Training of fishers in alternative livelihoods;

Mitigation of Impacts to Heritage Sites

A plan of action to preserve the integrity of heritage sites should be developed in collaboration/consultation with the JNHT. This will include but not necessarily limited to the following:

- All necessary precautions will be taken to prevent siltation of the Sunken City of Port Royal. This includes the establishment of siltation traps/screens;
- No docking or increased vessel traffic in and around Port Royal other than the Ship channel;
- No dredging within 100 meter of the boundaries of Ft. Augusta;
- No excavation will occur in and around the location of the historical graves;
- A one hundred meter setback will be established between the new development and the southwest corner of Fort Augusta;
- No other development is to be implemented around Fort Augusta without prior consultation with the JNHT;
- Archaeological Watching Brief (Monitoring) will be funded by the Port Authority throughout the dredging and dumping phase of the project.

Mitigation of impacts From Waste Disposal

Any land site identified for disposing of dredge material should be assessed for potential impacts and the necessary measures be taken to protect the environment and human health.

Public Perception

There was strong support for the proposed development and it was believed that it is important to community and national development. Keeping the public abreast of planned activities before project start-up and as it progresses; and communicating mitigation and monitoring plans to minimise negative impacts will increase awareness and acceptance.

2 . INTRODUCTION

As part of its strategic initiatives during the 2011/12 to 2013/14 period, the Port Authority of Jamaica (PAJ) intends to develop and upgrade the infrastructure and equipment to capitalise on its strategic position, as well as the impending opportunities in the containerised cargo market.

A key component of the strategic initiative is a proposal by PAJ to deepen the Port Bustamante Basin as well as deepen and widen areas of the Ship Channel to accommodate larger container vessels. It is intended to use some of the dredged material to reclaim land adjacent to Fort Augusta for future development as a container terminal.

Implementation of this project will enable the port to accommodate the draught of the largest vessels which will traverse the Panama Canal upon completion of the canal expansion programme. The PAJ dredging project will improve KCT's competitive advantage and enable the port to serve as a trans-shipment hub for draught restricted ports of the US East and Gulf Coast.

When completed, the channel will accommodate vessels with an approximate capacity of 13,000 TEUs with a maximum draft of 15.2 meters, a maximum ship length of 366 meters and beam of 48.8 meters.

This Environmental Impact Assessment (EIA) is required to inform the application for a permit to carry out the development and is supplemental to unpublished environmental assessments carried out in 2001 and 2006. The conduct of the EIA is guided by NEPA generic terms of reference for Port Development projects (**Appendix 1a**). Subsequently, NEPA has developed specific terms of reference for this project which requires more detailed work, not included in the generic terms of reference. The NEPA terms of reference is presented in **Appendix 1b**.

PROJECT BRIEF

The project is located in the Kingston Harbour, spanning the northwestern section of the harbour as well as areas outside the harbour. The coastline within the area of influence includes, from the north east, Greenwich Town Fishing Beach, Kingston Wharves and Kingston Container Terminal (KCT). KCT is contiguous with Kingston Wharves and continues along the coastline, encircling the Gordon Cay turning basin.

The Project is outlined in a technical report of August 2012 (PAJ/Mott MacDonald 2012). The Port Authority of Jamaica proposes to deepen Port Bustamante Basin, and deepen and widen areas of the Ship Channel to accommodate larger container vessels. It is intended to use some of the dredged material to reclaim land adjacent to Fort Augusta for possible future development as a container terminal.

The approximate volumes of material to be dredged as part of this campaign are summarised in **Table 1,** and are separated into Maintenance Dredge Volumes and Capital Dredge Volumes. As stated in correspondence from NEPA, these are defined as:

- Maintenance Dredge Volumes: The difference between the current depth and width of the channel and the previously approved maximum depth and width of the channel; and
- Capital Dredge Volumes: The difference between the previously approved maximum depth and width of the channel and the newly proposed final depth and width of the channel.

Table 1: Dredge Volumes

Classification	Approx In-Situ Volumes (cu.m)	Comment
Maintenance Dredge	500,000	Minimal maintenance dredge volumes are anticipated. A nominal allowance has been made that will be confirmed at the start of the dredging campaign
Capital Dredge:		
Ship Channel	14,000,000	Widening and Deepening to -17.0 mCD
Port Bustamante Basin	1,200,000	Deepening to -15.0 mCD
Total Capital Dredge	15,200,000	
Total to be Dredged	**15,700,000**	

3. PROJECT DESCRIPTION

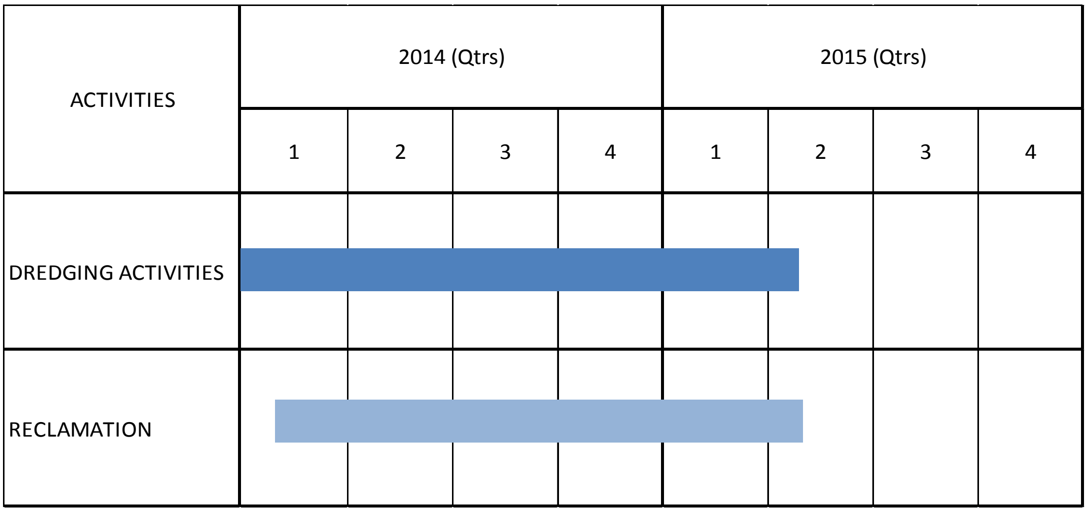
The proposed project calls for the development of a trans-shipment terminal at Fort Augusta, including the upgrade of the navigational access to Kingston Harbour and the dredging of Port Bustamante Basin. The main components of the development are as follows:

- Maintenance and capital dredging 15.7 million cubic metres of material from the ship channel and Port Bustamante and using as fill for berth construction;
- Removal and disposal of unsuitable material at Fort Augusta peninsula, prior to application of fill;
- Construction of reclamation bunds;
- Construction of 1,000m of berth;
- Procurement of fill material for reclamation works by dredging the areas identified;
- Reclamation of Fort Augusta peninsula with 4.0 million m^3 of borrow material to produce approximately 50 hectares of container storage areas and berth apron;
- Disposal of material either not suitable or required for the reclamation works;

The Port Authority proposes to retain the reclamation around Fort Augusta by the use of a vertical bulkhead. The newly created berth-face will be deepened to approximately 15 metres below chart datum, to suit the proposed depths of the upgraded ship channel.

The proposed dredging and reclamation activities will be carried out over a period of 15 months. Present plans call for dredging activities to take place over the period of January 2014 to April 2015, while reclamation is scheduled for February 2014 to April 2015. The provisional schedule indicating the phasing and timelines is shown at **Figure 1.**

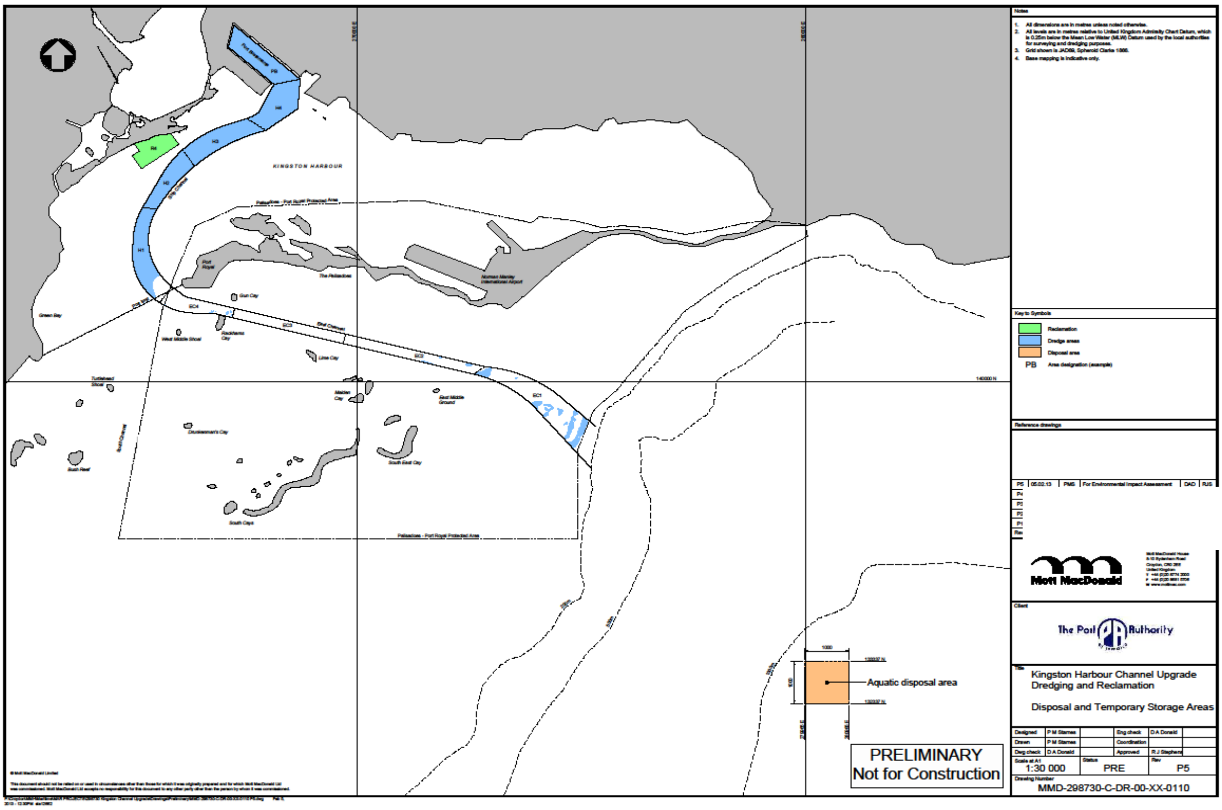
Figure 1: Provisional Schedule Showing Phasing and Timelines



3.1 Dredging Works (15 Months)

Dredging will be carried out in the ship channel and the Port Bustamante basin. The location of sites to be dredged and reclamation are illustrated in **Figure 2**.

Figure 2: Areas to be Dredged and Reclaimed



Source: Mott MacDonald

i) Ship Channel within Kingston Harbour

- From the harbour limit to the Port Bustamante Basin entrance
- deepening and widening of existing channel to -17.0 mCD
- development of a new swing basin with a depth of -17.0 mCD

Overall length of affected channel: 6,800 meters

ii) Port Bustamante Basin

- Deepening of basin to -15 mCD

Overall length of affected basin: 1,650 meters

The dredging requirements are provided on the following reference drawings shown in Appendix 2**:**

- MMD-298730-C-DR-00-XX-0101: General Arrangement
- MMD-298730-C-DR-00-XX-0102: Dredging Arrangement – Sheet 1
- MMD-298730-C-DR-00-XX-0103: Dredging Arrangement – Sheet 2
- MMD-298730-C-DR-00-XX-0104: Dredging Arrangement – Sheet 3
- MMD-298730-C-DR-00-XX-0109: Dredging Arrangement – Sheet 4
- MMD-298730-C-DR-00-XX-0105: Dredged Channel – Typical Sections

3.2 Reclamation Works (14 months)

As part of this project, a reclamation will be formed at Fort Augusta. The dimensions of the proposed reclamation are:

- 1 km frontage;
- Extending from the shore between 300 metres (North side) and 615 metres (South side);
- Area of approximately 50 hectares; and
- Formation level of +4.0 mCD.

The proposed reclamation is shown on the following reference drawings (Appendix 2):

MMD-298730-C-DR-00-XX-0106: Reclamation Area R4 (Terminal FA1) - Plan

MMD-298730-C-DR-00-XX-0108: Reclamation Typical Sections

It is estimated that approximately 4,000,000 cubic metres of material will be required to form the reclamation.

3.2.1 Reclamation Methodology

The envisaged methodology is described in the technical report by Mott MacDonald (Mott MacDonald 2012) as follows:

Site clearance: Before starting the reclamation, the Contractor will remove all visible debris, vegetation and topsoil from the affected shoreline. No filling will commence until the area has been prepared and pre-filling surveys have been executed. All waste material cleared from the reclamation area will be removed to an approved disposal site;

Formation of containment bunds: The Contractor will contain the reclamation material within the limits of the reclamation, including phasing the work such that the material placed is contained within adequate temporary bunds formed as the work progresses. This includes the formation of containment bunds around the perimeter of the reclamation area prior to commencement of filling in any area.

The bunds will be constructed using rubble mounded rock fill construction; unless the Contractor can demonstrate that an alternative material (e.g. sand won from the dredging campaign) will comply with the required performance and environmental requirements. If the founding material at the bund locations is identified as being sub-standard, replacement of the material may be required. The required restrictions, including the use of silt screens, etc., will be employed based on the results of the studies undertaken in the Environmental Impact Assessment, as well as the conditions of the NEPA license.

The level of any temporary bunds will be kept sufficiently above the level and in advance of the edges of the filling at any location to avoid general overflow or breaches. The surplus water will be directed off the reclamation area through weir boxes or overflows, which will be positioned and the sill heights adjusted as necessary to ensure maximum containment of dredged material.

Hauling of material to the containment bunds will proceed only when sufficient spreading and compaction equipment is operating at the place of deposition to ensure compliance.

The Contractor will ensure that the surplus water discharge causes no damage and will re-route return waste water channels and sluices as necessary. To achieve this, the contractor will provide all necessary measures including pumps, ‘waterboxes’, containment bunds, channels and outfall pipe systems correctly located and levelled to ensure deposition of dredged material within the reclamation and containment areas. The contractor will later fill up all temporary drainage channels and remove or compact temporary bunds.

The top 500mm of the reclamation will be formed with coarse sand selected from the dredging campaign and compacted with one pass of a smooth wheeled roller.

The coastal frontage of the reclamation will be protected through the provision of a rock armoured revetment, prior to the installation of the quay wall along the berth face.

4 DESCRIPTION OF THE ENVIRONMENT

The limit of the assessment extends a radius of 2 km, an area that includes for the purpose of the socioeconomic impact, the following communities: Greenwich/Newport West, Port Royal, Portmore, Passage Fort and Portsmouth. Physical/chemical and biological baseline evaluation focused on the area in the vicinity of Fort Augusta proposed for reclamation.

The environment within the zone of influence is described in terms of physical/chemical, biological and socioeconomic attributes. This has included an evaluation of water quality, ocean dynamics, coastal ecology, ocean dynamics and socioeconomic factors (public perception, land use, cultural aspects).

4.1 Method Statement

4.1.1 Physical/Chemical Environment

The physical/chemical environment is evaluated in terms of water quality, sediment quality and coastal dynamics. The evaluation is based on information collected for the current EIA as well as information collected for work carried out for the unpublished 2006 EIA in relation to this project.

4.1.1.1 Environmental Chemistry

Establishment of baseline levels of turbidity and suspended sediments is considered critical the setting of performance standards for any mitigation measures that may be employed to restrict the effect of the development activities being considered. The water quality assessment is based on data collected for the current EIA, prior data collected for the unpublished 2006 EIA and data collected during dredge monitoring in 2002 undertaken by TEMN in connection with dredging of the channel by the trailing suction hopper dredge, Cristoforo Colombo.

Sample Collection/Field Work:

Fieldwork was carried out on July 20, 2012 and June 12, 2013 to collect water and sediment samples as well as conduct field measurements. The first sampling event focussed on determination of general water quality parameters in the vicinity of the proposed reclamation site **Figure 3 .** The sampling sites were those selected for previous work done by TEMN in relation to this development (TEMN 2006). Parameters included dissolved oxygen, salinity, temperature and turbidity. Samples were taken for the determination of suspended solids in the laboratory.

Figure 3: Water Quality Sampling Sites July 2012.

The coordinates for the sites sampled in the follow up work on June 2013 are shown at Table 2 and represented in **Figure 4** and **Figure 5**.

Table 2: Coordinates of the Sampling Sites June 2013

Station ID	Description	Coordinates	
		N	W
FA1	Background	17.918230°	-76.828330°
FA2	Channel Outer - Near Port Royal	17.933050°	-76.855960°
FA3	Channel Middle - Near Ft. Augusta	17.961800°	-76.845640°
FA4	Channel Inner - Near Gordon cay	17.973240°	-76.825970°
FA5	R4 East	17.964730°	-76.847800°
FA6	R4 Central	17.964613°	-76.852400°
FA7	R4 West	17.963190°	-76.854150°

the determination of additional parameters in keeping with the terms of reference. Water samples were analysed for biological oxygen demand (BOD), total petroleum hydrocarbons (TPH) and trace metals (arsenic, chromium, copper, mercury, lead, nickel, tin, vanadium and zinc). Sediment samples were analysed for trace metals and were used to prepare elutriates that were also analysed to determine the suite of trace metals determined in the water samples. The elutriate test is intended to provide an indication of expected release of heavy metals from sediment to the water column during dredging/disposal.

Figure 4: Ft. August Port Development- Sampling Sites (June 2013)

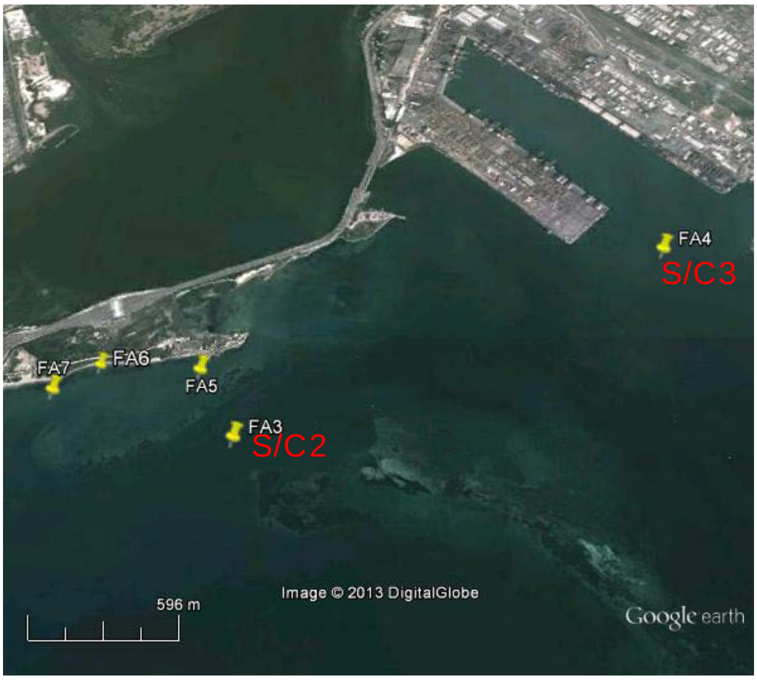
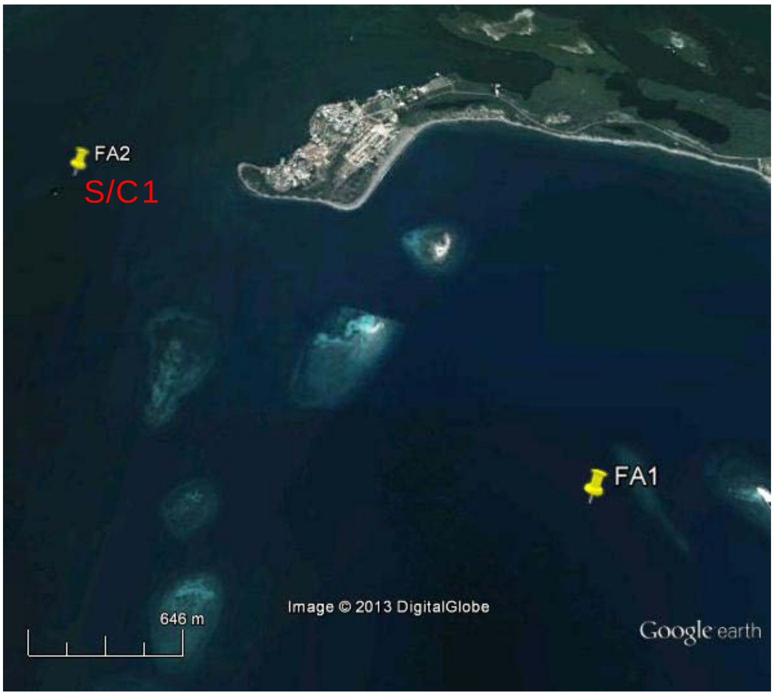


Figure 5: Ft August Port Development- Sampling Sites (June 2013)



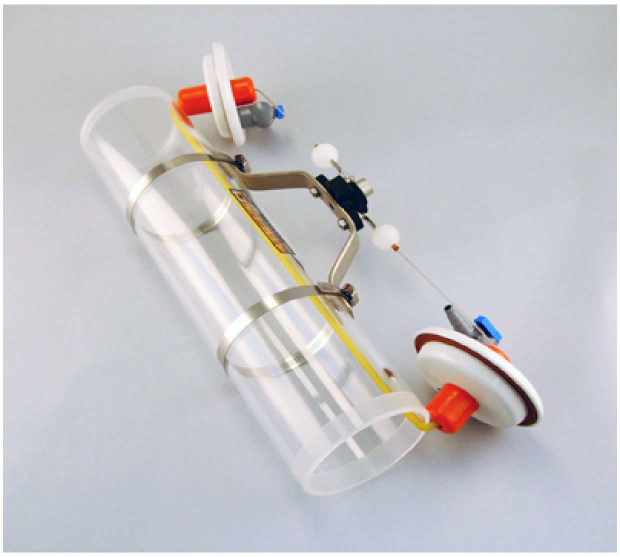
- Denotes Water Sampling Site S/C - Denotes sediment sampling Sites

Follow up sampling on June 12, 2013 was carried out to collect water and sediment samples for the determination of additional parameters in keeping with the terms of reference.

For follow up **water sampling,** seven sampling sites were selected to represent water quality at a background site, in the ship channel and at the site of the proposed reclamation (**Figure 4** and **Figure 5**). For the channel sites, samples were collected at the surface and bottom, while at the proposed reclamation site where depth was less than 2m sampling was done .5M below the surface only.

Sampling at depth was executed using the Model SKU 1920-G65 Wildco Van Dorn type Beta Horizontal Sampler (**Figure 6**). This sampler constructed from acrylic contains no metal parts and is designed for trace metal sampling. Intended for shallow or deep waters, these bottles are called “horizontal”

Figure 6: Beta Horizontal Sampler

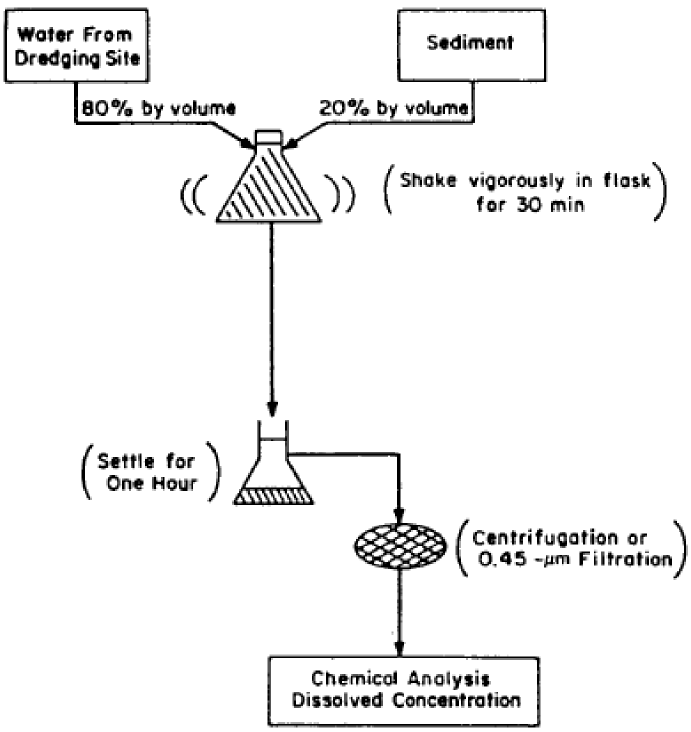


because they descend parallel to the substrate and are therefore ideal for sampling just above the bottom sediments.

Sediment sampling was done using a 2" PVC pipe pushed into the substrate manually to a depth of 2m. Due to substrate compaction at FA4, the pipe was set at a slight angle to the vertical to facilitate manual insertion. The entire sample was recovered and treated as a composite. A sample aliquot of approximately .5Kg was taken for analysis of the selected heavy metals at each site. Another aliquot of approximately .5Kg (wet weight) was used for preparation of an elutriate.

Elutriate preparation was based on the original elutriate test (**Figure 7**) (Federal Register 1973a, 1973b) and subsequent modification (Federal Register 1977, US Environmental Protection Agency and US Army Corps of

Figure 7: Elutriate Test – Schematic



Engineers 1977) to include the use of forced air for mixing. Standard procedures for the test specify that 20 per cent by volume of undisturbed sediments be mixed with 80 per cent by volume of water from the dredging site. Agitation by mechanical mixing for 1/2 hr. and release of compressed air through a diffusing stone is intended to simulate mixing and aeration by

Figure 8: Elutriate Preparation Set Up

hydraulic pipeline dredging. The mixture is allowed to settle for 1 hr. The supernatant is collected and filtered through a 0.45-micron filter and analysed for chemicals of concern.

Agitation was achieved using a vibration table (**Figure 8**). The compressed air source was split to enable simultaneous aeration of the three samples. Elutriates prepared from the sediment samples C1, C2 and C3, were assigned the ID numbers E1, E2 and E3 respectively.

Analyses

Water samples were analysed for biological oxygen demand (BOD), total petroleum hydrocarbons (TPH) and trace metals (arsenic, chromium, copper, mercury, lead, nickel, tin, vanadium and zinc). Sediment samples were analysed for trace metals and were used to prepare elutriates that were also analysed to determine the suite of trace metals determined in the water samples. Samples were analysed by NELAC accredited, ALS Laboratory in Jacksonville Florida, to determine the heavy metals as stipulated by NEPA. BOD and TSS and turbidity analyses were performed by the Environmental

Health Laboratory.Analytical methodology employed is summarised in Table 3.

Table 3: Summary of Analytical Methods

Parameter	Method	Detection Limit/Range	
		Water	Sediment
Non Metals:			
Biological Oxygen Demand (BOD)	5-Day Bottle method. Standard Methods. Method No.	≥.1mg/l	
DO	U-10 Horiba Water Checker or YSI Model 85 O-S-C-T meter	0 – 19.9	N/A
pH	U-10 Horiba Water Checker or YSI Model 85 O-S-C-T meter	0 – 14	N/A
Salinity	U-10 Horiba Water Checker or YSI Model 85 O-S-C-T meter	0 – 40ppt	N/A
Temperature	U-10 Horiba Water Checker or YSI Model 85 O-S-C-T meter	0 – 50^{o}C	N/A
Total Petroleum Hydrocarbons (TPH)	FL-PRO: Solvent Extraction & Gas Chromatography With FID	≥.581mg/l	N/A
Turbidity	U-10 Horiba Water Checker	0 – 800NTU	N/A
Heavy metals:			
Arsenic (As)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	6µg/l	≥.23mg/Kg
Chromium (Cr)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0.9µg/l	≥.02mg/Kg
Copper (Cu)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	2.0µg/l	≥.13mg/Kg

Parameter	Method	Detection Limit/Range	
		Water	Sediment
Non Metals:			
Lead (Pb)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	6µg/l	≥.26mg/Kg
Mercury (Hg)	EPA 245.1/7471B - Cold Vapour Atomic Absorption	≥.02µg/l	≥.0014mg/Kg
Nickel (Ni)	EPA Method 6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0.9µg/l	≥.04mg/Kg
Tin (Sn)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	2.0µg/l	≥.2mg/Kg
Vanadium (V)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	1.0µg/l	≥.11mg/Kg
Zinc (Zn)	EPA Method 200.7/6010B: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0.7µg/l	≥.4mg/Kg

4.1.1.2 Coastal Dynamics

Coastal dynamics investigation focused on acquisition of hydrodynamic field data within the greater Kingston Harbour and in the vicinity of the Fort Augusta expansion area. This was carried out between September 28 and September 30, 2012. To address concerns regarding erosion west of the proposed reclamation, we have also estimated a sediment budget based on computed longshore sediment transport. Based on the computed sediment transport rate and stated assumptions, a nourishment interval is calculated.

Fate of dredged material is based on the result of previous work done to quantify the parameters of such a release in the 2002 capital and maintenance dredging operation in Kingston Harbour using the STFATE model. STFATE was used to simulate short and long-term fate of dredged material due to dredging disposal operations and environmental processes.

The model predicts the distribution of dredged material through the water column and bathymetric distribution of dredged material on the seabed on the basis of individual disposal loads. STFATE accounts for various parameters including the type of disposal vessel, physical properties of the water column, and material properties.

The field data sets collected include water level, wave, and flow measurements at various locations in the vicinity of the Fort Augusta expansion area (**Figure 9**) as follows:

a. Water level, flow and wave measurements at the Hunts Bay bridge over two tidal cycles;
b. Water level, flow and wave measurements just offshore of the Fort Augusta expansion area over two tidal cycles;
c. Nearshore wave measurements at three locations in the vicinity of the Fort Augusta expansion area;
d. Bathymetry survey of the greater Kingston harbour for harbour scale wave modelling;
e. Field investigation of shoreline and beach processes in the vicinity of the Fort Augusta expansion area.

Figure 9: Sites of field measurements in the vicinity of Augusta expansion area.

Estimation of Significant Wave Height and Peak Wave Period Associated With Wind Conditions

Various empirical formulas have been developed to calculate wave height and period generated by certain wind conditions. The Coastal Engineering Manual (CEM) developed by the US Army Corps of Engineers (USACE) recommended the following formulas (Equations 1 through 4) for the estimation of significant wave height and peak wave period associated with wind conditions:

$$\frac{gH_{mo}}{u_*} = 4.13\times10^{-2}\times\left(\frac{gX}{u_*}\right)^{\frac{1}{2}} \quad (1)$$

$$\frac{gT_p}{u_*} = 0.751\left(\frac{gX}{u_*}\right)^{\frac{1}{3}} \quad (2)$$

$$C_D = 0.001(1.1+0.035U_{10}) \quad (3)$$

$$u_*^{\,2} = C_D U_{10}^2 \quad (4)$$

Where X = straight line fetch distance over which the wind blows (m); H_{mo} = energy-based significant wave height (m); C_D = drag coefficient; U_{10} = wind speed at 10 m elevation (m/s); and u_* = friction velocity (m/s).

Estimation of Longshore Sediment Transport

The rate of longshore sediment transport is calculated using the CERC formula, recommended by the USACE CEM (Coastal Engineering Manual). The CERC formula is the most commonly applied predictive estimation for the calculated total longshore sand transport rate Q_c in the surf zone, assuming that longshore sediment transport rate is proportional to the longshore wave-energy flux factor as:

$$Q_c = KAP_\ell \qquad \textbf{(5)}$$

in which K is the transport coefficient to be empirically determined. The commonly used K value of 0.77 is used here. The parameter A is calculated as:

$$A = \frac{1}{(\rho_s - \rho)g(1-p)} \qquad \textbf{(6)}$$

A is a conversion factor containing properties of the sediment with ρ_s = density of the sediment; ρ = density the water; g = gravitational acceleration; p = the porosity of sediment (a commonly used value of 0.4 is used here); and P_ℓ = longshore wave-energy flux factor at depth-limited wave breaking, given by:

$$P_\ell = \frac{1}{16\sqrt{\gamma}}\rho g^{\frac{3}{2}} H_{brms}^{\frac{5}{2}} \sin(2\theta_b) \qquad (7)$$

in which γ = wave breaker index (ratio of wave height to water depth at breaking); H_{brms} = root-mean-square (rms) breaking wave height; and θ_b = breaking wave angle. For a given beach, the CERC formula requires input of only the breaker height and angle. The breaking wave angle is a difficult parameter to estimate. In this study, a breaking wave angle of 25 and 15 degrees for waves generated by easterly and ESE wind, respectively, is assumed. Field study is necessary to verify this estimate.

4.1.2 Biological Environment

The objectives of the ecological component of the study were to inspect, assess and characterise the biological environment of Fort Augusta with particular emphasis on the marine littoral areas in the immediate vicinity of the expansion works. Sites to be affected by the expansion works for use as sources of fill or as areas where spoil material will be disposed, as well as the transportation corridors used to access these sites were also examined.

The main focus of the ecological survey was to quantify the spatial extent of seagrass beds and to identify the presence/absence of ecologically or commercially important species of fauna found in or immediately adjacent to the Fort Augusta reclamation site. The collected data are intended to update relevant information obtained during prior work by TEMN (TEMN 2006 unpublished EIA) and to determine the potential sensitivity of the area's flora and fauna to the anticipated impacts from the development activites. The data collected will be used to formulate possible mitigation actions and to examine alternative scenarios.

4.1.2.1 Aerial Survey

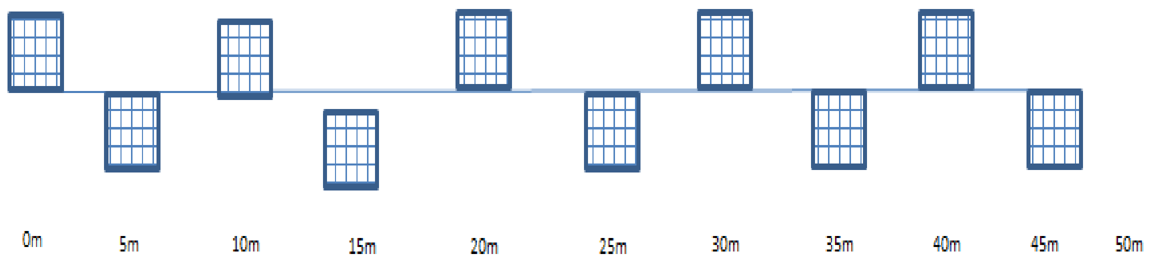
Aerial surveys of the sublittoral area at Fort Augusta were carried out in July and in August 2012. The surveys were conducted with a small multirotor unmanned air vehicle (UAV) carrying a high resolution camera. The automated flights occurred at altitudes varying between 40 and 80 meters. The photos acquired during these flights were post-processed in order to produce a continuous orthorectified and georeferenced mosaic of a section of the seabed immediately adjacent to the shoreline. The flight covered 900 meters of the beach west of Fort Augusta. The primary objective of this survey was to quantify the area covered by seagrass immediately adjacent the shoreline of the proposed reclamation site. The photos cover a band of seabed 50 meters wide where seagrass beds are clearly visible. Water turbidity did not allow visibility beyond 50 meters from the shore.

4.1.2.2 Marine Survey - Benthic Assessment

Detailed assessments of floral/faunal composition and status of littoral areas adjacent to site likely to be affected by the project were carried out in a manner similar to that detailed in Phase 1 of the EIA study, obtained during prior work by TEMN (TEMN unpublished EIA 2006).

Aerial photographs and schematics of the proposed project (**Figure 10**) define representative transects within and adjacent to the project area. 50m long transects, running perpendicular to the beach (same bearing for all) were surveyed at each site. Depth, visibility and substrate type (sand, mud, silt, and coarse sand) were recorded for each transect. Quadrats (0.25 m^2), placed at 5 m intervals along the transect **(Figure 10)**, were used to quantify seagrass shoots, urchins and any other flora and fauna encountered. Quadrats were photographed for future reference.

Figure 10: 50m transect schematic used for conducting benthic surveys.



Marine surveys were carried out in July and August of 2012. During the July survey, 6 transects were sampled (T1-T5, T5B and T58) in the vicinity of Port Henderson Fishing Beach (i.e. section of the beach to the southwest of and immediately in front of Fort Augusta and another (T8) near Gordon Cay (**Figure 11).** During the August survey additional transects (T6, T7, T9, T12, R1, R3) were carried out to the northeast of the reclamation site, where, due to proximity to the reclamation site, the development activities could negatively impact nearby inshore areas (near the Salina and the Fort Augusta foreshore) **(Figure 11)**.

4.1.2.3 Marine Survey – Fish

A questionnaire was designed to collect data on catch landings of fishers within Hunts Bay and Kingston Harbour. Designated fishing beaches within the vicinity of the proposed development site were visited, and interviews conducted with fishermen to:

i. Collect data pertaining to fish and shrimp landings (species and weights landed per unit time) as well as the presence/absence of exotic/protected/endemic species such as crocodiles, dolphins, etc.;
ii. Identify stakeholder concerns pertaining to the Fort Augusta project.

Fishing beaches visited (**Figure 12)** include:

- Greenwich Farm Fishing Beach
- Rae Town Fishing Beach
- New Causeway Fishing Beach (Dyke Road Fishing Complex)
- Port Royal Fishing Beach
- Port Henderson Fishing Beach
- Forum Fishing Beach

This data supplements similar surveys conducted in 2006 and provide updated presence/absence fish data for the area.

Figure 11: Transect locations are superimposed on the site plan schematic for the Fort Augusta land reclamation and channel dredging.

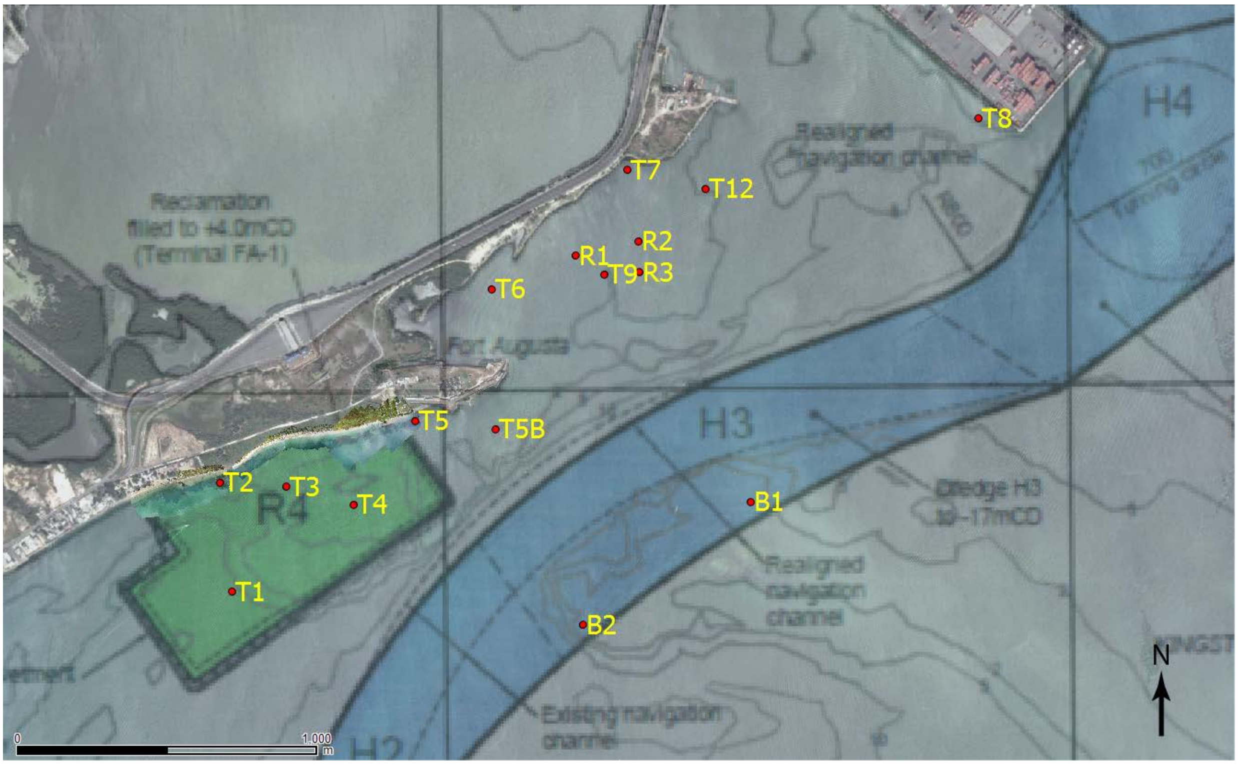


Figure 12: Fishing beaches where interviews were conducted.

4.1.3 Socioeconomic

The socioeconomic impact assessment (SIA) examines the socioeconomic and cultural setting of the study area and identifies potential impacts of the proposed development. The SIA study area includes areas within a 2 km radius of the proposed dredge and reclamation sites. Impacts are assessed at the micro (local), regional (parish) and macro (national) levels.

The SIA included desktop research and a socioeconomic and perception survey. Data sources included census data from the Statistical Institute of Jamaica (STATIN), the Jamaica Survey of Living Conditions (JSLC), the Economic and Social Survey of Jamaica (ESSJ), EIA reports that were previously conducted within the area, and results of the socioeconomic and perception survey. The surveys were undertaken to obtain detailed information on the public's perspectives on the potential impacts associated with the proposed project. Questionnaires were administered within the following communities located within the study area: Passage Fort, Edgewater, Westchester, Westbay and Portsmouth in Portmore, St. Catherine, and Greenwich Town in St. Andrew. One hundred and fifty (150) questionnaires were administered in the communities – an overall representative sample of five per cent (5%) of the total number of households within the impact area. Households are used to determine overall sample size as it allows for a greater level of participation from a wider cross section of residents. It also provides the opportunity for greater dissemination of information when households are involved, rather than individuals.

The standardised questionnaire consisted of a total of 58 closed and open-ended questions (see **Appendix 3**). It was designed to determine the socioeconomic characteristics of the study area (baseline) and perspectives of the public on the level and types of impact the proposed development would have on their local community and the country. The survey conducted on Saturday, September 15, 2012, was administered through personal interviews and had an overall response rate of 100%. While personal interviews are noted to be associated with high costs and tend to be time intensive, they have the advantage of high response rate and tend to be more favourable for open-ended questions. Uncertainty about the mail services in the study area also influenced the choice of survey instrument.

A public meeting reporting the preliminary findings of the EIA and obtaining comments from the public is a requirement of the National Environmental Protection Agency (NEPA). This will also enable a wider cross-section of stakeholders to provide feedback on the proposed development.

The impact on cultural heritage was assessed through reference to the Jamaica National Heritage Trust (JNHT) lists of designated sites and the distance of these sites from the proposed project site. While the SIA identifies cultural and heritage sites within the SIA study area and will assess the potential for impact based on proximity to project activities, an archaeological impact assessment is a separate activity that must be carried by an archaeologist in accordance with guidelines set by the JNHT.

The existing land use for this SIA study area was determined through the review of satellite imagery of Jamaica and topographic maps. Field verification of land uses were made during visits to the various communities. Parcel data for the SIA study area was obtained from the National Land Agency (NLA) and ESRI ArcGIS was used to produce the map and analyse the distribution of land uses.

4.2 Results

4.2.2 Physical/Chemical Environment

4.2.2.1 Environmental Chemistry

Data collected along the coastline from the Causeway in the north to Fort Augusta in the south for July 20, 2012 is presented at **Table 4.**

Table 4: Data for July 20, 2012

ID	Description	TIME (AM)	DEPTH (M)	SAL (ppt)	pH	T°C	DO (mg/l)	DOsat (mg/l)	DD (%)	TURB (NTU)
1T	Fort Augusta North	0842-0846	4.3	34.4	8.01	29.6	4.96	6.12	18.95	9
1B		0839-0841		34.5	8.01	29.5	4.91	6.12	19.77	10
2	St. Albans South	0828-0836	2.3	34.4	7.97	29.3	4.83	6.30	23.30	9
3	St. Albans North	0822-0826	0.8	34.2	7.89	29.1	4.10	6.30	34.92	3
4	Fort Augusta South	0811-0819	0.9	33.9	7.87	29.0	4.70	6.30	25.40	5
5	Hunts Bay (Causeway Bridge)	0848-0856	4.4	33.8	8.00	30.1	4.47	6.12	26.96	13
Minimum			0.8	33.8	7.87	29.0	4.10	6.12	18.95	3.00
Maximum			4.4	34.5	8.01	30.1	4.96	6.30	34.92	13.00
Average			2.5	34.2	7.96	29.4	4.66	6.21	24.88	8.17

Turbidity for all sites visited was in the range of 3NTU to 13NTU. Turbidity was highest (13NTU) at Hunt's Bay **(Station 5)**. Turbidity was lowest (3NTU) at St. Albans North **(Station 3).** Turbidity was 5NTU at Fort Augusta South (**Station 4**). Turbidity was 9NTU at St. Albans South (**Station 2)** and Fort Augusta North at the top (**Station 1T**) of the water column, and 10NTU at the bottom (**Station 1B).**

Total Suspended Solids (TSS) for all sites visited was in the range of 10mg/l to 45mg/l. TSS was highest at Fort Augusta North at the surface **(Station 1T)**, while at the bottom **(Station 1B)** TSS was 34mg/l. TSS was lowest at St. Albans North **(Station 3)**, while at St. Albans South **(Station 2)** TSS was 40mg/l. At Fort Augusta South **(Station 4)** and Hunts Bay **(Station 5)**, TSS was determined to be 33mg/l and 43mg/l respectively.

Salinity for all sites visited was in the range of 33.8ppt to 34.50ppt. Salinity was highest (34.5ppt) at Fort Augusta North at the bottom **(Station 1B)**, while at the surface **(Station 1T)** salinity was 34.4ppt. Salinity was lowest (33.8ppt) at Hunt's Bay **(Station 5)**. Salinity at St. Albans South **(Station 2)** was 34.4ppt and at St. Albans North **(Station 3)** it was 34.2ppt. Salinity at Fort Augusta South **(Station 4)** was 33.9ppt.

Dissolved Oxygen (DO) for all sites visited was in the range of 4.10mg/l to 4.96mg/l. DO was highest (4.96mg/l) at Fort Augusta North at the surface **(Station 1T)**, while DO at the bottom **(Station 1B)** was 4.91mg/l. DO was lowest (4.10mg/l) at St. Albans North **(Station 3)** while at St. Albans South **(Station 2)** DO was 4.83mg/l. At Fort Augusta South **(Station 4)** and Hunt's Bay **(Station 5)** the DO was 4.70mg/l and 4.47mg/l respectively.

Available data from the previous EIA (TEMN 2001) indicated levels of the trace metals chromium and lead in water that were below the test detection

Table 5: Kingston Transhipment Port Expansion EIA Water Quality Results April 8, 2001.

Location	Cr(ppb)	Pb(ppb)
Channel near Port Royal Surface	<0.5	<1.3
Channel near Port Royal Bottom	<0.5	<1.3
Channel Near Fort Augusta Surface	<0.5	<1.3
Channel Near Fort Augusta Surface	<0.5	<1.3
Channel Near Fort Augusta Bottom	<0.5	<1.3
Turning Bay near Gordon Cay	<0.5	<1.3

Table 6: Kingston Transhipment Port Expansion EIA, Sediment Analysis, April 8, 2001

Location	Sediment Analysis		Pore Water Analysis	
	Cr(mg/kg)	Pb(mg/kg)	Cr(ppb)	Pb(ppb)
Channel near Port Royal	13.0 (4.8)	34.2 (4.7)	<0.5	<1.3
Channel near Fort Augusta	13.9 (0.6)	29.0 (5.3)	<0.5	<1.3
Turning Bay near Gordon Cay	26.4 (1.0)	27.5 (6.0)	<0.5	<1.3

N.B. *Figures in parentheses represent the standard deviation of the results obtained from duplicate analyses*

level (**Table 5)** and levels in sediment (**Table 6)** that are well within levels regarded as typical (Hawkes et al 1962). Typical values of chromium and lead in soil are shown in **Table 7.**

Table 7: Background Values of Lead And Chromium In Soil.

Metal	Average Concentration in Soils (mg/kg)	Typical Range (mg/kg)
Chromium	200	5 -1000
Lead	10	2 -200

Source: Hawkes, H.E., and Webb, J.S. "Geochemistry in Mineral Exploration" (1962)

Follow up Sediment, Water and Elutriate Sampling

Field Measurements and Non Metals

The results of field measurements (dissolved oxygen, salinity and temperature) and specified non-metals (BOD, turbidity and total suspended solids) are presented **Table 8**.

Turbidity levels for the sites sampled on June 12, 2013 were in the range 0.2NTU to 4.9NTU. These levels were lower than the levels determined for sampling done in 2012 but were generally of the same order of magnitude. Turbidity level was highest (4.9NTU) at the background site at the surface (FA1T) where at the bottom of the water column (FA1B), the value was 2.5NTU. In the channel near Port Royal turbidity was 2.3NTU at the surface (FA2T) and 1.7NTU at the bottom of the water column (FA2B). In the channel near Fort Augusta, turbidity was 1.6NTU at the top (FA3T) and .2NTU at the bottom of the water column (FA3B). Near Gordon Cay, turbidity was 2.0NTU at the top (FA4T) and 4.1NTU at the bottom of the water column (FA4B). At Fort Augusta East (FA5) turbidity was 2.9NTU, at Fort Augusta Central (FA6) turbidity was 3.1NTU and at Fort Augusta West (FA7) turbidity was 2NTU.

Total Suspended Solids (TSS) levels were determined to be in the range 4mg/l to 9mg/l for all samples taken. TSS was highest in the channel near Port Royal at the top (FA2T) while at the bottom (FA2B), TSS was 4mg/l. TSS was lowest at Fort Augusta Central (FA6). At the background site, TSS was

Table 8: Results for Field data and Non- Metals from Sampling on Jun 12, 2013

ID	Description	TIME (AM)	DEPTH (ft)	SAL (ppt)	pH	T^{o}C	BOD	DO (mg/l)	DOsat (mg/l)	DD (%)	TURB (NTU)	TSS (mg/l)
FA1T	Background	0854-0851		27.4	7.78	29.9	0.3	7.04	6.51	-8.09	5	6
FA1B			47.5	26.6	7.63	29.9	0.6	8.93	6.54	-36.43	3	6
FA2T	Channel Near Port Royal	0926-0930		30.5	7.94	30.2	1.4	3.85	6.37	39.58	2	9
FA2B			49.9	30.8	7.95	29.6	1.5	3.91	6.42	39.13	2	4
FA3T	Channel Near Fort Augusta	0926-0930		30.5	7.89	30.4	0.6	3.25	6.35	48.83	2	7
FA3B			47.2	30.5	7.94	30.2	0.7	3.33	6.37	47.74	0	5
FA4T	Channel Near Gordon Cay	0926-0930		31.2	7.98	30.1	1.3	3.71	6.36	41.65	2	8
FA4B			44.5	31.1	7.88	30.2	0.7	3.61	6.35	43.16	4	5
FA5	Fort Augusta East	1023-1028	7.5	31.0	7.88	30.1	1.6	3.14	6.36	50.67	3	8
FA6	Fort Augusta Central	1041-1048	5.8	30.9	7.90	30.3	1.8	2.99	6.35	52.90	3	4
FA7	Fort Augusta West	1006-1012	7.0	30.8	7.89	30.2	1.2	3.15	6.36	50.48	2	5
STD				35.0	8.0 - 8.4		0.0 - 1.16	4.80			15	10
Minimum			5.85	26.60	7.63	29.60		2.99	6.35	-36.43	0.19	4.00
Maximum			49.85	31.20	7.98	30.40		8.93	6.54	52.90	4.86	9.00
Average			29.89	29.96	7.98	30.10		4.53	6.41	29.58	2.46	6.44

ppt – parts per thousand; mg/l – milligrams per litre; NTU – Nephelometric Turbid Units
STD - Standard.

6mg/l at the top (FA1T) and bottom of the water column (FA1B). In the channel near Fort Augusta, TSS was 7mg/l at the top (FA3T) and 5mg/l at the bottom of the water column (FA3B). In the channel near Gordon Cay, TSS was 8.0mg/l at the top (FA4T) and 5mg/l at the bottom of the water column (FA4B). At Fort Augusta East (FA5) TSS was 8.0mg/l and at Fort Augusta West (FA7) TSS was 5mg/l.

Salinity levels were in the relatively narrow range 26.6ppt to 31.2ppt. In general, salinity levels were marginally higher at the bottom of the water column. The lowest salinity level (26.6ppt) was determined at the background site at the bottom of the water column (F1B) where at the surface (FA1T) , salinity was 27.4ppt. In the channel near Port Royal, salinity was 30.5ppt at the surface (FA2T) and 30.8ppt at the bottom (FA2B). In the channel near

Fort Augusta, salinity was uniform (30.5ppt) at the top (FA3T) and bottom (FA3B). Near Gordon Cay salinity was 31.2ppt at the surface (FA4T) and 31.1ppt at the bottom (FA4B). Salinity was in the narrow range 30.8ppt to 31ppt for the three nearshore sites in the vicinity of Fort Augusta (FA5, FA6 and FA7).

Dissolved oxygen (DO) levels were in the range 2.99mg/l to 8.93mg/l for all sites. DO levels were generally lower within the harbour being in the range 2.99mg/l to 3.91mg/l. DO was lowest (2.99mg/l) at Fort Augusta Central (FA6). DO was highest at the background site where levels exceeded the saturation level indicating supersaturation. Here, DO was 7.04mg/l at the surface (FA1T) and 8.93mg/l at the bottom (FA1B). In the channel near Port Royal, DO was 3.85mg/l at the surface (FA2T) and 3.91mg/l at the bottom (FA2B). In the channel near Fort Augusta DO was 3.25mg/l at the top (FA3T) and 3.33mg/l at the bottom of the water column (FA3B). IN the vicinity of Gordon Cay DO was 3.71mg/l at the top (4T) and 3.61mg/l at the bottom of the water column (FA4B). At Fort Augusta East (FA5) DO was 3.14mg/l and at Fort Augusta West (FA7), DO was 3.15mg/l.

Biological oxygen demand (BOD) was determined to be in the range 0.3mg/l to 1.8mg/l for all samples taken. BOD was highest at Fort Augusta Central (FA6) and lowest at the background site at the surface (FA1T). At the bottom of the water column at the background site (FA1B), BOD was 0.6mg/l. In the channel near Port Royal BOD was 1.4mg/l at the top (FA2T) and 1.5mg/l at the bottom (FA2B). In the channel near Fort Augusta, BOD was 0.6mg/l at the top (FA3T) and 0.7mg/l at the bottom of the water column (FA3B). In the channel near Gordon Cay, BOD was 1.3mg/l at the surface (FA4T) and 0.7mg/l at the bottom of the water column (FA4B). At Fort Augusta East (FA5), BOD was 1.6mg/l and at Fort Augusta West (FA7) BOD was 1.2mg/l.

Trace Metals

The results of **trace metals** analyses on water samples and elutriates are presented in **Table 9**. Most metals were well within USEPA criteria for protection of marine life. The full laboratory report is presented at Appendix 4.

Arsenic (As) and lead (Pb) were undetected in all marine samples at a test detection level of 6µg/l. The elutriate E3 prepared from the core sample collected at the site near Gordon Cay indicated slight leaching of As to yield a concentration (6.7µg/l) just above the detection level (6µg/l). Most of the other parameters (chromium, mercury, nickel, vanadium and zinc) indicated levels that were well within the criteria or expected values.

A standard was not found for total **tin (Sn)** in marine waters, but a WHO reference (WHO indicated that the levels determined for this parameter in water samples collected, were within the range normally found in sea water. Of the metals Analysed, only copper indicated values close to or slightly greater than the criteria values.

Copper (Cu) levels in water samples, were determined to be slightly higher than the criteria value for most sites, with the elutriate showing a level similar to the level determined at the background site **(Figure 13)**. In the case of nickel (Ni), all levels were within the criteria value with this metal being undetected at all sites except at Ft. Augusta Central where the concentration was 1µg/l. The elutriates E1 and E2, prepared from the core samples C1 and C2 taken from the outer and mid channel respectively, indicated release of nickel levels that were approximately 54% and 17% of the USEPA criteria level respectively **(Figure 14).**

Figure 13: Copper in Water Samples June 12, 2013

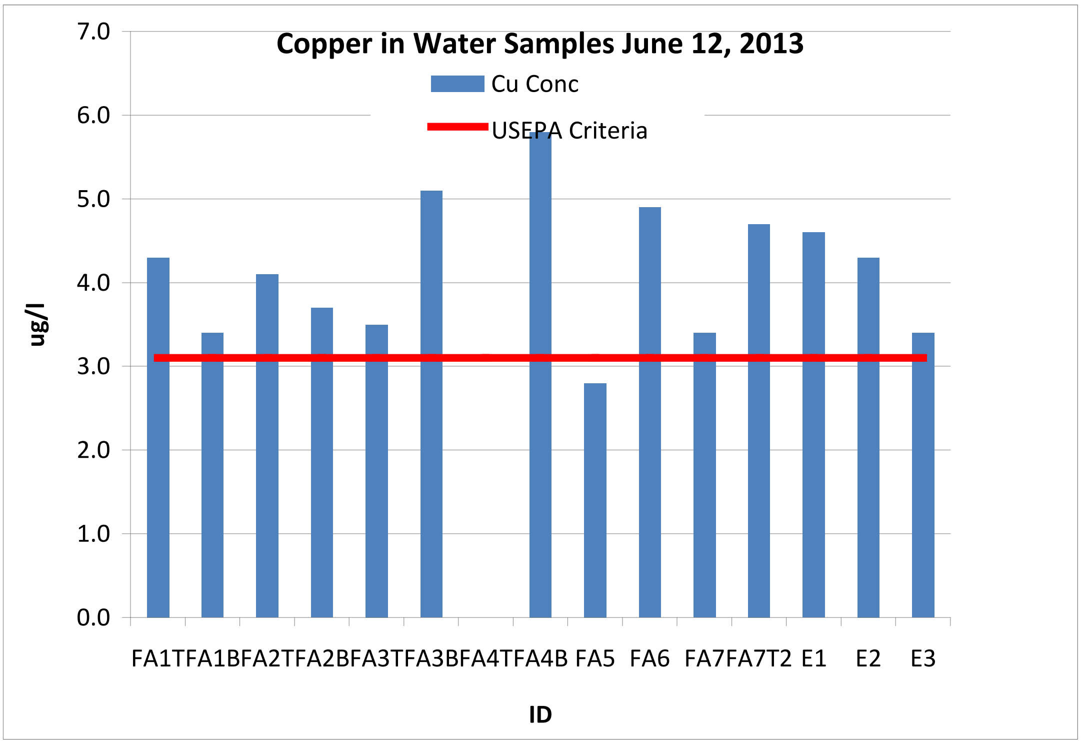


Table 9: TPH and Trace Metals in Water Samples & Elutriate, June 12, 2013

Sample ID	TPH (ppm)	As (ug/L)	Std[1]	Cr (ug/L)	Std[1]	Cu (ug/L)	Std[1]	Hg (ug/L)	Std[1]	Ni (ug/L)	Std[1]	Pb (ug/L)	Std[1]	Sn (ug/L)	Ref[2]	V (ug/L)	Std[3]	Zn (ug/L)	Std
FA1T	0	0.0	36	0.0	50.0	4.3	3.1	0.0	0.9	0.0	1.0	0.0	8.1	3.2	3.0	2.0	650.0	0.0	81.0
FA1B	0	0.0	36	0.0	50.0	3.4	3.1	0.0	0.9	0.0	1.0	0.0	8.1	2.4	3.0	2.3	650.0	1.0	81.0
FA2T	0	0.0	36	0.0	50.0	4.1	3.1	0.0	0.9	0.0	1.0	0.0	8.1	0.0	3.0	3.5	650.0	0.7	81.0
FA2B	0	0.0	36	1.4	50.0	3.7	3.1	0.0	0.9	0.0	1.0	0.0	8.1	0.0	3.0	0.0	650.0	0.0	81.0
FA3T	0	0.0	36	0.0	50.0	3.5	3.1	0.02	0.9	0.0	1.0	0.0	8.1	0.0	3.0	4.0	650.0	0.0	81.0
FA3B	0	0.0	36	0.0	50.0	5.1	3.1	0.00	0.9	0.0	1.0	0.0	8.1	0.0	3.0	2.2	650.0	3.7	81.0
FA4T	0		36		50.0		3.1	0.02	0.9		1.0		8.1		3.0		650.0		81.0
FA4B	0	0.0	36	2.2	50.0	5.8	3.1	0.02	0.9	0.0	1.0	0.0	8.1	0.0	3.0	2.7	650.0	4.5	81.0
FA5	0	0.0	36	0.0	50.0	2.8	3.1	0.02	0.9	0.0	1.0	0.0	8.1	0.0	3.0	3.5	650.0	0.0	81.0
FA6	0	0.0	36	2.2	50.0	4.9	3.1	0.00	0.9	1.0	1.0	0.0	8.1	0.0	3.0	3.7	650.0	0.8	81.0
FA7	0	0.0	36	1.3	50.0	3.4	3.1	0.00	0.9	0.0	1.0	0.0	8.1	0.0	3.0	3.0	650.0	0.0	81.0
FA7T2	0	0.0	36	0.0	50.0	4.7	3.1	0.00	0.9	0.0	1.0	0.0	8.1	0.0	3.0	2.7	650.0	0.0	81.0
E1	0	0.0	36	3.6	50.0	4.6	3.1	0.04	0.9	4.5	1.0	0.0	8.1	0.0	3.0	19.5	650.0	1.4	81.0
E2	0	0.0	36	0.0	50.0	4.3	3.1	0.03	0.9	1.4	1.0	0.0	8.1	0.0	3.0	23.8	650.0	1.0	81.0
E3	0	6.7	36	0.0	50.0	3.4	3.1	0.00	0.9	0.0	1.0	0.0	8.1	2.3	3.0	37.9	650.0	0.8	81.0

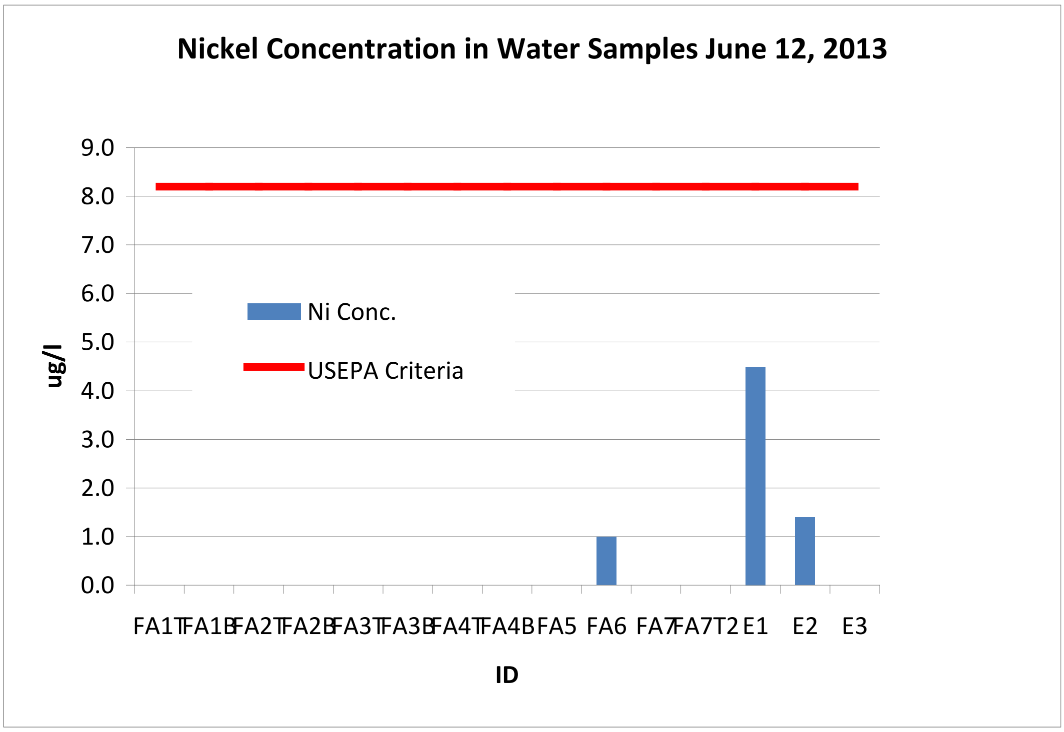
1) USEPA CCC Aquatic Life Criteria

http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

2) WHO Ref 2005

3) USEPA 1972

Figure 14: Nickel Concentration in Water Samples June 12, 2013



Tin (Sn) was undetected (<2µg/l) at all sites within the harbour but was almost equal to the reference value (WHO 2005) at the background site (FA1T and FA1B) outside the harbour near Port Royal **(Figure 15**). The elutriates E1 and E2 indicated no release of tin (Sn) from the cores C1 and C2 taken from the outer and mid harbour respectively. Elutriate E3 prepared from the core sample C3 taken from the inner channel near Gordon cay indicated a level of tin (Sn) equivalent to the sample taken at the bottom of the water column at the background site (1B).

Vanadium (V) was present in all samples at levels well below the USEPA criteria level for salt water (**Figure 16**). The elutriates indicated a slight leeching of vanadium that produced concentrations more than an order of magnitude below the criteria value.

Figure 15: Tin in water samples June 12, 2013

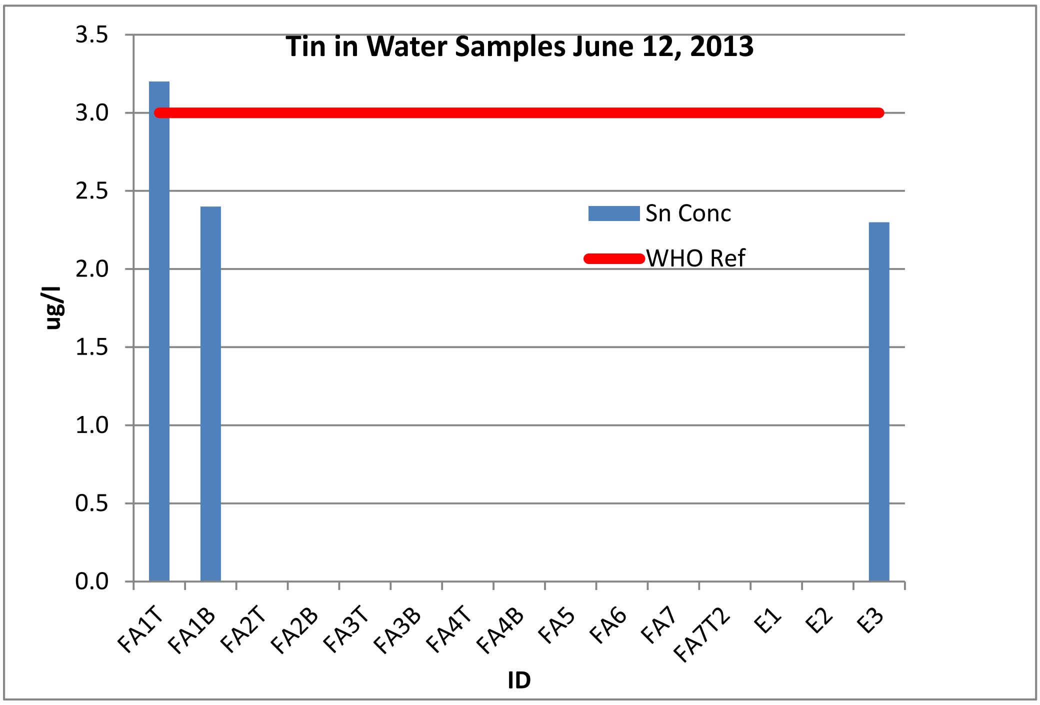
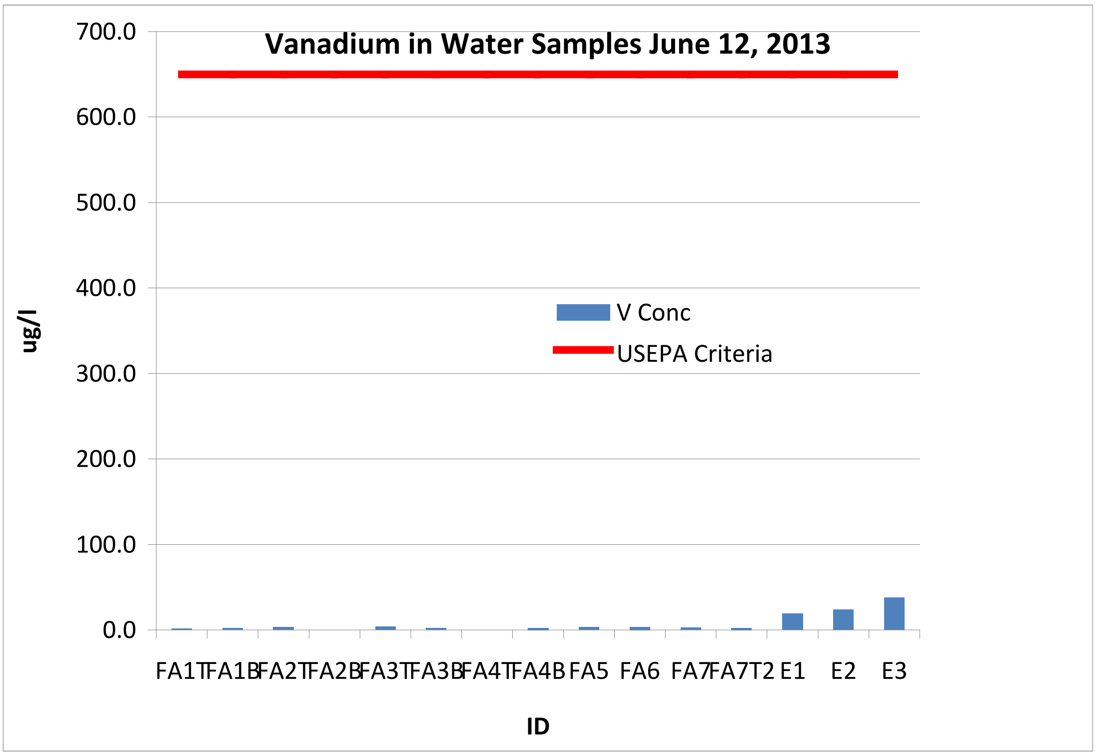


Figure 16: Vanadium in Water Samples June 12, 2013

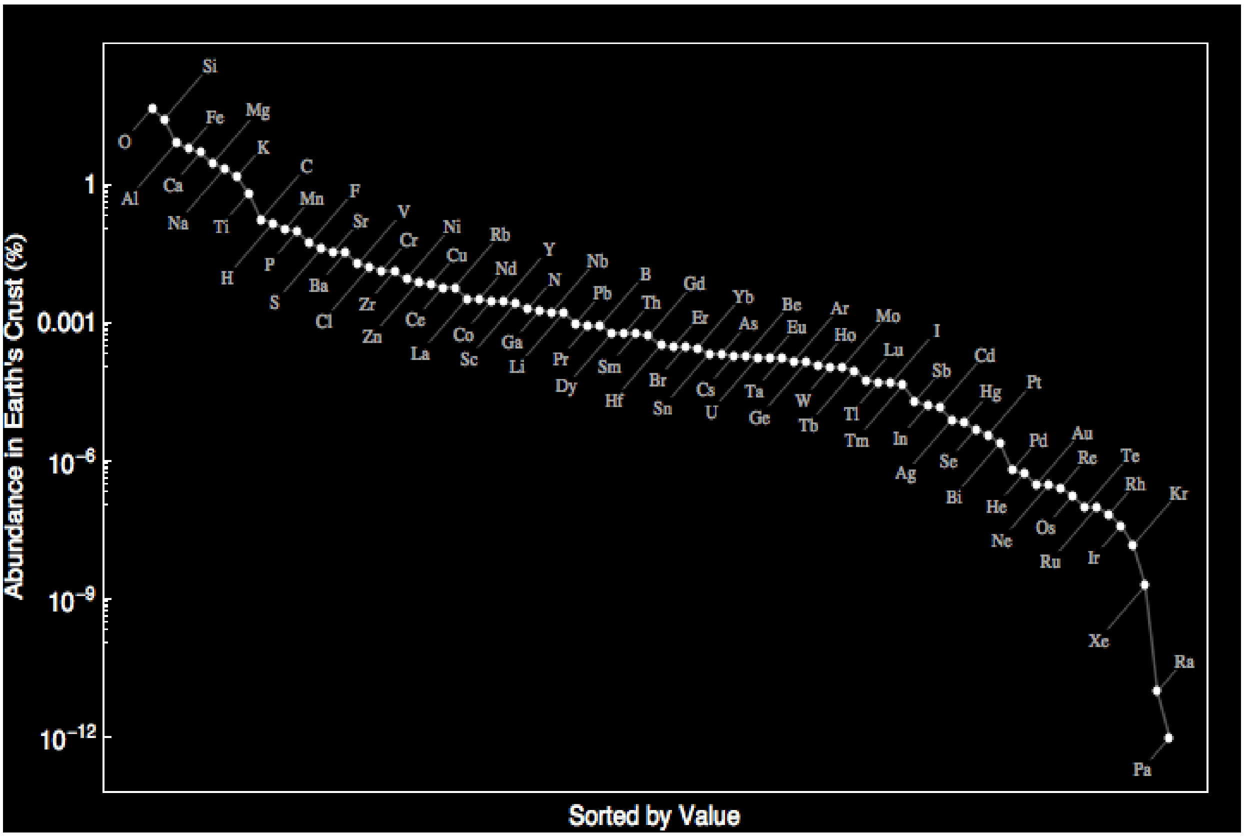


Zinc (Zn) levels were well below the USEPA sea water criteria level for all water samples. Concentrations of Zn in the three elutriates were similar to those found in the water samples. The elutriate indicated some leaching but the resulting concentrations were also well below the criteria levels.

Sediment

The trace metals determined are all present in the earth's crust (**Figure 17**). It is expected however that these levels will be influenced by natural phenomenon as well as human activity.

Figure 17: Elements of the Periodic Table in the Earth's Crust



Source: http://www.periodictable.com/Elements/062/data.html

Table 10: Trace Metals in Sediment Samples

Sample ID	TS %	As	BG[1]	Cr	Std[2]	Cu	Std[2]	Hg	Std[2]	Ni	Std[3]	Pb	Std[3]	Sn	Ref[4]	V	Ref[5]	Zn	Std[3]
C1	70	6.64	50	14.4	160	10.7	108	0.065	0.7	6	21	7.79	47	0.9	8	18.4	150	22.7	150
C2	64	8.1	50	17.6	160	35.4	108	0.074	0.7	8.9	21	8.1	47	0.7	8	41.5	150	39.4	150
C3	52	8.61	50	25.3	160	60.5	108	0.113	0.7	12.6	21	11.2	47	2.0	8	58.3	150	62.4	150

TS - Total Solids

NB: Units in mg/Kg unless otherwise stated

1) Maher & Butler 1988
2) Environment Canada Probable Effect Level (PEL)
3) NOAA Guideline Value 1999
4) WHO 2005
5) El-Moselhy 2006

The results of sediment analyses are presented in **Table 10**. The trace metals determined in the sediment samples were all below known standards or guideline values. In general however, the highest levels of trace metals were determined for the sediment samples taken from the inner channel near Gordon Cay suggesting some effect from land based activity. This effect was most pronounced for copper (**Figure 18**), nickel (**Figure 19**), lead (**Figure 20**), vanadium (**Figure 21**) and zinc (**Figure 22**).

Figure 18: Copper in Sediment Samples June 12, 2013

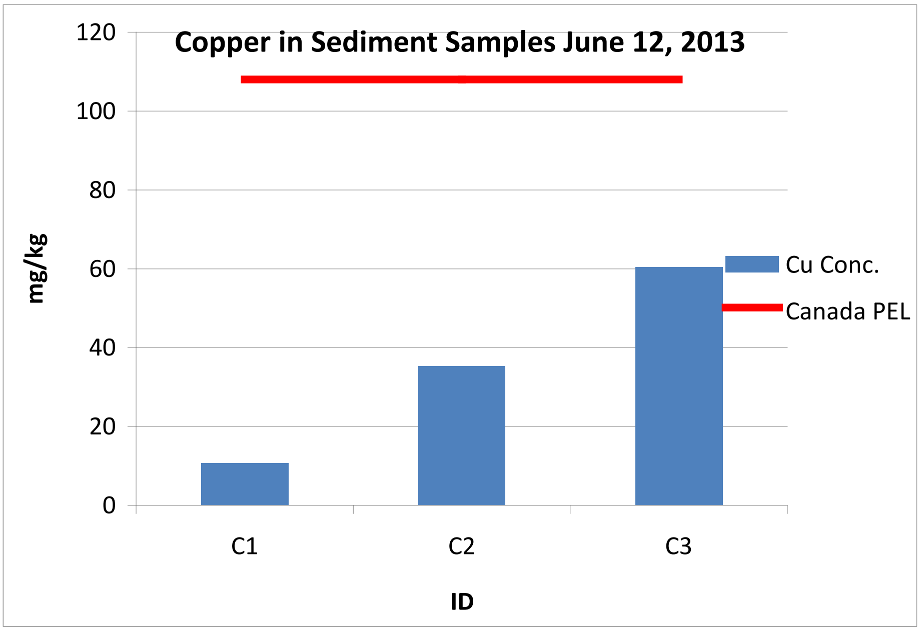


Figure 19: Nickel in Sediment June 12, 2013

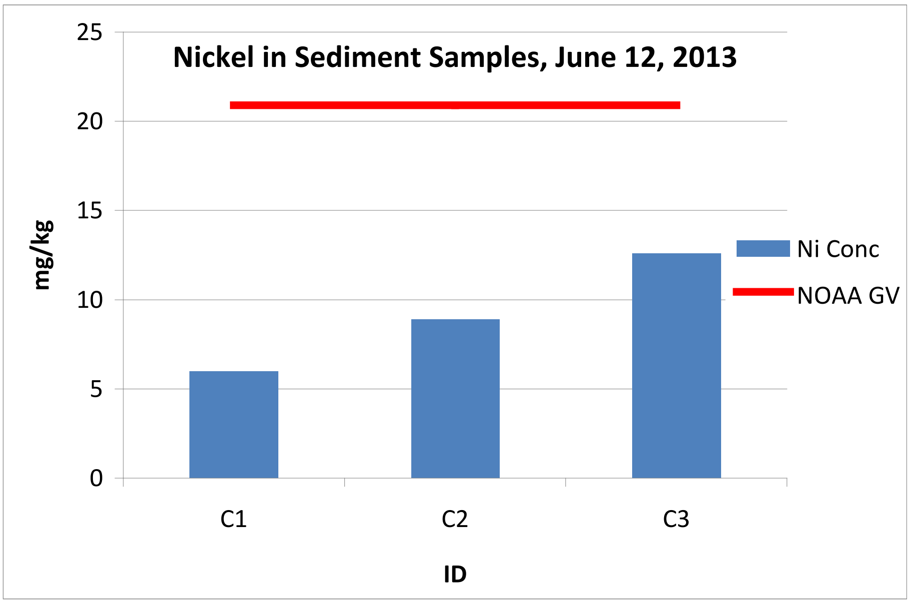


Figure 20: Lead in Sediment Samples June 12, 2013

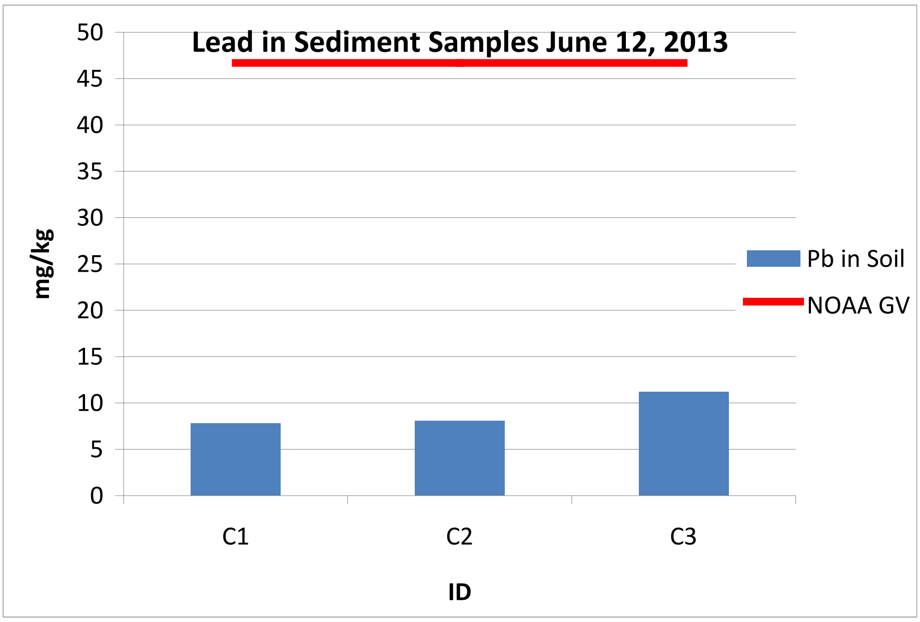


Figure 21: Vanadium in sediment Samples June 12, 2013

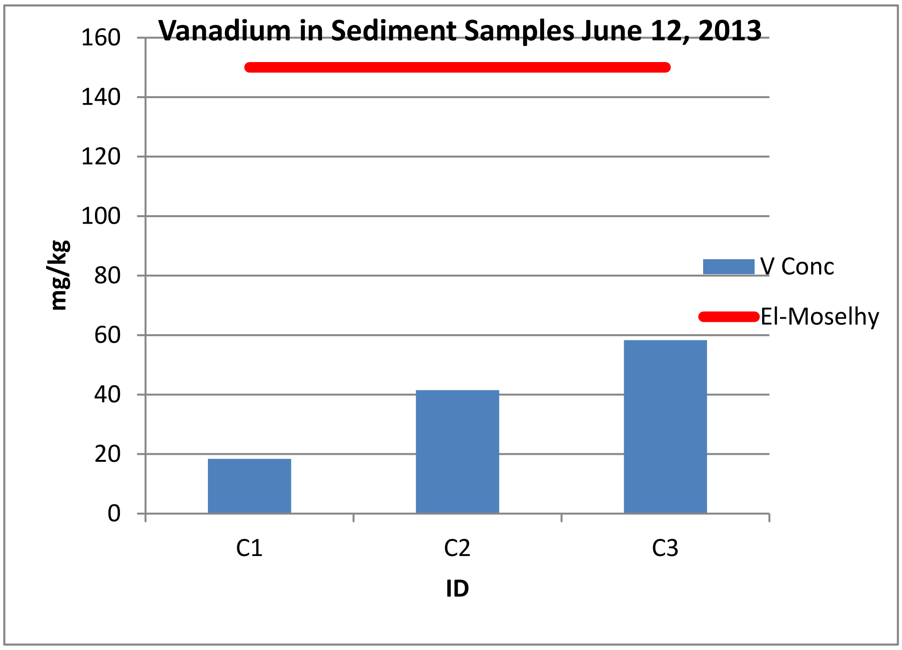
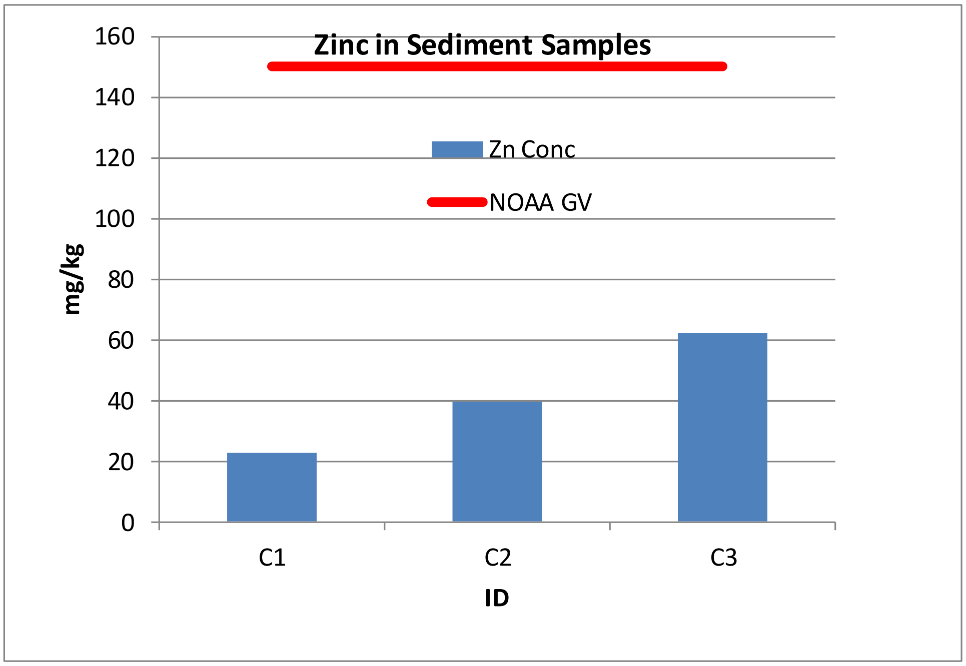


Figure 22: Zinc in Sediment Samples, June 12, 2013

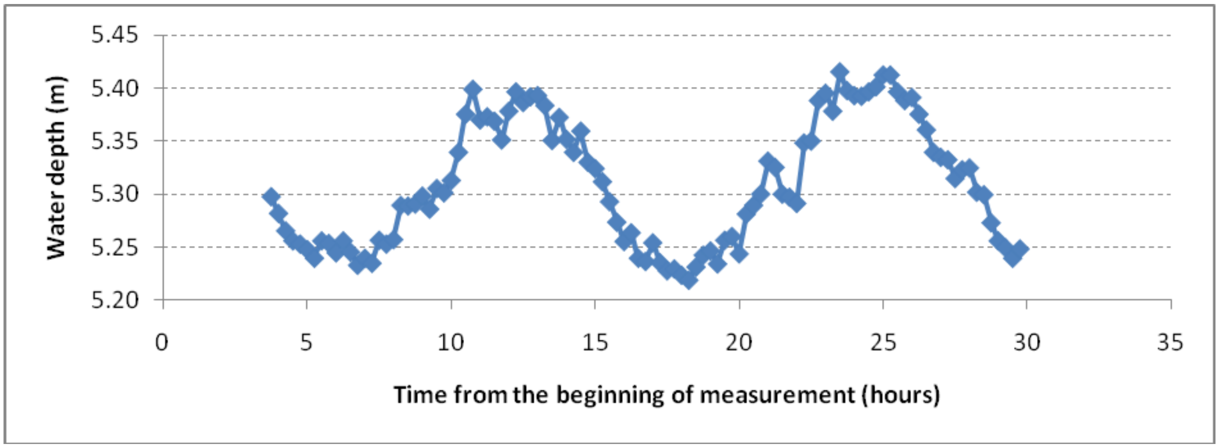


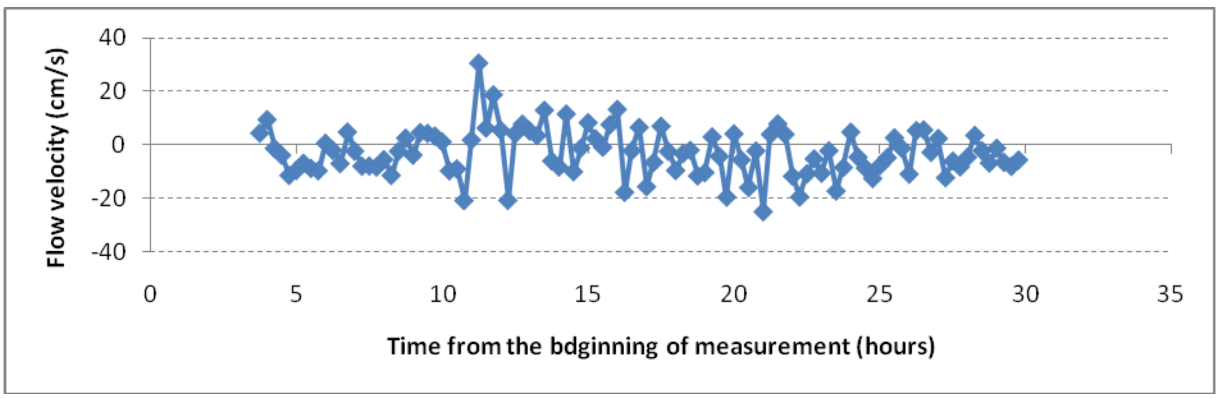
4.2.2.2 Coastal Dynamics

Analysis of Field Data

Figure 23 illustrates water level and flow measurements just outside the Hunts Bay Bridge (location is shown in **Figure 9**).

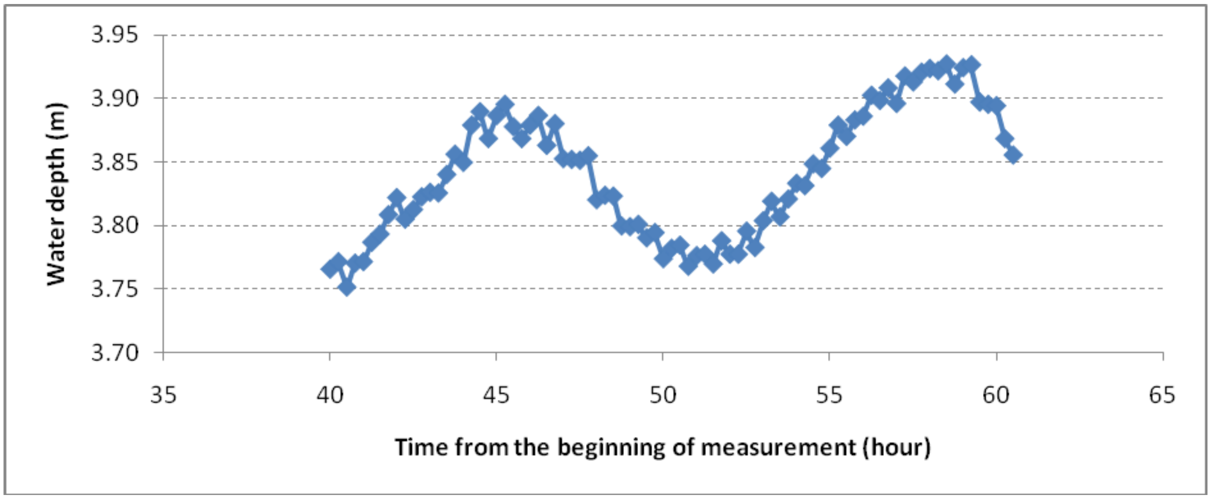
Figure 23: Initial results from the water level and flow measurement just outside the Hunts Bay bridge (harbour side). Upper: water level; lower: flow velocity (positive: toward Hunts Bay; negative: toward Kingston Harbour).





This initial data indicates the semi-diurnal tide (from September 28, 12:45 to September 29, 14:45) had a range of ±0.17m representing a couple of spring tides. Flow velocity near the bridge was generally weak during the two-day measurement period and did not indicate a tidal signal despite the fact that the measurements were conducted during two large spring tidal cycles. The measured velocities ranged mostly between 20 cm/s toward Hunts Bay (positive) and 20 cm/s toward Kingston Harbour (negative). A net flow, averaging approximately 3 cm/s, out of the Hunts Bay, was measured. This is expected due to the various in-flows from streams and canals into Hunts Bay. Moderate rainfall occurred during the two day measurement period.

Figure 24: Initial results from the water level and flow measurement just offshore from the proposed Fort Augusta expansion area. Upper: water level; lower: flow velocity (positive: toward Hunts Bay; negative: toward Kingston Harbour).



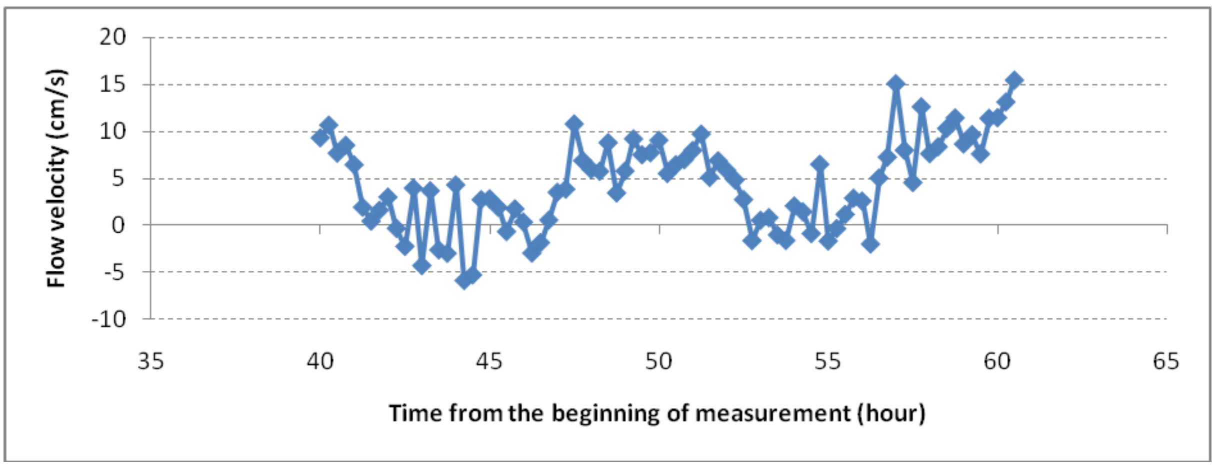


Figure 24 illustrates the initial results from the water level and flow measurement at **Station 2**, just seaward of the Fort Augusta expansion area (location is shown in **Figure 9**). This initial data indicates the semi-diurnal tide (from September 29 16:00 to September 30 12:30) had a range of 0.15m (**Figure 24**), representing a couple of spring tides.

The flow velocities just offshore the proposed Fort Augusta reclamation area were generally weak during the two-day measurement period or did not register despite the fact that the measurements were conducted during two large spring tidal cycles. The measured velocities ranged mostly between 5 cm/s toward the Kingston Harbour (negative) and 15 cm/s toward the ocean (positive). A net flow, averaging approximately 4.4 cm/s, along the shoreline toward the ocean, was measured. This likely represents a longshore current toward the southwest driven by the easterly wind during the two-day measurement period. It is worth noting that the easterly wind is dominant in this area. Based on experience, the wind speed was moderate to below average. Therefore the longshore current can be considerably stronger than measured here. This longshore current may have considerable implications to the state of adjacent beaches, as discussed in the following sections.

Summary of the Field Data

1) Flow through the Hunts Bay Bridge is not significantly driven by tidal water-level fluctuations. The main driver for the flow is likely the discharges from the streams and canals, both natural and artificial. Previous modelling efforts have shown strong flow through the Hunts Bay channel. This was not measured, as expected, by the present effort under non-flood conditions, although under a large spring tide condition**.**

2) Tidal-driven flow in the order of 10-15 cm/s, was measured along the Fort Augusta expansion area. More importantly, a net southwest-ward longshore current, likely driven by the persistent and dominant easterly wind, was measured. It is worth noting that the longshore current, averaging about 4.4 cm/s, was measured outside the surf zone. The longshore current can be significantly stronger within the surf zone due to oblique wave breaking. This longshore current may have significant implications to the state of beaches in the vicinity of the project area.

Concerns Based on Field Data and Observations

Of concern is the shoreline to the west, and down drift, of the proposed Fort Augusta expansion area where the beach is severely eroded (**Figure 25**)**. Figure 25** illustrates a typical section of the beach to the west of the proposed project area where historically, there used to be a relatively healthy beach along this section of shoreline. Not only has the beach been completely eroded along nearly the entire section, but there is evidence indicating that the infrastructure is being compromised. Given the persistent westward longshore sand transport and wave forcing, the construction at Fort Augusta will likely further reduce sand supply from the east and therefore worsen the shoreline state along the section of the beach to the west. Though the erosion exists prior to the proposed development, it is recommended that remediation actions be seriously considered as part of the mitigation for the proposed development.

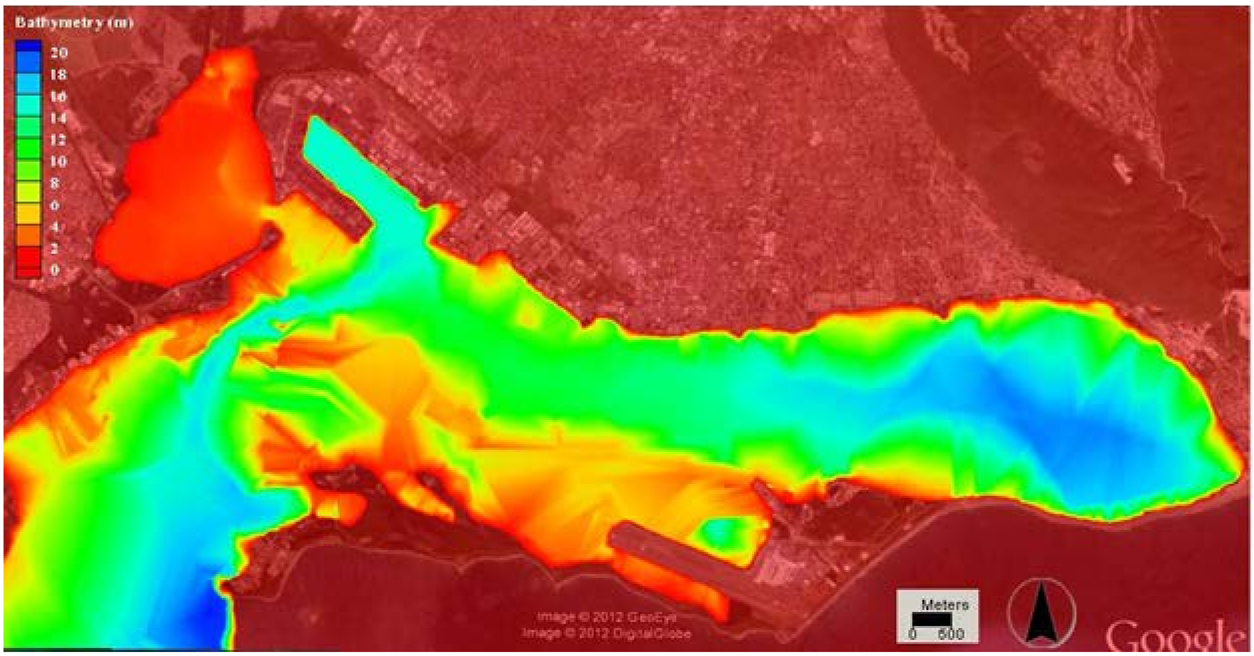
Figure 25: Severe beach erosion and structural damage along the shoreline to the west of the proposed Fort Augusta expansion area. Without mitigation, this section of the shoreline will likely experience further erosion and infrastructure damage.

Results of CMS-WAVE Modelling

The CMS-WAVE model is developed by the US Army Corps of Engineer Research and Development Centre and has been broadly used for applications in tidal inlets and coastal harbours (http://cirp.usace.army.mil/wiki/CMS-Wave).

Waves within the confines of Kingston Harbour are mostly generated by local winds. Since wave patterns are strongly influenced by bathymetry, a rather detailed and up-to-date bathymetry was collected for the wave modelling study. **Figure 26** illustrates the bathymetry of Kingston Harbour collected by this study. Deep water in the eastern portion of the harbour and along the dredged channel is apparent. Water depth in Hunts Bay is mostly less than 1 m.

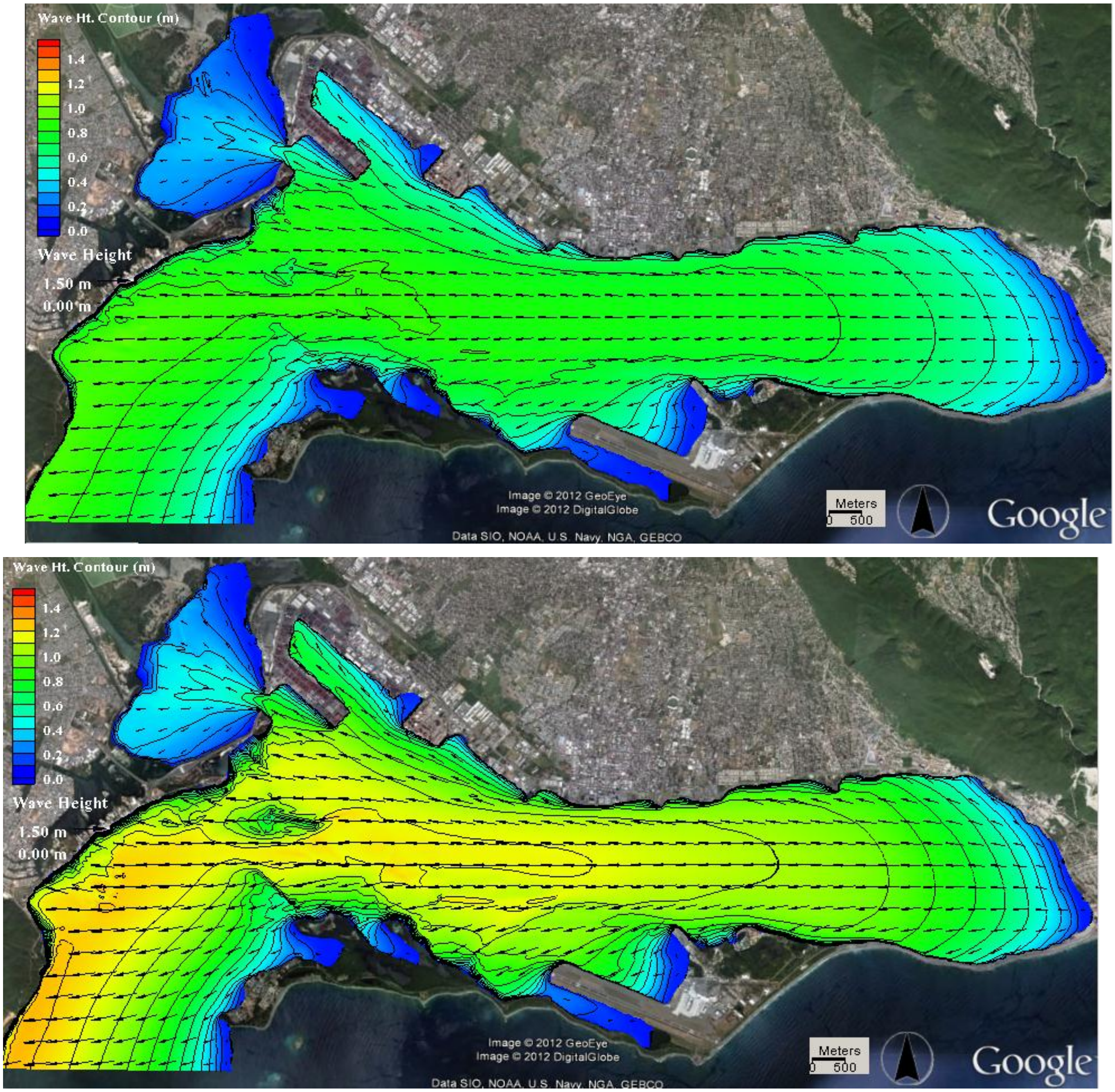
Figure 26: Bathymetry of the greater Kingston Harbour



Waves generated by the dominant easterly wind are investigated using the CMS-Wave model. Six wind speeds, 5, 7, 9, 11, 13, and 15 m/s, approaching from east, east-northeast, and east-southeast are used to generate waves within Kingston Harbour. Scenarios without the Fort Augusta expansion, i.e., the current condition, are compared with those with the construction of the Fort Augusta expansion. Two relatively strong wind conditions, with 9 m/s (or 32.4 km/hour or 20.1 miles per hour) and 13 m/s (39.6 km/hour or 24.6 miles per hour) speed, approaching from east, east-northeast, and east-southeast, are discussed in the following sections. Results from other wind conditions are similar. Wave conditions within the entire bay (without the expansion), wave conditions at the project area without the expansion, and wave conditions at the project area with the expansion are discussed.

Figure 27 illustrates wave conditions over the entire Kingston Harbour under an easterly approaching wind at 9 m/s (**Figure 27 upper**) and 13 m/s (**Figure 27 lower)**. The dominant wave direction is largely the same as the easterly incident wind direction. Some wave diffraction around the protruding landmass was modelled. The wave height increases toward the west as the wind fetch increases, as observed in the field. As expected, the stronger 13 m/s wind generated much higher waves of nearly 1.2 m toward the western end of the harbour. Wave height dissipation due to increased friction over the shallow water next to the dredged channel is predicted. The beach in the vicinity of the Fort Augusta expansion area is experiencing relatively higher waves than most of the harbour areas. This explains the severe erosion observed there. Regional scale wave conditions are not influenced by the proposed Fort Augusta expansion. Although **Figure 27** shows the cases without the expansion, the cases with the expansion are largely the same as this scenario.

Figure 27: Modelled wave conditions in the entire Kingston Harbour under an easterly approaching wave at 9 m/s (upper panel) and 13 m/s (lower panel) wind speed.



The modelled wave conditions at the project site, comparing the cases without and with the proposed Fort Augusta expansion, are shown in **Figure 28** and **Figure 29.** shows the cases with the easterly incident wind speed of 9 m/s and **Figure 29** shows the cases with the easterly incident wind speed of 13m/s. The most significant and apparent influence of the proposed Fort Augusta expansion is the sheltering of waves to the west of the proposed structure. Waves directly to the west of the protrusion are much smaller than those without the structure due to sheltering. The wave heights increase further away from the structure. This creates a wave-energy gradient just west of the structure, which may subsequently induce a gradient of longshore sand transport. The transport gradient will cause beach erosion down drift of the structure because more sand will leave the system than that coming into the system. Influences of wave reflection off the vertical walls are localised and are not well resolved even with the small 10 X 10 m grid. Hence the effects of reflection are deemed negligible. **Figure 29** illustrates the cases with a stronger wind of 13 m/s, approaching from the east. Compared to the 9 m/s wind case, the waves generated by the stronger wind are higher. The influences of the shallow water to the east are more apparent. The shadow zone is larger and has a large wave-energy gradient. As such, there is high potential for beach erosion resulting from stronger winds. Similar to the weaker wind case, wave reflections from the vertical wall are not expected to be significant.

Figure 28: Modelled wave conditions at the project area under an easterly approaching wave at 9 m/s, without (upper panel) and with (lower panel) the proposed structure.

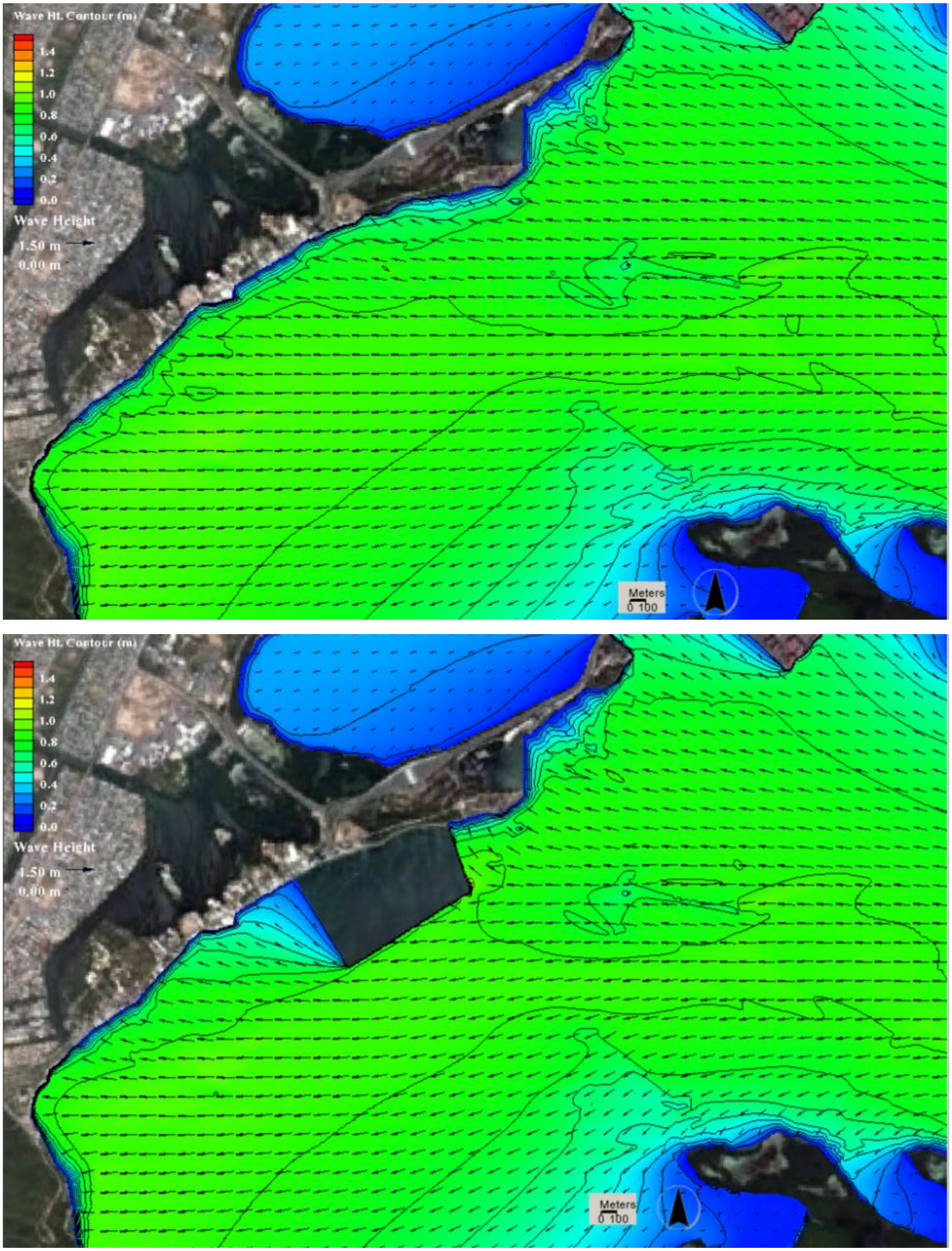


Figure 29: Modelled wave conditions at the project area under an easterly approaching wave at 13 m/s, without (upper panel) and with (lower panel) the proposed structure.

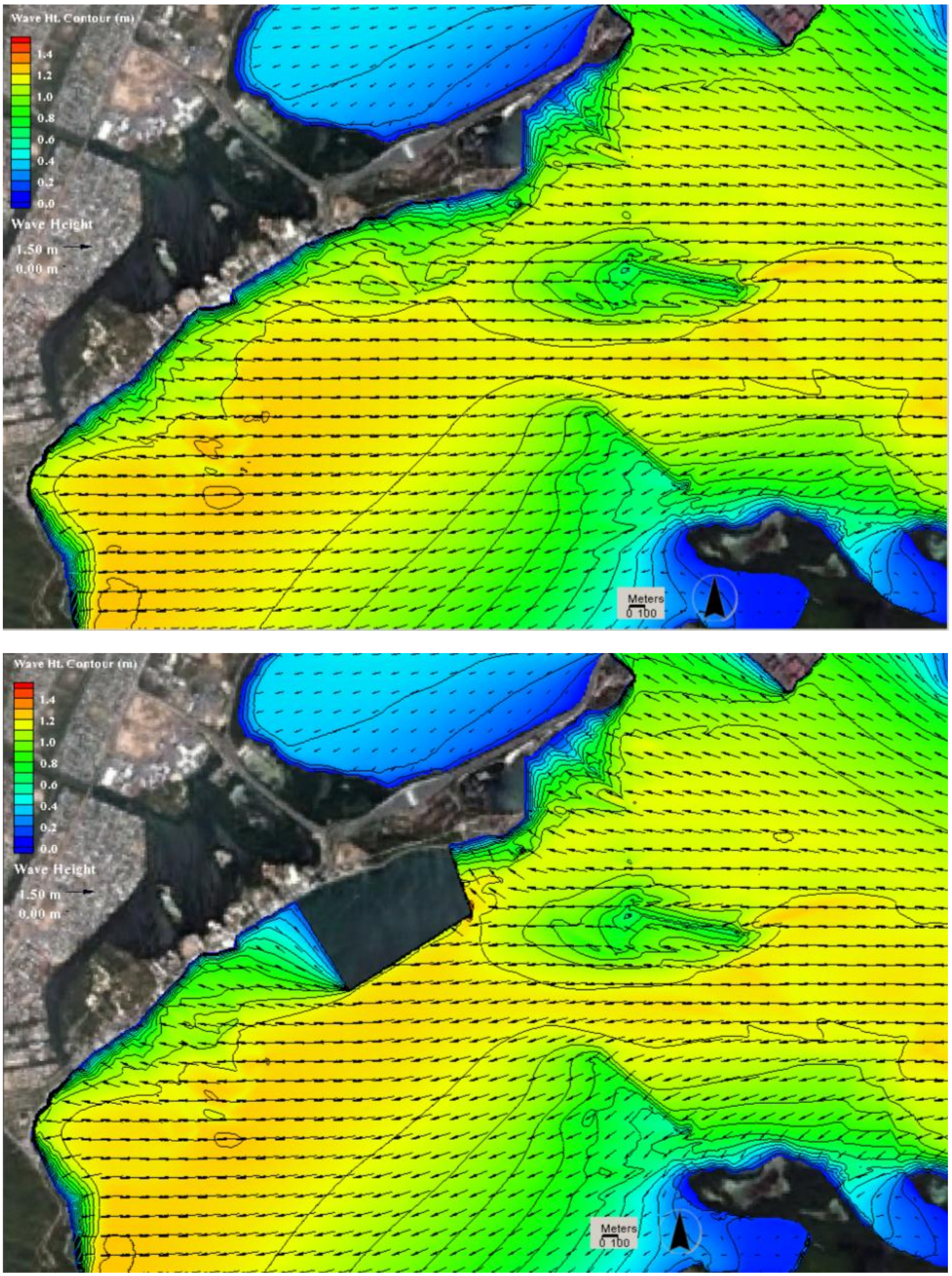
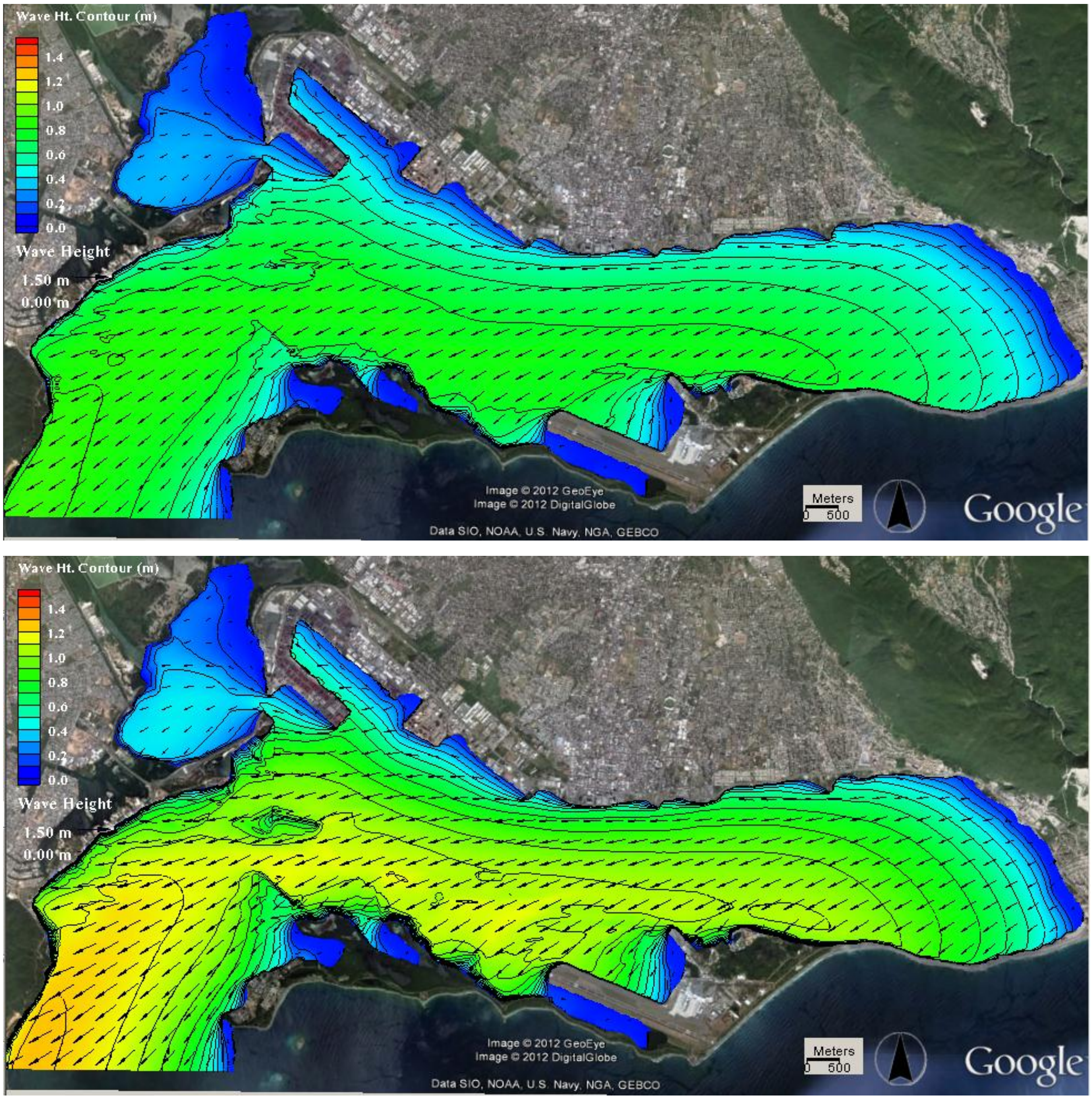


Figure 30 illustrates wave conditions over the entire Kingston Harbour under an east-northeasterly approaching wind at 9 m/s (**Figure 30 upper**) and 13 m/s (**Figure 30 lower**). This incoming wind has a slight angle approaching from the mainland. The dominant wave direction is largely the same as the east-northeasterly approaching wind direction. Due to the orientation of the local shoreline, the project area is somewhat sheltered from the east-northeasterly wind. This results in moderately smaller waves as compared to the case with easterly approaching wind (**Figure 29**). Some wave diffraction around the protruding landmass was modelled. The wave height increases toward the west as the wind fetch increases, as observed in the field.

As expected, the stronger 13 m/s wind generated much higher waves of nearly 1.2 m toward the western end of the harbour. Wave height dissipation due to increased friction over the shallow water next to the dredged channel is predicted. The beach in the vicinity of the Fort Augusta expansion area is experiencing relatively higher waves than most of the harbour areas, although moderately smaller than the easterly wind case. This explains the severe erosion observed there. Regional scale wave conditions are not influenced by the proposed Fort Augusta expansion. Although **Figure 30** shows that case without the expansion, the case with the expansion is largely the same at this scale.

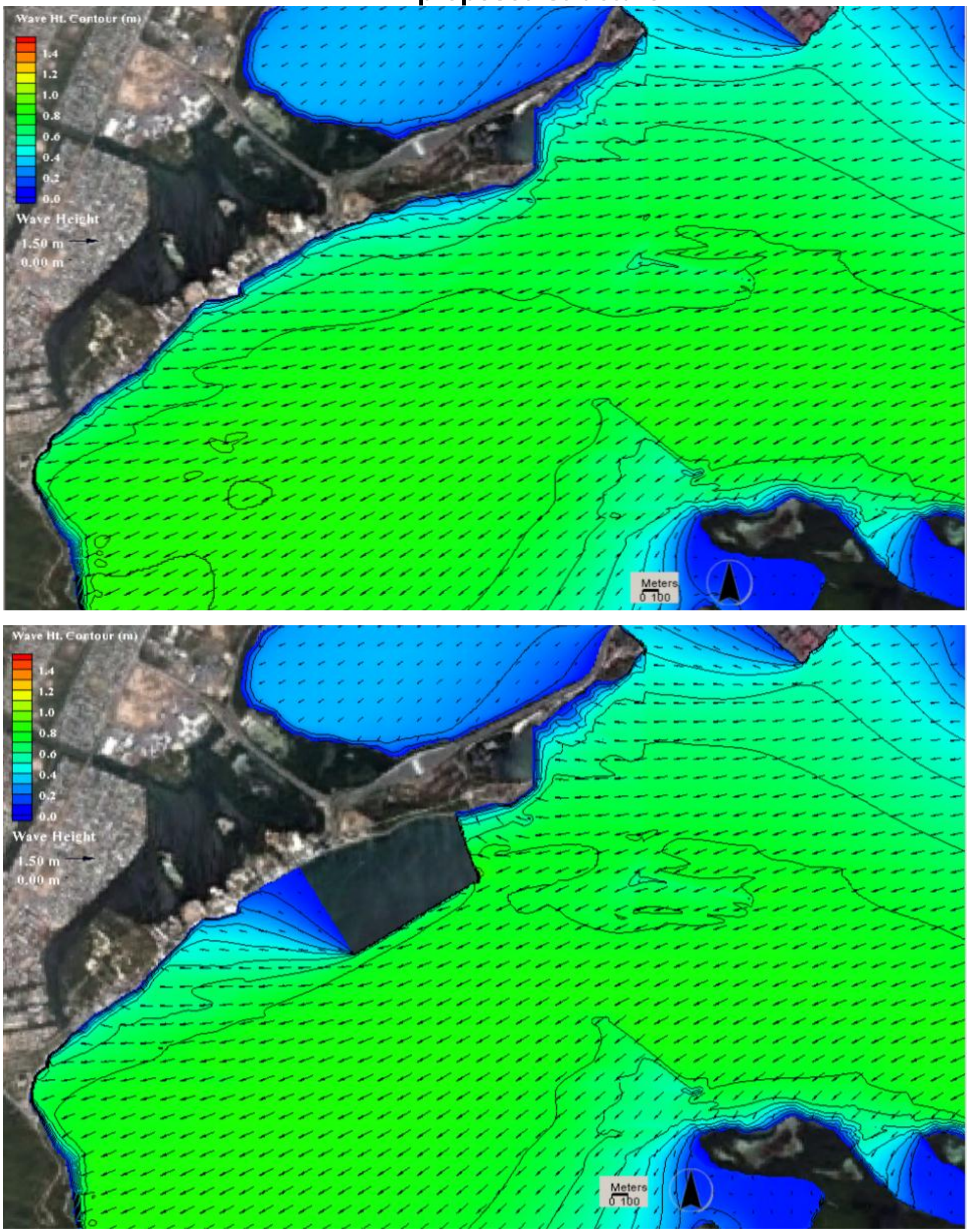
Figure 30: Modelled wave conditions in the entire Kingston Harbour under an east-northeasterly approaching wave at 9 m/s (upper panel) and 13 m/s (lower panel) wind speed.



The modelled wave conditions at the project site, comparing the cases without and with the proposed Fort Augusta expansion, are shown in **Figure 31** and **Figure 32**.

Figure 31 shows the cases with the east-northeasterly incident wind speed of 9 m/s. Similar to the case of easterly approaching wind and wave, the most significant and apparent influence of the proposed Fort Augusta expansion is the sheltering of waves to the

Figure 31: Modelled wave conditions at the project area under an east-northeasterly approaching wave at 9 m/s, without (upper panel) and with (lower panel) the proposed structure.



west of the structure. Other than the modestly smaller waves at the greater project site for this wind condition, the sheltering effects are largely similar to the easterly approaching wind. Waves directly to the west of the protruding structure are much smaller than those without the structure due to sheltering. The wave heights increase further away from the structure. This creates a wave-energy gradient just west of the structure, which may subsequently induce a gradient of longshore sand transport. This transport gradient will cause beach erosion down drift of the structure because more sand will leave the system than is coming into the system. Influences of wave reflection off the vertical wall are largely very local and are not well resolved even with the small 10 X 10 m grid.

Figure 32 illustrates the cases with stronger wind of 13 m/s, approaching from the east-northeast direction. Compared to the 9 m/s wind case, the waves generated by the stronger wind are higher. The influences of the shallow water to the east are more apparent. The shadow zone is larger also with a large wave-energy gradient. Therefore, again there is a high potential for beach erosion to occur with stronger winds. Similar to the weaker wind case, wave reflections from the vertical wall are not expected to be significant.

Figure 33 illustrates wave condition over the entire Kingston Harbour under an east-southeasterly approaching wind at 9 m/s (**Figure 33 upper**) and 13 m/s (**Figure 33 lower**). This incoming wind has a slight angle approaching from the ocean. The dominant wave direction is largely the same as the east-southeasterly approaching wind direction. Due to the orientation of the local shoreline, the project area is more exposed to the east-southeasterly wind. This results in moderately higher waves as compared to the case with easterly and east-northeasterly approaching wind **(Figure 27** and **Figure 30** respectively)**.** Some wave diffraction around the protruding landmass was modelled, similar to the previous two cases. The wave height increases toward the west as the wind fetch increases, as observed in the field. As expected, the stronger 13 m/s wind generated much higher waves of nearly 1.2 m toward the western end of the harbour. Wave height dissipation due to increased friction over the shallow water next to the dredged channel is predicted.

Figure 32: Modelled wave conditions at the project area under an east-northeasterly approaching wave at 13 m/s, without (upper panel) and with (lower panel) the proposed structure.

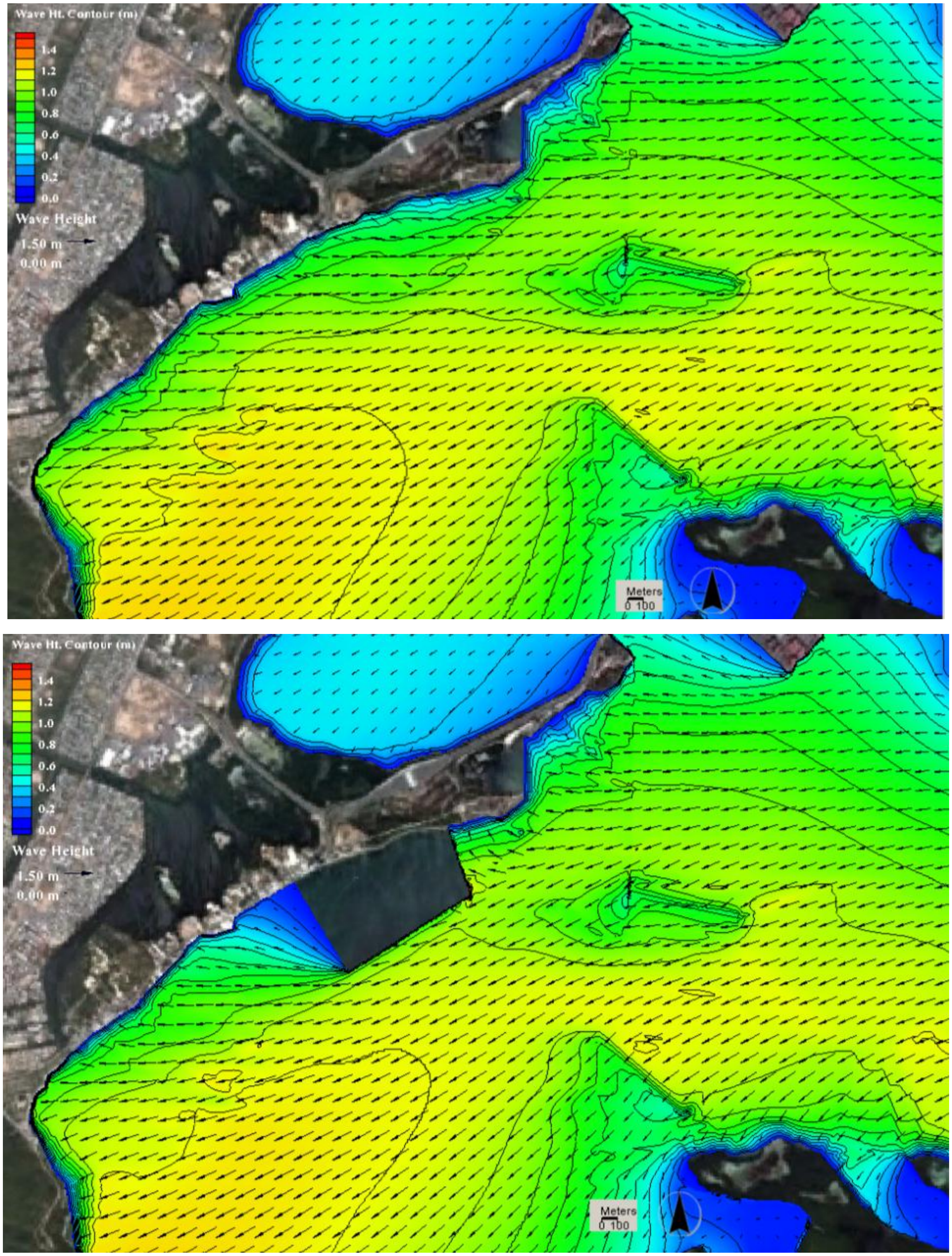
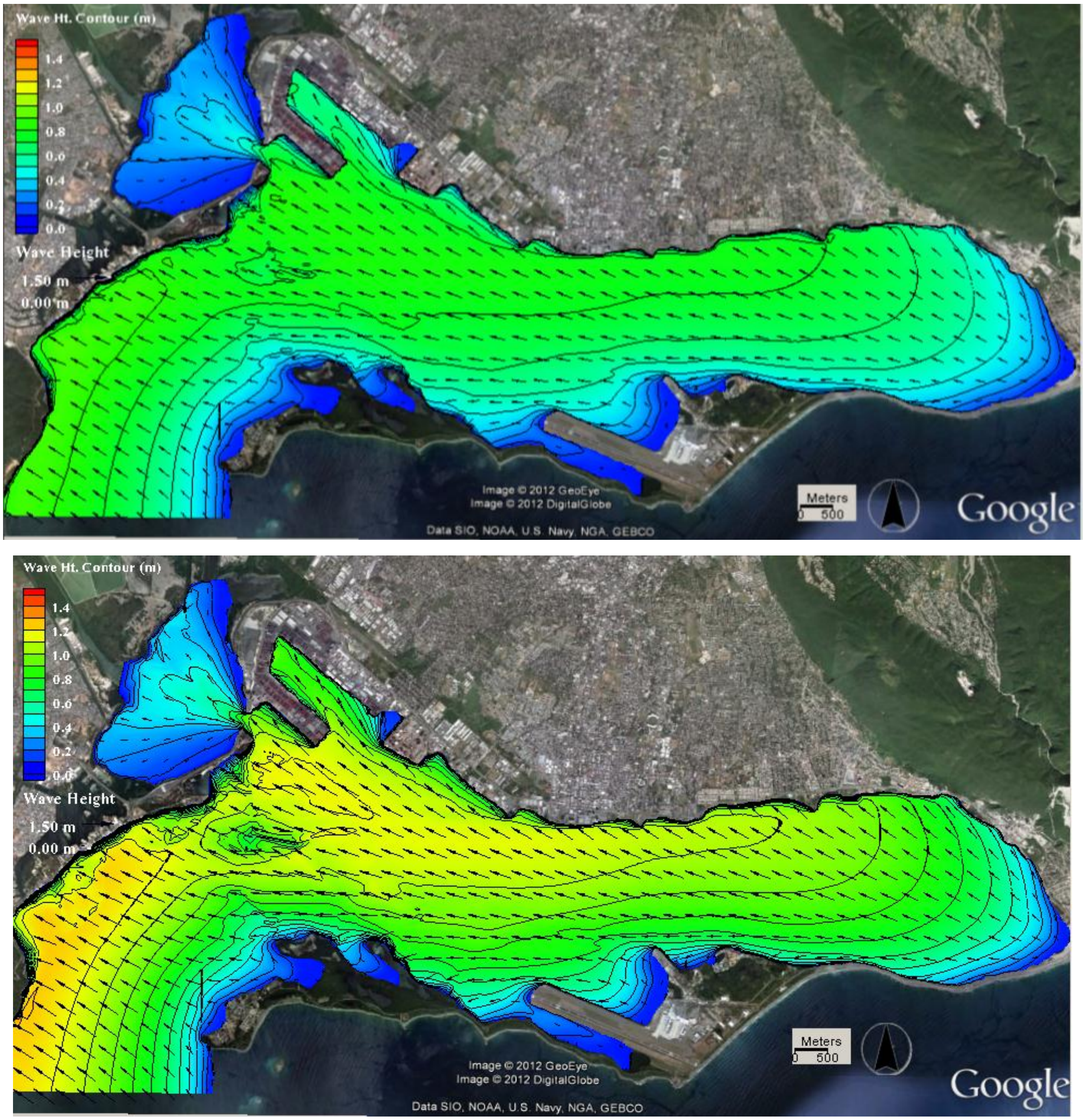


Figure 33: Modelled wave conditions in the entire Kingston Harbour under an east-northeasterly approaching wave at 9 m/s (upper panel) and 13 m/s (lower panel) wind speed.



The beach in the vicinity of the Fort Augusta expansion area experiences relatively higher waves than most other harbour areas. The waves are moderately higher than the easterly and east- northeasterly wind cases due to the onshore component. This explains the severe erosion observed. Regional scale wave conditions are not influenced by the proposed Fort

Augusta expansion. Although **Figure 33** shows the case without the expansion, the case with the expansion is largely the same at this scale.

The modelled wave conditions at the project site, comparing the cases without and with the proposed Fort Augusta expansion, are shown in **Figure 34** and **Figure 35**. **Figure 34** shows the cases with an east-southeasterly incident wind speed of 9 m/s. Similar to the case of easterly and east-northeasterly approaching wind and wave, the most significant and apparent influence of the proposed Fort Augusta expansion is the sheltering of waves to the west of the structure. Due to the onshore component of the east-southeasterly wind, the waves at the project site are modestly higher than the cases with easterly and east-northeasterly wind. In addition, the shadow zone is smaller. Waves directly to the west of the protruding structure are much smaller than those without the structure due to sheltering. The wave heights increase further away from the structure. This creates a wave-energy gradient just west of the structure, which may subsequently induce a gradient of longshore sand transport. The transport gradient will cause beach erosion down-drift of the structure because more sand will leave the system than that coming into the system. Influences of wave reflection off the vertical wall are largely very local and are not well resolved even with the small 10 X 10 m grid.

Figure 35 models the case with a stronger wind of 13 m/s, approaching from the east-southeast direction. Compared to the 9 m/s wind case, the waves generated by the stronger wind are higher. The influence of the shallow water to the east is more apparent. The shadow zone is larger also with a large wave-energy gradient, compared with the weaker wind conditions. Compared to the different wind approaching angles, the shadow zone is smaller due to the onshore component of the incoming wind. A high potential for beach erosion exists with stronger winds. Similar to the weaker wind case, wave reflections from the vertical wall are not expected to be significant.

Figure 34: Modelled wave conditions at the project area under an east-southeasterly approaching wave at 9 m/s, without (upper panel) and with (lower panel) the proposed structure.

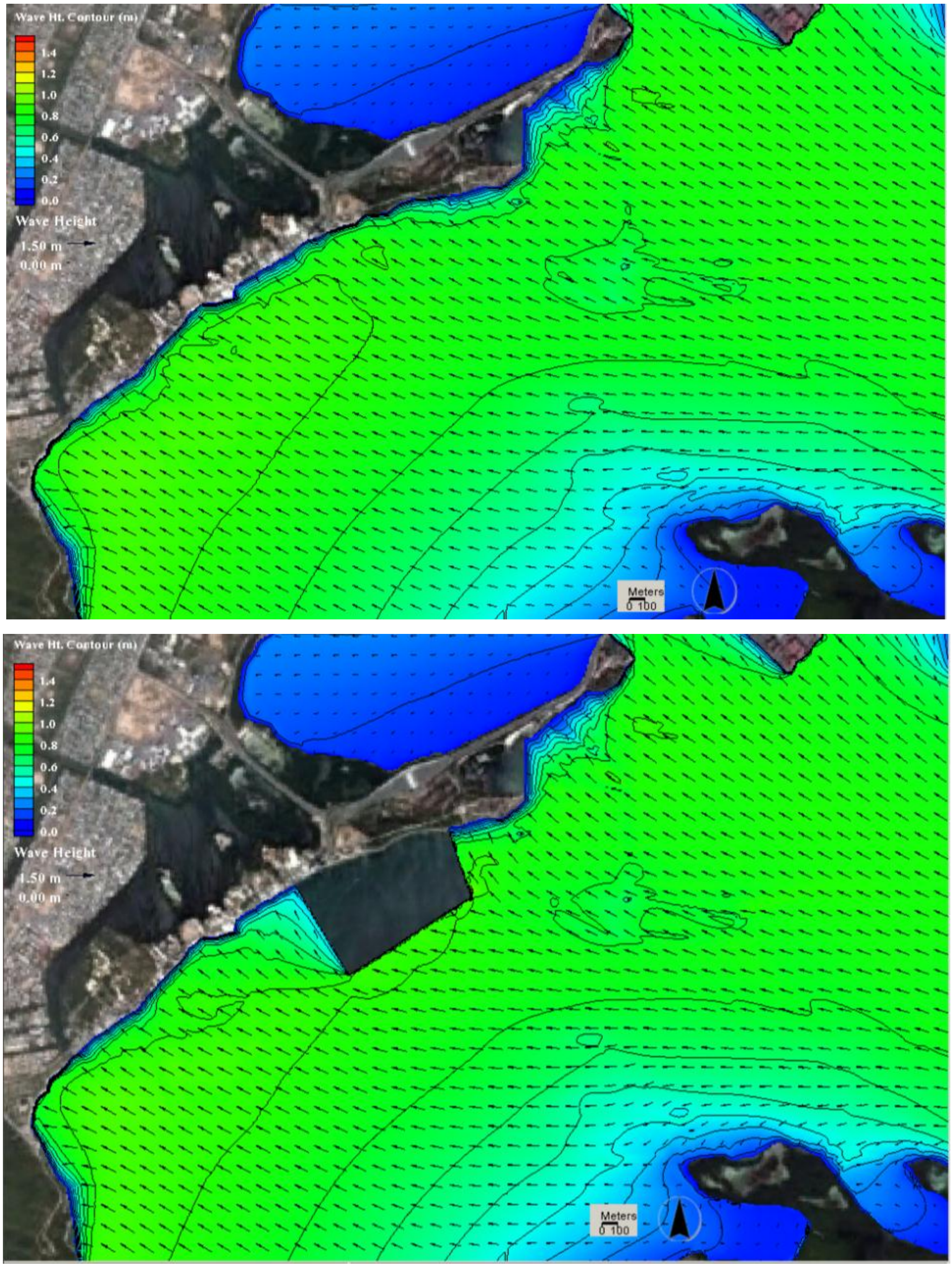
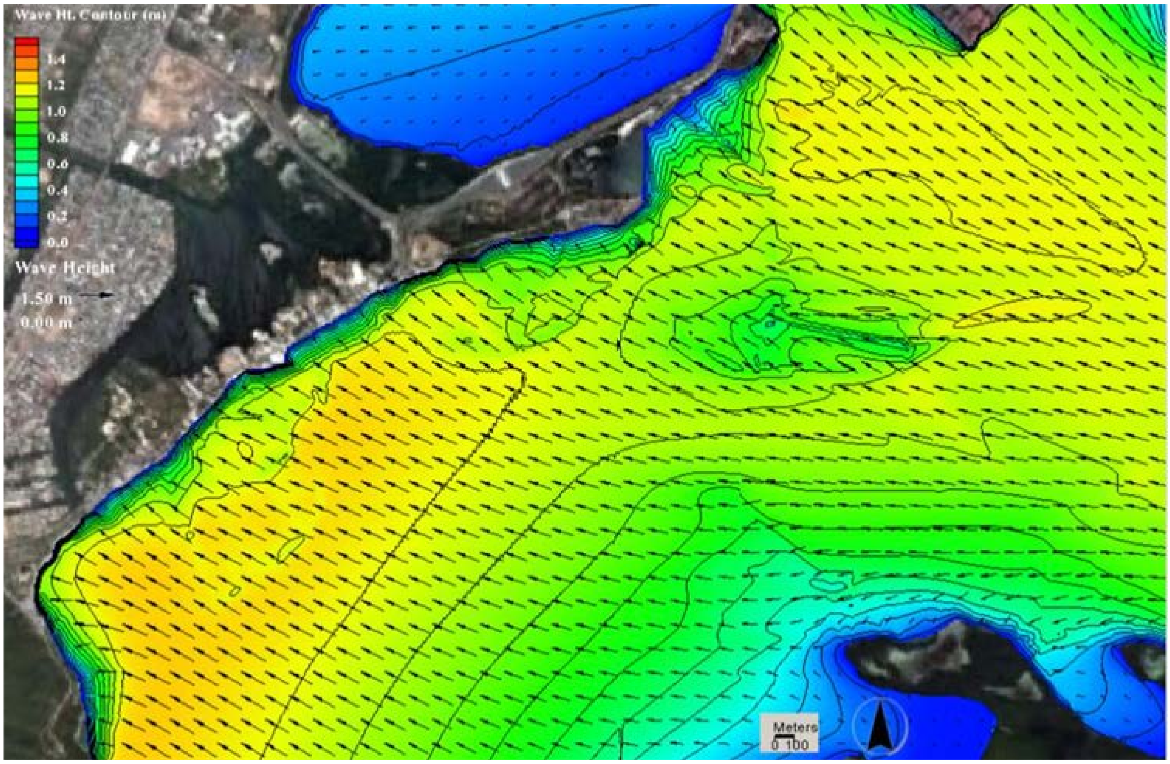
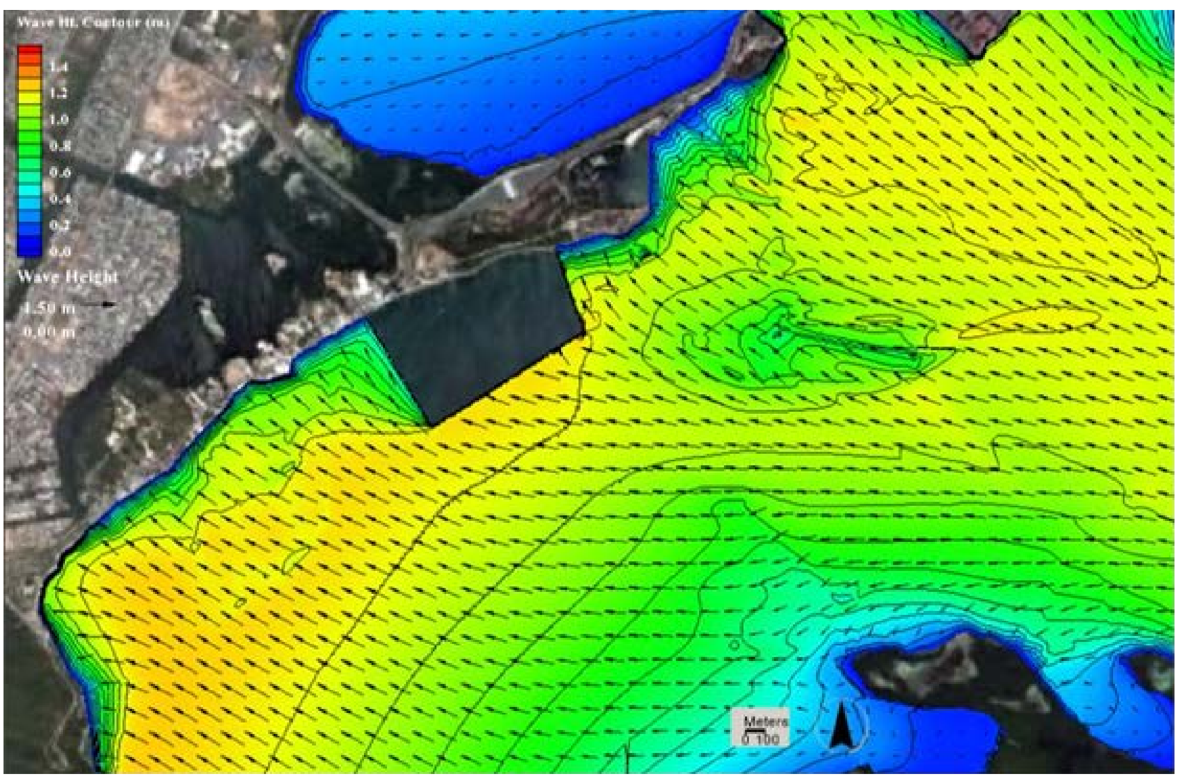


Figure 35: Modelled wave conditions at the project area under an east-southeasterly approaching wave at 13 m/s, without (upper panel) and with (lower panel) the proposed structure.





In summary, the CMS-Wave modelling results suggest that the proposed Fort Augusta expansion will have negligible influence on the overall wave conditions in the greater Kingston Harbour. Wave reflections from the vertical seawall will not have significant influence on wave conditions at the project site. The major influence of the expansion will be the wave sheltering to the west. While reducing the overall incident wave energy to the west of the proposed structure, the expansion will create a large gradient of wave height, and therefore wave energy. The wave-energy gradient will induce a gradient in longshore sand transport to the west. As it has been established that the main longshore transport is to the west, it is anticipated that the wave energy gradient in the lee of the structure will impart a gradient in longshore transport as well. This is independent of the quantity of sediment passing. If the amount leaving the area just down drift to the west is greater than that being replenished, some erosion will occur. This will add to the already stressed condition along the beach.

Results from CMS-FLOW Modelling

Given a small tidal range of mostly less than 30 cm and the large and deep entrance to the harbour, the tidal driven flow within the greater harbour area is weak. Based on the measurements just harbour-ward of the Hunts Bay Bridge, the tidal driven flow velocity should be less than 10 cm/s. The flow into and out of Hunts Bay can be significantly driven by discharges related to heavy rainfall as well as wind-driven currents. Although the entire Kingston Harbour is modelled, the following discussions will be focused on the flow patterns along the project area and through the Hunts Bay Bridge. The input tide conditions are based on field measurements. The input flood and wind conditions are varied to investigate flow patterns driven by an extreme flood, a moderate flood, and a small flood under strong easterly wind conditions.

Input Tide, Flood, and Wind Conditions

The CMS-FLOW model was run for 224 hours, during which a series of schematic scenarios were investigated including:

1) Tide-driven flow with negligible discharge and wind forcing. This run is used to compare with the field measurement to verify the model.
2) Flood and tide-driven flow patterns.
3) Wind and tide-driven flow patterns.

Figure 36 illustrates the input tide conditions. These are based on the measurements at the Hunts Bay Bridge. As discussed earlier, the measurements were conducted during a large spring tide. As such, the input tides represent mid-fall large spring tide conditions.

Figure 36: Input tide conditions for the cms-flow model run, based on field measurements.

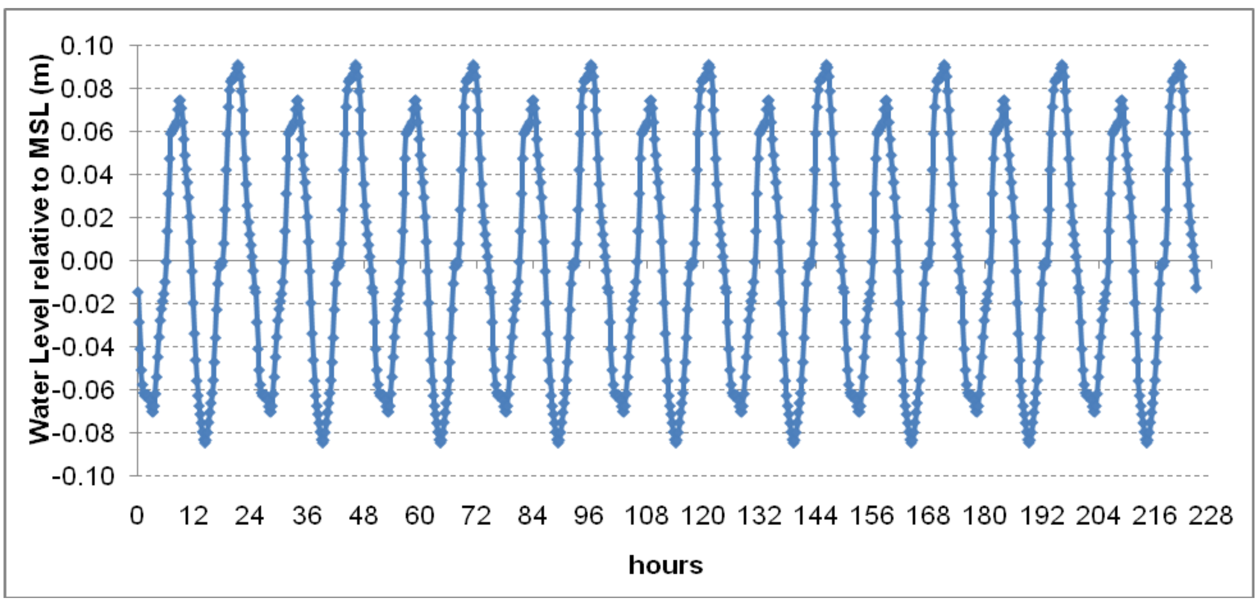


Figure 37 illustrates the input discharge from the main drainage gully (structured) at the northern end of Hunts Bay. Three schematic discharge events into the Hunts Bay are modelled here, including 1) a medium flood, left peak in (**Figure 37**) representing a 0.5 m/s flow through the 200-m wide and 2-m deep gully into Hunts Bay, 2) an extreme flood (middle peak in **Figure 37**, likely on the order of 50 to 100 year flood) representing a 2.0

m/s flow through the 200-m wide and 2-m deep gully, and 3) a large flood representing a 1.0 m/s flow through the 200-m wide and 2-m deep gully. Flood condition, with the same incoming flow velocity, was input through the small creek in the northwest corner of Hunts Bay (**Figure 37**). Because the creek is much smaller (about 10% cross-sectional area), the overall volume of the discharge is small as compared to the main gully. However, similar discharge patterns (i.e., the peaks in **Figure 38**) through the small creek were applied to the model.

Figure 37: Input Schematic Discharge Values For The CMS-Flow Model Run.

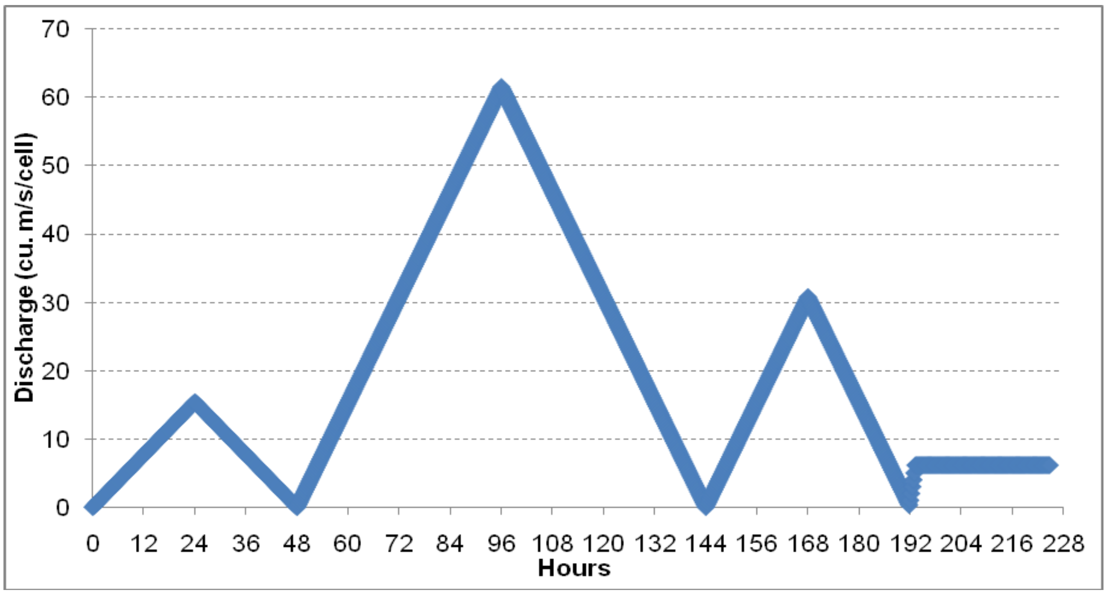


Figure 38: Input schematic wind conditions for the cms-flow model run.

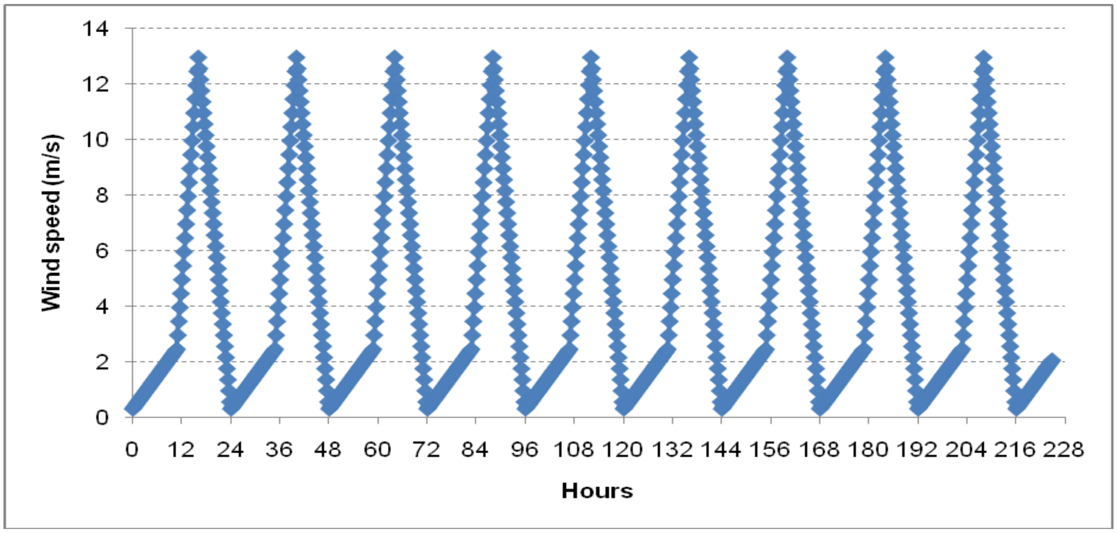
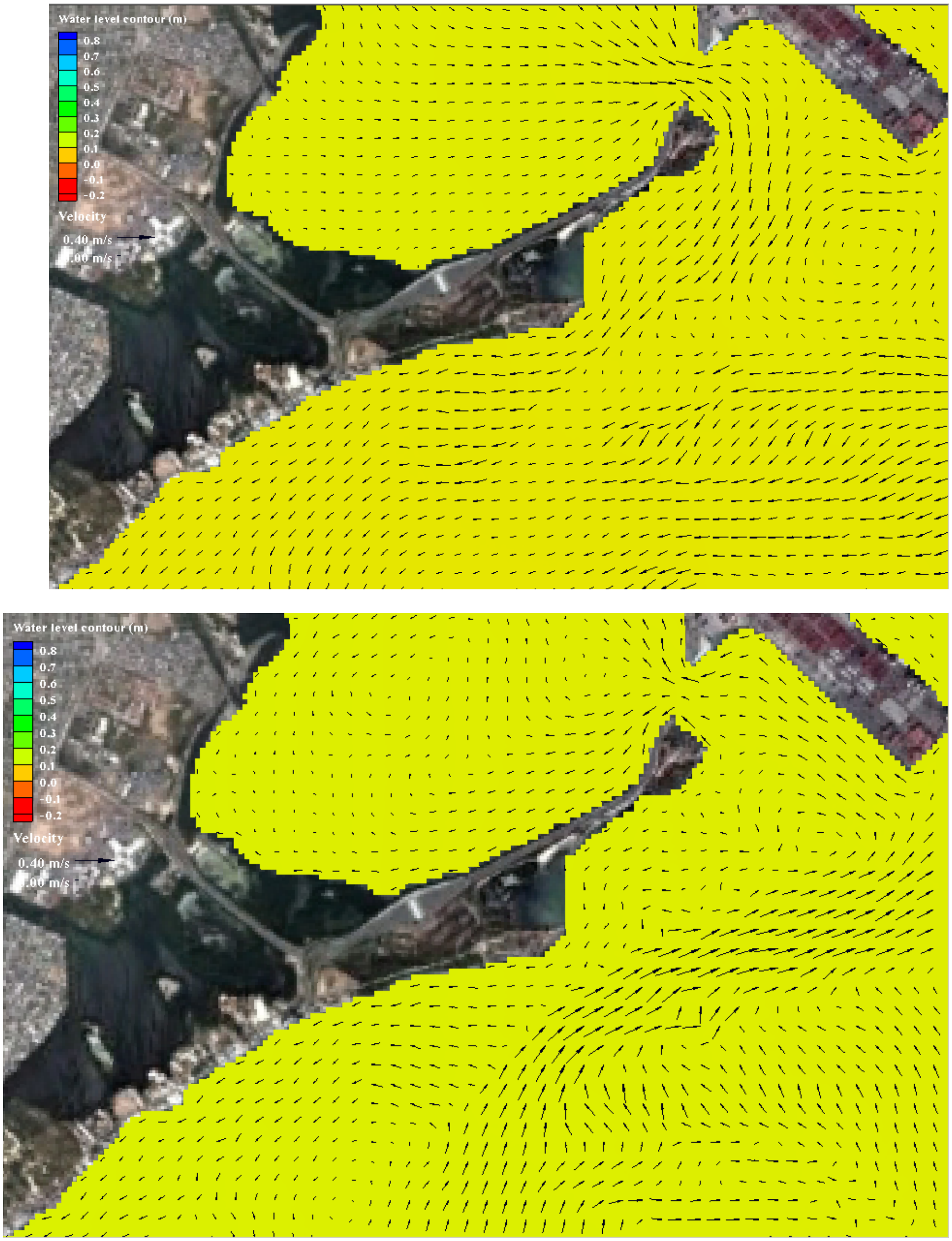


Figure 38 illustrates the input schematic wind conditions for the CMS-FLOW model run. The input wind conditions simulate the typical afternoon sea-breeze. The simulated easterly wind develops in the late morning and peaked to a strong 12 m/s in the mid-afternoon and then dies out in the late evening. This rather regular easterly wind, although not expected to have significant influence on the overall circulation pattern in the greater Kingston Harbour in terms of magnitude flow velocity, may have considerable influence on residual flow pattern. For this study, the easterly wind blowing along the shoreline of the project area may generate considerable longshore current, as observed during the field and discussed in the previous sections.

Modelled Flow Patterns

Since the main goal of the efforts here is to examine the flow patterns in association with sediment transport, residual flows do not play a significant role in transporting sediment, especially sand-sized sediment. The flow velocities for most of the bay are small. The following discussions focus on the project area and areas with relatively strong flow, such as near the Hunts Bay Bridge. **Figure 39** illustrates the modelled flow pattern during a spring tide with negligible discharge from Hunts Bay. In addition, both cases are from late evening and almost midnight. The simulated afternoon sea-breeze has died down therefore the simulated flow, is mainly driven by tide. The upper panel of **Figure 39** shows the case of peak ebb flow. The flow through the harbour-side of the channel on the order of 10-15

Figure 39: Modelled flow pattern during a spring tide with negligible discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. Without the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.4 m/s.



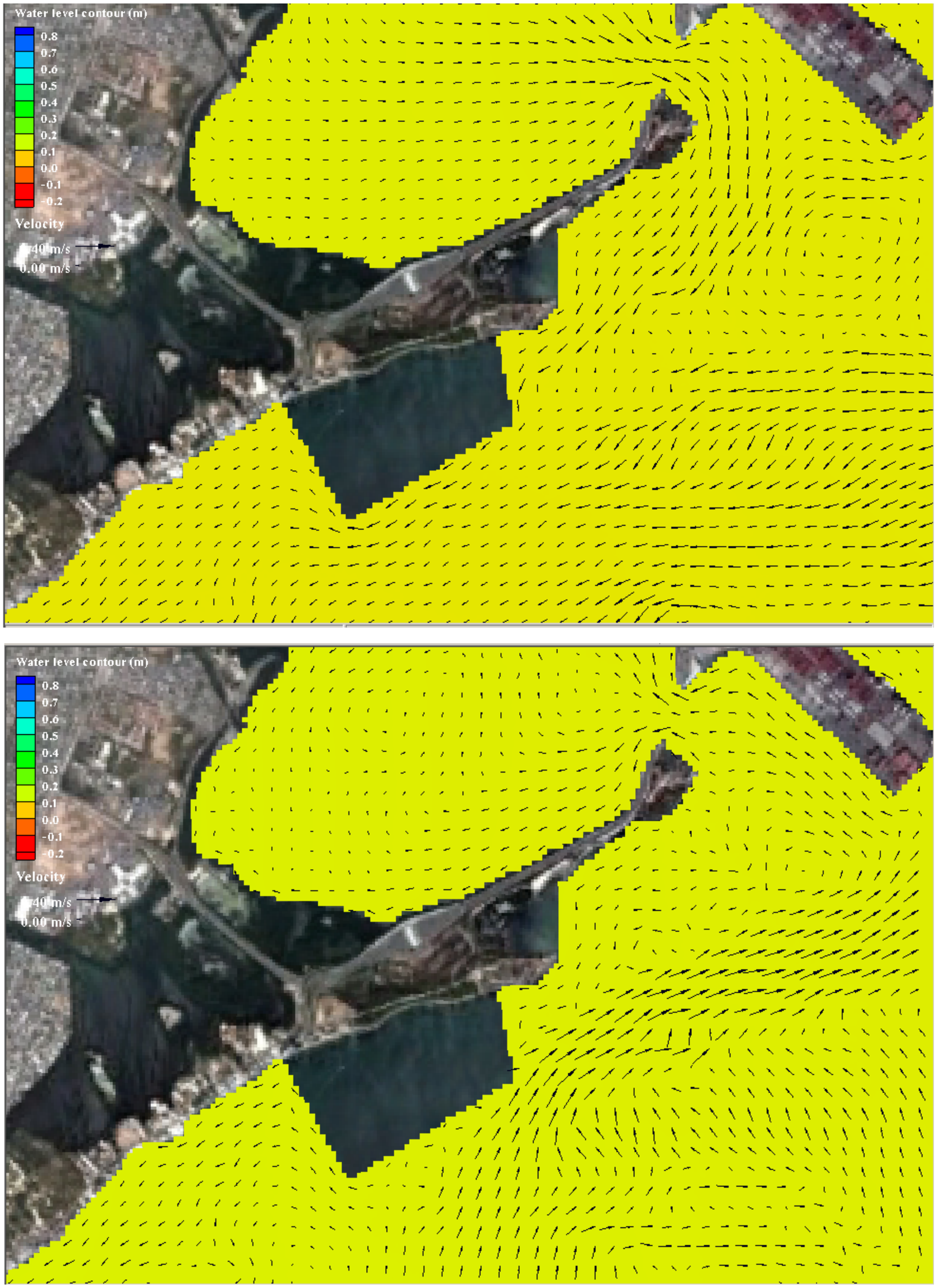
cm/s,

generally agrees with the field measurements discussed above. The ebb flow bends to the west and flows along the Fort Augusta shoreline. This also agrees with the observed spatial pattern of the mud plume after a storm event. The velocity is relatively small, on the order of 5 – 10 cm/s. This westward bend of the flow is likely related to the Coriollis effect. The lower panel of **Figure 39** illustrates the case of peak flood flow. The magnitude of the flow through the channel which is in the order of 10 – 15 cm/s, also agrees with the field measurements. The spatial flow pattern of the flood flow is quite different from that of ebb flow, comparing the upper and lower panels. The flood flow enters the Hunts Bay along the northeast side, opposite from the ebb flow.

Significant to the Fort Augusta expansion, the flood flow is very weak along the project site, in contrast to the relatively strong ebb flow along the project shoreline. This different flow pattern results in an ebb-domination at the project location. This, combined with highly oblique incident waves driven by the easterly wind, as discussed above, should result in persistent westward longshore sand transport. The differential ebb-flood flow patterns contribute to the beach erosion observed along the section of shoreline west of the expansion area. **Figure 40** shows the modelled flow pattern with the Fort Augusta expansion. Overall, the expansion has little influence on flow pattern, even at the local scale. The protrusion seems to faintly block the ebb flow resulting in a slightly weaker ebb flow along the shoreline to the west of the expansion. A weak gyre formed west of the protruding structure. Overall, these minor differences should not have any significant influences on sediment transport patterns from Hunts Bay. Both cases are from late evening and almost midnight.

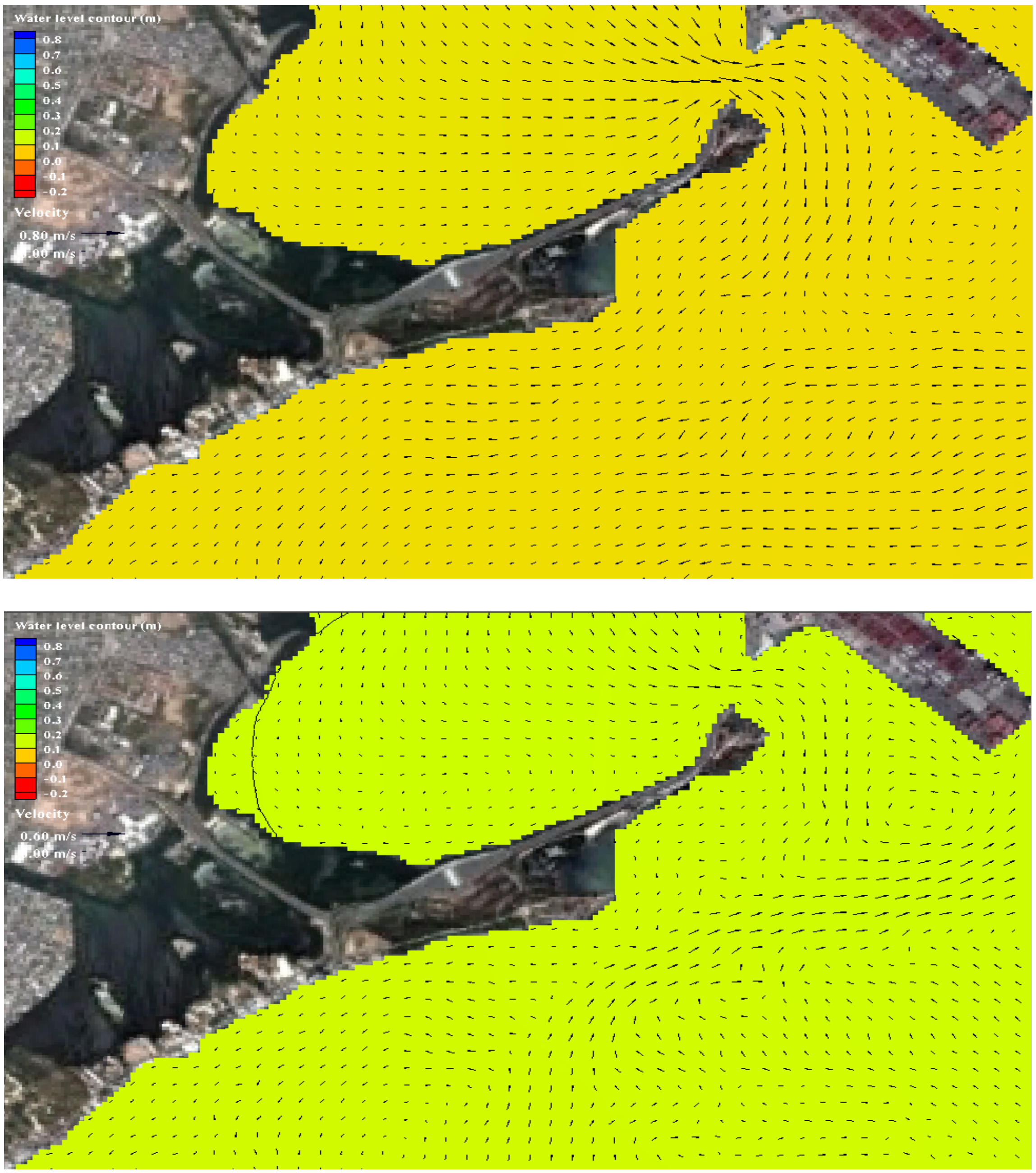
Figure 41 illustrates the modelled flow pattern during a spring tide with a modest discharge from Hunts Bay. The simulated afternoon sea-breeze has died down. Therefore, the modelled flow pattern should not be influenced by wind and should be mostly driven by discharge and tides. The upper panel of **Figure 41** shows the case of peak ebb flow. The flow through the harbour-side of the channel is on the order of 20-30 cm/s. It is worth noting here that the scale of the vector, indicated in the figure caption, is different for different cases. Therefore, the same length vector represents different flow velocities in different figures. The ebb flow, strengthened by the discharge, bends to the west and flows along the Fort Augusta shoreline. This also agrees with the observed spatial pattern of the muddy

Figure 40: Modelled flow pattern during a spring tide with negligible discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. With the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.4 m/s.



plume after a storm event. The velocity increased over the previous tide-only case and is in the order of 10 – 20 cm/s. This westward bend of the flow is likely related to the Coriolis

Figure 41: Modelled flow pattern during a spring tide with a modest discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. Without the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.8 m/s for the upper and lower



effect. The low*er panel of* **Figure 41** illustrates the case of peak flood flow. It is worth noting that the vector scale is different (smaller) for the flood case than for the ebb case in order to effectively illustrate the flow pattern. The magnitude of the flow through the channel is in the range 10 – 15 cm/s, directed out of Hunts Bay. The discharge counter-reacted with the incoming flood flow. The spatial flow pattern of the flood flow is quite different from that of ebb flow, comparing the upper and lower panels. The flood flow is blocked by the discharge from entering the Hunts Bay. Significant to the Fort Augusta expansion, the flood flow is very weak in the ebb direction along the project site, in contrast to the relatively strong ebb

flow along the project shoreline. This different flow pattern results in ebb domination at the project location. Furthermore, this ebb-domination is enhanced by the discharge. These, combined with highly oblique incident waves driven by the easterly wind, as discussed above, should result in persistent westward longshore sand transport. This differential ebb-flood flow patterns contribute to the beach erosion observed along the section of shoreline west of the expansion area.

Figure 42 shows the modelled flow pattern with the Fort Augusta expansion. Overall, the expansion has little influence on flow pattern, even at the local scale. The protrusion seems to faintly block the ebb flow resulting in a slightly weaker ebb flow along the shoreline to the west of the expansion. A weak gyre formed west of the protruding structure. Overall, these minor differences should not have any significant influences on sediment transport patterns.

The flood flow is blocked by the discharge from entering the Hunts Bay. Significant to the Fort Augusta expansion, the flood flow is very weak along the project site, in contrast to the relatively strong ebb flow along the project shoreline. This different flow pattern results in **Figure 43** illustrates the modelled flow pattern during a spring tide with an extreme discharge from Hunts Bay. Both cases are from almost midnight. The simulated afternoon sea-breeze had died down therefore the modelled flow pattern, should not be influenced by wind and should be mostly driven by discharge and tides. In this case, the flow in the vicinity of Hunts Bay Bridge is dominated by the extreme discharge. The upper panel of

Figure 42: Modelled flow pattern during a spring tide with a modest discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. With the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.8 m/s for the upper and lower pane

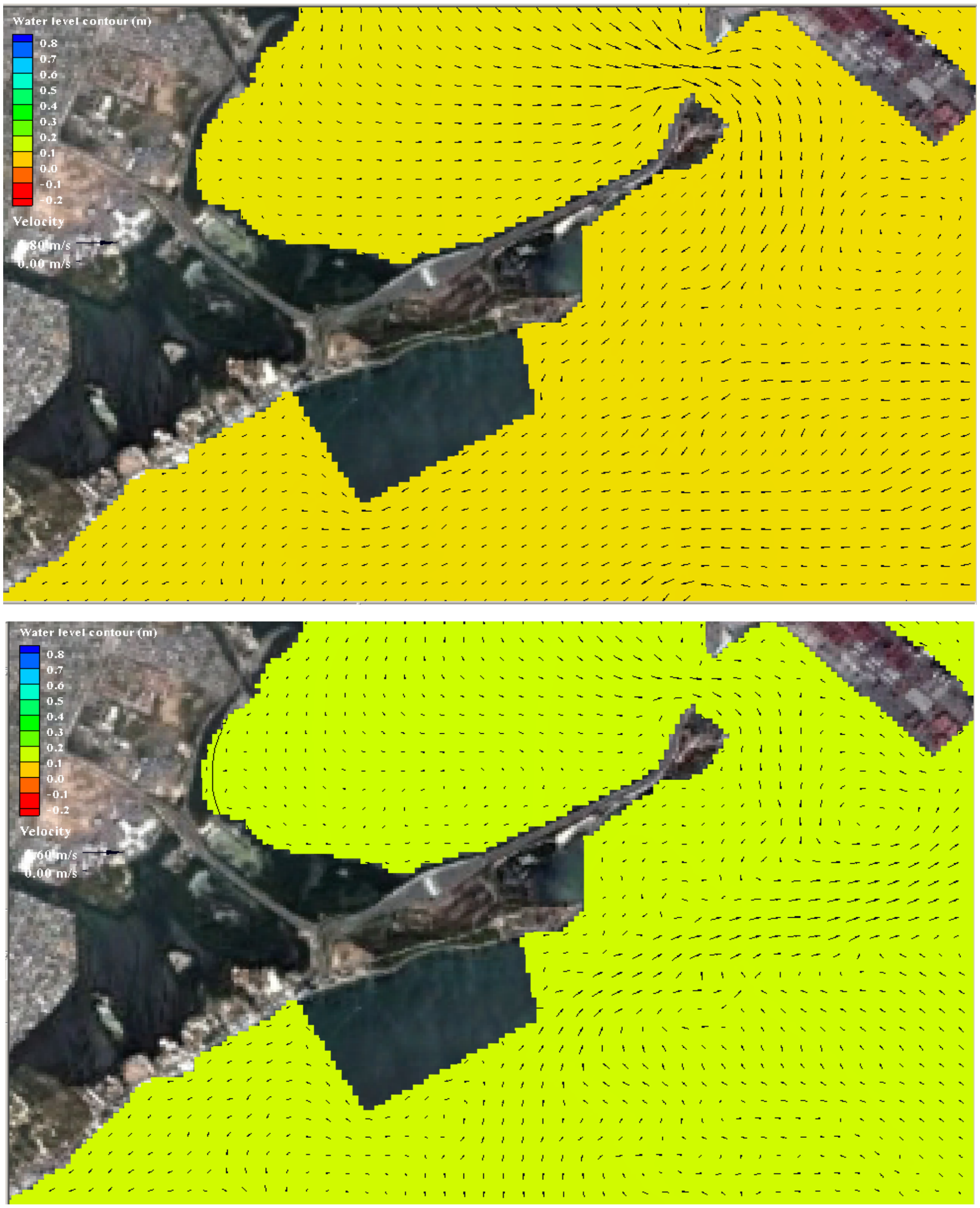
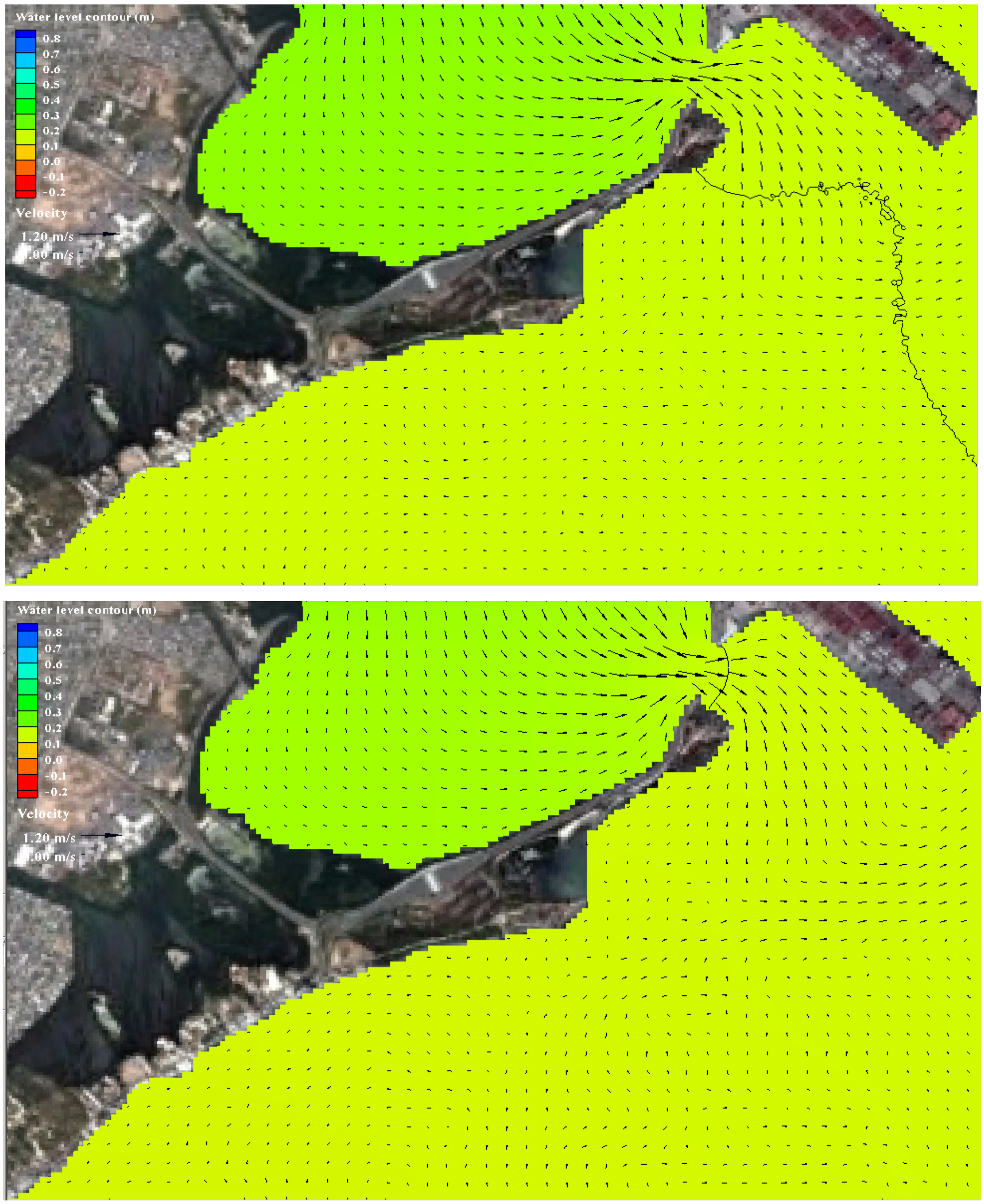


Figure 43 shows the case of peak ebb flow. The flow through the harbour-side of the channel is on the order of 100-120 cm/s. It is worth noting here that the scale of the vector,

Figure 43: Modelled flow pattern during a spring tide with an extreme discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. Without the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 1.2 m/s for both upper and low



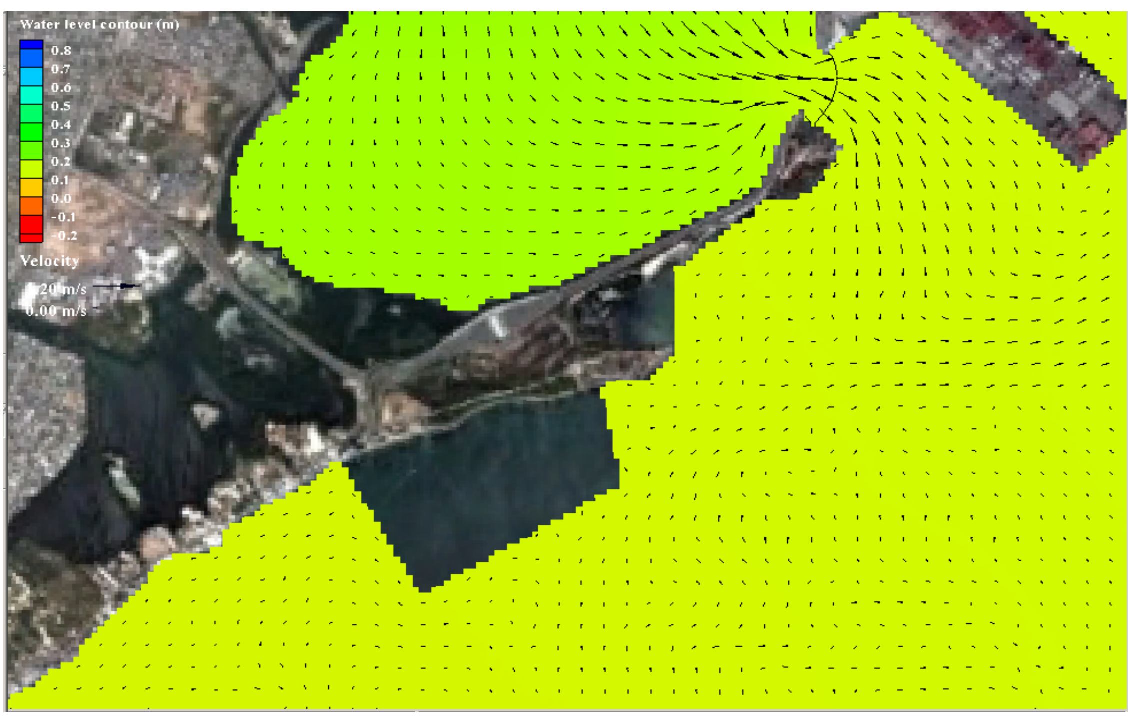
indicated in the figure caption, is different for different cases. Therefore, the same length vector represents different flow velocities in different figures. The ebb flow significantly strengthened by the discharge, bends to the west, with rapid (spatial) decrease in velocity and flow along the Fort Augusta shoreline. This also agrees with the observed spatial pattern of the mud plume after a storm event. The velocity increased over the previous tide-only case and is in the range 10 – 20 cm/s. This is not much greater than that for the small flood. This relates to the dispersion of the flood water in the relatively big and deep greater Kingston Harbour. This westward bend of the flow is likely related to the Coriolis effect. The lower panel of **Figure 43** illustrates the case of peak flood flow. The magnitude of the flow through the channel is on the range 80 – 100 cm/s, directed out of Hunts Bay. The discharge significantly overwhelmed the incoming flood flow. Part of the discharge water flows into the harbour with the flooding tide. The spatial flow pattern of the flood flow is quite different from that of ebb flow, comparing the upper and lower panels.

The flood flow is blocked by the discharge from entering the Hunts Bay. Significant to the Fort Augusta expansion, the flood flow is very weak along the project site, in contrast to the relatively strong ebb flow along the project shoreline. This different flow pattern results in ebb domination at the project location. Furthermore, this ebb-domination is enhanced by the discharge. This, combined with highly oblique incident waves driven by the easterly wind, as discussed above, should result in persistent westward longshore sand transport. This differential ebb-flood flow patterns contribute to the beach erosion observed along the section of shoreline west of the expansion area.

Figure 44 shows the modelled flow pattern with the Fort Augusta expansion. Overall, the expansion has little influence on flow pattern, even at the local scale. The protrusion seems to faintly block the ebb flow resulting in a slightly weaker ebb flow along the shoreline to the west of the expansion. A weak gyre formed west of the protruding structure. Overall, these minor differences should not have any significant influences on sediment transport patterns.

Figure 45 illustrates the modelled flow pattern during a spring tide with a large discharge from Hunts Bay. Both cases are from almost midnight to early morning. The simulated afternoon sea-breeze has died down. Therefore, the modelled flow pattern should not be influenced by wind and should be mostly driven by discharge and tides. In this case, the flow in the vicinity of Hunts Bay Bridge is dominated by the large discharge. The upper

Figure 44: Modelled flow pattern during a spring tide with an extreme discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. With the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 1.2 m/s for both upper and lower



panel of **Figure 45** shows the case of peak ebb flow. The flow through the harbour-side of

Figure 45: Modelled flow pattern during a spring tide with a large discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. Without the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.8 m/s for both upper and lower panels.

the channel is on the order of 60-80 cm/s. It is worth noting here that the scale of the vector, indicated in the figure caption, is different for different cases. Therefore, the same length vector represents different flow velocities in different figures. The ebb flow is significantly strengthened by the discharge, bends to the west, with rapid (spatial) decrease in velocity and flow along the Fort Augusta shoreline. This also agrees with the observed spatial pattern of the muddy plume after a storm event. The velocity increased over the previous tide-only case and is in the range 10 – 20 cm/s. This is rather similar to the small flood and extreme flood cases. This relates to the dispersion of the flood water in the relatively big and deep greater Kingston Harbour. This westward bent of the flow is likely related to the Coriolis effects. The lower panel of Figure 45 illustrates the case of peak flood flow. The magnitude of the flow through the channel is in the range 40 – 60 cm/s, directed out of Hunts Bay. The discharge significantly overwhelmed the incoming flood flow. Part of the discharge water flows into the harbour with the flooding tide. The spatial flow pattern of the flood flow is quite different from that of ebb flow, comparing the upper and lower panels. The flood flow is blocked by the discharge from entering the Hunts Bay.

Significant to the Fort Augusta expansion, the flood flow is very weak along the project site, in contrast to the relatively strong ebb flow along the project shoreline. This different flow pattern results in an ebb-domination at the project location. Furthermore, this ebb-domination is enhanced by the discharge. This, combined with highly oblique incident waves driven by the easterly wind, as discussed above, should result in persistent westward longshore sand transport. This differential ebb-flood flow patterns contribute to the beach erosion observed along the section of shoreline west of the expansion area.

Figure 46 shows the modelled flow pattern with the Fort Augusta expansion. Overall, the expansion has little influence on flow pattern, even at the local scale. The protrusion seems to faintly block the ebb flow resulting in a slightly weaker ebb flow along the shoreline to the west of the expansion. A weak gyre forms west of the protruding structure. Overall, these minor differences should not have any significant influences on sediment transport patterns.

Figure 46: Modelled flow pattern during a spring tide with a large discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. With the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.8 m/s for both upper and lower pane.

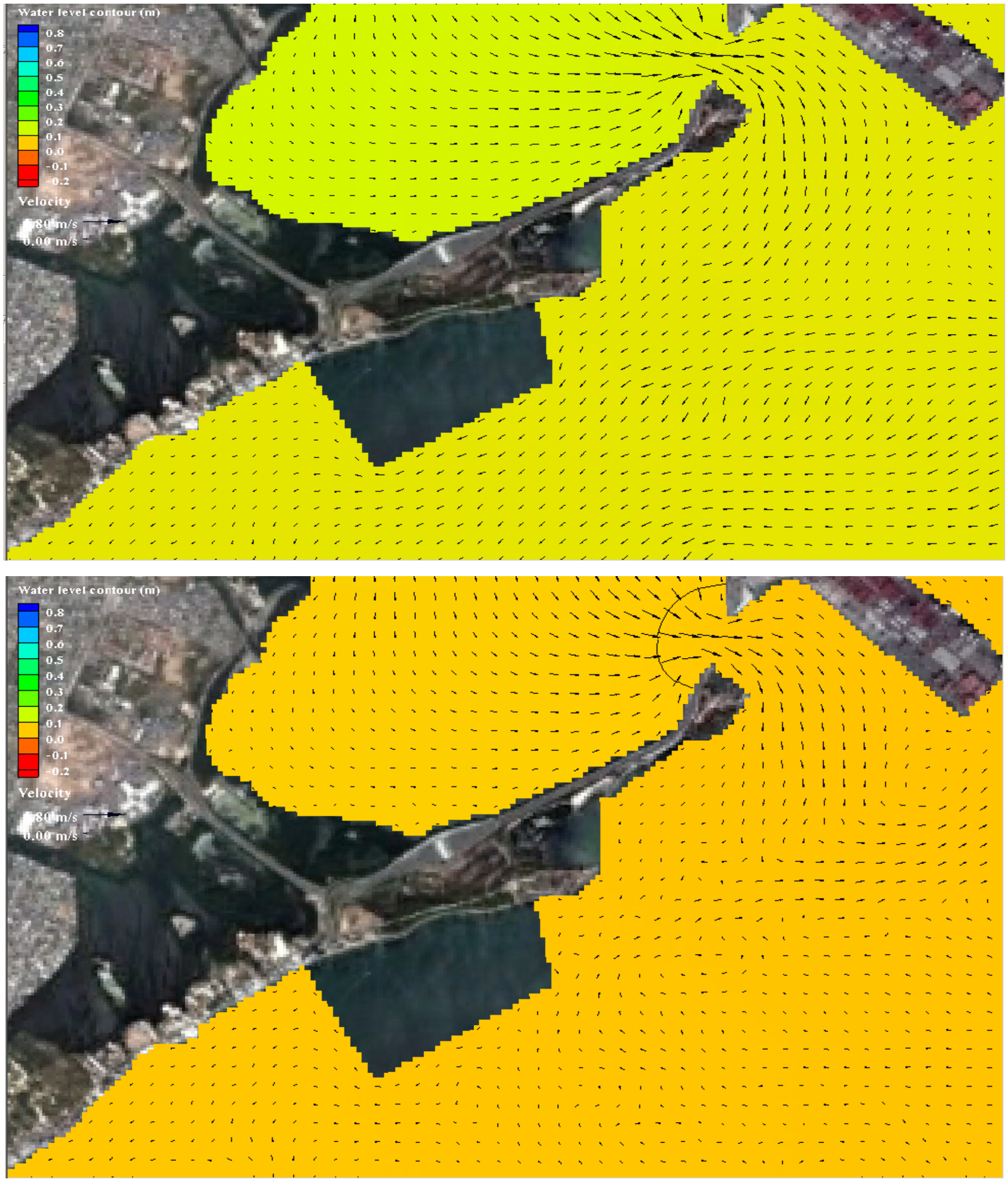
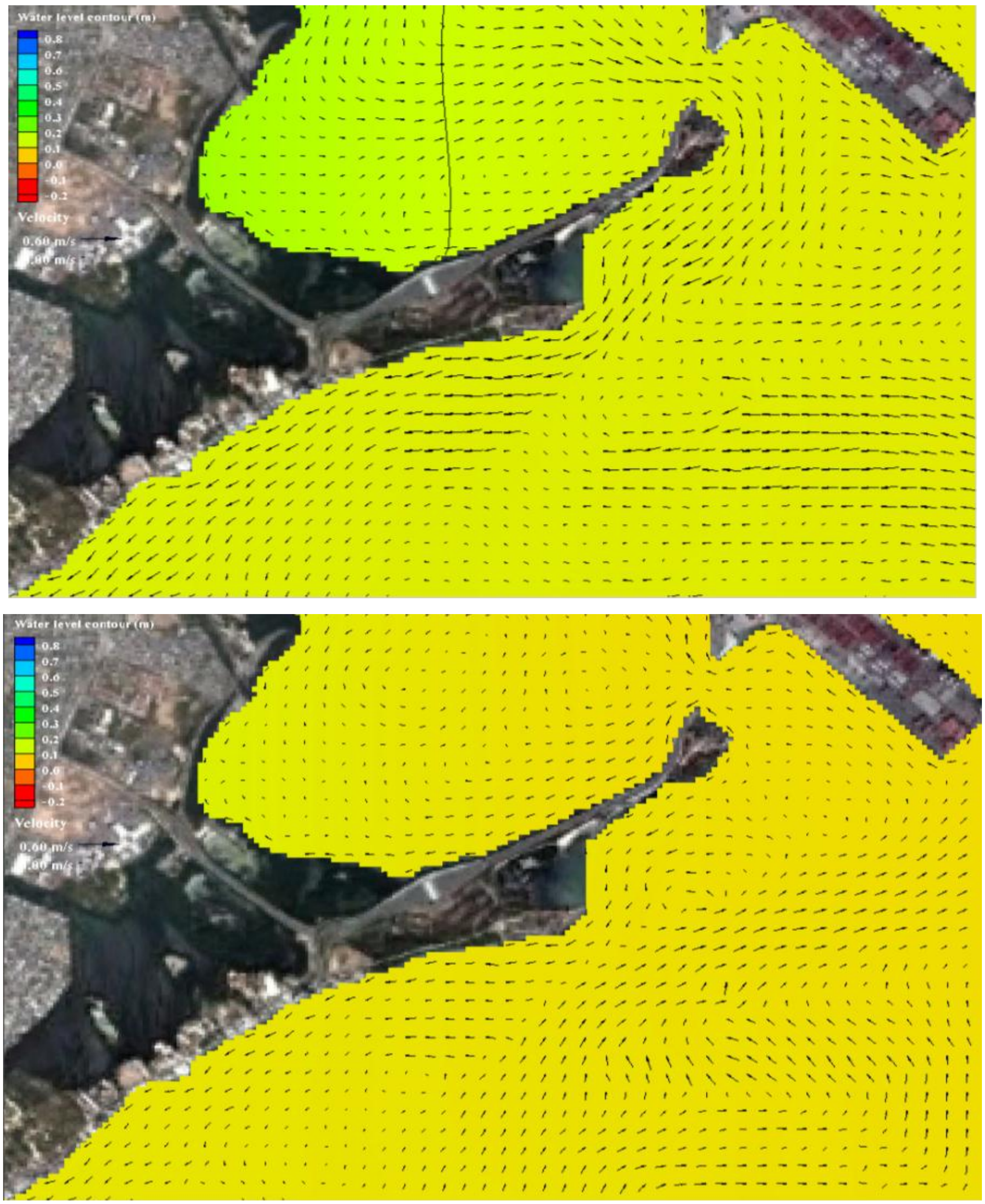


Figure 47 illustrates the modelled flow pattern during a spring tide with a small discharge from Hunts Bay. Both cases are from late afternoon when the simulated afternoon sea-breeze peaked at nearly 12 m/s. Therefore, the modelled flow pattern should be

Figure 47: Modelled flow pattern during a spring tide with a strong easterly wind and a small discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. Without the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.6 m/s for both upper and lower panels.

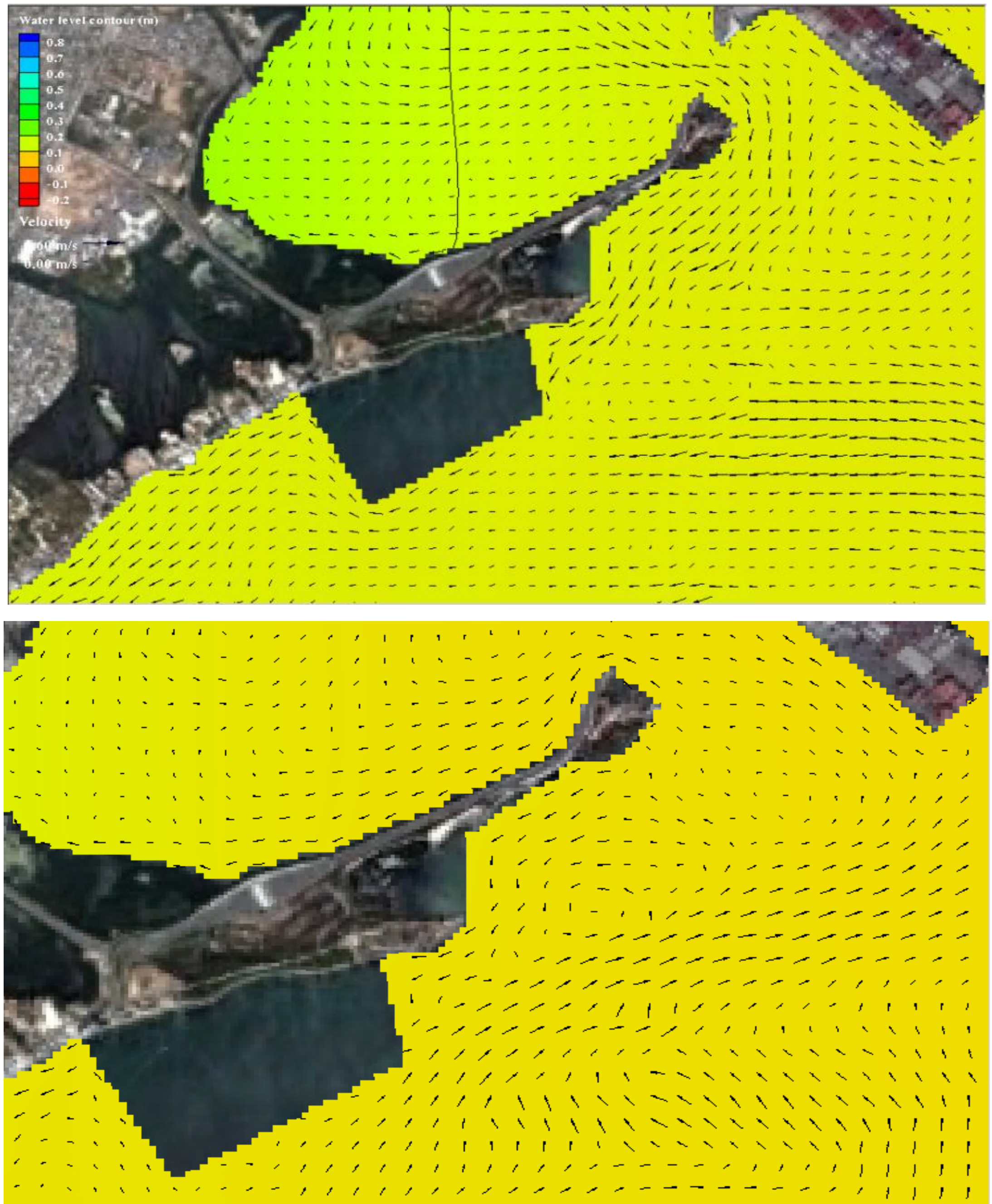


significantly influenced by wind forcing in addition to tides. The upper panel of **Figure 47** shows the case of peak ebb flow. The flow through the harbour-side of the channel is in the order of 15 -30 cm/s. It is worth noting here that the scale of the vector, indicated in the figure caption, is different for different cases. Therefore, the same length vector represents different flow velocities in different figures. The ebb flow outside the Hunts Bay, significantly strengthened by the strong wind, bends to the west and flows along the Fort Augusta shoreline. This also agrees with the observed spatial pattern of the mud plume after a storm event. The velocity increased over the previous weak wind cases and is in the order of 15 – 30 cm near the shoreline. This is stronger than the previous weak wind cases. This relates to the significant wind-driven current in the shallow water. This westward bent of the flow is likely related to the Coriolis effects and assisted by the easterly wind. The lower panel of **Figure 47** illustrates the case of peak flood flow. The magnitude of the flow through the channel is in the order of 10 – 20 cm/s, directed into Hunts Bay. The strong easterly wind also generated a westward flow along the project shoreline. This is different from all the previous cases with weak wind. The spatial flow pattern of the flood flow is quite different from that of ebb flow, comparing the upper and lower panels.

Significant to the Fort Augusta expansion, the flood flow is still weak along the project site, in contrast to the relatively strong ebb flow along the project shoreline. This different flow pattern results in ebb domination at the project location. Furthermore, this ebb-domination is enhanced by the discharge. This, combined with highly oblique incident waves driven by the easterly wind, as discussed above, should result in persistent westward longshore sand transport. This differential ebb-flood flow pattern contributes to the beach erosion observed along the section of shoreline west of the expansion area.

Figure 48 shows the modelled flow pattern with the Fort Augusta expansion. Overall, the expansion has little influence on flow pattern, even at the local scale. The protrusion seems to faintly block the ebb flow resulting in a slightly weaker ebb flow along the shoreline to the west of the expansion. A weak gyre formed west of the protruding structure. Overall, these minor differences should not have any significant influences on sediment transport patterns.

Figure 48: Modelled flow pattern during a spring tide with a strong easterly wind and a small discharge from Hunts Bay. Upper panel: peak ebbing; lower panel: peak flooding. With the proposed Fort Augusta expansion. NOTE: the vector scale bar equals to 0.6 m/s for both upper and lower panels.



Wave Heights and Peak Wave Periods for Different Wind Conditions

The greater study area is influenced by a combination of sea breeze and easterly trade winds. Within the Kingston harbour, the waves are mostly generated by local wind. The studied shoreline is oriented largely northeast-southwest, along 230^o. Therefore, easterly wind approaching from 90 degree and ESE wind approaching from 112.5^o generate highly oblique waves. These highly oblique waves are believed to be the main driving force for longshore sediment transport along the studied shoreline.

The SE wind approaches the studied shoreline nearly perpendicularly, and with limited fetch, is assumed to have secondary importance to longshore sediment transport as compared to the E and ESE winds. Furthermore, little information is available on swells propagating through the large Kingston Harbour opening. It is assumed here that longshore sediment transport driven by the swell is not significant and is thus neglected during this phase of the study. The swell driven longshore sediment transport should be directly toward the east, in the opposite direction of the trade-wind and sea-breeze driven longshore transport estimated herein. The assumption of the negligible swell-driven longshore sediment transport may not be valid. Further study is recommended to confirm this assumption. Should this assumption be invalid, then a lesser amount of nourishment would be required.

Wind data collected at Norman Manley International Airport from 1998 to 2009 were analysed to estimate of longshore sediment transport and sediment budget. As discussed above, winds approaching from E and ESE should have the dominant influence on longshore sediment transport. Winds from other directions should have secondary influence on longshore sediment transport due to the following reasons: 1) they have limited fetch, 2) they are perpendicular to the shoreline, 3) they are infrequent, or 4) offshore directed.

Southeast wind occurs relatively frequently in the study area. However, southeast wind is directly approximately perpendicular to the shoreline orientation. Its influence on longshore sediment transport is therefore small. Winds approaching from other directions are typically weak with low occurrence frequency.

Figure 49 illustrates the occurrence frequency of easterly wind at various speeds. The easterly wind occurs more frequently in the summer from June to October, likely associated with the development of afternoon sea breeze. The easterly wind typically peaks at around 17 knots (8.7 m/s) and occurs less than 2% of the time. Easterly wind tends to generate highly oblique waves to the shoreline and is capable of transporting significant amount of sediment westward alongshore, as discussed herein.

Figure 49: Speed and occurrence frequency of easterly wind during each month, based on wind data collected at Norman Manley International Airport from 1998 to 2009.

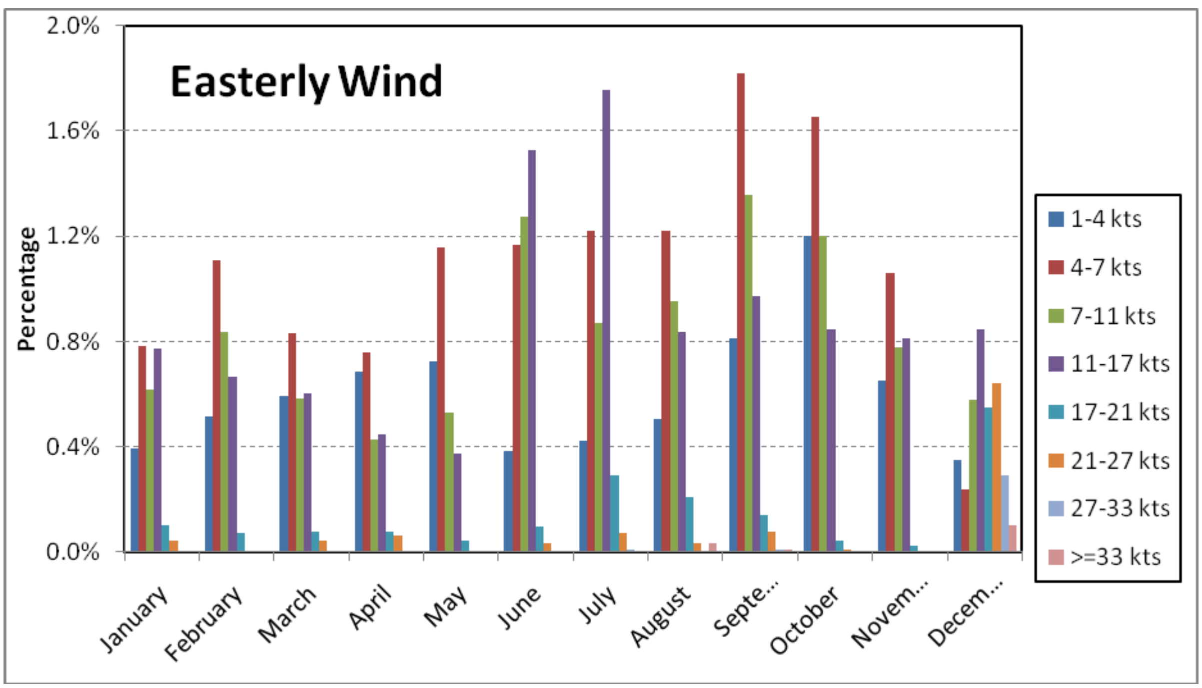
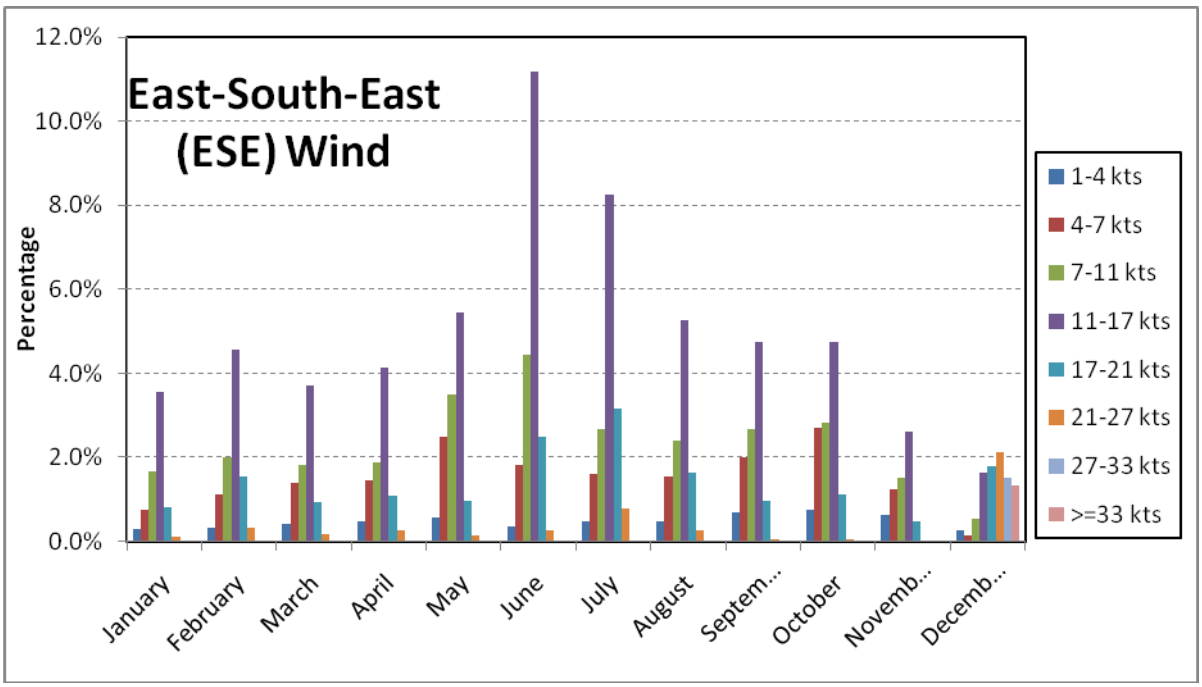


Figure 50 illustrates the occurrence frequency of east-south-easterly (ESE) wind at various speeds. The ESE wind occurs much more frequently than the easterly wind, over 10% of the time versus less than 2%. Similar to the case of easterly wind, the ESE wind occurs much more frequently in the summer from June to October than during the winter, likely

associated with the development of afternoon sea breeze. The easterly wind typically peaks at around 17 knots (8.7 m/s) and occurs quite frequently of around 10% of the time in June and July. ESE wind tends to generate oblique waves to the shoreline and is capable of transporting significant amount of sediment westward alongshore, as discussed in the following.

Figure 50: Speed and occurrence frequency of ESE wind during each month, based on wind data collected at Norman Manley International Airport from 1998 to 2009.



The calculated significant wave heights and peak wave periods for easterly and ESE wind are summarised in **Table 11**. The middle point wind speed, e.g., 14 kts (or 7.2 m/s), was used to calculate the wave height. For the easterly wind, a wind fetch of 14200 m was measured from the Kingston Harbour map. For the ESE wind, a wind fetch of 8000 m was measured from the map. The frequencies of occurrences of each wave conditions are the same as that of the wind, as illustrated in Figures 3x and 4x. The calculated wave height and period from this analytical method are similar to those obtained from the numerical wave model, the results of which were discussed in the draft EIA.

Table 11: Wave height and period generated by easterly wind, with a wind fetch of 14200 m for the studied beach.

Wind speed (m/s)	1.29	2.83	4.63	7.20	9.77	12.35	15.43	18.01
Significant wave height (m)	0.07	0.15	0.26	0.42	0.58	0.76	0.98	1.18
Peak wave period (s)	1.40	1.83	2.18	2.55	2.85	3.12	3.40	3.61

Table 12: Wave height and period generated by ESE wind, with a wind fetch of 8000 m for the studied beach.

Wind speed (m/s)	1.29	2.83	4.63	7.20	9.77	12.35	15.43	18.01
Significant wave height (m)	0.05	0.12	0.19	0.31	0.44	0.57	0.74	0.88
Peak wave period (s)	1.15	1.51	1.80	2.11	2.36	2.57	2.80	2.98

Sediment Budget

Based on the computed wave height (**Table 11** and **Table 12**), the assumed breaking wave angle (25 and 15 degrees), and the wind occurrence frequency illustrated in **Figure 49** and **Figure 50**, the total rate of longshore sediment transport along the studied beach is estimated to be 31000 cubic meters per year. It is worth emphasising that the calculated rate of longshore sediment transport represents an estimate of the ***potential*** rate of transport. Given the severely depleted beach conditions, practically no sand is presently available to be transported by the longshore current. Consequently, the present longshore sediment transport rate along the studied beach is likely close to zero simply because there is no sand available. However, once sand is restored on the beach, e.g., through beach nourishment as discussed in the following, the potential rate of longshore sediment transport should be realised.

In summary, it is reasonable to assume that limited amount of sand is lost to the offshore areas due to the relatively small waves within harbour. The sediment budget along the studied beach is therefore mainly driven by westward longshore sediment transport. Based on the above discussion, the potential sediment budget is estimated to be in the order of 31000 cubic meters per year to the west. This amount is considered conservative given the assumptions made in computation of the estimated sediment budget.

This initial analysis does not account for the possible eastward transport due to swells coming through the large Kingston Harbour entrance as well as infrequent southerly wind. Refining of these estimates would require detailed study to acquire a level of field data beyond the scope of this assessment. Detailed sediment budget incorporating local shoreline variations and structural conditions can only be established with a detailed field study, and is recommended as a follow-up project.

4.2.3 Biological Environment

Given the geographical location of Kingston Harbour and its long standing function as the main trans-shipment port for the island and the region, the harbour has been subject to decades of environmental stress arising from:

- Industrialisation and expansion of harbour infrastructure (dredging, land reclamation, etc.);
- Maritime traffic and associated waste and pollution;
- Point source pollution from hazardous industrial waste and contaminants, untreated sewage and chemical spills; and
- Non-point source pollution including farm run-off through riverine inflow and solid waste from gullies draining into the harbour.

The environmental status of Kingston Harbour has been studied extensively over the years with a focus on impacts of various disturbances on critical marine habitats in the area including the seagrass beds, mangrove stands and coral reefs, and the associated flora and fauna (Webber & Webber, 2003).

In the mid-seventies Wade (1976) documented the degraded state of the benthos in both the inner and the outer harbour (**Figure 51**)**.** The degradation was attributed to the inflow of storm water, industrial waste, untreated municipal sewage and dredging activities. In the 1950s and 1960s dredging occurred in the context of the construction work for the Norman Manley International Airport and the Causeway link to the Portmore area. The building of Gordon Cay and various other facilities in the 1980s and 1990s, along with repeated maintenance dredging of the ship channel over the years have contributed to the continued degradation of marine habitats within the harbour.

Figure 51: Kingston Harbour - Four distinct Areas, Upper Basin, Inner Harbour, Outer Harbour and Hunts Bay (Goodbody, 1970).

Local fishermen interviewed, expressed the view that disposal of dredge material within the harbour over the years has contributed to the continued degradation of marine habitats within the harbour, including the destruction of mussel beds as well as shrimping grounds along the shore of the inner and outer harbour. Fishers also attribute episodes of mortality to dredging events. Spoil discharged within the confines of the harbour resulted in extensive sediment plumes lingering over and smothering nursery and fishing grounds. More recent dredging exercises which involved the disposal at sites outside the harbour, but still relatively close to the coastline, reportedly impacted the normal migration routes of fishes such as the red snapper for a period of two years (TEMN, EIA – Development of the Kingston Container Terminal, Gordon Cay, 2002).

Hunts Bay, a shallow basin (~10 km^2) with an average depth of 2.5m, is connected to the north-western portion of the Kingston Harbour by a narrow channel under the Causeway (Ranston & Webber, 2003). The sediment within the bay is highly anoxic, soft grey-black mud. The water within the bay contrasts between saline and brackish, with variable nutrient and contaminant levels due to inflow from Rio Cobre and Duhaney Rivers as well as discharge from the Jew and Sandy Gullies (Ranston *et al*. 2007).

Various studies have been conducted on plankton distribution within Kingston Harbour and the use of planktonic communities as bioindicators of eutrophication and changes in water quality (Webber & Webber, 1998, Webber *et al.* 2003), some of which suggest that Hunts Bay may be even more impacted and degraded than other areas within Kingston Harbour (Dunbar & Webber, 2003).

Despite the degraded conditions, the bay has been identified as the main nursery area for shrimp within the harbour (Iversen & Munro, 1969). Studies on marine shrimp in Kingston Harbour by Chin (1994) indicated that at least two species (*Penaeus schmitti, Penaeus duorarum*) spent most of their life cycle in Hunts Bay and other western harbour muddy-bottomed areas. The penaeid shrimp fishing is carried out predominantly in Hunts Bay from where the fishermen follow the shrimp stocks in their seasonal migration to the deeper waters of the Outer Harbour and adjacent areas (Galbraith & Ehrhardt, 2000).

Kingston Harbour supports recreational, subsistence and commercial fisheries. Fisheries resources include shrimp, conch, lobsters, coastal pelagics (herring, sprat, etc.), reef and reef associated finfish (snapper parrot etc.) and the now rare, larger pelagic fish such as dolphins, kingfish, mackerel and jacks. The most notable habitats for fishes are the mangrove and seagrass beds adjacent to Port Royal and along the outer (western) harbour.

There are numerous fish species associated with the Port Royal mangroves and adjacent seagrass beds including the sea bream (*Archosargus rhomboidalis*), family Sparidae, silverside (Atherinidae), dusky anchovies (Engraulidae), mackabacks (Gerreidae), porcupine fishes (Diodontidae), parrotfishes (Scaridae) and wrasses (Labridae). The role of mangrove stands and seagrass beds as nurseries for fishable resources (fishes, spiny lobster, shrimps and conch) in Kingston Harbour have been documented over the years by Goodbody (1969), Ross (1982) and more recently by Aiken *et al.* (2008) who made a strong case for conservation of Port Royal mangrove stands and seagrass beds.

In the 1970s, it was estimated that there were approximately 1,000 hectares of turtle grass (*Thalassia testudinum*) in Kingston Harbour, concentrated mostly in the shallow areas of the Middle Ground and Pelican Shoals and some along the southern shoreline of the Inner Harbour and on the western side of the ship channel (Goodbody 1970, Greenway, 1995). Greenway (1973) documented the importance of turtle grass beds (*Thalassia testudinum*) as nursery grounds for fish and refugia for invertebrates such as crabs and urchins, contributing directly to the abundance and diversity of fish and other species in Kingston Harbour.

When Greenway conducted her studies in the 1970s, fish species such as *Sparisoma chrysopterum* (redtail or pink parrot), *S. radians* (yellowtail parrot), *Scarus croisensis* (princess parrot), *Thallasoma bifasciatum* (bluehead wrasse) were dominant on seagrass beds throughout Inner Harbour, and crustacean species such as *Panulirus argus* (spiny lobster) and *Callinectes* spp. (swimming crab) more prevalent. By contrast, more recent studies (Aiken *et al.* 2008) point to a marked decrease both in abundance and diversity of fish associated with mangroves and adjacent seagrass beds near Port Royal. Out of the 42 species identified within the Harbour the dominant finfish were the sea bream (*Archosargus rhomboidalis*) 76%, balloonfish (*Diodon holacanthus*) 5% and silver jenny (*Eucinostomus gula*) 4%.

The continued fragmentation, destruction and degradation of marine habitats within Kingston Harbour have negatively impacted the abundance of fishable resources. Areas located in the busiest part of the western portion of the container port facility were once very productive, but after being dredged in the late 1960s and again in the mid1970s and later for the construction of Gordon Cay, they are now barren. The only surviving fishable resources in the vicinity would be the occasional roving small pelagic fish such as sprats and herring (Clupeidae) or leatherjacket jacks (Carangidae). Areas impacted by dredging or development do not recover their function as fish or crustacean nursery grounds. As such, it is essential to preserve the few areas in the harbour where the seagrass and mangroves maintain their function and harbour the remaining fishable resources (Aiken, Pal & Perry, 2008).

4.2.3.1 Ecology

Aerial Survey

The images acquired by the drone during the survey flights were assembled in a continuous mosaic covering 1 kilometre of the shoreline west of Fort Augusta. The width of the water area covered by the survey varies from 50 to 100 meters and was dictated by the degree of turbidity at the time of the flight. The water transparency in and around the Kingston Harbour is very poor (0.5 to 1.0 m) as compared to most of the Jamaica coastline (up to 40 meters). Under these circumstances, the camera optics and post-processing enhancements can detect seagrass beds to a depth of approximately 2 meters. The left and centre portions of the area surveyed (**Figure 52)** were acquired under such conditions. The area to the extreme right benefited from a period of exceptionally calm weather and, as a result, the depth of the survey visibility increased to about 3 meters, allowing for extended area coverage.

The seagrass areas visible in **Figure 52** were outlined and measured using ArcGIS utilities. The resulting aerial coverage of seagrass areas is presented in **Figure 53.** In addition, there were two cases where the survey captured only a portion of a seagrass area, the rest of it being obscured by water turbidity. In these cases, the survey images were used to guide divers to map the obscured portion of the area, as can be seen at the T2 point in **Figure 53**.

Figure 52: Photo mosaic of surveyed area. The resolution of the mosaic is < 1cm/pixel.

Figure 53: Extent of near-shore seagrass beds.

Table 13 lists the estimated surface area of the seagrass beds outlined in **Figure 53.**

Table 13: Estimated Area Of Seagrass Beds.

Area	Surface (m²)
1	18,529
2	2,605
3	7,271
4	1,596
5	1,786
Total	**31,787 m² (3.18 ha)**

Marine Survey – Benthic Assessment

Most of the seagrass beds in between Port Henderson and Fort Augusta are found within a 50- 150 m band from shore at a depth of <2m. Further from shore along Transects **T1 and T3** (**Figure 11)** the sediments are primarily fine sand, mud and silt. The area is impacted by chronic sedimentation. Individual transect descriptions are provided below and the pertinent data are summarised in **Table 14**.

Transect 1 (**Figure 54**) located to the southwest of the reclamation area at a depth of 7m, spanned a barren substrate of sand and fine mud. The visibility at 7m was less than 0.5m.

Figure 54: Images from Transect 1

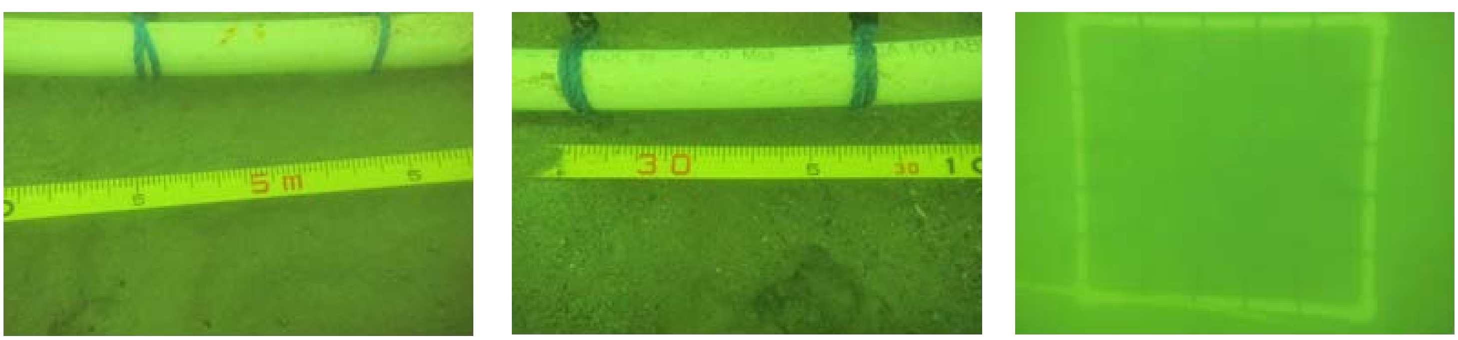


Table 14: Summary of transects surveyed in the vicinity of the Fort Augusta Reclamation site.

Transect	***Lat/Long (DMS)***	***Depth (m)***	***u/w Visibility (m)***	***Substrate Type***	***Avg.# Shoots (per m²)***	***Avg. Blade Length (cm)***	***Avg. # Urchin (per m²)***
T1	17° 57' 38.376"N 076° 51' 14.3634"W	7	0.5	Silt	-	-	-
T2	17° 57' 49.6074"N 076° 51' 16.56"W	1.5	0.5	Seagrass	380	21	3
T3	17° 57' 49.176"N 076° 51' 9.432"W	3	0.5	Silt; mixed coarse sand/ sparse	-	-	-
T4	17° 57' 47.3394"N 076° 51' 2.0874"W	3.5	0.5	Algae; coarse sand/dense seagrass	-	-	-
T5	17° 57' 55.98"N 076° 50' 55.4994"W	1.5	0.5	Coarse sand/dense-patchy seagrass	283	29	12
T5B	17° 57' 55.1154"N 076° 50' 46.752"W	2	0.5	Coarse sand/patchy seagrass	232	29	1
T6	17° 58' 9.5514"N 076° 50' 47.184"W	2.5	1	Fine sand	-	-	-
T7	17° 58' 21.8274"N 076° 50' 32.4594"W	1	1	Seagrass	218	-	-
T8	17° 58' 27.1194"N 076° 49' 54.48"W	3.5	0.2	Mud	-	-	-
T9	17° 58' 11.064"N 076° 50' 34.98"W	2.7	1	Fine sand	-	-	-
T12	17°58'19.88"N 076°50'24.04"W	2.5	1	Fine sand	-	-	-
R1	17° 58' 13.0074"N 076° 50' 38.1114"W	1.2	1	Fine sand	-	-	-
R2	17° 58' 14.5"N 076° 50' 31.1994"W	1	1	Seagrass	135	-	4
R3	17° 58' 11.2794"N 076° 50' 31.1994"W	1	1	Seagrass	350	30-35	8
B1	17° 57' 47.6274"N 076° 50' 19.176"W	2.5	1	Sand/algae	-	-	-
B2	17° 57' 34.956"N 076° 50' 37.3194"W	3.5	1	Patches of dense seagrass	396	25-30	6

Transect 2 (**Figure 55)** located in the shallows near the Port Henderson Fishing beach spanned a patchy *Thalassia testudinum* seagrass bed with shoot densities ranging from 100-437 shoots/m^2. The area appears to be a healthy and mature seagrass bed that is now entwined with algal species, namely *Dictyota* and *Bryopsis* spp. *Lytechinus variegatus* were observed throughout the seagrass bed at an average density of 3.2 urchins/m^2.

Figure 55: Images from Transect 2.

Transect 3 (**Figure 56)** located ~50 m from the shore spanned a sandy substrate with the occasional urchin and sea star dotting the barren substrate.

Figure 56: Images from Transect 3.

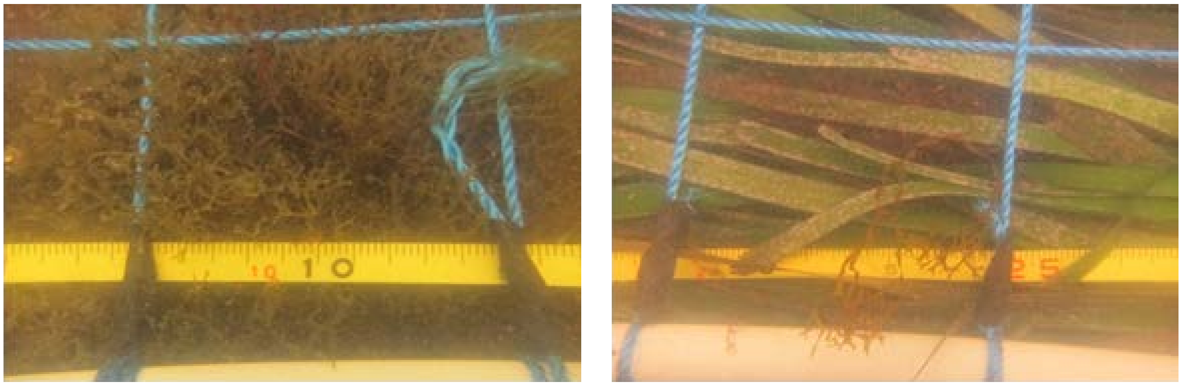
Transect 4 (**Figure 57**) located ~300m from shore between Port Henderson and Fort Augusta. The substrate can best be described as mixed coarse sand with rubble and

crushed shells, overgrown with patches of algal mats including Dictyota, Caulerpa, Wrightiella and Hypnea species. Urchins (Lytechinus variegatus, 0.5/m^2), clusters of juvenile conch and the occasional yellow stingray (Urobatis jamaicensis) can be found scattered among the rubble and algal patches.

Figure 57: Images from Transect 4.

Transects 5 and 5B (**Figure 58)** traversed patchy seagrass (*Thalassia testudinum*) beds located near the beach, immediately south of and extending seaward in front of Fort Augusta. The seagrass shoot density was estimated at 283 shoots/ m^2 nearshore in and 232 shoots m^2 further away from the shore. The mature seagrass beds are interspersed with algal mats (*Dictyota, Caulerpa, and Wrightiella*). The area supports a dense population of urchins (*Lytechinus variegatus*) at 12 urchins/m^2, most of which were juveniles (<5cm in diameter). Juvenile conch was found on the sandy substrate at the edge of the seagrass bed.

Figure 58: Images from Transects 5 and 5B.

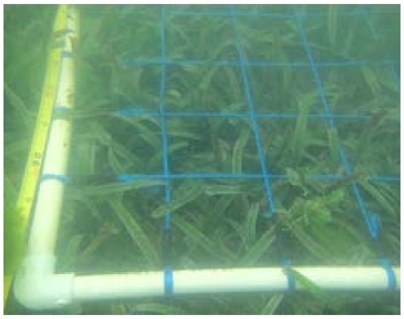


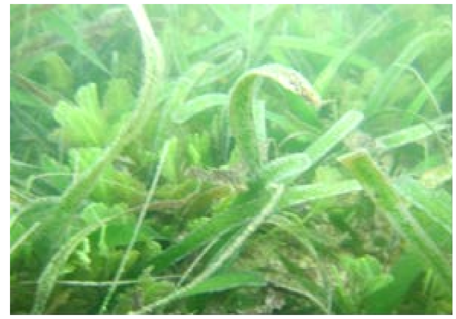
Transect 6 (**Figure 59**) located in front of the Salina in shallow water (~1 m) spanned a sandy bottom. A single conch was counted along the length of the transect.

Figure 59: Images from Transect 6.

Transect 7 (**Figure 60**) located in the shallow water southwest of the Causeway is comprised of patches of thick seagrass (*Thalassia testudinum*, ~ 280 shoots/m^2) strewn across expanses of coarse sandy substrate.

Figure 60: Images of Transect 7.

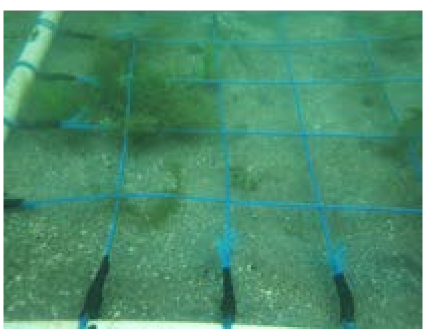




Transect 8 which is located in front of Gordon Cay (location shown in **Figure 11**) is heavily impacted by chronic sedimentation coming from Hunts Bay and the re-suspension of riverine sediments. The substrate is anoxic brownish-red mud. Photos of the substrate could not be obtained due to poor visibility.

Transects 9, 10 and 12 (**Figure 61**) located ~ 100 meters from shore from the Salina, spanned a sandy substrate (depth ~1m). Urchins, seastars and juvenile conch were observed sporadically along the transects.

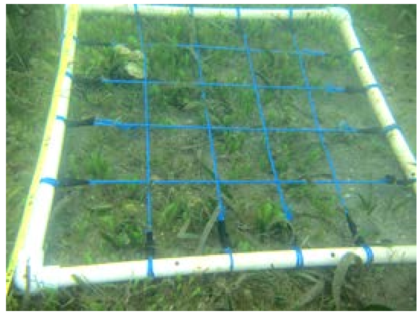
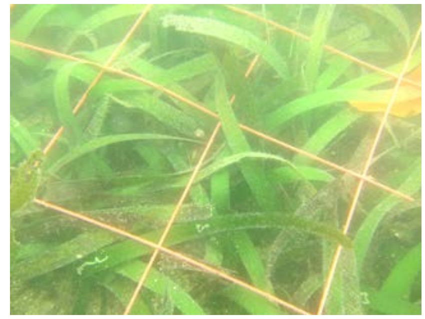
Figure 61: Transects 9, 10 and 12.



Additional Random **transects RS1, RS2 and RS3** (**Figure 62**) surveyed in the Port Henderson embayment at a depth of 1m. **RS1** comprised primarily sandy substrate with algal patches interspersed with *Syringodium filiforme*. Urchins and juvenile stingrays were observed along the transect. **Transect RS2** spanned a sandy substrate with intermittent patches of seagrass, with an average shoot density of ~50 shoots/m^2 and 0.8 urchins/m^2.

Transect RS3 on the other hand, covered a dense seagrass bed with 350 shoots/m^2 and 8 urchins/m^2.

Figure 62: Random transects RS1, RS2 and RS3.

Transects B1 and B2 (**Figure 63**) were also surveyed near the channel (H3, **Figure 11**) where the plans call for dredging and widening of the ship channel. The substrate at **Transect B1** was barren coarse sand with bivalve shells, sporadic algal growth and occasional sightings of sea cucumbers, urchins, brittle stars and sting rays. **Transect B2** traversed a mixture of sand and mixed rubble with patches (3-5 m wide) of dense *Thalassia testudinum* bed (~395 shoots/m^2). The urchin (*Lytechinus variegatus*) density was relatively high at 7 urchins/m^2.

Figure 63: Transects B1 and B2.



4.2.3.2 Marine Survey – Fisheries

The six designated fishing beaches within the immediate vicinity of the proposed development area were visited and interviews conducted with fishermen to collect data pertaining to fish and shrimp landings as well as the presence/absence of protected/endemic species such as dolphins, crocodiles, etc. Summary of common and rare fish species found in fish landings at beaches where interviews were conducted are presented at **Table 15.**

Many of the fishermen interviewed, fished only within the confines of Kingston Harbour, however many expressed that this was becoming an increasing challenge due to a steady decline in fish stocks. This has forced them to venture outside the harbour to deeper waters and to areas near Hellshire to the south-west, Lime Cay to the south-east, out to St. Thomas, St. Elizabeth and even as far as Pedro Cays.

Most of the fishermen have been fishing in the harbour and its surroundings for over 20 years. They use a variety of fishing methods that tend to be specific to a given beach, more specifically, fishing nets (gill and seine nets) at Rae Town and Forum fishing beaches, fish pots and hook and line at Port Royal and tanks (diving) at Port Henderson fishing beach. Shrimping is carried out with push nets primarily within Hunts Bay and in nearby shallow areas in front of Fort Augusta and near the Palisadoes strip especially between the Airport and the Port Royal mangroves. The shrimp appear to come from the Hunts Bay shallows and migrate towards the seagrass beds in the harbour and back in to Hunts Bay at different times of the year. Below is a summary of interviews carried out at the six beaches.

Greenwich Farm Fishing Beach

The majority of the fishermen interviewed fish on a full-time basis primarily in Kingston Harbour. However, due to the gradual decrease in the fish abundance over the years they have been forced to fish in open waters outside of the harbour. Over the years they have observed changes in the diversity and the abundance of fish noting a decrease in the number of snappers, jack, groupers and doctor fish. Large fish are rare. Using fishing nets, fish pots and hook and line they most frequently catch sprat, red and silver snapper, jack, grunts, groupers and shad. The average weight of fish varies between ½ to ¾ pound (a

Table 15: Summary Of Common And Rare Fish Species Found In Fish Landings At Beaches Where Interviews Were Conducted.

Common Fish	Scientific name	Family	Rare Fish	Scientific name	Family
Bream	*Archosargus rhomboidalis*	Sparidae	Black Snapper	*Apsilus dentatus*	Lutjanidae
Sprat	*Sprattus sp.*	Clupeidae	Yellow Tail Snapper	*Ocyurus chrysurus*	Lutjanidae
Shad	*Alosa sp.*	Clupeidae	Doctor Fish	*Acanthurus chirurgus*	Acanthuridae
Maccaback (yellowfin majora)	*Gerres cinereus*	Gerreidae	Butterfish	*Peprilus sp.*	Stromateidae
Silvery jenny	*Eucinostomus gula*	Gerreidae	Jack	*Caranx sp.*	Carangidae
Mackerel	*Decapterus macarellus*	Carangidae	Grunt	*Haemulon sp.*	Haemulidae
Redtail parrot	*Sparisoma chrysopterum*	Scaridae	Goliath grouper/ Jewfish	*Sparisoma chrysopterum*	Serranidae
Parrot Fish	Scarus sp.	Scaridae	Grouper	*Epinephelus sp.*	Serranidae
Kingfish	*Scomberomorus cavalla*	Scombridae	Jewfish/ Squirrel Fish	*Holocentrus rufus*	Holocentridae
Pink Snapper	*Lutjanus sp.*	Lutjanidae	Lionfish	*Pterois volitans*	Scorpaenidae
Red Snapper	*Lutjanus campechanus*	Lutjanidae			
Blue Snapper	*Lutjanus kasmira*	Lutjanidae			
Dog Teeth Snapper	*Lutjanus jocu*	Lutjanidae			
Grey Snapper	*Lutjanus griseus*	Lutjanidae			
Silver Snapper	*Lutjanus vivanus*	Lutjanidae			
Wenchman	*Pristipomoides aquilonaris*	Lutjanidae			
Tarpon	*Megalops sp.*	Megalopidae			
Snook	*Centropomus undecimalis*	Centropomidae			
Barracuda	*Sphyraena barracuda*	Sphyraena			

change from 1½ pound fish previously caught). They have observed that the variety of fish has also decreased since the appearance of lionfish within the harbour waters. Most of the fishers here do not do shrimp, however it is common knowledge that the best shrimping grounds are within Hunts Bay and in the shallow waters outside of the bay, near Fort Augusta. The shrimp follow seasonal migration routes from Hunts Bay to the middle of the harbour. Shrimp with eggs are seen between the end of May and July and the best time for catching shrimp is just after heavy rains. Turtle sightings are rare and they are mostly seen out at sea. Crocodiles are quite common, especially in mangrove areas, while dolphins are seen within the harbour on average once per month. Manatees have never been seen by any of the fishermen. There is a general awareness of the harbour expansion works, with information provided mostly by word-of-mouth. Many are concerned that the proposed development will destroy the shrimping grounds within the harbour waters and that the project will negatively impact the fisheries within the harbour at large.

Rae Town Fishing Beach

Most fishermen from Rae Town fishing beach are full time fishers who obtain their catch within the harbour and the cays, but must occasionally venture outside of the harbour to meet their quotas. Their catch includes snapper, grunt, jack, sprat and wenchman snapper. They rarely see yellow tail snapper, black snapper, grunt or lionfish. They do not fish for shrimp, however if they are caught with eggs they are put back. From their observation shrimp are present all year round, but the population has declined due to increasing pollution and garbage within the harbour waters. The average weight of fish caught is ¾ pound, down from 1½ pounds. They have not noticed changes in fish diversity but did note the presence of lionfish within the harbour waters. Turtles have been sighted out at sea up to six times per year. Crocodiles are a common sight, especially in mangrove areas. Occasional dolphin sightings were reported near Portland. Manatees have not been observed. The fishermen are aware of the proposed dredging plans and some are of the opinion that it will further decrease the abundance of fish in the harbour and that it could take 3-4 years for the fish stocks to start recovering.

New Causeway Fishing Beach (Dyke Road Fishing Complex)

The fishermen fish in Hunts Bay and within the harbour but are forced to areas such Morant Cays, south edge, and outside the cays. Their catch includes, shrimp, mud conch, snook, sprat, mackabacks, crabs, jack, snapper and kingfish. Rare fish caught include groupers, jewfish, grunt and squirrel fish. Fish landings are reported to vary according to season as well as weather. Those who fish for shrimp do so primarily in Hunts Bay and at the beach near the Fort Augusta as well as in select areas within Kingston Harbour. The general consensus is that the population has been gradually diminished through repeated dredging activities and the disposal of dredge material in the north east corner of Hunts Bay during the construction of the new toll road. The shrimp population has not yet recovered. The best time of year for shrimping is between May and September. They mostly find shrimp with eggs in March. The weight of fish landings vary between 50 and 200 pounds, while the shrimp catch can vary from 2 to 50lbs per day.

Since the development of the toll road fishers have been forced to fish further out at sea due to a generalised decrease in the abundance of fish within the Harbour. Many shrimpers have been forced to change their profession due to the lack of supply and the reduction in the size and quality of shrimp. They have observed turtles at Bushy and Lime Cays, however sightings are rare. They also commented on the abundance of crocodiles behind Fort Augusta. The presence of dolphins has decreased over the past 30 years. They say the “harbour too dirty”. Manatees have not been observed. Most of the fishermen were unaware of the dredging plans and feel that they are not adequately informed. Some are of the opinion that Hunt’s Bay should be rehabilitated and declared a fish sanctuary. They believe that the dredging will further decrease the abundance of shrimp and fish and that recovery will take up to 5 years.

They fear loss of income due to the destruction of the shrimping area, which extends from Hunts Bay, under the Causeway Bridge and south alongside Fort Augusta in the shallows. Fishermen are also concerned with the destruction of a heritage site and believe it should be preserved and used for tourism. The fishermen expressed the desire to be consulted about developments in Kingston Harbour so they can be informed of the decisions taken and so that they can voice their concerns with the developers.

Port Royal Fishing Beach

The fishermen from Port Royal fish at various locations from the dock at Port Royal, Port Henderson, Lime Cay, Salt River, and South Edge. Their catch includes jack, snapper, grunt, kingfish, barracuda, tarpon, and lobster. They rarely see butterfish, doctor fish, parrot fish and lionfish and have observed a reduction in the abundance of jack, snapper and grunt. They do not fish shrimp. Turtles are a common sight around the cays. Crocodiles are seen in Hellshire and near the Salina. Dolphins are seen regularly near Port Henderson. There were no reports of manatee sightings but sharks are becoming more common. Most of the men were not aware of the dredge plans within the harbour. Those who were aware of the project expressed concerns that the harbour water is going to be “condemned”.

Forum Fishing Beach

The fishermen based at this fishing beach are primarily divers and venture into areas such as South Reef, Half-moon and Wreck reefs to fish. Over the last few years the hurricanes have devastated the south coast reef systems forcing them to go deeper and further out to sea to catch fish. Their catch includes snapper, pink and blue parrot fish. Groupers are becoming rare. Shrimps are rarely seen and are not fished by the fishermen located on this beach. They attribute the decline in shrimp abundance to habitat destruction and chronic pollution. Turtles are common site at the beach while crocodiles are seen occasionally. Dolphins can be seen feeding on shrimp near Wreck reef, especially when the seas are calm. The fishermen are aware of the dredge plans in the harbour and suggest that the dredged material be dumped further out at sea in order to prevent further smothering of seagrass and reef areas.

4.2.4 Socioeconomic Baseline

The proposed development will be undertaken in the western section of the Kingston Harbour. The project site is situated in the border region of three parishes namely, St. Catherine, Kingston and St. Andrew. The potential direct impact zone of the proposed project comprises communities located within a 2km radius of the proposed project site. The communities which fell within the impact zone include Passage Fort and Portsmouth in the coastal municipality of Portmore in the parish of St. Catherine, and Greenwich Town and New Port East and West communities in Kingston and St. Andrew (KSA). Primary data sources for this socioeconomic baseline were mainly Census data from the Statistical Institute of Jamaica (STATIN), the Jamaica Survey of Living Conditions (JSLC), the Economic and Social Survey of Jamaica (ESSJ), and results of the socioeconomic and perception survey.

4.2.4.1 Demography

The population of Kingston and St. Andrew (KSA) was 603,753 according to the 2011 census report (STATIN, 2012). This represented a 1.0% increase compared with 2001, with all the increase occurring in St. Andrew (**Table 16).** Kingston however saw a decline of 7.5%, a trend that persists from the 1970s. The parish of St. Catherine was reported with a population of 516,167, an increase compared with 2001. The three parishes combined accounts for 42% of the country's population. The Portmore municipality is the second largest urban centre in St. Catherine. It accounts for

Table 16: Population Kingston, St. Andrew, St. Catherine, and Jamaica

	2011	2001	% Change	Annual Growth Rate
Kingston	88,801	96,019	-7.5	-0.8
St. Andrew	514,951	501,932	2.6	0.3
Total KSA	603,752	597,951	1.0	0.1
KMA	584,267	579,001	0.9	0.1
St. Catherine	516,167	482,265	7.0	0.7
Portmore	182,153	156,931	16.1	1.6
All Jamaica	2,697,049	2,607,232	3.4	0.3

Source: STATIN, 2012

approximately 35% of the population of the parish and is considered a dormitory town for the Kingston Metropolitan Area[1] (KMA). There are some forty-two (42) communities within the municipality, two of which are within the SIA study area and direct impact zone.

The SIA study area includes the communities of Passage Fort and Portsmouth in Portmore; Greenwich/Newport West in St. Andrew; and Port Royal in Kingston. The population of the study area was estimated at 24,891, with Passage Fort being the largest with 10,570 persons (**Table 17**). Greenwich town has a population of 7,779 while Port Royal has 1,251. Population changes in the communities were consistent with parish changes where those in St. Andrew and St. Catherine experienced increases and the Kingston community saw a decline. The average household size for all communities in the study area was 4 with the exception of Greenwich Town/Newport West.

[1] The KMA includes Kingston and urban St. Andrew.

Table 17: Population Kingston, St. Andrew, St. Catherine, and Jamaica

	2011	2001	No. Households	Average Household Size
Port Royal	1,251	1651	338	4
Greenwich Town/Newport West	7,779	7561	2,641	3
Passage Fort*	10,570	9112	2,867	4
Portsmouth*	5,291	4,561	1,435	4
Total	**24,891**	**13,673**	**7,281**	**3**

**Estimated based on intercensal change for Portmore Municipality - Source: STATIN, 2012*

4.2.4.2 Household Profile

The socioeconomic survey included a total of 150 persons, of which 63.3% were the head of household. Approximately 53% of the household heads were females. The 18-29 and 30-39 age groups had the highest level of participation in the survey (30.0% and 33.3% respectively), while the 60 and over cohort had the lowest number of participants (**Table 18).**

Approximately 65.8% of all households comprised between one and three persons. The average household size within the surveyed area was 3, with the minimum being one (1) and the maximum being fifteen (15). Fifty one per cent (51%) of all households surveyed had no children living in them. From the seventy-three (73) households that had children, approximately 76% had between one (1) and two (2) children. The average household had one child.

4.2.4.3 Housing

a) Tenure

Analysis of the housing data gathered from the survey showed that an estimated 46.7% of persons interviewed owned the dwelling they occupied; almost nine (9) percentage points higher than the number of persons renting. Home ownership was higher among

Table 18: Demographic Characteristics of Respondents

Gender		
	Frequency	**Per cent**
Female	79	53
Male	71	47
Total	150	100
Age		
18-29	45	30
30-39	50	33
40-49	25	17
50-59	16	11
60 and Over	14	9
Total	150	100

respondents in Portmore (52%) than those residing in the Kingston and St. Andrew (KSA) area (24%). Home ownership in the areas surveyed was notably below the national average and parish averages reported in the 2011 census (**Table 19**).

Census data revealed that home ownership was the most common tenure type in all three parishes as well as the country. St. Catherine had the highest proportion, with 64% of all households reported owning the house they occupied in 2011 (see **Table 19**). Rent and Rent Free were the other common tenure types. Squatting in dwelling was highest in Kingston at 3.2%. The proportion of households that reported owning the land on which their dwelling is situated varied by region. Ownership was highest in St. Catherine at 54% followed by St. Andrew and Kingston. For households in Kingston, rent and rent free were the most common land tenure type. Interestingly 4.2% of households reported squatting on land in St. Catherine, 4.0 percentage points higher than those reported squatting in their dwelling (**Table 20**).

Table 19: Housing Tenure, KSA, St. Catherine & Jamaica, 2011

	Tenure (% of Households)					
	Own	**Rent**	**Lease**	**Rent Free**	**Squatted**	**Other**
Kingston	30.3	31.7	1.3	30.7	3.2	0.1
St. Andrew	48.6	30.2	2.6	15.1	1.5	0.2
St. Catherine	64.0	19.4	2.5	11.8	0.7	0.2
Jamaica	60.3	20.0	1.7	15.4	1.0	0.2

Table 20: Land Tenure, KSA, St. Catherine & Jamaica, 2011

	Tenure (% of Households)					
	Own	**Rent**	**Lease**	**Rent Free**	**Squatted**	**Other**
Kingston	24.0	33.6	2.4	30.9	3.8	0.5
St. Andrew	40.7	26.7	7.2	18.0	0.4	0.2
St. Catherine	54.1	15.8	9.3	14.7	4.2	1.6
Jamaica	50.0	17.3	6.2	20.4	4.3	0.3

Source: STATIN, 2012

b) Housing Quality Index (HQI)

The quality of housing as measured by the Housing Quality Index (HQI) was relatively high in the two parishes included in the study area. Households in KSA lived in dwellings with HQI of 79.0 while those in St. Catherine had HQI of 76.4 in 2008 (Planning Institute of Jamaica (PIOJ), 2010). HQI for the parishes were higher than the national average of 71.4. The HQI is a measured using a set of indicators and benchmarks (**Table 21**) which is averaged. The HQI in KSA and St. Catherine indicated that high percentages of households had dwellings with the benchmarks. HQI in the Kingston Metropolitan Area (KMA) which includes KSA and St. Catherine was 71.5 in 2010 (PIOJ, 2010). The high HQI of the region was reflected in survey data which revealed that 91% of respondents have dwellings with walls of concrete block and steel. Approximately 99% used electricity for lighting; and 81%

indoor tap water.

Table 21: Housing Quality Index

Indicator	Benchmark
Material of Outer Walls	Walls of concrete block & Steel
Main source of Water	Indoor Tap
Main Source of Lighting	Electricity for Lighting
Toilet Facility	Exclusive Use of Water Closet
Kitchen Facilities	Exclusive Use of Kitchen
Number of Persons per Habitable Room	Number of Persons per Habitable Room ≤1

Source: PIOJ, 2010

4.2.4.4 Infrastructure and Services

a) Transportation

The SIA study area has a network of roads that includes Class A, B and C roads. Major thoroughfares in the study area include the Marcus Garvey Drive; Spanish Town Road; Fort Augusta Drive; George Lee Boulevard and the Palisadoes Road into Port Royal. The Causeway/Portmore Toll Road is the major commuter Highway which connects the KMA and Portmore via the Hunts Bay Bridge and Portmore to the old capital of Spanish Town with three lanes in each direction and a speed limit of 110 kilometres per hour (68 mph). Traffic volume data for 2005, 2006 and 2012 were obtained for various intersections within the study area. The areas were within 0.5km of KCT and Fort Augusta. The 2012 data was limited to the George Lee Boulevard/Naggo Head Drive intersection. Traffic volumes averaged 33,734 vehicles.

Causeway and Marcus Garvey Drive	32,646
Marcus Garvey Drive/Ninth Avenue	32,496
Marcus Garvey Drive/Fourth Avenue/Second Avenue	32,541
Marcus Garvey Drive/East Avenue	34,491
George Lee Boulevard/Naggo Head Dive (2012)	31494

The study area is served by JUTC (Jamaica Urban Transport Company) which provides bus transportation for residents both locally and into Kingston and Spanish Town. Privately-operated bus and taxi services are also available to the public in the area. The JUTC increased its fleet size by 100 buses and operated an average of 319 buses per month in the wider Kingston Metropolitan Region (including the study area) in 2011 (ESSJ, 2012).

The communities are served by the Norman Manley International Airport with over 130 flights weekly. The Tinson Pen Aerodrome, a domestic airport, is also located in close proximity to the proposed project site. The study area is also served by the Norman Manley International Airport. Fisherfolk within the study area travel by boat for their livelihoods. The site is located within the Kingston Port which handled over 2,700[2] ship calls and an estimated 16,864 thousand tonnes of cargo in 2011 (PIOJ, 2012).

Survey results for mode of travel to work and school showed that private vehicle and JUTC Public Bus were the main modes (**Table 22**).

Table 22: Mode of Travel to Work and School (%)

Mode of Transport	% Respondents
Private Vehicle	22
Public Bus (JUTC)	15
Walk	10
Other and Public Bus	6.7
Taxi	4.7
Other/No Response	42.7

[2] This estimate includes cargo and petroleum at Petrojam

b) Health Services

The study area is served by numerous private and public health care facilities. The public services can be further disaggregated into primary (Kingston Public and Victoria Jubilee Hospital in KSA and Spanish Town Public Hospital in St. Catherine) and secondary (health centers and clinics) care facilities. A number of other hospitals are located within the KMA (Kingston Metropolitan Area) as well as numerous private facilities. Approximately 45% of survey respondents have access to health insurance. Facilities that survey respondents reported that they use include:

- Portmore
    - Waterford Health Centre
    - Greater Portmore Health Centre
    - Christian Pen Health Centre
- Greenwich Town/Newport West
    - Oak Glades Health Centre

c) Educational Services

The municipality of Portmore is served by thirty-eight (38) educational institutions offering early childhood, primary, secondary and tertiary education. The Portsmouth infant and primary schools are located within the Portsmouth community. There are no formal educational institutions in the community of Passage Fort.

The Greenwich Town and Newport West communities are served by several education institutions located within the Kingston and St Andrew area. The community of Greenwich Town has two (2) educational institutions providing early childhood and primary education. These are the Greenwich Town Infant and All-Age schools.

The community of Port Royal is served by the Port Royal Primary and Infant School. Residents access educational services within the KMA.

Approximately 83.4% of all respondents surveyed had been educated beyond the primary level. Some 30.7% had attained tertiary education via enrolment at a University, 18% had received vocational training and 34.7% had achieved secondary level education. Less than 10% of the total number of persons surveyed communicated they had attained no formal educational training.

d) Police and Fire Services

There are three (3) police stations serving the Municipality of Portmore. These are the

i. Caymanas Police Station
ii. Bridgeport Police Station
iii. Waterford Police Station

The Waterford Police Station serves the communities of Passage Fort and Portsmouth. The Portmore Fire Station is the only emergency fire service provider in the Municipality. Greenwich Town is served by the Denham Town, Hunts Bay and Hannah Town Police Stations and Trench Town fire station. Port Royal is served by the Portmore Police Station and Port Royal Fire Station.

The Kingston Harbour is also policed by the Jamaica Defence Force Coast Guard and the Marine Division of the Jamaica Constabulary Force. Fire protection is provided by the Jamaica Fire Brigade which reportedly owns three fire boats serving the three major ports including the Kingston Harbour.

4.2.4.5 Amenities

Electricity & Cooking Fuel

Electricity was the main source of lighting for 98.7% of survey respondents. This is higher than the national and parish averages reported in the 2011 census, which ranges from 91% to 96%. The main supplier of electricity in the study area is the Jamaica Public Service Company (JPSCo), with the communities within the study area receiving transmission from the Hunts Bay Power Station on Marcus Garvey Drive. This station has an estimated capacity of 65.8 MW. Less than 1% of respondents use electricity for cooking. The main source of fuel for cooking was liquefied petroleum gas (LPG) as indicated by 95% of respondents.

Water

Approximately 81% of survey respondents accessed potable water supplies via a public source that was piped into their dwelling. Other sources of potable water supplies included community tanks, public sources piped into yards and private tank. Fifty-five per cent (55%) of the persons surveyed indicated that they experienced disruptions in their water supplies. The frequency of disruptions was at least once to twice per week. The National Water Commission (NWC) is the main public supplier of water to households within the study area.

Sewerage Services

The National Water Commission is the largest provider of sewerage services in the parishes of St. Catherine and St. Andrew. The sewerage infrastructure in Portmore is extensive and well developed and includes five (5) wastewater treatment plants (WTPs). Over 95% of the population is connected to NWC sewerage and estimated that an average of 36,400 cubic meters per day (m_3/d) of sewage flows to these plants (i.e. 8 million gallons per day (mgd). The National Water Commission is presently upgrading the sewerage facilities in Portmore under the Portmore Sewerage Project.

The community of Greenwich Town is connected to the Greenwich Town Treatment plant which offers primary treatment and has a capacity of 5mgd.

Telecommunications

The study area is served by telecommunication services. Sixty-six per cent (66%) of respondents reported having cellular phones only, while the remaining respondents had both landlines and cellular phones.

Solid Waste Disposal

Some 98% reported having their garbage collected by a private or public waste collection service. This figure markedly exceeds the parish averages of 62.9 for St. Andrew, 55.6% in Kingston and 47.9% in St. Catherine (STATIN, 2012). The remaining 2% of survey respondents reported burning their garbage. Of those who reported waste collection services, 65% had regular collection schedules of at least once weekly. Approximately 31% had their garbage collected once or twice per month, largely households within the Portsmouth community of Portmore. The National Solid Waste Management Authority (NSWMA) is the governing body responsible for solid waste management in Jamaica. The Authority provides waste collection services to households within the study area through the Metropolitan Parks and Market (MPM). MPM's wasteshed spans the parishes of St. Catherine, Clarendon, St. Thomas, Kingston and St. Andrew. Private commercial entities however, have to make arrangements for their garbage to be picked up (at a cost), either through the NSWMA or private contractors.

4.2.4.6 Community Organisation and Social Linkages

a) Overview

Interaction and dialogue with community members, is arguably one the most critical aspects of the EIA report. The community structure is an important component, which ultimately creates the platform for which community members can share their concerns and outline their expectations as it relates to the introduction of developments within their community. This section of the survey provides an overview of the existing community structure and provides a look at the leadership structure and social capital which exists within the community.

An estimated fifty-five per cent (55%) of the total number of persons surveyed were aware of a community citizen's association in their community. The lowest level of awareness was in the communities of Passage Fort and Greenwich Town, where more than 50% of residents were not aware of the presence of a citizen's association in their community.

The survey also revealed that respondents were generally unaware of the existence of voluntary organisations and outreach programmes within the communities. Only 23% of persons were aware of the existence of voluntary groups within their community, while less than 13% were aware of outreach programmes being undertaken in their community. Voluntary groups identified included the Lions and Rotary Club, Police Youth Club, Neighbourhood watch groups and the church. Outreach programmes identified included community development programmes such as beautification projects, welfare projects and educational projects for children such as learning centres. The church was identified as the main voluntary organisation involved in conflict resolution and programmes targeting the elderly.

Respondents were found to be more knowledgeable about sporting programmes in their community. From the total number of persons surveyed within the SIA area 60.7% indicated that they were aware of the presence of a sporting team and/or club within their community.

b) Community Development: Projects, People and Citizen Involvement

Persons were found to have some level of interest in the development of their community, but were overall very limited in their involvement in community affairs. There were a few concerns raised about the general lack of citizen involvement within the communities surveyed. This was largely reflected in the data as persons were found to be generally unaware of the activities taking place in their community. Less than 60% of the persons surveyed were aware of the existence of a community centre in their community and only 20% indicated that they utilised the centre. In fact 13% of respondents indicated that they valued nothing about their community. Fifty-two per cent (52%) acknowledged that neighbours and the quietness of their surroundings was what they valued most in their community.

In terms of community development needs, persons identified the creation of jobs, business development and a reduction in criminal activities as the three (3) main areas that they felt required major improvements in their community. The need for community facilities and youth development programmes was also mentioned.

4.2.4.7 Economy

The proposed development site is located in one of the most important economic zones of the country. Economic activities included industrial, commercial and shipping activities of the Kingston Wharves, various warehouse operators, brokerage firms and supporting banking services at Newport West. The fishing communities, retail trade and commercial services and fishing also contribute to economic activities in the area.

The Greenwich Town economy is supported mainly by activities undertaken within the fishing, manufacturing and retail trade industry. The base of the fishing economy in the community is the Greenwich Town fishing village located off Marcus Garvey Drive. The 2009 EIA of the Petrojam Refinery Upgrade Project prepared by TEMN highlighted a previous study that estimated approximately 350 fisher folk operating from the fishing beach in 2002. In 2009, there were some 80 structures on the beach that were used as shops, equipment sheds and were 'lived-in'.

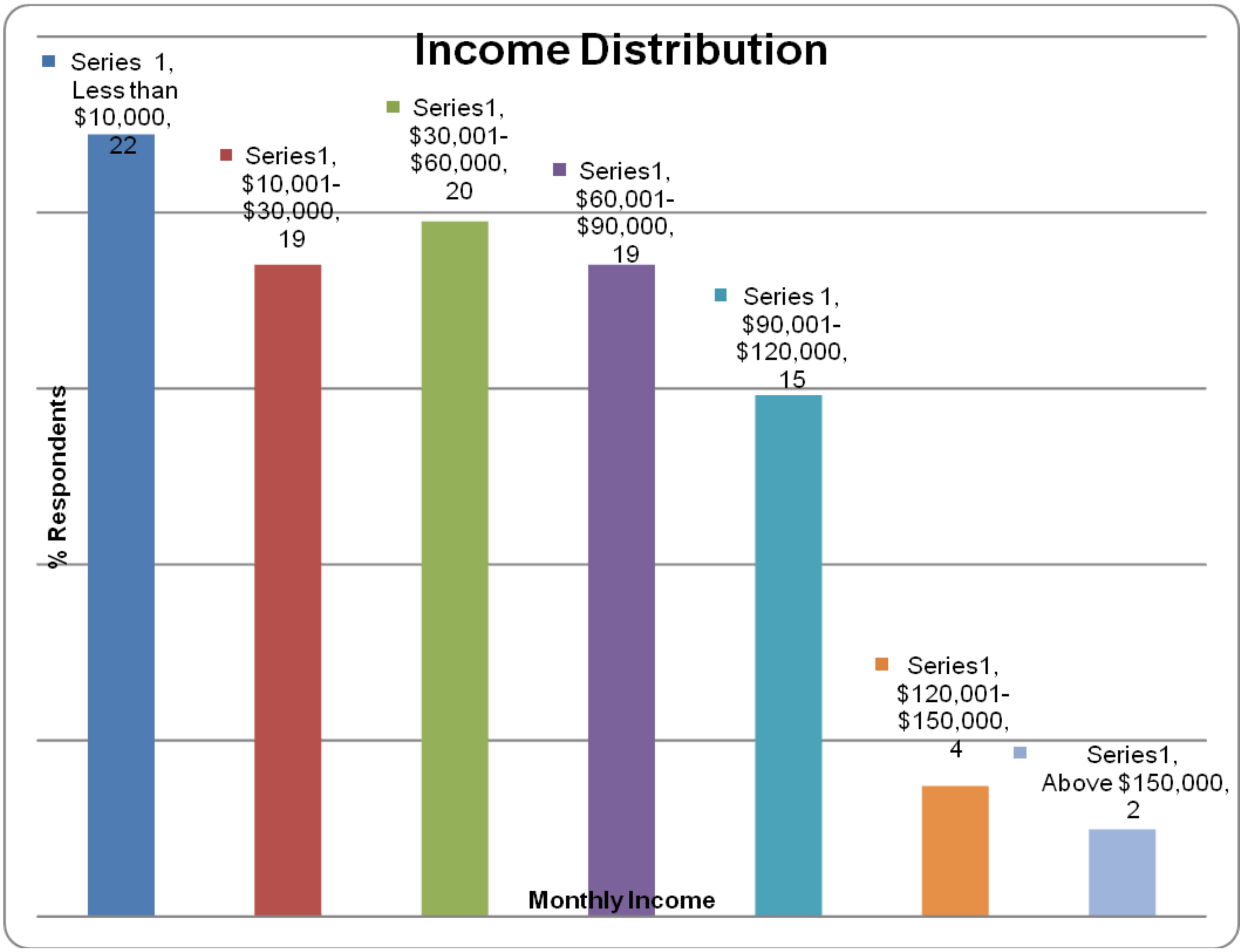
The main economic base of the town of Port Royal is recreational and fishing. Recreational activities focus on the rich heritage of the town and restaurants serving seafood from local fisherfolk.

The Portmore economy is supported mainly by the construction, services, and wholesale and retail trade (Trade) industries. The Kingston Metropolitan Area provides employment to much of the residents of the Municipality.

4.2.4.8 Employment and Income

Approximately 6.5 out of every 10 persons (65.3%) surveyed reported being employed. Of those employed, 66% had full-time employment, 1.4% was self-employed and 1.3% indicated that they were either employed part-time or seasonally. An overwhelming amount of the persons surveyed were employed within the retail trade and service industry. Only 1.3% of persons surveyed were employed within the 'professional services' industry e.g. teachers, accountants etc. Approximately eighty-two per cent (82%) of persons employed revealed their income i.e. 81 of the 98 persons. Analysis of the data on income showed that 60.4% of persons earned $60,000 or less monthly (**Table 23**). Only 6.1% of the total number of persons providing their income earned in excess of $120,000 monthly. Sixty-

Table 23: Income Distribution



three per cent (63%) of all persons surveyed indicated they had some form of income that was not linked directly to employment. Approximately one-third of all residents received additional income through remittances.

4.2.4.9 Heritage Sites

There are numerous heritage sites within the KSA area. The main sites located within the study area are summarised below. These sites are listed by the JNHT. A complete list of all heritage sites in the parishes of Kingston, St. Andrew and St. Catherine can be viewed on the JNHT website (http://jnht.com/index.php). Some specific sites in the parish of St. Catherine are:

- Fort Augusta - completed in the 1750s and named Fort Augusta in honour of the mother of King George III.
- Fort Small - built in 1782 to protect the bay between Port Henderson and the Hellshire Hills.
- Highway 2000 - Jamaica's first toll highway. It will be constructed in two phases. (JNHT, 2012).

Stated concerns of the JNHT with regard to possible impact to heritage sites within the zone of influence of the project include:

- The possible high levels of siltation resulting from dredging, dumping and prop-wash that may seriously compromise the integrity of the Port Royal Sunken City;
- The destruction/damage of significant underwater archaeological sites and artefacts unidentified;
- Compromise of Fort Augusta historical and archaeological integrity;
- Disruption of historical graves associated with Fort Augusta;
- Funding of archaeological work during the project.

a) Fort Augusta

Fort Augusta is a large fortification built between 1740 and 1750 at the entrance to Kingston Harbour. The fort falls within the borders of the Municipality of Portmore and is one of the most significant sites in the community. The fort was built to accommodate 80 guns to guard the western end of Kingston Harbour. In the 1950s, it was converted into a prison and has become inaccessible to the general public ever since then. At that time, artefacts from the military graves located just outside the fort were brought into the fort.

b) Fort Small

Fort Small was built in 1782 to protect the bay between Port Henderson and the Hellshire Hills. The fort was built by David Small and designed to mount eight 24 pounder guns and one ten inch mortar. Fort Small was extensively repaired in 1790 and was placed on the island's list of forts in 1799. It was about that time, that the name of the fort was changed to Fort Clarence, probably in honour of William, Duke of Clarence. He became King of England in 1820 and reigned until 1837. The masonry platform and the vault of the fort's magazine are now in ruin and covered by bushes.

c) Passage Fort

First known as “The Passage” (the point of Spanish embarkation from St. Jago de la Vega-Spanish Town), this fort was used by Captain William Jackson and Sir Anthony Shirley, Englishmen from Barbados and St. Kitts respectively, who landed here in 1642 and went on to plunder Spanish Town.

Another major historical event connected with this fort was the 1655 landing of Admiral Penn and General Venables. Having failed to capture Haiti (Santo Domingo), the English expedition came to Jamaica, attacking Passage Fort with some 36 ships, troops numbering 7,000, and a sizeable regiment. After the initial advance, the Spaniards deserted the fort, fleeing from the advancing English invaders. A few days later, the Spaniards surrendered relinquishing their 161- year hold on the island.

d) Port Royal

The entire community of Port Royal which includes the Palisadoes and adjoining sea and cays, is considered a historic and archaeological site. Port Royal is described as having a “rich and wicked” history which was traced back to a period when the sand spit that is Port Royal and the Palisadoes, was used as a fishing camp for Tainos. By 1655, the Spaniards reportedly invaded Jamaica and developed the area as a fort. It is documented that by the

17th century, Port Royal was the “headquarters for buccaneers and pirates” such as Henry Morgan. These activities contributed to the town becoming an important economic centre. However, in 1692, the town was destroyed by an earthquake that sunk a part of the town (“the Sunken City”) and killed over half of the population. The town was rebuilt but was never the same. Today the town is a small quiet community with recreational activities and fishing as its main economic base. The NMIA, the Caribbean Maritime Institute (CMI) and the Royal Jamaica Yacht Club (RJYC) are other major institutions/organisations also located on the Palisadoes. Some important sites within the Port Royal historic town are:

- St. Peter's Church - Original Church destroyed by the great earthquake of 1692 in Port Royal.
- Fort Charles - The first fort erected in Port Royal was Fort Charles. It was built in the late 1650-60.
- Port Royal Forts including Fort Carlisle, Fort Morgan, and Fort Rocky.
- Port Royal - was called "the richest and wickedest city in the world".
- Admiralty Houses - part of the Old Naval Dockyard in Port Royal.
- Port Royal Terrestrial Archaeology.
- Port Royal Underwater Archaeology.

The Port Royal Underwater Archaeology includes the “Sunken City”, artifacts that were discovered underwater after the 1692 earthquake. The sites include:

- The remains of Fort James (1989);
- The King’s Warehouse and Fort James (1956-1959);
- Some 20 to 30 buildings found sunken (1965-1968);
- Buildings near the intersection of Queen and High Street (1981-1990).

4.2.4.10 Macroeconomic

Several sectors that are important to macroeconomic performance of the country will be directly or indirectly impacted by the proposed development.

The Transport, Storage & Communication Industry is an important sector to Jamaica's economic development. With industry value added of $104,937.2 million (current prices), the sector contributed 11.2 % to Gross Domestic Product (GDP) in basic values at constant (2007) prices (PIOJ, 2012). The corresponding contribution to goods and services production was 10.7%. In 2011, 2,694 vessels visited the Port of Kingston accounting for 16,864 000 tonnes of cargo. Some 3,471 of these were domestic, 2,172 were Petroleum Product, and 13,393 were trans-shipment.

The PIOJ identified "expansion and privatisation of the maritime/shipping infrastructure and enhancements to ports" as core activities of the Maritime Transport sector in 2011. These and other initiatives were reportedly guided by the Medium Term Socio-Economic Policy Framework 2009-2012 and the Sector Strategy for Transport under the Vision 2030 Jamaica-National Development Plan. The activities highlighted included the planned developments at KCT. The activities were also framed within a broader global and regional context in which the geographic location of Jamaica and the asset of having one of seven of the world's most protected natural harbours (Kingston Harbour) provide a distinct competitive advantage in global trans-shipment. Specifically, the Panama Canal Expansion Programme due to be completed in 2014. It was estimated that 5% of worldwide shipping traffic passed through the Panama Canal in 2005. By 2007 approximately 70% of the United States goods crossed it. Some projections indicate that cargo volume through the canal will be 510 million tons by 2025. The expansion project will enable larger ships to traverse the canal potentially increasing the number and types of vessels and volume of cargo passing through. Improving Jamaica's shipping infrastructure and services is seen as a way of "positioning the Port as a regional logistics, multi-modal, mega hub." The goal is to significantly increase vessel calls to the Port of Kingston as a trans-shipment point to and from the Panama Canal.

Jamaica's marine fish production was estimated at 14,208 tonnes in 2011, an increase from 12,314 tonnes in 2010. The sector combined with Agriculture and Forestry contributed 6.6% to total real gross domestic product (GDP) of the country in 2011 (ESSJ, 2012). STATIN estimated that the contribution to GDP of the fisheries sector alone was 0.4% (representing approximately 3% when adjusted for value added). Fisheries export (identified as a "non-traditional export") totalled US $7,986,000 for that year (ESSJ, 2012). The industry employs a large portion of persons residing in coastal areas including 21,536 fishers with 583 registered boats at 187 fishing beached across the country in 2010.

Trade (combined with repair and installation of machinery) is identified in the ESSJ as the single largest contributor to GDP, accounting for 18.1% of Real GDP in 2011. The industry is largely comprised of Micro, Small and Medium-sized enterprises (MSMEs) which employ approximately 80% of the labour force in Jamaica.

With valued added (current prices) of $83,843.4 million in 2011, the construction industry is a very important industry to the country as a whole and local communities (ESSJ, 2012). The sector contributed 7.5% of Real GDP in 2011, relatively similar to 2009 and 2010 at 7.6% contribution.

LABOUR

1. *Construction Cost*: The project could cost in the region of US$160 million depending on the condition of the material to be dredged. This estimate is subject to confirmation by the results of a geotechnical (borehole) study which is scheduled to be completed in the first quarter of FY2013/14.

2. *Operational Cost:* The land reclamation will create 50 hectares of land on which a container terminal will be developed. It is anticipated that this container terminal will have a capacity of approximately 2M TEUs. At this level the terminal will require significant level of labour to facilitate its operations. The workforce could be in the region of 800-900 persons drawn largely from the local market, and a construction and operation costs of J$7B.

4.2.4.11 Natural Resource Management

All respondents to the survey acknowledged that their community had one or more types of natural resources. Fifty-eight per cent (58%) of all respondents utilised these natural resources for domestic, commercial and recreational purposes. From the total number of persons acknowledging the use of natural resources, 46% used these resources for domestic purposes only, 30% for recreational purposes only, 5% for commercial purposes only and the remainder utilised these resources for both domestic and recreational purposes.

a) Wildlife

According to approximately seventy-one per cent (71%) of respondents, birds were the most common wildlife in their community. Less than one per cent (1%) of respondents indicated seeing turtles within their community.

b) Pollution Threats

Forty-two (42%) per cent of all respondents surveyed indicated that natural resources were being threatened by various sources of pollution. Major pollution threats identified included illegal disposal of solid waste, release of untreated sewage and effluent, chemical spills, boat leaks and reduction in air quality as a result of various forms of emissions.

4.2.4.12 Land Use

a) Onsite

All project activities are confined to the Kingston Harbour. Dredging will be conducted from the northwestern portion of the inner harbour extending south southeast to the outer harbour. The area proposed for reclamation is along the shore adjacent to Fort Augusta. Land use in the study area is represented at **Figure 64** and **Figure 65.**

b) Land uses within 0.5 km the study area

Land uses within 0.5km of the project activities include the Port facilities and associated commercial and light industrial activities to the west/northwest. This includes the Kingston Free Zone, Kingston Wharves Limited, light industrial and commercial uses that are associated with port activities including National Commercial Bank, Lascelles and T. Geddes Grant. The Greenwich, Forum, Causeway Beaches are located in this general direction. Also within this zone are the Portmore Tool Road/Causeway and Hunts Bay and the mainly commercial portions of Portmore. Within 0.5km of activities by the entrance to the harbour is the community of historic town of Port Royal and the underwater archaeological sites.

c) Within 0.5km - 2km of the Site

Lands within 0.5km – 2km of the project activities consist of commercial and light industrial to northwest and north. The Tinson Pen Aerodrome is also located to the northeast. The residential communities of Passage Fort, Portsmouth and Greenwich Town are located within this zone. Institutional, government and open spaces are also uses within the study area. Lands surrounding the wider harbour area consists of a wide range of land uses consistent with urban centres and one that the centre of economic activities for the country.

d) Recent/Planned Developments

Proposed developments within the study area include the proposed Reconstruction of Berths 6 & 7 of the Kingston Wharves facilities adjacent to the project site. The project will include demolition of existing structures, driving piles and backfilling. This project will likely be impacted by the channel widening.

A recent development activity was the Petrojam Refinery Upgrade Project. Claude Davis and Associates in collaboration with TEMN conducted the EIA for this project in 2009. The goal of the project was to upgrade the refinery expanding its capacity to refine 50,000 barrels per day (bpd) of oil, up from 35,000 bpd. The project was noted to be of national significance with far reaching impacts. Petrojam Refinery is located between 0.5km and 2km from the site.

Figure 64: Land Use Fort Augusta and Environs Area

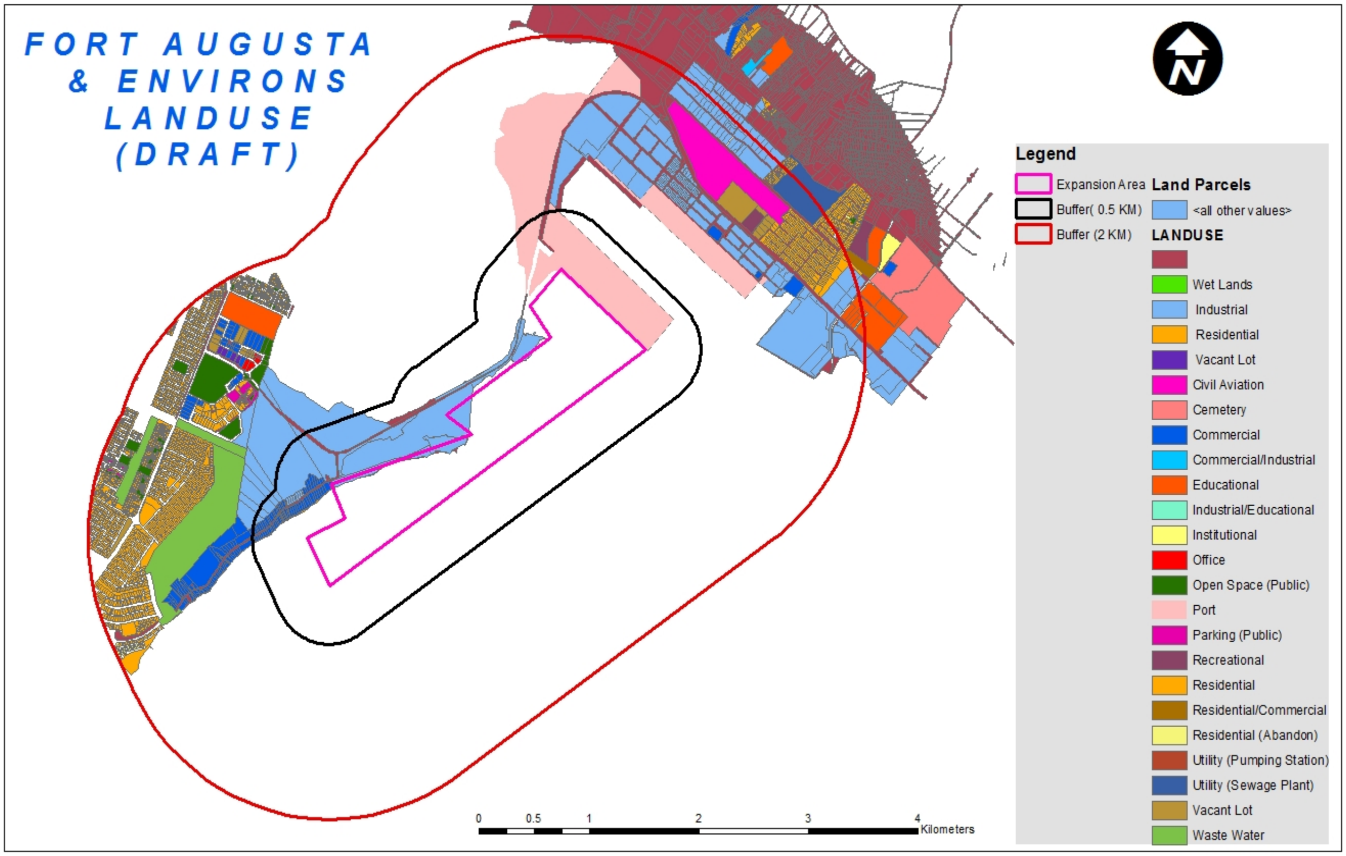
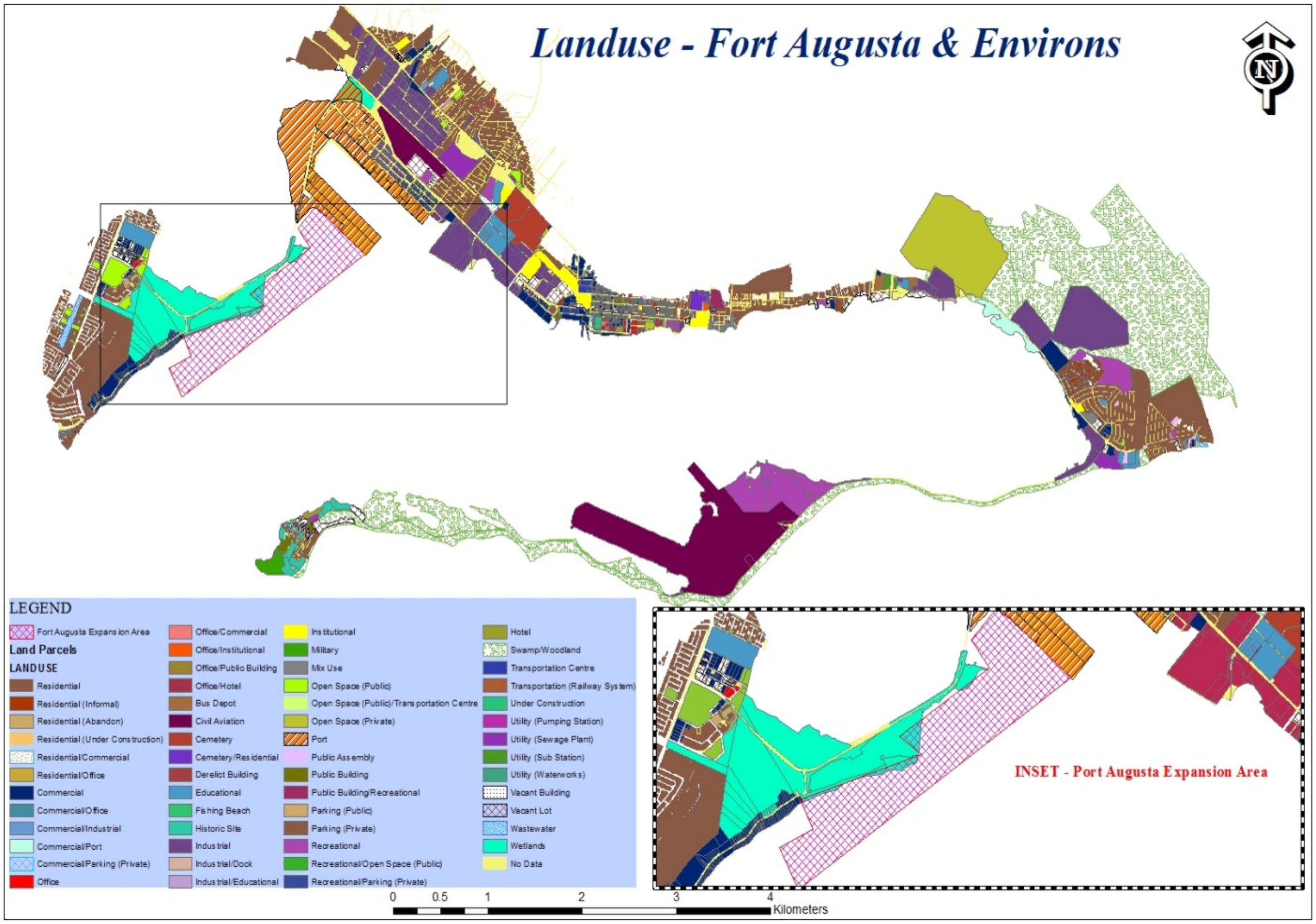


Figure 65: Land Use Wider Harbour Area 1



5. POLICIES, LEGISLATION AND REGULATIONS

5.1 Legislation

Jamaica has fifty-two (52) statutes that have jurisdiction over matters of the environment. They range from public health to physical planning and land use with many instances of overlap in responsibilities and in some instances are in need of being rationalised, coordinated and strengthened.

As a case in point, The Natural Resources Conservation Authority Act, 1991, provides the broad regulatory framework for the control of development activities through the environmental impact assessment (EIA) process as well as a number of other acts subsumed under the NRCA act. The Town Planning Department/KSAC has a manual which provides guidelines for development, including projects in the coastal zone. The Fisheries Division of the Ministry of Agriculture however has distinct responsibilities for fishing activities island wide. Thus, the responsibility for regulating and facilitating sustainable development, rests with several disparate authorities and different pieces of legislation. The proposed project will be executed by the Port Authority of Jamaica on behalf of the Government of Jamaica.

Legislation considered relevant to this project includes:

The Port Authority Act
The Harbours Act (1874)
The NRCA Act (1990)
The Land Acquisition Act
The Town and Country Planning Act
The Local Improvements Act
The Wildlife Protection Act
The Fisheries Industry Act

The Port Authority Act empowers the Port Authority to declare harbours, and establish or alter boundaries of harbours; establish the Marine Board to make rules for the regulation and control of harbour and ship channels. It allows for the prohibition of the discharge of rubbish, earth, stone, ballast, mud, oil, mixtures with oil or its residues, as well as the removal of stones and gravel from reefs, shoals, or cays. The Marine Division of the Port Authority regulates the construction of structures on or over the water, or dredging activities. The Act empowers the Authority to regulate the use of all port facilities in the port including berths and stations, and accompany and remove vessels. It also allows the Authority to make by-laws for the control and management of the wharves and premises regulate the loading and discharging of vessels and carry out the compulsory acquisition of lands for bringing into effect any of the provisions of the Act.

The Harbours Act allows the Marine Board to make rules for the regulation and control of any harbour in the Island and of the channels and approaches leading thereto and of persons, boats and vessels using such harbour or approaches, and for all purposes connected with any such matters. According to the Act, the duty of the Harbour Master includes all matters relating to maintaining and protecting the harbour and shipping channels.

The NRCA Act (1990) established NRCA with primary responsibility for protection and management of the country's natural resources and control of pollution including atmospheric pollution. NRCA's powers and responsibilities include the following:

- Establishing and enforcing pollution control and waste management standards and regulations;
- Guiding environmentally appropriate development through such tools as prescribing areas;
- Requiring environmental impact assessments, and granting permits and licences;

- Maintaining a system of national parks and protected areas;
- Promoting broad public awareness through information, environmental education and outreach activities;
- Monitoring and enforcing environmental laws and regulations, especially those included in the NRCA, Beach Control, Watershed Protection, and Wildlife Protection Acts;
- Providing national environmental leadership, coordinate activities of other government agencies, and support local, non-government efforts at protecting and enhancing the environment;

The NRCA through the Environmental Action Programme (ENACT) and in collaboration with the **Bureau of Standards Jamaica** and other key government and private sector agencies formed a national working group on developing guidelines and standards for Environmental Management Systems.

In general, planning permission through the Permit and License System must first be sought from the NRCA. **The Environmental Health Unit (EHU)** of the **Ministry of Health** in conjunction with local planning authorities monitors construction work to ensure that all development restrictions and requirements are properly adhered to. The NRCA may also require implementation of an environmental monitoring plan.

The Land Acquisition Act states that the Commissioner of Lands is responsible for the acquisition of all lands needed by the Government of Jamaica for public purposes. The Commissioner may acquire these lands either by way of private treaty or by compulsory acquisition (if there was no agreement).

The Town and Country Planning Act regulates land use, in accordance with legal instruments known as Development Orders. Development Orders (broad based land use plans and regulations). Development Orders are to control both rural and urban land development, ensure proper sanitary conveniences, coordinate building of roads and other public services, protect public amenities (conservation areas, wetlands, mangroves). Authorised issue of Tree Preservation Orders provides for the protection of designated trees, groups of trees and woodlands. The Act establishes area-specific standards for land use, density and zoning. At present, Development Orders cover most of the urban areas of Jamaica, as well as the entire coastline up to one mile inland and a number of parishes.

The Local Improvements Act controls the subdivision of land and requires that anyone wishing to subdivide land for building, lease, sale, or other purposes, must provide the local planning authority with a plan for approval. The act is administered by the Kingston & St. Andrew Corporation (KSAC) and the Parish Councils, which have the power to approve or deny subdivision applications within their jurisdictions, based on the advice of their Planning and Building Subcommittee and the local Fire Superintendent.

The Wildlife Protection Act prohibits the removal, sale, or possession of protected animals and the use of dynamite, poison or other noxious material to kill or injure fish.

Although the Act also prohibits the discharge of trade effluent or industrial waste into any harbour, stream, river canal etc., it has been superseded by the NRCA Act which provides for permits or licences for the discharge of trade effluent into waters. There is also Draft Trade Effluent and Sewage Regulations promulgated under the NRCA Act and these regulations incorporate trade effluent standards which specify limits for discharges of trade effluent and draft ambient water quality Standards.

The Fishing Industry Act establishes the Fisheries Division responsibility for licensing fishermen and fishing boats, protection of the fishery by establishment of closed season, creation of fish sanctuaries, and penalties for landing or sale of illegally caught fish. The Fishing Industry Act 1975 is at this moment still the main piece of legislation that provides for the regulation of the fishing industry in Jamaica. A Licensing Authority, in practice the Director of Fisheries, is empowered by the Act to issue licences, and is required to keep a register of all licences issued. In addition to the licence to fish, every boat used for fishing whether for business, recreation or sport, must be registered under the Act and the owner of the boat must possess a licence authorising the boat to be used for fishing.

5.2 Other Significant Legislation and Policies

A number of other instruments legislation and policies also have a bearing on environmental management. These Include:

- The Tree Preservation Order;
- National Land Policy (1996);
- National Industrial Policy (1996);
- Jamaica Energy Policy (2006 - 2020): Green Paper;
- Policy for the National System of Protected Areas (1997).

The Tree Preservation Order which provides for the protection of all trees from destruction or mutilation of any kind, except with the express permission of the local planning authority, the national Land Policy (1996).

The National Land Policy (1996) establishes the framework to enhance the efficient planning, management, development and use of land. It is comprehensive in order to achieve complementary and compatible development which is in harmony with economic and socio-cultural factors. Chapter 3 of the National Land Policy includes rural development and the protection of watershed and fragile areas, exploitation of mineral resources, and crop and livestock production.

T**he National Industrial Policy (1996)** was developed against a backdrop of a changing global economy and the need for Jamaica to rise to the attendant challenges, in this context to implement its stated commitment to a market led economy. The policy however recognises that industrialisation carries with it economic and social implications, that industrial activity may necessitate the exploitation of natural resources, but that the pursuit of economic development cannot be in isolation of the need for environmental protection and management. The sustainable use and management of the environment becomes a critical component of the policy.

The main objectives of the **Jamaica Energy Policy (2006 - 2020): Green Paper** energy policies are as follows:

- Ensure stable and adequate energy supplies at the least economic cost in a deregulated and liberalised environment to enhance international competitiveness and to improve quality of life of householders;
- Provide an appropriate environment conducive to private sector participation in electricity generation;
- Make electricity available to the remaining areas of the island, especially in deep rural areas and at affordable rates to lifeline customers;
- Diversify the energy base and encourage the development of indigenous energy resources where economically viable and technically feasible; and ensure the security of energy supplies;
- Protect the economy from the volatility in energy prices which has been experienced with petroleum fuels and which will continue as oil supplies become more limited;
- Encourage efficiency in energy production, conversion and use with the overall objective of reducing the energy intensity of the economy;
- Complement the country's Industrial Policy recognising the importance of energy as a critical input to industrial growth and stability;
- Minimise the adverse environmental effects and pollution caused by the production, storage, transport and use of energy, and minimise environmental degradation as a result of the use of fuel wood; and
- Establish an appropriate regulatory framework to protect consumers, investors and the environment.

Policy for the National System of Protected Areas (1997)

Jamaica has a rich and diverse natural heritage created by its geographical location and its varied topography, geology and drainage. That diversity endowed the island with a scenic beauty sought after by Jamaicans and visitors. In the face of deteriorating environmental conditions, a system of protected areas provided the means to conserve and ensure the sustainable use of Jamaica's biological and cultural resources. The Palisadoes peninsula, its surrounding waters with mangroves and seagrass meadows and the adjacent Port Royal Cays and coral reefs comprised an ecological complex of significant social and economic value to Jamaica. That area was designated a protected area in September, 1998.

5.3 Relevant International Treaties

Jamaica is signatory to a number of international treaties and conventions that obligate signatories to take wide ranging measures in support of environmental protection and sustainable development, including enacting enabling legislation.

Relevant International Treaties include**:**

- Specially Protected Areas and Wildlife (SPAW) Protocol encouraged the establishment of protected areas to conserve rare and fragile ecosystems and habitats.
- Cartagena Convention was an international treaty signed by all Caribbean nations, obligating them to marine pollution monitoring and control of ship borne and land based sources of hydrocarbon (oil) pollution.
- The Earth Summit Treaties signed by Jamaica at the UN Conference on Environment and Development including Agenda 21 the Biodiversity Convention, and the Framework Convention on Climate Change;
- UN Conference on Small Islands Developing States;
- UN Convention on the Convention on the Law of the Sea;
- The 1972 London Convention on the Prevention of Marine Pollution and *1996 Protocol* (London Protocol);

Specially Protected Areas and Wildlife (SPAW) Protocol encouraged the establishment of protected areas to conserve rare and fragile ecosystems and habitats.

Cartagena Convention was an international treaty signed by all Caribbean nations, obligating them to marine pollution monitoring and control of ship borne and land based sources of hydrocarbon (oil) pollution.

The Earth Summit Treaties signed by Jamaica at the UN Conference on Environment and Development including Agenda 21, the Biodiversity Convention, and the United Nations Framework Convention on Climate Change, the UN Conference on Small Islands Developing States, the UN Convention on the Convention on the Law of the Sea, the London Convention on the Prevention of Marine Pollution, all obligate Jamaica to take wide ranging measures in environmental protection and sustainable development, including enacting over-riding legislative authority in environmental matters to the Ministry of Health and Environment.

The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. The International Convention for the Prevention of Pollution from Ships (MARPOL) was adopted on November 2, 1973 at IMO and covered pollution by oil, chemicals, and harmful substances in packaged form, sewage and garbage. The Protocol of 1978 relating to the 1973 International Convention for the Prevention of Pollution from Ships (1978 MARPOL Protocol) was adopted at a Conference on Tanker Safety and Pollution Prevention in February 1978 held in response to a spate of tanker accidents in 1976 - 1977 (Measures relating to tanker design and operation were also incorporated into a Protocol of 1978 relating to the 1974 Convention on the Safety of Life at Sea, 1974). As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument is referred to as the International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), and it entered into force on 2 October 1983 (Annexes I and II).

The Convention includes regulations aimed at preventing and minimising pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes.

The International Ship and Port Facility Security Code (ISPS Code) is a comprehensive set of measures to enhance the security of ships and port facilities, developed in response to the perceived threats to ships and port facilities in the wake of the 9/11 attacks in the United States. The ISPS Code is implemented through chapter XI-2 Special measures to enhance maritime security in the International Convention for the Safety of Life at Sea (SOLAS). The Code has two parts, one mandatory and one recommendatory.

In essence, the Code takes the approach that ensuring the security of ships and port facilities is a risk management activity and that, to determine what security measures are appropriate, an assessment of the risks must be made in each particular case.

The purpose of the Code is to provide a standardised, consistent framework for evaluating risk, enabling Governments to offset changes in threat with changes in vulnerability for ships and port facilities through determination of appropriate security levels and corresponding security measures.

The London protocol 1996 provides a framework for prevention of marine pollution by dredged sediment that is known to receive significant sources of hazardous pollutants directly or indirectly.

6 IMPACTS ASSESSMENT ANALYSIS

6.1 Methodology

An assessment of the overall project alternatives and analyses of the potential environmental and social impacts during construction and after the upgrade is presented in this section. The environmental impacts specified in the Terms of Reference can be grouped into four components (study disciplines), namely:

Physical/Chemical,

Biological/ecological,

Sociological and

Economic/Macroeconomic.

The definitions for these are as follows:

Physical/chemical	Covering all physical and chemical aspects of the environment, including finite (non-biological) natural resources, and degradation of the physical environment
Biological/ecological	Covering all biological aspects of the environment, including renewable natural resources, conservation of biodiversity, species interactions pollution of the biosphere
Socioeconomic	Covering all human aspects of the environment, including social issues affecting individuals and communities; together with cultural aspects, including conservation of heritage, and human development
Macroeconomic	Covering macroeconomic consequences of environmental change, both temporary and permanent within the context of the project activities.

Sensitive parameters in all the study disciplines that describe the impacts for the current situation during and after dredging and reclamation will be assessed for their overall impact using the rapid impact assessment matrix (RIAM) method (Jensen, 1998). The RIAM method provides an overall assessment where there are multi-disciplinary factors since the method allows data from different disciplines to be analysed against common important criteria within a common matrix, thereby providing a clear assessment of the major impacts. Such an assessment can be done for each project alternative and in the present case will be done for the "do nothing" case and for the preferred alternative.

The RIAM is based on two groups of assessment criteria and the means by which semi-quantitative values for each of these criteria can be assigned for the impacts in the four environmental components and then consolidated to give an overall assessment. The impacts of project activities in the environmental components are assessed against the two groups of criteria, and for each component, a score (using the defined criteria) is determined, which provides a measure of the impact expected from the component.

The assessment criteria fall into two groups:

Criteria that are of importance to the condition, and which can individually change the score obtained (Group A).

Criteria that are of value to the situation, but individually should not be capable of changing the score obtained (Group B).

The value ascribed to each of these groups of criteria is determined by the use of a series of simple formulae. These formulae allow the scores for the individual components to be determined on a defined basis.

The scoring system requires simple multiplication of the scores given to each of the criteria in group (A). The use of multiplier for group (A) ensures that the weight of each score is expressed (since summation of scores could provide identical results for different conditions).

Scores for the value criteria group (B) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values in group (B) is fully taken into account.

The sum of the group (B) scores is then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition. The process can be expressed as follows:

(a1) x (a2) = aT

(b1) + (b2) + (b3) = bT

(aT) x (bT) = ES

Where:

(a1) and (a2) are the individual criteria scores for group (A)

(b1) to (b3) are the individual criteria scores for group (B)

aT is the result of multiplication of all (A) scores

bT is the result of summation of all (B) scores

ES is the assessment score for the condition.

Positive and negative impacts are depicted by using scales that go from negative to positive values through zero for the group (A) criteria. Zero is the ‘no-change’ or ‘no-importance’ value. The use of zero in group (A) criteria allows a single criterion to isolate conditions which show no change or are unimportant to the analysis.

Zero is avoided in the group (B) criteria. If all group (B) criteria score zero, the final result of the ES will also be zero. This condition may occur even where the group (A) criteria show a condition of importance that should be recognised. To avoid this, scales for group (B) criteria use ‘1’ as the ‘no-change/no-importance’ score.

6.1.1 Assessment Criteria

The criteria, together with their appropriate judgement scores are as follows:

Group (A) criteria

Spatial Importance of condition (A1)

A measure of the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect.

The scales are defined as follows:

4 = important to national/international interests

3 = important to regional/national interests

2 = important to areas immediately outside the local condition (aspect-specific study areas)

1 = important only to the local condition (Petrojam plant site)

0 = no importance.

Magnitude of change/effect (A2)

Magnitude is defined as a measure of the scale of benefit/dis-benefit of an impact or a condition:

+3 = major positive benefit

+2 = significant improvement in status quo

+1 = improvement in status quo

0 = no change/status quo

-1 = negative change to status quo

-2 = significant negative dis-benefit or change

-3 = major dis-benefit or change.

Group (B) criteria

Permanence (B1)

This defines whether a condition is temporary or permanent, and should be seen only as a measure of the temporal status of the condition (e.g.: an embankment is a permanent condition even if it may one day be breached or abandoned; whilst a coffer dam is a temporary condition, as it will be removed).

1 = no change/not applicable
2 = temporary
3 = permanent.

Reversibility (B2)

This defines whether the condition can be changed and is a measure of the control over the effect of the condition. It should not be confused or equated with permanence.

1 = no change/not applicable
2 = reversible
3 = irreversible.

Cumulative (B3)

This is a measure of whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions. The cumulative criterion is a means of judging the sustainability of a condition, and is not to be confused with a permanent/irreversible situation.

1 = no change/not applicable
2 = non-cumulative/single
3 = cumulative/synergistic

It is possible to change the cumulative component to one of synergism, if the condition warrants consideration of additive effects.

6.1.2 Overall Assessment

The various ES values are grouped into ranges and assigned alphabetic or numeric codes (see **Table 24)** so they may be more easily compared.

Table 24: Environmental Score/Range Value

Environmental Score (ES)	Range value (RV) (Alphabetic)	Range value (RV) (Numeric)	Description of Range Value
72 to 108	E	5	Major positive change/impact
36 to 71	D	4	Significant positive change/impact
19 to 35	C	3	Moderate positive change/impact
10 to 18	B	2	Positive change/impact
1 to 9	A	1	Slight positive change/impact
0	N	0	No change/status quo/not applicable
-1 to -9	-A	-1	Slight negative change/impact
-10 to -18	-B	-2	Negative change/impact
-19 to -35	-C	-3	Moderate negative change/impact
-36 to -71	-D	-4	Significant negative change/impact
-72 to -108	-E	-5	Major negative change/impact

The assessments that follow are made first for the period during construction and after the upgrade. The bases for assessment of the existing situation were provided in **Section 5**. Tabulations of the ES scores for each of the four environmental components (Physical/Chemical, Biological/ecological, Socioeconomic/cultural and Macroeconomic) are provided in the following four sections.

6.2 Identification and Assessment /Analysis of Potential Impacts

6.2.1 Physical/chemical

6.2.1.1 Water Quality

Water quality data collected within the proposed project site indicate levels for TSS that were a little higher than the proposed NEPA ambient standard for sea water. The levels were also higher than the range determined for previous work by TEMN (TEMN 2001 unpublished).

i) During Dredging/Reclamation

The main impact expected is the increase in suspended solids at the site to be dredged as well as possible transportation of this suspended matter to adjacent/down-current areas. This increase in TSS/turbidity is expected to be temporary and levels are expected to return to background shortly after cessation of the dredging event(s).

The sediment to be dredged is not adjudged to be toxic based on analyses carried out previously and for the current assessment. This is not surprising given that the source of the sediment is from the surrounding watershed within which the main activities are residential, commercial, agricultural and to a much less extent industrial. Analysis of sediment indicates no levels of the targeted trace metals that would give cause for concern. Further, the results of elutriate analyses indicate that release of the targeted trace metals will not occur or will yield levels well below acceptable concentrations.

Results from previous dredge monitoring at sites shown in **Figure 66** indicate that effects of the dredging were largely localised at the dredge site (Station 3) and confined to the channel **Figure 67**. The effect was not noticeable at sampling locations to the north (Station 2), northeast (Angel Beacon Station 6) and southwest of the dredge site (Delbert Sicard Beacon Station 4).

ii) After Dredging

A return to baseline conditions for water quality shortly after cessation of the dredging and reclamation works is expected. Monitoring of dredging operations indicated a return to near

Figure 66: Dredge Monitoring Sites March, 2002

normal levels at the dredge site within 30 minutes of cessation of a dredging event **Figure 68**.

The proposed method for the reclamation works should ensure that impact to turbidity level in the vicinity will decrease once the retaining works are completed. The retaining works proposed is expected to prevent erosion of the fill and return of sediment to the harbour.

Figure 67: Dredge Monitoring March 11, 2002

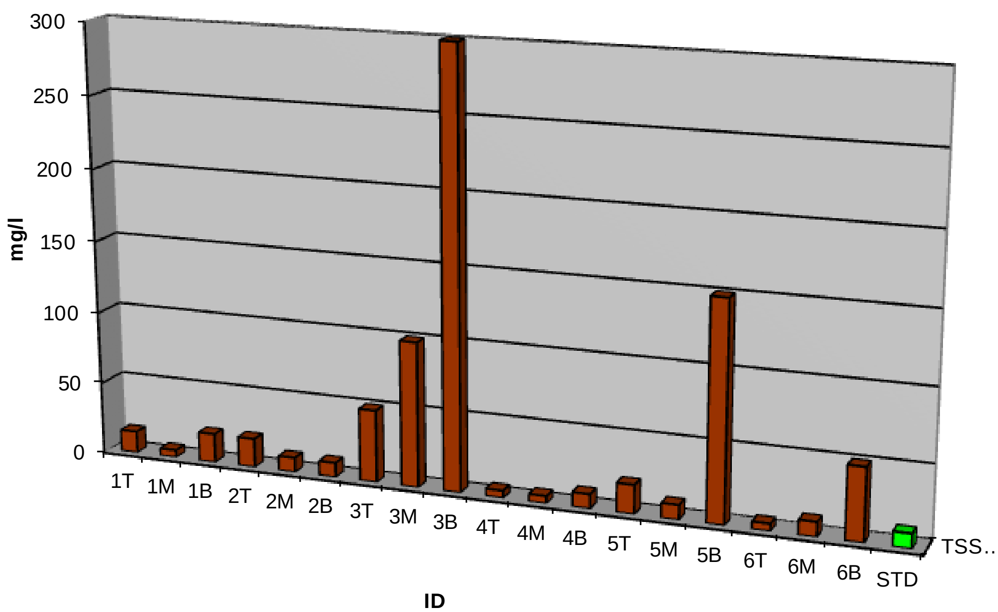
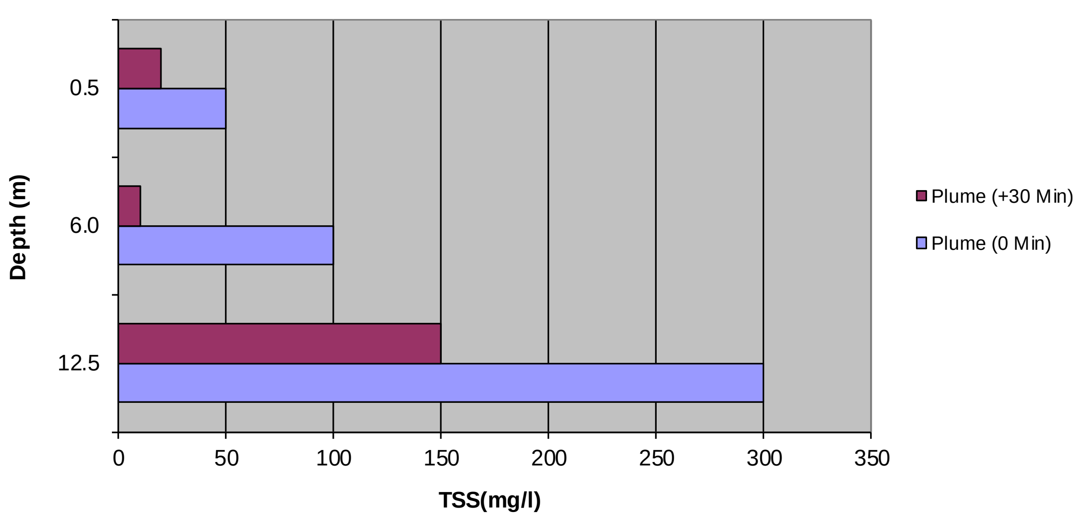


Figure 68: TSS Profile at Dredge Site



6.2.1.2 Coastal Dynamics

a) During Dredging/Reclamation

As identified in the previous section on water quality, the main impacts during dredging and reclamation will be due to turbidity plumes generated from these activities. During reclamation, whether by ‘rainbowing’ or pipeline discharge, an effluent with a high concentration of suspended solids will return to the nearshore waters. As fines are disposed at the 1000m contour (deep water disposal site), a turbidity plume will form as the material disperses and sinks. Monitoring of previous operations of disposal at the 1000m contour indicate all traces of the plume to vanish about twenty minutes after release from a hopper barge. Given the high visibility of these deep waters, the disappearance of the plume indicates that rapid sinking into the abyss occurs along with significant dispersion. Thus this operation has been deemed to have negligible impact on the environment.

The actual shape and movement of the plumes will depend on the *in situ* conditions of the forcing currents due to tides and winds, and also due to water quality parameters (most importantly density differences between the ambient and effluent waters) at the time. Turbidity barriers, silt traps and berms should be used to minimise the impacts from these plumes.

It should also be noted that as the reclamation area is being constructed, it will have a transient effect on the local wave-climate and longshore transport as outlined in the report. These effects will increase as the size of the reclamation increases towards its final configuration.

b) After Dredging

After dredging, the main impact will be to the wave-climate and longshore littoral transport in the lee (westward from) the proposed reclamation. It is recommended that a beach reclamation and stabilisation programme in this zone be undertaken as it will be of significant benefit to both the physical and socioeconomic status of the area.

6.2.2 Biological/Ecological Impacts

The 3 hectares (~7 acres) of Turtlegrass (*Thalassia testudinum*) that remain in the shallow waters near Fort Augusta serve as nursery grounds for various species of fishes living in Kingston Harbour and appear to be a critical area for shrimpers on western side of the harbour. The seagrass areas are also essential to the process of longshore drift by consolidating the sandy substrate, thereby contributing to the stabilisation of nearby beaches.

The proposed land reclamation required for the creation of a berthing and container storage facility at Fort Augusta will result in the destruction of seagrasses and the loss of their associated functions and services in the immediate vicinity of the project.

Impacts during Construction

Potential terrestrial impacts during construction are negligible since the site is already degraded from longstanding construction activities such as the Fort itself as well as other beach front developments, some of which have been abandoned. Existing beach vegetation is also impacted by the chronic accumulation of garbage washing up onshore. Other than grounds-keeping activities at the Fort Augusta prison itself there are no apparent land management activities in progress. The proposed terminal construction will destroy the existing beach habitat near the Fort but the ecological impact to the terrestrial environment in the immediate area of the development should be minor. The shoreline downstream of the development is likely to be impacted from the disruption of its sediment supply (due to ecosystem fragmentation) and will consequently be subject to erosion. The use of terrestrial plants for coastal stabilisation will be essential in these downstream areas.

There is the potential for debris to create breeding sites for pests and also lead to blockage of storm water drainage channels.

Potential marine impacts due to construction activities can arise from runoff water that contains construction related sediment and hydrocarbon contaminants. The construction related discharges are not likely to be significant provided appropriate containment measures aimed at reducing runoff/sediment from construction activities are put in place.

It is anticipated that there may be periodic dredging activities to maintain the docking capability of ships offloading or loading materials at the proposed dock. Such dredging will require licences that will address dredging impacts and is therefore outside the scope of this EIA.

The most significant marine impacts relate to:

1. the loss of seagrass habitat in the immediate dredge fill and donor site areas;
2. the loss of other associated fauna such as urchins and conch unless these individuals are specifically removed prior to the commencement of dredging activities;
3. the loss of feeding, and nursery habitat for turtles, fishes and the loss of important
4. shrimping grounds on the western side of the harbour;
5. decreased floral and faunal diversity for the harbour ecosystem;
6. decreased longshore drift of sediment to beaches downstream of development area.

b) Biological Impacts after the Dredging

Potential terrestrial impacts at the immediate development site are negligible since the site is presently degraded. However, the current state provides an opportunity for landscaping to mitigate impacts which could decrease the flora, fauna and biodiversity of the area. Improper management and/or storage/removal of construction debris could create breeding sites for pests and also lead to blockage of storm water drainage channels. Furthermore, the certain loss of seagrass beds due to land reclamation has the potential to negatively impact sediment trapping and reduce the supply of sediments available to maintain shoreline stability immediately downstream. Beach erosion represents a potentially severe and chronic impact which will require proper monitoring and mitigation, including the placement of appropriate shoreline stabilisation measures to prevent excessive erosion.

Potential marine impacts due to operational activities are considered to be significant because of the increased risk of release of petroleum products and re-suspension of sediment due to an increase in maritime activity. This is expected to exacerbate the impact to an already impacted harbour ecosystem and the presence of immediately adjacent wetland habitat which appears to be at least intermittently used by crocodiles. Given the proximity to the entrance to the harbour the potential also exists for these petroleum products to be carried out of the harbour to impact reef systems immediately downstream or into Hunts Bay, depending on the tidal cycle. The reefs in this area are already highly stressed by excess nutrients and suspended solids in the water coming from Kingston Harbour. Mitigating the compounded impacts from existing stress and additional stress from construction, including the release of petroleum-based toxins into the system and elevated sedimentation/turbidity will be essential to the survival of both harbour and reef systems. Given that the benthos inside Hunts Bay is anoxic from chronic organic and inorganic pollution and high sedimentation levels, serious consideration must be given to protecting and where possible, rehabilitating, existing nursery and shrimping grounds that are not directly impacted by harbour construction and operations.

6.2.3 Socioeconomic & Cultural

During Dredging & Reclamation

a) Land Use

Potential land use impacts from dredging activities will be indirect as the activity will be confined to the sea. Reclamation of land along the Fort Augusta peninsula will increase land surface area of the country. The reclaimed land is proposed for terminal and container storage. Land use impacts will also occur if the option to dispose of dredge material not used for reclamation on land is chosen. Land use impacts will be direct, short and long term and significant.

b) Disposal of Dredge/Reclamation Waste

Waste will be generated from both dredge and reclamation activities. The proposed handling options for dredge material include the use of the material as fill material for reclamation with any excess stored in a suitable site on lands not yet identified. Any residual materials will be disposed of at an aquatic site at the 1,000 metre contour. Reclamation activities will involve the clearing of the site and waste disposed at an approved site. Disposal of materials on land will potentially have land use impacts and the potential for other implications based on site characteristics and that of the material (e.g. quality).

c) Traffic

Traffic impacts will be as a result of the movement of workers to and from points of access to project activities. This will be in the vicinity of reclamation site on the landward side and the port for movement on and off dredge vessels. Vehicular traffic will mainly affect the Portmore Causeway/Highway 2000 and exits accessing the KCT, and Marcus Garvey Drive.

There will be small increase in traffic with additional dredging vessels present in the harbour. The Kingston Port had 2,694 vessel calls in 2011 which equates to approximately seven vessels per day throughout the year. The channel is also used by other marine interests such as the Petroleum Corporation of Jamaica, which also has vessel calls delivering petroleum and related products for refining. There are also interests in the inner harbour (northeast) such as the Cement Company, Jamaica Aggregates and operators of small boats such as the fishing interests. Proposed dredging activities will be scheduled around the activities of current harbour users. As such traffic impacts during this project phase will be short-term and minor.

d) Employment

There will be positive and negative Impacts to employment during the construction phase.

It is anticipated that approximately 200 jobs will be created during the construction phase. Opportunities will also be created for divers, environmental experts, surveyors, truck drivers, heavy equipment operators and casual labourers. In addition, business opportunities will be created for quarry operators for the supply of boulders required for the reclamation.

There could be negative impact to fisherfolk within the harbour. Loss of fisheries would result in loss of livelihood for these communities. One consequence of this is unemployment, changes in sources of livelihood or continuation of fishing. Continuing the activity would likely increase overheads as distance travelled to catch sites would likely increase, and would depend on volatile petrol prices. The profitability of the fishing may also decline with any potential reduction in catch size and increase overhead.

Employment impacts during dredging/reclamation may be significant, positive and negative in the short and long-term.

e) Community Development/Recreation

Indicators of community development generally include employment rate, investments and economic activities. The proposed development will contribute to increases in rates of employment. This may in turn foster economic activities within the community. An employed population will have income and residual income to spend on goods and services within the community. They may invest in property, whether improving existing or developing new properties. The project would also represent a significant capital investment in the community.

Recreation impacts may occur as a result of dredging. Recreational use of beaches within the area was identified as one of the main activities for residents in the study area. Beaches were also identified as a natural resources and asset to the community. Sediments from dredging may impact water quality at these beaches. Contaminants in sediments depending on level may also pose human health risks (see water quality and coastal dynamics sections).

f) Public Perception

Perceived impacts of the proposed dredging were mainly negative. The perceived impacts included pollution of the harbour and marine resources; loss of recreational resources (beaches); destruction of fisheries and shrimp grounds; loss of livelihoods for fishing interests; increase in traffic; and noise. Positive impacts identified included employment opportunities; business and community development and associated benefits of reduced crime. Fishing interests within the harbour indicated that fisheries recovery from previous dredging activities in the harbour took anywhere from four to ten years.

g) Macroeconomic

Macroeconomic impacts during dredging/reclamation activities will include the capital investment represented by the project (information not available) as well as the contribution of employment creation and community development to the economy and development of the country.

There is a potential for costs related to any major negative environmental impacts that affect natural resources such as fisheries.

h) Heritage/Historical Sites

Heritage sites within the direct zone of impact of the proposed development are Fort Augusta and Port Royal's Sunken City. The proposed area for reclamation is immediately adjacent to the Fort Augusta heritage site. Additionally, proposed channel widening will require dredging less than 0.5km of the historic town of Port Royal and its Underwater Archaeology – the "Sunken City." The boundaries of the proposed dredge area are also adjacent to the boundary of the Palisadoes Protected Area. These historic structures are vulnerable to impacts from vibrations from construction and dredging equipment as well as sediments. Any activities directly impacting these sites must be approved by the JNHT. Heritage impacts may be significant and long-term.

Specific potential impacts of concern to the JNHT include:

- The possible high levels of siltation resulting from dredging, dumping and prop-wash that may seriously compromise the integrity of the Port

Royal Sunken City;

- The destruction/damage of significant underwater archaeological sites and artefacts unidentified;
- Compromise of Fort Augusta historical and archaeological integrity;
- Disruption of historical graves associated with Fort Augusta;
- Funding of archaeological work during the project.

6.2.3.1 Post Dredging & Reclamation

Land Use

Land use impact after reclamation and dredging will be the availability of new land for development. While the land is for a specific purpose (terminal and container storage) and it is not available for other types of development, there will be an increase in land asset. This is a positive significant long-term impact.

Traffic

Traffic impacts post dredging and reclamation on land will be negligible. Marine traffic will increase with the capability of the channel to accommodate larger vessels in addition to current traffic. Traffic impact on land will be insignificant. Increased harbour traffic will be positive, significant and long-term as it meets project and national development goals.

Community Development/Recreation

Post dredging/reclamation impacts on community development would be as result of long-term employment and associated benefits to the wider community.

There will be no post project impact on recreational resources.

d) Employment

The number of post project employment will be lower than during dredging/reclamation activities. However, there will be need for labour to man the newly created facility on the reclaimed land.

Macroeconomic

The project is a national goal included in Vision 2030 – Jamaica National Development Plan and the Medium Term Socio-Economic Policy Framework 2009-2012. The project aims at giving the country strategic competitive advantage as a trans-shipment point for cargo within the region (Caribbean and Latin America) and to take advantage of the widening of the Panama Canal to accommodate larger vessels. This will positively impact the industry which contributed 11.2% to GDP; 10.7% to goods and services production at a value added of $104,937 million (current Prices) in 2011 (PIOJ, 2012).

The value of national assets will be higher. The capacity of the channel to accommodate larger vessels will enable the port to benefit from larger ships traversing the upgraded Panama Canal, increasing the number and type of ships and amount of cargo passing through the port. This will increase earnings including foreign currency.

Waste Disposal

Any excess dredge material not used for reclamation will be stored but there will be no port project waste disposal impacts.

Heritage/Historical Properties

Projected post project impacts on heritage sites include:

- The destruction/damage of significant underwater archaeological sites and artefacts unidentified;
- Compromise of Fort Augusta historical and archaeological integrity
- Disruption of historical graves associated with Fort Augusta;

6.2.3.2 Potential Impacts identified in Household Survey

This section gives an overview of the perspective of stakeholders on the potential negative and positive impacts that may arise with the implementation of the proposed project.

More than half of all the persons surveyed (51.3%) indicated that they were aware of the proposed development at Fort Augusta by the Port Authority. Radio and television were the two mediums by which persons had acquired information about the project. Sixty-eight per cent (68%) of respondents however had no comments on the proposed project. For those who expressed an interest in the project, they indicated that though they supported the project, they felt more information was required in order for citizens to be better informed about the potential positive and negative impacts the proposed development will have on their respective communities.

Positive Impacts

An estimated 68.7% of the persons surveyed were in support of the proposed project. Sixty-eight per cent (68%) of all persons deemed the proposed project as being ‘important’ or ‘very important’, while 22.7% of respondents viewed the project as not being important. The remaining respondents had no response.

a) Employment

Eighty-three per cent (83%) of all respondents felt the project would create some form of employment opportunity for persons living within close proximity to the project site or those within surrounding within the surrounding environs. Only eight per cent (8%) of respondents indicated that the project would have a largely negative effect on employment, while an estimated 5% felt there would be no employment opportunities created. Youth employment was considered a major potential impact of the proposed development, which some respondents felt would result in a reduction in crime.

Seventy-four per cent (74%) of respondents felt the necessary skills required during the construction and operational phases of the project were available in the communities surveyed. However an estimated sixty-nine per cent (69%) of respondents felt there would be no personal benefits from the project.

b) Business Development

Respondents were generally optimistic about the prospects the proposed development would have on local businesses. An estimated 76.7% of all respondents indicated that the proposed project will have an overall positive impact on the economy through the creation and support of businesses. Only 10% of respondents believed the overall impact would be negative on business development, while 10.7% of respondents expected no change in the local economic climate for businesses. Persons who felt the project would spur economic growth indicated that the economy and businesses by extension would benefit from increases in foreign exchange revenues.

c) Reduction in Crime Levels

Respondents who were in favour of the project pointed to some of the indirect benefits to be had from the proposed project, of which the reduction in crime was identified by persons as being a possible positive impact. Employment of youths within the communities was seen as a likely factor that would result in less persons becoming members of gangs and engaging in criminal activities.

Negative Impacts

a) Dredging of Harbour and Pollution of Marine and Coastal Resources

Though the project found favour with the vast majority of respondents, there were still concerns about the dredging of the harbour to accommodate the proposed project. Approximately 26.7% of respondents indicated that they were not in favour of dredging in order to facilitate the proposed expansion of the proposed. Approximately 36% of respondents in the fishing village of Greenwich indicated that dredging the harbour was not worth the risk. Respondents who do not support dredging activities felt proposed dredging of the harbour would result in pollution of beaches and smothering of coastal resources that supported marine life.

b) Loss of recreational resources

Approximately 25% of all respondents felt the project would have an overall negative impact on recreation. Respondents noted that use of coastal resources (beach) was a favourite pass-time of residents within their respective communities and this project posed a risk to such resources.

c) Limited Personal Benefits

Only twenty-nine per cent of respondents felt the project would benefit them directly. Direct benefits identified by respondents included employment opportunities, while indirect benefits included possible reduction in crime. Negative impacts included increases in the nuisance noise levels and possible increase in traffic congestion.

d) Increase in Traffic

A general increase in traffic volumes was one of the concerns raised by respondents, particularly those in the communities within Portmore. Persons surveyed felt the roadways would see a distinct increase in the number of vehicles using the roadways as the proposed project in the construction and operational phases would attract a large number of heavy duty equipment and vehicles and also personal vehicles used by workers and other potential users of the site.

e) Increase in Nuisance Noise

An increase in nuisance noise was identified as a potential negative impact, but it was not considered a major threat to respondents, particularly those located outside the 0.5km buffer zone of the proposed project site.

6.2.3.3 Potential Impacts Identified by Fishing Group

Surveys were conducted at fishing beaches within the Kingston Harbour for their perceived impacts of the proposed project. Surveys were conducted at Greenwich, Rae Town, Causeway, Forum and Port Royal Fishing Beaches. Awareness of the project was very high among fishers at the Greenwich, Forum and Rae Town beaches but low at the Causeway and Port Royal beaches. Other community members (word-of-mouth) and the Sea Bed Authority were the main source of prior information on the project. **Table 25** outlines a list of the potential impacts that fishermen have associated with the proposed project. There was belief that fishers within the harbour at large will be negatively affected. The fishermen expressed the desire to be consulted about developments in Kingston Harbour so they can be informed of the decisions taken and be given an opportunity to voice their concerns with the developers. The fishermen also stated that based on their experiences from similar past projects in the harbour, the recovery time for fisheries in the harbour would between four and ten years. Some were of the opinion that Hunt's Bay should be rehabilitated and declared a fish sanctuary.

Table 25: Potential Impacts as Identified by Fishermen based on Location.

Location	**Potential Impact of Development**
Greenwich Town	
	Destroy fish and shrimp grounds/sites in the harbour
	Better boats will be required to use harbour after dredging
	Possible relocation of fishermen from current location
Forum (Portmore)	Kill small fishes located close to wharf
	Smothering/pollution of fish grounds, including breeding grounds, seagrass and reef areas
	Destruction of fishing grounds
	Dredging in the past has killed shell fish (oyster, crabs and shrimps)
	Fear of relocation
	Slowing down of fishing business due to temporary loss of suitable fish catch
Causeway (Portmore)	Further decrease in shrimp and fish
	Loss of income from destruction of shrimp and fish in an area extending from Hunts Bay under the Causeway Bridge and south along Fort Augusta in the shallows
	Destruction of heritage site that should be preserved for tourism

Location	**Potential Impact of Development**
Port Royal	"Harbour water would be condemned"

6.3 RAPID IMPACT ASSESSMENT MATRIX

Environmental Component No Action (Existing Situation) Alternative							
Activity/Discipline	**Spatial Importance (0 to 4)**	**Magnitude of change/effect (-3 to + 3)**	**Permanence (1 to 3)**	**Reversibility (1 to 3)**	**Cumulative (1 to 3)**		
Parameter	A1	A2	B1	B2	B3	ES	RV
Physical and Chemical Components:							
Hydrology (Ground and Surface water)							
Site Preparation	0	0	1	1	1	0	
Shoreline Stability	4	-1	3	2	3	-32	
Wave Reflection	0	0	0	0	0	0	
Current Regime	2	0	0	0	0	0	
Marine Water Quality Impacts							
DO	1	0	1	1	1	0	
TSS/TUR	1	0	1	1	1	0	
O/G	2	0	1	1	1	0	
Heavy Metals	1	0	1	1	1	0	
Stormwater:							
DO	0	0	1	1	1	0	
TSS	2	0	1	1	1	0	0
O/G	2	0	1	1	1	0	
pH						0	
Heavy Metals	2	0	1	1	1	0	
Gaseous emissions							
SO2	0	0	1	1	1	0	0
NOx	0	0	1	1	1	0	0
CO	0	0	1	1	1	0	0
TSP	1	0	1	1	1	0	0
VOC	0	0	1	1	1	0	0
CO2	4	0	1	1	1	0	0
Occupational							
Dust	2	0	1	1	1	0	0
Noise	1	0	1	1	1	0	0
Solid Waste Management							
Site Waste management	1	0	1	1	1	0	0

Environmental Component No Action (Existing Situation) Alternative							
Activity/Discipline	**Spatial Importance (0 to 4)**	**Magnitude of change/effect (-3 to + 3)**	**Permanence (1 to 3)**	**Reversibility (1 to 3)**	**Cumulative (1 to 3)**		
Parameter	A1	A2	B1	B2	B3	ES	RV
Putrescible Solid Waste						0	
Municipal Waste						0	
Metal Scrap						0	
Biological and Ecological Component							
(Terrestrial)							
Impacts on biota & habitats	1	0	1	1	3	0	0
Terrestrial (Avifauna)	0	0	1	1	1	0	0
Marine:							
Potential for Accidental releases	2	-1	2	2	3	-14	-2
Impacts on local biota, biodiversity, Habitats	2	0	1	1	3	0	0
Sociological and Cultural Components							
Land Use	3	0	1	1	1	0	0
Community Development	3	0	1	1	1	0	0
Public perception	2	0	1	1	1	0	0
Heritage/Historical Sites	3	0	1	1	1	0	0
Economic and Operational components							
Employment and Income	3	0	1	1	1	0	0
Traffic (land)	2	0	1	1	1	0	0
Traffic (marine)	3	0	1	1	1	0	0
Transhipment Capacity and Earnings	4					0	0
Fishing Community	2	0	1	1	1	0	0

Environmental Component During Construction							
Activity/Discipline	Spatial Importance (0 to 4)	Magnitude of change/effect (-3 to + 3)	Permanence (1 to 3)	Reversibility (1 to 3)	Cumulative (1 to 3)		
Parameter	A1	A2	B1	B2	B3	ES	RV
Physical and Chemical Components:							
Hydrology (Ground and Surface water)							
Site Preparation	0	0	1	1	1	0	0
Demolition activities						0	
Construction	2	0	1	1	1	0	
Shoreline Stability	3	-1	3	2	3	-24	
Wave Reflection	1	-1	3	3	2	-8	
Current Regime	0	0	1	1	1	0	
Marine Water Quality Impacts							
Dredging/Reclamation							
TEMP						0	
DO	1	-1	2	2	2	-6	-1
TSS/TUR	1	-2	3	3	3	-18	-2
O/G	2	-1	2	2	2	-12	-2
Heavy Metals	2	0	1	1	1	0	0
TEMP						0	
DO	0	0	1	1	1	0	
TSS	2	0	1	1	1	0	
O/G	2	0	1	1	1	0	
Heavy Metals	2	0	1	1	1	0	
Storm Water Management						0	

Environmental Component During Construction (Cont.)							
Activity/Discipline	**Spatial Importance (0 to 4)**	**Magnitude of change/effect (-3 to + 3)**	**Permanence (1 to 3)**	**Reversibility (1 to 3)**	**Cumulative (1 to 3)**		
Parameter	A1	A2	B1	B2	B3	ES	RV
Gaseous emissions							
SO2	1	-1	2	2	2	-6	-1
NOx	1	-1	2	2	2	-6	-1
CO	1	-1	2	2	2	-6	-1
TSP	1	-1	2	2	2	-6	-1
VOC	1	-1	2	2	2	-6	-1
TRS						0	
CO2	3	-1	2	2	3	-21	-3
Occupational							
VOCs						0	
Dust	1	-1	2	2	3	-7	-1
Noise	1	-1	2	2	3	-7	-1
Solid Waste Management							
Site Waste management	1	-1	2	2	3	-7	-1

Environmental Component During Construction							
Activity/Discipline	**Spatial Importance (0 to 4)**	**Magnitude of change/effect -3 to + 3)**	**Permanence (1 to 3)**	**Reversibility (1 to 3)**	**Cumulative (1 to 3)**		
Parameter	A1	A2	B1	B2	B3	ES	RV
Putrescible Solid Waste						0	
Municipal Waste						0	
Metal Scrap						0	
Biological and Ecological Component							
Terrestrial:							
Impacts on biota & habitats	1	-1	3	2	3	-8	-1
Terrestrial (Avifauna)	1	-1	1	1	2	-4	-1
Marine:							
Potential for Accidental releases	2	-2	2	2	3	-28	-3
Impacts on local biota, biodiversity, habitats	2	-3	3	3	3	-54	-4
Sociological and Cultural Components							
Land Use	3	2	3	3	2	48	4
Community Development	3	0	1	1	1	0	0
Public safety						0	
Human health	3	0	1	1	1	0	0
Public perception	3	-2	3	2	3	-48	-4
Economic and Operational components							
Employment and Income	3	1	2	2	3	21	3
Traffic (land)	2	-1	2	2	2	-12	-2
Traffic (marine)	3	-2	2	2	3	-42	-4
Transhipment Capacity and Earnings	4	0	1	1	1	0	0
Fishing Community	2	-3	3	3	3	-54	-4

Environmental Component Post Construction							
Activity/Discipline	**Spatial Importance (0 to 4)**	**Magnitude of change/effect (-3 to + 3)**	**Permanence (1 to 3)**	**Reversibility (1 to 3)**	**Cumulative (1 to 3)**		
Parameter	A1	A2	B1	B2	B3	ES	RV
Physical and Chemical Components:							
Shoreline Stability	3	-3	3	2	3	-72	
Wave Reflection	1	-1	3	3	2	-8	
Current Regime	2	-1	3	3	3	-18	
Marine Water Quality Impacts							
DO	2	0	1	1	1	0	0
TSS/TUR	2	0	1	1	1	0	0
O/G	2	-1	2	2	3	-14	-2
Heavy Metals	1	0	1	1	1	0	0
Biological and Ecological Component							
Terrestrial:							
Impacts on biota & habitats	1	-3	3	3	3	-27	-3
Terrestrial (Avifauna)	1	-1	3	3	2	-8	-1
Marine:							
Potential for Accidental releases	2	-2	2	2	3	-28	-1
Impacts on local biota, biodiversity, habitats	2	-3	3	3	3	-54	-4
Sociological and Cultural Components							
Land Use	3	3	3	3	3	81	5
Community Development	2	1	3	2	3	16	2
Public perception	2	3	3	1	1	30	3
Heritage/Historical Site	3	-1	3	2	3	-24	-3
Economic and Operational components							
Employment and Income	3	2	3	3	3	54	4
Traffic (land)	2	1	3	1	2	12	2
Traffic (marine)	4	3	3	1	3	84	5
Transhipment Earnings	4	3	3	1	3	84	5
Fishing Community	2	-3	3	2	3	-48	-4

RIAM SUMMARY

Activity/Discipline	Existing		During Construction		Post Construction	
Parameter	ES	RV	ES	RV	ES	RV
Physical and Chemical Components	***-32***	***0***	***-119***	***-5***	***-112***	***-2***
Hydrology (Ground and Surface water)	0	0	0	0	0	0
Coastal Dynamics	-32	0	-32	0	-98	0
Marine Water Quality Impacts	0	0	-36	-4	-14	-2
Gaseous emissions	0	0	-30	-4	0	0
Occupational	0	0	-7	-1	0	0
Noise	0	0	-7	-1	0	0
Solid Waste Management	0	0	-7	-1	0	0
Biological and Ecological Component	***0***	***0***	***-94***	***-5***	***-117***	***-5***
Terrestrial	0	0	-12	-2	-35	-3
Marine/Benthos	0	0	-82	-5	-82	-5
Sociological and Cultural Components	***-14***	***-2***	***0***	***0***	***103***	***4***
Economic and Operational components	***0***	***0***	***-87***	***-5***	***186***	***5***
Overall Scores	-46	-4	-300	-5	60	4

7 ASSESSMENT OF ALTERNATIVES TO PROJECT

7.1 Dredging

The proposed dredging and land reclamation activity is required for the development of the new berths and storage area in the vicinity of Fort Augusta. A connection between the channel and the berth will have to be created and the areas around the berths themselves will have to be deepened to accommodate the ships envisioned to use them. This will be essential in order to maintain the port's competitiveness. Shipping activities have increased very significantly over the past five years. Further, the vessels are getting longer and the average number of containers per vessel has also increased. In the region as whole shipping activities have doubled over the past five years, and it is anticipated that this activity will triple within the next 10 years. The capacity of the largest container ships (a function of size) has almost doubled in the last five years. It is expected that the Port of Kingston will have to accommodate vessels of this size within the next decade. The port will therefore have to be developed to handle these larger vessels and to provide the berthing and storage required. This would help position itself as one of, if not, the major port in the region, it stands to lose some of the current clients to other ports which are currently carrying out development (e.g. Jacksonville, Fort Everglades, Manzanillo, Cristobal and Balboa in Panama, San Juan in Puerto Rico, and Rio Haina in the Dominican Republic). It is therefore critical to the continued success of the Port of Kingston that the development project should continue. The dredging of the channel and development of the additional berthing and storage areas would ensure that more of the longer vessels now coming on stream could be accommodated in the Port of Kingston. On completion of this project, the port will be able to accommodate the draught of the largest vessels which will traverse the Panama Canal. The dredging project will improve KCT's competitive advantage and enable the port to serve as a trans-shipment hub for draught restricted ports of the US East and Gulf Coast. This is a preferred alternative.

7.2 No Dredging

If the channel is not enlarged and extended to allow the larger vessels now in use (and those anticipated) over the medium term to access the Fort Augusta berths, the Port of Kingston would lose clients. This would have a significant negative effect on the Jamaican economy. This alternative is not preferred.

7.3 Reclamation

Reclamation is required to develop the berthing facilities in the vicinity of Fort Augusta as currently the site is not suitable for berth development. As described in **Section 8.1**, the development of increased capacity for berthing and container storage will be essential if the port is to grow to meet its potential. The socio-economic impacts will have to be addressed. This is a preferred alternative.

7.4 No reclamation

The berths and storage facilities in the vicinity of Fort Augusta cannot be developed without reclamation. This alternative is not preferred.

8. IDENTIFICATION OF PROPOSED MITIGATION MEASURES

8.1 Physical/Chemical

8.1.1 Water Quality

Given that the main problems anticipated are associated with the quantity and quality of the sediment to be dredged and used as fill, it is recommended that the dredging and filling operation be contained to prevent significant sediment transportation to adjoining areas. Effectiveness of containment strategies should be verified by monitoring of water quality at sensitive areas and/or areas down-current of the dredging and filling sites.

Specifically, consideration should be given to:

- Deployment of silt screen around the construction/working face of the containment bund until the reclamation berm is finished such that the quality of the water exiting the reclamation is similar to the quality of the water in the adjacent location
- At a minimum, fortnightly aerial monitoring of the movement of the dredge to and from the disposal site;
- Development of a water quality monitoring programme around the dredge and fill sites for suspended solids, Turbidity and DO during and after the dredging. This would be carried out weekly for the first month and fortnightly for subsequent months until the reclamation berm has been completed.

Once the containment bund is in place, risk of sediment coming from the reclamation will be minimised, as placement of material will be within the bund. Any overflow water will go into settlement ponds, with weirs to prevent silt returning into the sea.

Water quality monitoring programme should be carried out weekly during the dredging, and should be supplemented by weekly aerial observations. Aerial observations and ground monitoring should be coordinated to occur simultaneously as far as possible.

8.1.2 Coastal Dynamics

Given the persistent westward longshore sand transport and wave forcing, the expansion at Fort Augusta will likely further reduce sand supply from the east with implications for the state of the shoreline west of the proposed reclamation. As discussed in the wave modelling results, the construction of the Fort Augusta expansion will result in a rather strong gradient of the wave energy, which may subsequently result in additional stress to the beaches to the west.

Overall, the proposed expansion has little influence on the flow patterns even at local scales. The flow modelling illustrated an ebb-domination pattern along the project shoreline. This ebb domination, in addition to the highly oblique waves generated by the easterly wind, contributed to the beach erosion along that section of shoreline to the wet of the proposed expansion. It is recommended that some shore protection measures be developed for the shoreline west of the proposed expansion to mitigate against further erosion due to the proposed shoreline modification.

Alternative 1

A beach nourishment project could be implemented to restore the severely depleted beach to the west of Ft. Augusta land reclamation area with a re-nourishment cycle of approximately every five years.

The nourishment could take advantage of the dredged sediment from the channel deepening. In addition to sub-aqueous disposal of the dredged material, a small portion of the dredged material could be disposed along the shoreline west of the proposed reclamation to restore the severely eroding beach. Based on the above sediment budget analysis, the restored beach should last for at least 5 years before a re-nourishment project would need to be considered.

Alternative 2

Deposit suitable dredged material at the northeast corner of the proposed reclamation and allow the natural coastal processes to distribute the material westward over time.

8.2 Ecology

The mitigation plan should be implemented through a joint programme between the PAJ, Fisheries Division and UWI, Centre for Marine Sciences. It is recommended that the plan address direct impacts from the dredging and reclamation activities through a mix of interventions. The area proposed for reclamation (R4) is a known shrimp habitat shrimp habitat whose function will be lost due to the development. The mitigation of this loss will be carried out through the replanting of the removed seagrass at suitable sites. The replanting must be carried out bearing in mind the need to assess the specific importance of the area to be lost, to the life cycle of the shrimp. The detailed seagrass mitigation plan is presented at **Appendix 5.**

Recommended mitigation for the construction of the "reclamation" area and the widening of the nearby channel include:

- Initial dredging to a slightly greater depth than absolutely necessary thereby reducing the need for maintenance dredging;
- Careful mapping of seagrass areas to be directly affected by the dredging/reclamation and replanting as required by NEPA to compensate for possible mortality. The approach to the identification of candidate sites for seagrass replanting will be guided by a desk study to establish areas of seagrass coverage in Kingston Harbour and environs (if necessary) over the last 10 to 15 years. This information would be evaluated in conjunction with critical physical parameters including light, temperature, turbidity/TSS, salinity and wave energy to identify sites where transplantation is likely to be most successful;

The following specific measures are recommended to address impact to shrimp/fish ecology:

- Development of suitable habitat to increase population size available for harvesting. Creating viable alternative fishing sites through habitat enhancement. This will be achieved in part through the replanting of seagrass;

- Use of artificial reefs which have been scientifically proven to create viable habitat for fisheries, and have been successfully deployed in many fisheries globally;

- Identification of suitable sites for habitat creation and mitigation in consultation with the Fisheries Division.

8.3 Fishing Interests/Other Harbour Users

Negative socioeconomic impact on the fishing community will be mitigated through the joint programme between the PAJ and Fisheries Division. Users of the harbour need to be aware of planned activities and alternatives available and/or recommended for them. This is especially necessary during dredging activities. Using appropriate tools to control sediment plumes and pollution will reduce impact on fisheries.

Based on consultation with the Fisheries Division the following specific measures are recommended to address impact to fishers:

- Clear demarcation of restricted areas to reduce conflict with fishers and reduce damage to fishing gear. Consultation and communication at all stages of project planning and implementation will increase awareness, reduce conflict and also minimise physical damage to gear;

- Establishment of a fund to compensate for verifiable loss of fishing gear, disruption in activity and other operational losses associated with the dredging reclamation activities. This fund could be used to finance a mix of activities including but not necessarily limited to:

- Purchasing motorised craft for leasing or granting to displaced fishers who have successfully completed training in operating these crafts;
- Making payments to those directly affected;
- Training of fishers in alternative livelihoods;

Heritage Sites

A plan of action to preserve the integrity of heritage sites should be developed in collaboration/consultation with the JNHT. This will include but not necessarily limited to the following:

- All necessary precautions to be taken to prevent siltation of the Sunken City of Port Royal. This includes the establishment of siltation traps/screens;
- No docking or increased vessel traffic in and around Port Royal other than the Ship channel;
- No dredging within 100 meter of the boundaries of Ft. Augusta;
- No excavation in and around the location of the historical graves;
- Establish a one hundred meter setback between the new development and the southwest corner of Fort Augusta;
- No other development to be implemented around Fort Augusta without prior consultation with the JNHT;
- Archaeological Watching Brief (Monitoring) to be funded by the Port Authority throughout the dredging and dumping phase of the project.

Waste Disposal

Any site identified for disposing of dredge material should be assessed for potential impacts and the necessary measures taken to protect the environment and human health.

Public Perception

There was strong support for the proposed development and it was believed that it is important to community and national development. Keeping the public abreast of planned activities before project start-up and as it progresses and communicating mitigation and monitoring plans to minimise negative impacts will increase awareness and acceptance.

9. DRAFT ENVIRONMENTAL MONITORING PLAN

It is recommended that during the actual dredging and disposal procedures, a monitoring programme be implemented. This programme should include the following:

- An examination of all important environmental parameters should be carried out during the first week of the operation. If no adverse effects are noted, monitoring should be fortnightly. This monitoring will be carried out more frequently during unusual weather conditions, or if adverse effects are noted.
- Turbidity and other sensitive water quality readings should be taken at all sensitive areas outside of the area of the screens initially, and at regular intervals throughout the operation.
- Current readings and examination of plumes should be taken on a spot check basis throughout the area of interest.
- Aerial photographs (unannounced) should be taken regularly to determine if the dredge is operating according to recommendations.
- Fortnightly soundings at the approved offshore dump site;
- A continuous record of wind speed and direction should be made throughout the period of dredging.

Fortnightly reports should be sent to the NEPA on the dredging activities unless conditions develop which warrant more frequent reporting. Spot checks should be done on nearby reefs to monitor any siltation at least once per month, preferably every two weeks.

9.1 SCOPE AND METHODOLOGY

The monitoring programme is designed to ensure that the requirements of the Licence and Permit granted by the NEPA will be met. Monitoring and mitigation of impacts during the implementation of the project will also require co-ordinated scheduling of activities between the Port Authority of Jamaica/dredge contractor and the consultants, as well as regular reports to NEPA.

Environmental chemistry and ecological parameters that may be affected by construction and operation of the development will be monitored to provide the data as needed.

Field observations and measurements will be correlated simultaneously with weather prevailing conditions, so that any change in weather can be compensated for. In order to abide by the terms of the Licence and the Permit set by the authorities, and certify satisfactory completion of the project, it will be necessary to perform the following:

a. **The monitoring of water quality parameters**, to include but not necessarily restricted to Turbidity, Total Suspended Solids (TSS), and Dissolved Oxygen (DO) during the implementation and post construction phases of the project. Samples will be collected at various locations (approved by the NEPA) twice during the first week of operation, weekly and then at weekly or fortnightly intervals, depending on the nature of the activities being carried out at the time. (See Monitoring Plan Appendix). Monitoring will be carried out more frequently as required if the results of initial monitoring suggest that there is a potential threat to the environment.

b. **Random aerial photographs** will be taken at regular intervals to determine whether the project is being carried out according to the stipulations of the Permit.

c. **A suite of ecological observations** would be required to observe any changes in the composition of marine, (benthic, pelagic) and terrestrial flora and fauna;

d. **Coastal dynamics** would require current readings and examination of plumes be taken on a spot check basis throughout the area of interest.

e. Final monitoring will be carried out at least three weeks after the works are complete or according to the specific requirements for post project monitoring dictated by NEPA.

9.2 WATER QUALITY MONITORING

Sample Collection

Surface and sub-surface water samples will be collected at all sites where water depth exceeds 2m using a Van Dorn sampler or similar device. For depth less than 2m a single sample will be collected at .3m below the surface. Surface samples will be designated “T” and bottom samples will be designated “B”. Sampling at surface and bottom will be carried out during the first month to establish variation with depth. In subsequent months sampling will be restricted to the surface. Field measurements will however be taken at surface and bottom throughout the monitoring exercise.

Sampling will be carried out regularly before and during the dredging as follows: fortnightly monitoring for the suite of parameters beginning four weeks before the anticipated beginning of the dredging, twice in the first week after commencement of dredging then weekly thereafter. This could be modified if the environmental situation in the field requires more frequent monitoring. The post construction monitoring of the project will continue for the periods to be stipulated in the licenses and will include all of the parameters requested for each site, except for instances where NEPA has indicated specific post project monitoring with detailed reporting schedules. Sites to be sampled will be selected from those investigated for the EIA (**Figure 4** and **Figure 5**)

Sample Analysis

Laboratory analyses will be carried out by local facilities in accordance with Standard Methods for the Analysis of Water and Wastewater or EPA methodology to determine levels of TSS, Turbidity. Dissolved Oxygen (DO), temperature, salinity and any other parameters as required by conditions of the permit. Methodology will be that presented at **Table 3.**

9.3 ECOLOGY

Technical integrity of dredging operation to be monitored throughout the construction phase. The following activities should be carried out on a daily basis:

- Inspect along the length of sediment curtains and spoil delivery pipes for overflows and leakages;
- Monitor and assess sediment plumes along random spots throughout the area of impact when dredging/reclamation operations are ongoing or recently completed in the stated areas;
- Turbidity and other water quality readings will be taken at all sensitive areas to be identified outside of the area of the screens initially, and at regular intervals throughout the operation, including Port Royal and environs including the vicinity of the sunken city;
- Aerial monitoring of the dredge operation to ensure proper containment of the sediment plumes and run-off from the reclamation;
- Monitoring in the vicinity of landside landfill area to assess any impacts (e.g. runoff) throughout the period of deposition;
- Spot checks to be done on nearby reefs and seagrass areas to monitor the extent of siltation at least once per month and if possible, every two weeks.

Monitoring sites will be selected in collaboration with NEPA from those sites investigated for the EIA (**Figure 11**).

9.4 OUTPUT

The information from the monitoring exercise will be used by the consultant to guide the Port Authority regarding the efficacy of the mitigation measures being implemented. Any changes required to enhance the effectiveness of existing mitigation actions would then be recommended. Monitoring reports will contain the results of water quality and ecological examinations, as well as photographic monitoring carried out, in the period preceding the report, as well as recommendations for action, if required, for improving the construction process from an Environmental perspective. Data will be presented in both tabular and spatial form on maps prepared for this purpose. Monitoring reports would be produced according to the following schedule, in hard copy and electronic format:

1. Monitoring Report No. 1 - within one week following commencement of construction;
2. Monitoring Reports No. 2 onwards – three weeks after the end of the monthly monitoring period or as required by the permit conditions;
3. Post Project Monitoring will take place three weeks after the works are complete and the Final Monitoring Report will be submitted within four weeks after completion of the post project monitoring, except for instances where NEPA has indicated specific post project monitoring with detailed reporting schedules.

10. ALTERNATIVES TO THE PROJECT

No alternatives to this project are being considered at this time.

11. CONCLUSION

The present EIA addressees the proposal by the Port Authority of Jamaica to deepen the Port Bustamante Basin and areas of the Ship Channel to accommodate larger container vessels and use some of the dredged material to reclaim land adjacent to Fort Augusta for future development as a container terminal. Implementation of the project will position Jamaica as a trans-shipment point for the largest cargo vessels within the Caribbean and Latin American region. The project will positively impact the earnings of the shipping industry in Jamaica by increasing the number, types of ships and cargo volume passing through the port.

Analysis of the potential environmental and social impacts during/after the construction and after the upgrade, as well as an assessment of the project alternatives was carried out within the framework of the study disciplines specified in the Terms of Reference. Within the project's zone of influence the **physical/chemical environment** was evaluated in terms of water and sediment quality within the greater Kingston Harbour and in the vicinity of the Fort Augusta expansion area. TSS levels within the study area were a little higher than the proposed NEPA ambient standard for sea water. The levels were also higher than the range determined in the area during previous work by TEMN in 2001. The main impact identified was an increase in suspended solids at the dredge site as well as possible transportation of this suspended matter to smother adjacent/down-current areas. Increased TSS/turbidity levels at both this and the reclamation works site were expected to be temporary and return to background levels days after cessation of the dredging event. Turbidity barriers, silt traps and berms are deemed sufficient for controlling or minimising the impact of the sediment plumes associated with dredging and reclamation activities. Toxic levels of heavy metals were not detected in the sediments to be dredged.

The **coastal dynamics investigation** used hydrodynamic field data to generate CMS-Wave modelling information. These results suggest that the proposed Fort Augusta expansion would have negligible influence on the overall flow patterns and wave conditions at local scales. The major influence of the expansion would be wave sheltering to the west of the proposed vertical seawall to induce a large gradient in wave height and in wave energies associated with long-shore sand transport. The resulting transport gradient would likely induce an ebb-dominated wave pattern combined with highly oblique waves (from easterly winds) along the project shoreline. These features could exacerbate beach erosion in areas with less sediment input than output and add to the already stressed condition along the beach there. Land reclamation has the potential to reduce the supply of sediments readily available to maintain shoreline stability immediately downcurrent. Shoreline erosion could conceivably spread northward to affect the southern border of the newly created "reclamation area". It is recommended that some shore protection measures be developed for the shoreline west of the proposed expansion to mitigate against further erosion due to the proposed shoreline modification.

The main focus of **the ecological survey** was to quantify the spatial extent of potentially vulnerable seagrass beds and identify the presence/absence of ecologically or commercially important species of flora or fauna in or immediately adjacent to the Fort Augusta reclamation site via aerial and benthic surveys. From aerial surveys, seagrass areas in the vicinity of the proposed reclamation site were estimated at 3.2 Ha. The seagrass beds were found mostly within a 50- 150 m band from shore at a depth of <2m, and were comprised primarily of climax community (*T. testudinum* – turtle grass) species with variable shoot densities between 100 and 450 shoots/m^2. Further from shore, the sediments were primarily fine sand, mud and silt from chronically elevated levels of suspended solids. Terrestrial impacts include the destruction of a beach habitat which is already degraded. Potential marine impacts include the loss of seagrass habitat and associated fauna (diversity) in the immediate dredge, donor and fill site areas; loss of feeding, nursery habitat (for turtles, fishes) and the loss of important shrimping grounds on the western side of the harbour. Increased hydrocarbon contaminant levels and re-suspension of bottom sediments during dredging, construction and subsequent operation of the facility have the potential to foul and destroy fishing gear and also create a chronic impact to reefs downcurrent and mangroves within the harbour. In Hunts Bay, where the benthic zone is anoxic from chronic organic pollution and high sedimentation levels, serious consideration should be given to protecting and where possible rehabilitating, existing nursery and shrimping grounds. Fisheries resources currently exploited by stakeholders at the six designated fishing beaches within the immediate vicinity of the proposed development area included declining stocks of shrimp, conch, lobsters and twenty nine species of coastal pelagics (herring, sprat, etc.), reef and reef associated finfish (snapper, parrot etc.) and the now rare, larger pelagic fish such as dolphin fish, kingfish, mackerel and jacks. Many fishers interviewed stated that the declining stock situation was forcing them to go farther afield from their normal fishing grounds. Fishers also stated that past dredging projects in the harbour had a negative impact on fish abundance and that the recovery time for the fishery was between four and ten years. Hunts Bay was identified as an important nursery area for the harbour shrimp population and suitable for rehabilitation and eventual declaration as a fish sanctuary. Any site identified for disposing of dredge material should be assessed for potential impacts and the necessary measures taken to protect the environment and human health.

The **socioeconomic study** examined the relevant public perception, land use and cultural aspects of the area at micro (local), regional (parish) and macro (national) levels within a 2 km radius of the proposed dredge and reclamation sites. The proposed development site is located in one of the most important economic zones of the country. Economic activities include industrial, commercial and shipping activities of the Kingston Wharves, warehouse operators, brokerage firms and supporting banking services at Newport West. The fishing communities, retail trade, commercial services and fishing also contribute to economic activities in the area. Land use impacts were limited to traffic considerations from the movement of workers to and from work and heavy vehicles related to port construction and operations. The dredging operation is expected to impact vessel traffic, and in this regard, the PAJ and the Harbour Master will need to agree with the dredging contractor, the necessary measures to minimize traffic delays. Increased employment potential and high value revenue generation from associated business development will be important at local and national levels however these benefits may not extend to existing stakeholders (fishermen) unless intensive ecosystem rehabilitation measures are implemented in the vicinity. During dredging, loss of recreational beach use within the area was identified as a main negative impact for resident stakeholders especially when dredging was taking place. A plan of action to preserve the integrity of heritage sites should be developed in collaboration/consultation with the JNHT.

The rapid impact assessment matrix for the present case (which includes the “do nothing” scenario) produces very negative overall scores (ES= -42; RV= -4) for all categories or disciplines examined. The RIAM scores from the construction phase of the project are even more negative (ES= -321; RV= -5) or representative of degrading impacts for the environment. Scores for the preferred project alternative with mitigation are positive (ES= +60; RV= +4) and indicative of improved environmental conditions.

Several important actions will be required to mitigate the negative impacts associated with this proposed development. They range from efforts to minimise the spread of sediment laden waters; maintaining sand supply to eroding beaches in the area and include actions that replace lost marine habitat and improve biodiversity and ecosystem productivity. Techniques to ensure adequate communication with stakeholders in the area to modify their daily operational routines so as to minimise the impacts to them individually or as a group as well as compensation for any actual loss of income by stakeholders during and after construction activity also needs to be considered.

The local fishermen expressed concern over the impact that any dredging operations may have on fish stocks, however; in general there was strong public support for the proposed development as it is considered important to community and national development. Keeping the public abreast of planned activities before project start-up and as it progresses, as well as communicating mitigation and monitoring plans to minimise negative impacts will increase awareness and acceptance. A monitoring plan should be used as a management tool to provide evidence, measured against baseline parameters established *a priori*, which can be used to support or mitigate impacts in a timely manner during the various phases of the project. Unscheduled aerial surveillance can be used to monitor dredge operations to ensure compliance.

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13. GLOSSARY OF TECHNICAL TERMS

(MSMEs)	Micro, Small and Medium-Sized Enterprises
cm/s	Centimetre per second
CMI	Caribbean Maritime Institute
CMS-FLOW	Coastal Modeling System-Flow Model
CMS-WAVE	Coastal Modeling System-WAVE Model
EHU	The Environmental Health Unit
EIA	Environmental Impact Assessment
ENACT	Environmental Action Programme
ES	Environmental Score
ESRI	Environmental Systems Research Institute, Inc.
ESSJ	Economic and Social Survey of Jamaica
FA	Fort Augusta
GDP	Gross Domestic Product
GIS	Geographic information system
HQI	Housing Quality Index
ISPS Code	International Ship and Port Facility Security Code
JNHT	Jamaica National Heritage Trust
JPSCo	Jamaica Public Service Company
JSLC	Jamaica Survey of Living Conditions
JUTC	Jamaica Urban Transport Company
KCT	Kingston Container Terminal
KMA	Kingston Metropolitan Area
KSA	Kingston and St. Andrew
KSAC	Kingston & St. Andrew Corporation
LPG	Liquefied Petroleum Gas
m/s	Metres per second
MARPOL	The International Convention for the Prevention of Pollution from Ships
mg/l	Miligrams per litre
MMD	Mott MacDonald
MPM	Metropolitan Parks and Market
NEPA	National Environment and Planning Agency
NLA	National Land Agency
NMIA	Norman Manley International Airport
NRCA	Natural Resources C0nservation Authority
NSWMA	National Solid Waste Management Authority
NWC **PAJ**	The National Water Commission Port Authority of Jamaica
PIOJ	Planning Institute of Jamaica
RIAM	Rapid Impact Assessment Matrix
RV (Alphabetic)	Range Value (equivalent to environmental score) A - E or N

RV (Numeric)	Range Value (equivalent to environmental score) -5 to +5
SIA	Socioeconomic Impact Assessment
SOLAS	International Convention for the Safety of Life at Sea
SPAW	Specially Protected Areas and Wildlife
STATIN	Statistical Institute of Jamaica
TEMN	Technological and Environmental Management Network
TEU	Twenty-foot Equivalent Unit
UAV	Unmanned Air Vehicle
WTPs	Wastewater Treatment Plants

14. APPENDIX

APPENDIX 1a – GENERIC TERMS OF REFERENCE

Notes for NEPA for Generic Terms of Reference

This generic Terms of Reference (TOR) is applicable to **Drainage Projects, Dredging & Excavation and Land Reclamation & Modification** (including the reclamation of wetlands and riverine areas). The TOR outlines the aspects of an Environmental Impact Assessment (EIA) which when thoroughly addressed will provide a comprehensive evaluation of the site, in terms of predicted environmental impacts, needed mitigation strategies, potentially viable alternatives to the proposed development and all related legislation.

In reality, significant environmental issues may be site specific and it is expected that these be incorporated accordingly. Sites of special consideration are:

Coastal Areas: Areas to be considered as coastal should include estuarine areas where a river flows into the sea. Issues such as Coastline stability, coral reef, mangrove and wetland, seagrass impacts, unique coastal environments, saline intrusion upstream which may introduce contaminants to the river system, nutrient loading in coastal waters and impact on coastal commercial fishing should be examined. If dredging will be involved, the spoil disposal site should be evaluated equally with the proposed port infrastructure sites.

Upland Areas: Issues such as slope stability, impact on drainage patterns, property etc. should be examined.

Rivers/ Riverine Areas: Issues such as erosion and siltation, nutrient loading of the river system, macro-invertebrate habitat destruction and loss of biodiversity. Disrupting of regular flow of the river and the possible impact of upstream activities on the mangrove, sea grass, and coral reef systems needs to be assessed.

Sites located within and adjacent to areas listed as protected or having protected species: The main issue(s) of concern will in part be determined by the local legislation as well as GOJ responsibilities under applicable international conventions. The impact of the development on the specific sensitivities of the protected area should be highlighted. Mitigation of impacts should assess if the post mitigation status would be acceptable in the protected area context. Alternative sites should be rigorously evaluated.

Dredging and excavation are processes which involve the sediment/substrate removal. Consequently special attention must be paid to the technique and equipment to be used to ensure that sediment/substrate instability is minimised, as is the spread of spoil plumes in the water body being dredged. An assessment of recycling or re-using the spoil from dredging or excavation must be explored. Drainage projects have special issues of concern. These include habitat loss by virtue of drainage, change in drainage and flooding potential, the safe disposal/relocation of drained fluid, habitat loss and destruction.

Any type of land reclamation needs special consideration. Land reclamation of wetlands, riverine or estuarine, needs critical examination. The wetland ecosystem has been proven to be among the most productive of worldwide ecosystems. Consequently any reclamation of these areas will result in a net loss of species biodiversity and loss of specialised habitats and niches. Issues of special consideration include, fluid displacement, change in drainage patterns, flooding potential and reduced water retention capacity of sediment/substrate. The possibility of the displaced fluid reclaiming its area needs to be critically examined.

Terms of Reference

The Environmental Impact Assessment should:

1) Provide a complete description of the existing area proposed for modification. Detail the elements of the project, highlighting areas to be reserved for drainage/dredging/excavation/land reclamation and the areas which are to be preserved in their existing state.
2) Identify the major environmental issues of concern through the presentation of baseline data which should include social and cultural considerations. Assess public perception of the proposed development.
3) Outline the Legislations and Regulations relevant to the project.
4) Predict the likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and indicate their relative importance to the design of the development's facilities.
5) Identify mitigation action to be taken to minimise adverse impacts and quantify associated costs.
6) Design a Monitoring Plan which should ensure that the mitigation plan is adhered to.
7) Describe the alternatives to the project that could be considered at that site

To ensure that a thorough Environmental Impact Assessment is carried out, it is expected that the following tasks be undertaken:

Task #1. Description of the Project

Provide a comprehensive description of the project, noting areas to be reserved for modification, areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment. This should involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate, and include information on location, general layout and size, as well as detailed pre-, and post project plans. For projects to be done on a phased basis it is expected that all phases be clearly defined, the relevant time schedules provided and phased maps, diagrams and appropriate visual aids be included. This should involve the use of maps, site plans and other graphic aids, as appropriate, and include information on location, general layout and size,.

Task #2. Description of the Environment

This task involves the generation of baseline data which is used to describe the study area as follows:

i) physical environment
ii) biological environment
iii) socio-economic and cultural constraints.

It is expected that methodologies employed to obtain baseline and other data be clearly detailed.

Baseline data should include:

(A) Physical

i) a detailed description of the existing **geology** and **hydrology.** Special emphasis should be placed on storm water run-off, flooding potential, drainage patterns and any effect on groundwater by modification of the substrate/sediment. Any substrate stability issues that could arise should be thoroughly explored.

ii) **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the development. Quality Indicators should include but not necessarily be limited to nitrates, phosphates, faecal coliform, and suspended solids.

iii) Climatic conditions and air quality in the area of influence, including particulate emissions from stationary or mobile sources, NO_x, SO_x, wind speed and direction, precipitation, relative humidity and ambient temperatures,

iv) Noise levels of undeveloped site and the ambient noise in the area of influence.

v) Obvious sources of pollution existing and extent of contamination.

vi) Availability of waste management facilities.

(B) Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic) of the area, with special emphasis on rare, endemic, protected or endangered species. Migratory species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Generally, species dependence, niche specificity, community structure and diversity ought to be considered. Special attention should be paid to any coral reefs and seagrass beds proposed for modification.

(C) Socio-economic & cultural

Present and projected population; present and proposed land use; planned development activities, issues relating to squatting , community structure, employment, distribution of income, goods and services; recreation; public health and safety; cultural peculiarities, aspirations and attitudes should be explored. The historical importance of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires.

Task #3 - Legislative and Regulatory Considerations

Outline the pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the NRCA Act, the Wildlife Protection Act, the Forestry Act, the Town and Country Planning Act, The Port Authority Act (if dredging is involved), and the appropriate international convention/protocol/treaty where applicable.

Task #4 - Identification of Potential Impacts

Identify the major environmental and public health issues of concern and indicate their relative importance to the design project. Identify potential impacts as they relate to, (but are not restricted by) the following:

- change in drainage pattern
- flooding potential
- landscape impacts of excavation and construction
- loss of natural features, habitats and species by modification
- Impact on coastal stability
- pollution of coastal, surface and ground waters
- impact of dredging and excavation and spoil disposal
- impact of spoil plumes generated by dredging
- Air pollution
- capacity and design parameters of proposed waste treatment facility (If any).
- socio-economic and cultural impacts.
- risk assessment
- noise
- coral reef smothering, proliferation of macro algal species and loss of sea grass beds.
- solid waste management.

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts. Identify avoidable as well as irreversible impacts. Characterise the extent and quality of the available data, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should be represented in matrix form with separate matrices for pre and post mitigation scenarios.

Task #5 Mitigation

Prepare guidelines for avoiding, as far as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development. Quantify and assign financial and economic values to mitigating methods.

Task #6 - Monitoring

Design a plan to monitor implementation of mitigatory or compensatory measures and project impacts during and post development. An Environmental Management Plan for the long term operations of the facility should also be prepared.

An outline monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit license(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

The Monitoring report should also include, at minimum:

- Raw data collected. Tables and graphs are to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

Task #7 - Project Alternatives

Examine alternatives to the project including the no-action alternative. This examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself. Refer to NEPA guidelines for EIA preparation.

All Findings must be presented in the EIA report and must reflect the headings in the body of the TORs, as well as references. Eight hard copies and an electronic copy of the report should be submitted. The report should include an appendix with items such as maps, site plans, the study team, photographs, and other relevant information.

APPENDIX 1b – NEPA TERMS OF REFERENCE

Ref: 2012-01017-BL00031

25 September 2012

Mr. Mervis Edghill Port
Authority of Jamaica 15-17
Duke Street Kingston

Dear Mr. Edghill:

Re: Application for a Beach Licence under the Beach Control Act. 1956 in respect of Dredging at Kingston Harbour. Kingston.

Reference is made to the captioned, document entitled "Kingston Harbour Channel Upgrade Dredging at Kingston Harbour: Project Details" dated August 2012, meeting on the 12 September 2012 with the Port Authority of Jamaica (PAJ) and Technological & Environmental Management Network Limited (TEMN) and your letter dated 19 September 2012.

As discussed, the Agency hereby confirms that you will be required to conduct an Environmental Impact Assessment (EIA) for the proposed project. Attached for your use is the document tided "Terms of Reference for Environmental Impact Assessment for the Kingston Harbour Channel Upgrade at Kingston Harbour, Kingston by the Port Authority of Jamaica". You are required to review the attached documents and submit any comments you may have to allow for the finalization of the TOR in advance of the EIA.

Additionally, please be advised that with due consideration to the request by PAJ for a reconsideration of the need for a chemical analysis of the sediments in the area proposed to be dredged; the Agency remains resolute with the requirement for the following reasons:

- The disposal of any material at sea is subject to obligations under the London Convention (1972) and it is imperative that the information being requested is available as a consequence.
- A study conducted by the Agency has indicated that within the harbour the concentration of various metals may be elevated and as such this information is required to guide any decision on the handling, use and disposal of the dredged material.

In light of the above, the requirement for the chemical analysis of the sediments has been included in the Terms of Reference for the Environmental Impact Assessment. If there are any queries, please do not hesitate to contact the undersigned or Miguel Nelson at 754-7540 ext. 2166 or email miguel.nelson@,nepa.gov.jm.

Yours Sincerely,
National Environment and Planning Agency

THE PORT AUTHORITY OF JAMAICA
SEP 27 2012
REGISTRY

Ainsley Henry
Directorj^Application Management Division
***for* Chief Executive Officer**

AH/mn

End.: Terms of Reference for Environmental Impact Assessment for the Kingston Harbour Channel U
Kingston Harbour, Kingston by the Port Authority of Jamaica

Any reply or subsequent reference to this communication should be addressed to the Chief Executive Officer, to the attention of the officer dealing wilfTthe matter, and the reference quoted where applicable.

Managing and protecting Jamaica s land, wood and water A
Government of Jamaica Agency

Terms of Reference for Environmental Impact Assessment for the Kingston Harbour Channel Upgrade at Kingston Harbour, Kingston by the Port Authority of Jamaica

The Environmental Impact Assessment (EIA) should include but not be limited to the following:

1) Introduction
2) Project Brief
3) Description of the proposed project in detail
4) Complete description of the existing site proposed for development
5) Policies, Legislation and Regulations relevant to the project
6) Identification and assessment of the potential direct, indirect, cumulative, positive and negative environmental impacts
7) Identification of proposed mitigation measures
8) Presentation of a draft Environmental Monitoring Plan
9) Assessment of public perception of the proposed development
10) Identification of alternatives to the project or aspects of the project that could be considered at that site or at any other location
11) Conclusions
12) List of References
13) Glossary of Technical Terms
14) Appendices (should include reference documents, maps, photographs, data tables, the composition, name and qualification of team that undertook the assessment, notes of public consultation sessions, sample of instruments used in community surveys, etc.)

1.0 Introduction

The Introduction should give a background, explain the need for and the context of the project

2.0 Project Brief

Gives a summary of the project activities, including site location maps and project timelines

3.0 Project Description

This section should provide:

- Detailed description of the project objectives and phases (where applicable), including all applicable timelines for the various aspects of the project (from pre to post development)
- Site maps illustrating areas to be developed and areas to be preserved in their existing state
- A comprehensive description of all aspects of the project noting areas for modification (dredging, reclamation, temporary storage and material disposal) supported by the use of maps, diagrams and other visual aids where appropriate. This description should detail all activities and features which will introduce risks or generate an impact (positive or negative) on the environment including but not limited to seagrass or coral relocation, wetland modification, sediment transport patterns
- Details of the quantity of material required to be dredged to maintain current operational depths, that required to achieve newly proposed operational depths and the fate of the dredged spoils, including what quantity and quality material is proposed to be reused for reclamation, stored for future use and disposed off
- Details of the methods and equipment to be employed to undertake each aspect of the project including dredging, transportation of dredged spoils, disposal of spoils, storage of material and secondary activities such as refueling of vessels

- Details of any required decommissioning of the works and/or facilities

4.0 Description of the Environment

This section should provide a complete description of the study area including geographical boundaries and methodologies used for the collection of baseline data. The description should include the following aspects of the environment:

4.1 Physical Environment

- Baseline water quality data which should include, but not be limited to; turbidity, TSS, TDS, hydrocarbons, heavy metals (total metals, Mercury, Lead, Arsenic, Copper, Vanadium, Chromium, Nickel, Zinc and Tin), conductivity, BOD and DO.
- chemical analysis of the sediments including but not limited to the concentration of the following metals: Mercury, Lead, Arsenic, Copper, Vanadium, Chromium, Nickel, Zinc and Tin
- Bathymetry of the site including areas to be dredged, reclaimed or used as temporary storage
- Obvious sources of existing pollution and extent of contamination

4.2 Biological Environment

- Detailed description of the flora and fauna (terrestrial and aquatic) present at the site with special emphasis on rare, threatened, endangered, endemic, protected, invasive and economically important species
- Identification and description of the different ecosystem types and structure including species dominance, dependence and diversity, habitat specificity and community structure
- Possible biological loss or habitat fragmentation

4.3 Socio-Economic

- Cultural and archaeological assessment conducted in collaboration with the Jamaica National Heritage Trust
- Assessment of the present and proposed uses at the site including any land acquisition needs and impacts on current users (fishermen, etc.) of the area during and post development

5.0 Policy, legislation & Regulatory Consideration

This section should provide details of the pertinent regulations, policies and standards governing environmental quality, safety and health, cultural significant finds, protection of endangered species and land use control. The examination of the legislation should include at a minimum the Natural Resources Conservation Authority Act, Beach Control Act, Jamaica National Heritage Trust Act, Wild Life Protection Act, Town and Country Planning Act, Harbours Act and the Fishing Industry Act and appropriate international conventions/protocols/treaties, where applicable.

6.0 Identification and Assessment/Analysis of Potential Impacts

This section should detail all significant potential environmental, health and safety impacts that may arise as a result of the development. The determination of significance of the identified impacts should be based on the classification of all the identified impacts/risks using appropriate criterion such as severity, duration, reversibility, etc. These should include but not be limited to:

- Loss of biodiversity at all proposed impacted sites
- Loss of ecosystem functions as a result of habitat loss and fragmentation
- Pollution and disturbance of the marine environment as result of incidents with equipment or vessels, etc.; increased turbidity; release of latent pollutants in the sediments and contamination of disposal, reclamation and storage sites
- Changes in the sediment transport and wave patterns, and coastline dynamics - including

erosion and accretion
- Loss of natural and archeologically significant features
- Socio-economic and cultural impacts including impacts on existing activities at the site and the surrounding areas

7.0 Mitigation

This section should provide practical solutions for avoiding, reducing and compensating (eg. restoration or rehabilitation) for any identified impacts, including the proposed timeline for the implementation these mitigation measures. Full details of the methods proposed to be employed in the implementation of these measures should be provided, including details on the materials and location. Where appropriate, maps and diagrams should be used to illustrate areas where mitigation measures are proposed to be implemented.

8.0 Environmental Monitoring

The Environmental Monitoring Plan should detail:
- the locations selected for monitoring
- the parameters which will be monitored for each activity or implemented mitigation measure
- the proposed methodology to employed for the monitoring of the various parameters
- the frequency of the monitoring
- the proposed format that the monitoring reports
- the frequency of the submission of the monitoring reports
- the responsible parties for the monitoring

9.0 Public Participation/Consultation

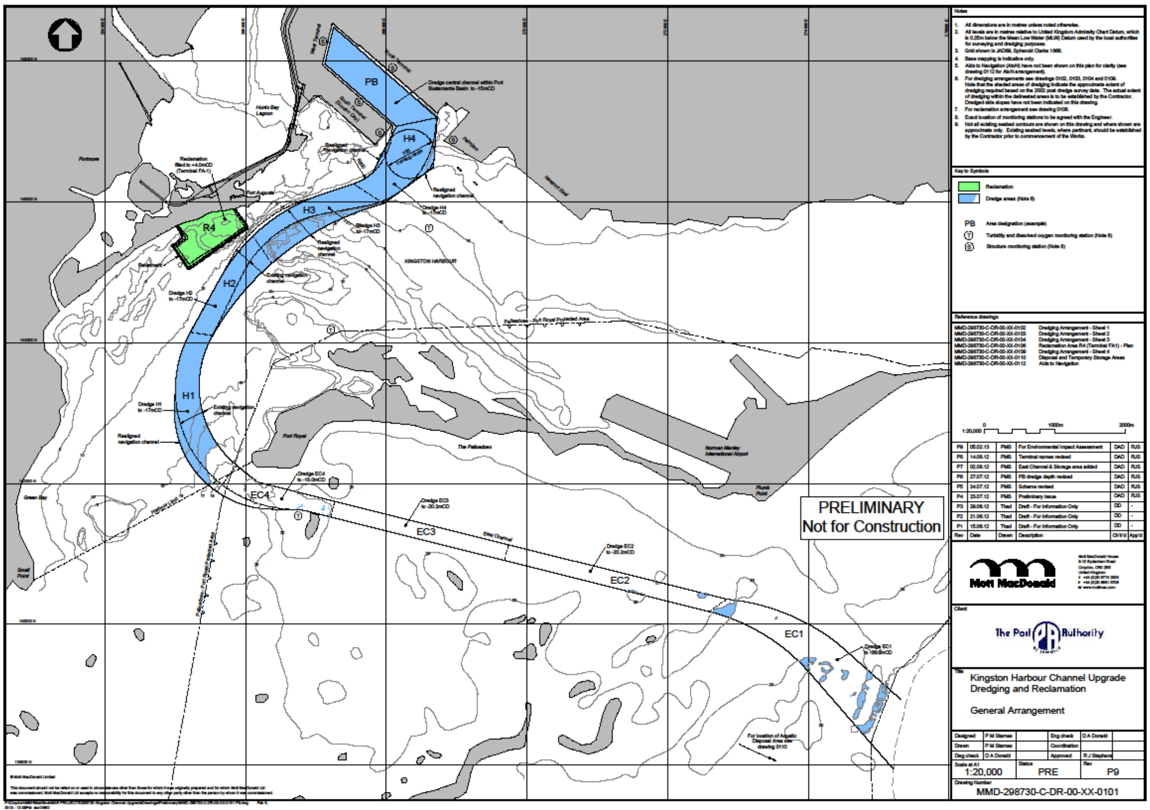
A public presentation of the EIA findings will be required to discuss, inform and solicit the comments of the public on the proposed development. This public presentation should be:
- Conducted at an appropriate location agreed to by the National Environment and Planning Agency (NEPA)
- Held in accordance with the NEPA's Guidelines for Conducting Public Presentations available on the Agency's website (www.nepa.gov.jm)

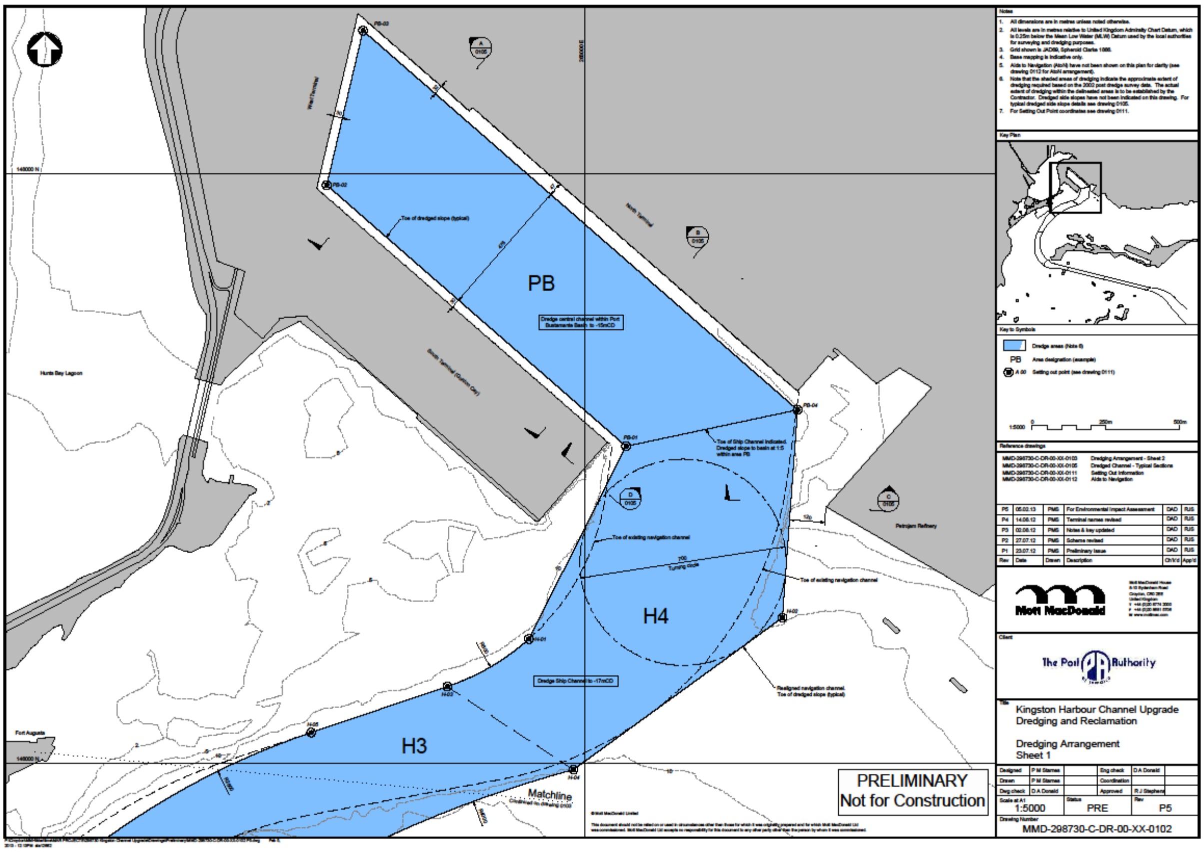
10.0 Identification of Alternatives

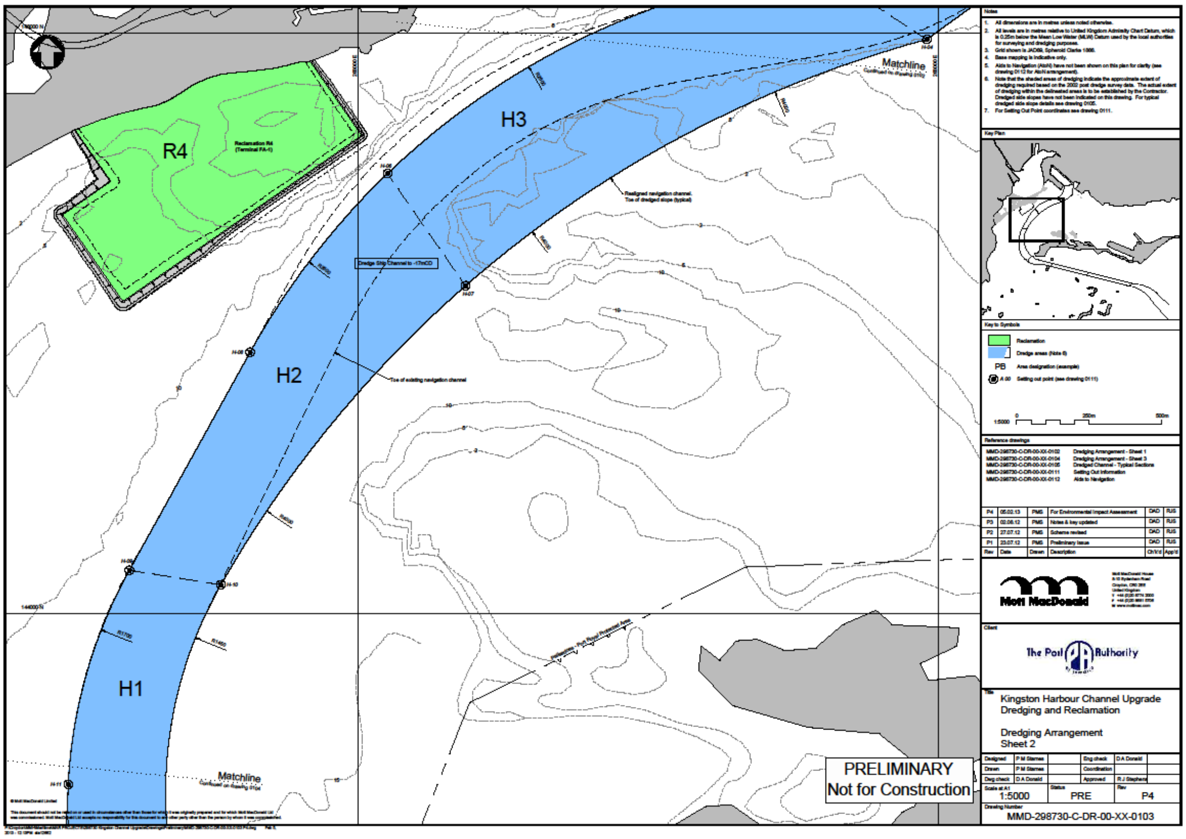
This section should examine and detail alternatives to the project or aspects of the project including the no-action alternative. This examination should incorporate the use history of the overall area in which the development is proposed and previous uses.

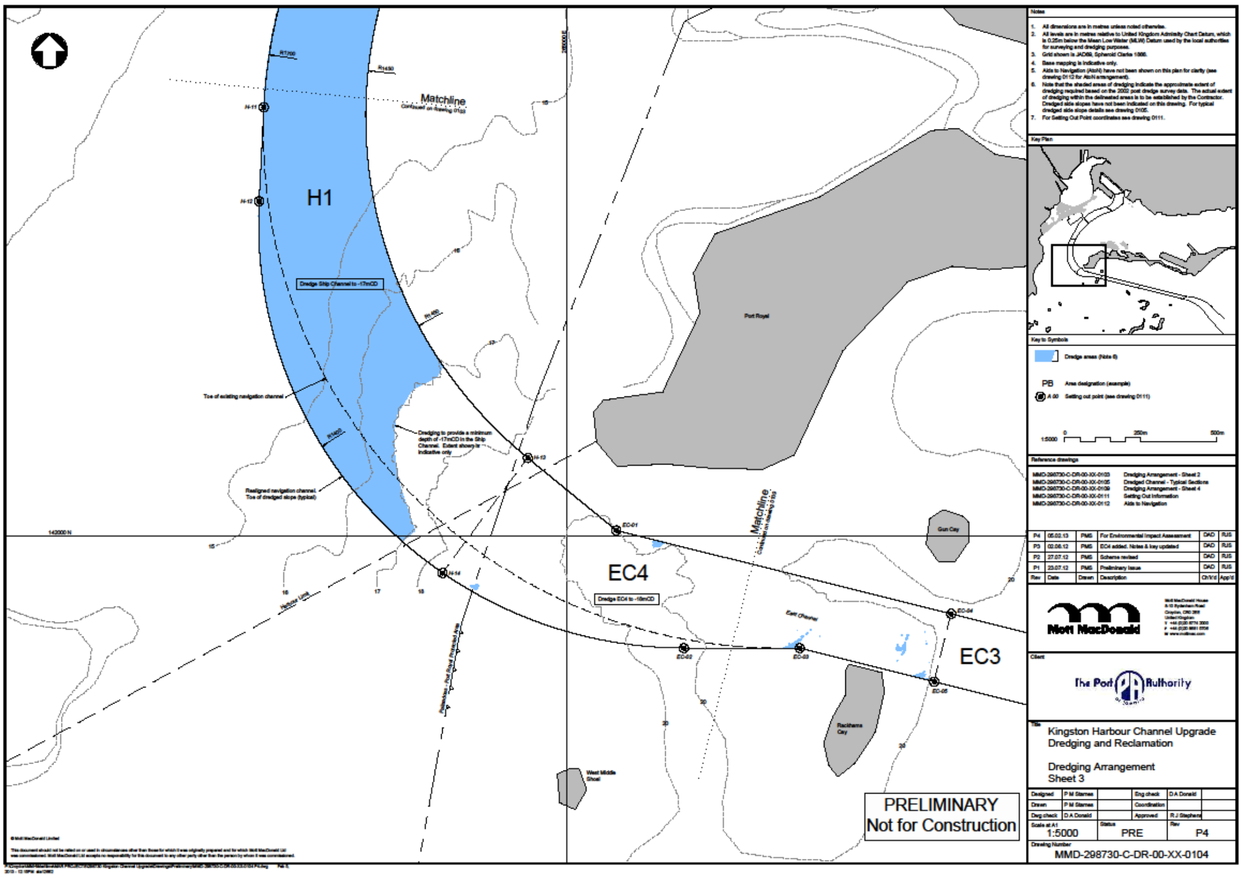
All findings must be presented in the EIA report and must reflect the headings in the body of the TOR, as well as references. Ten hard copies and an electronic copy of the report should be submitted. The EIA should include an appendix with items such as; maps, site plans, the study team, photographs, and other relevant information.

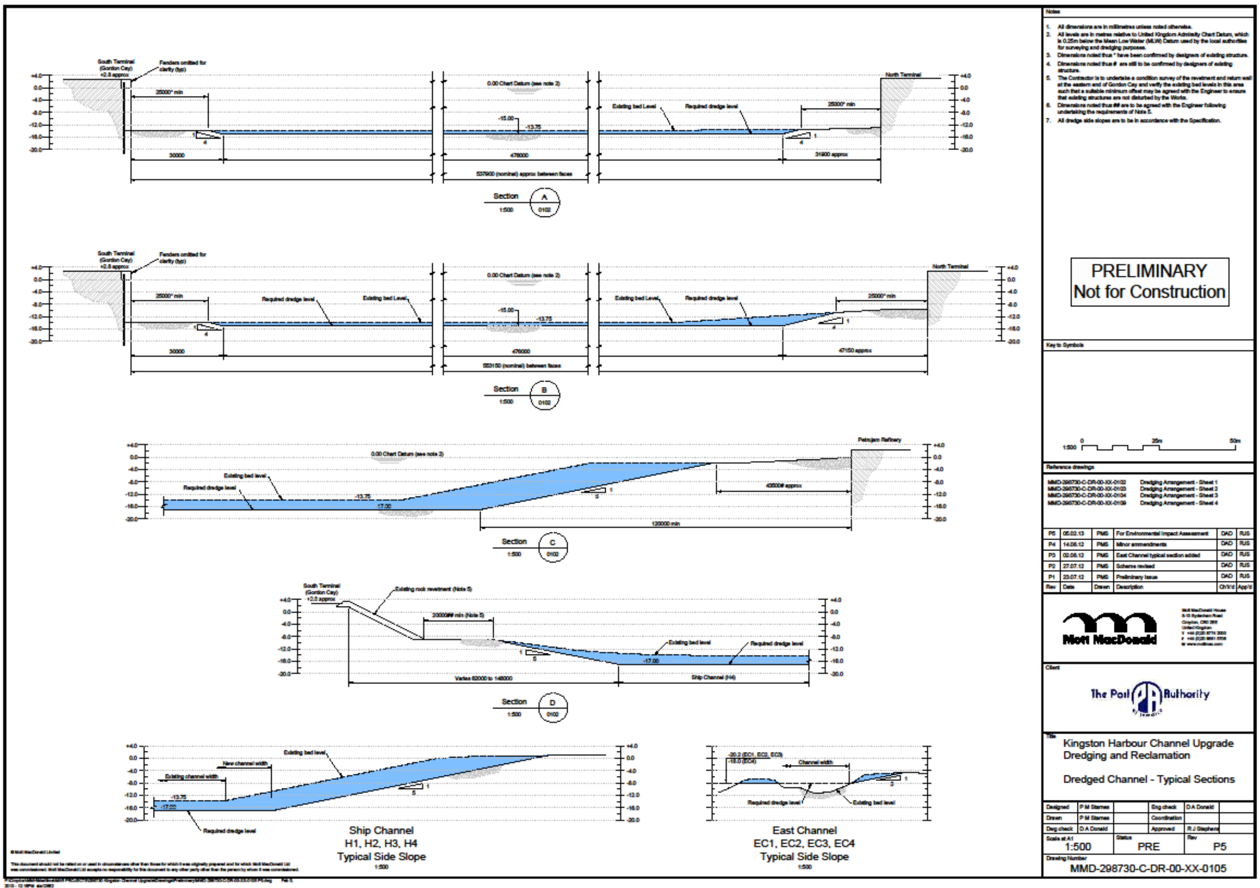
APPENDIX 2 – REFERENCE DRAWINGS

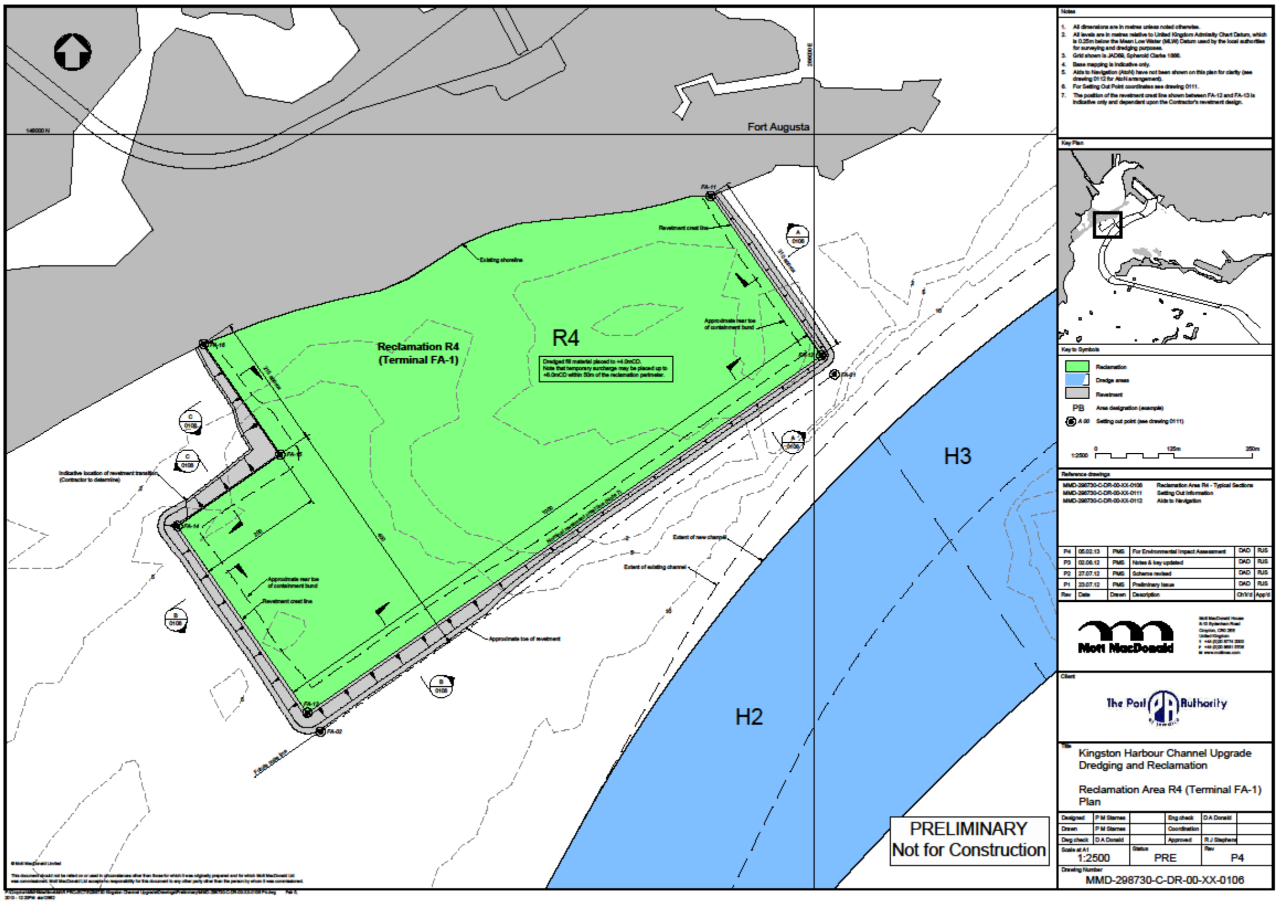


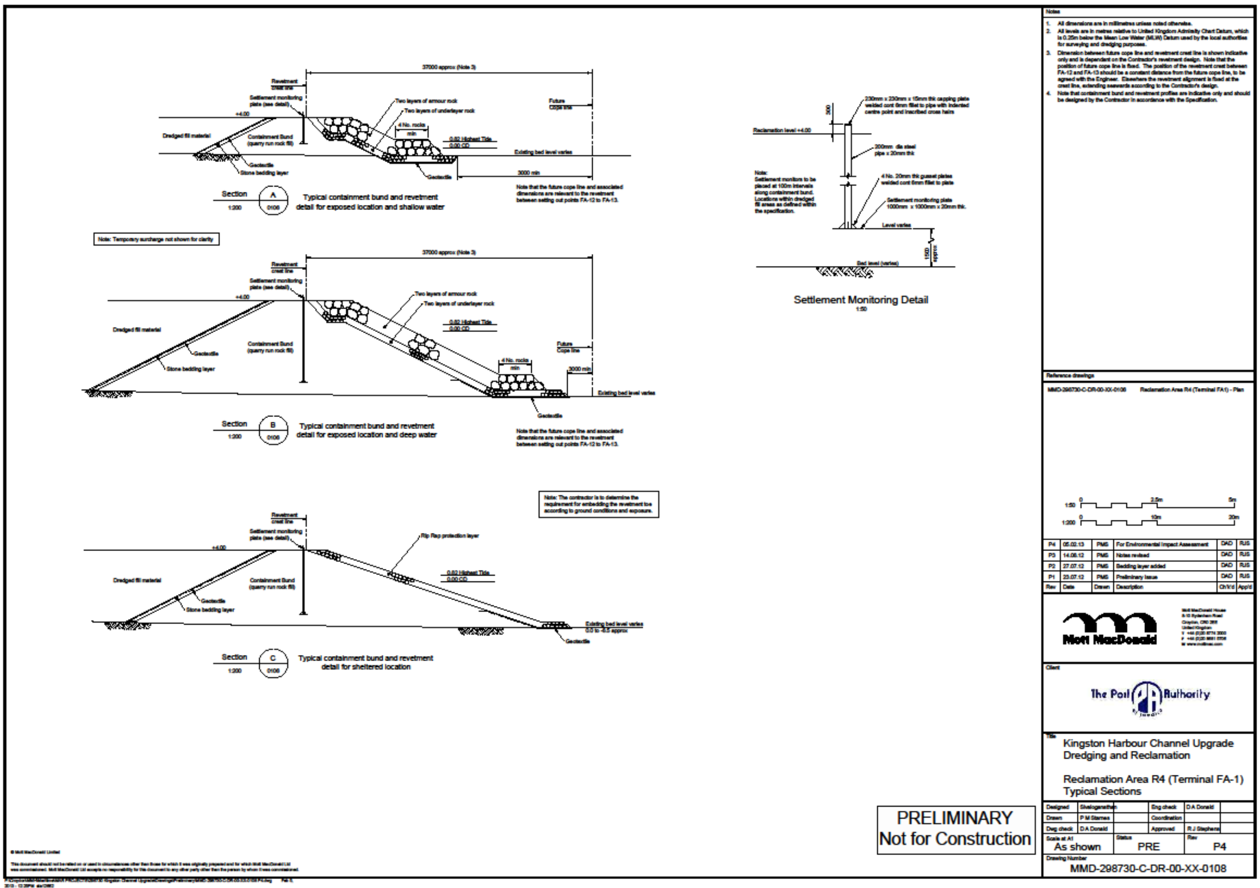

PB
H4
H3
Matchline
PRELIMINARY
Not for Construction
Mott MacDonald
The Port Authority
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Dredging Arrangement
Sheet 1
Designed
P M Starnes
Eng check
D A Donald
Drawn
P M Starnes
Coordination
Dwg check
D A Donald
Approved
R J Stephens
Scale at A1
1:5000
Status
PRE
Rev
P5
Drawing Number
MMD-298730-C-DR-00-XX-0102

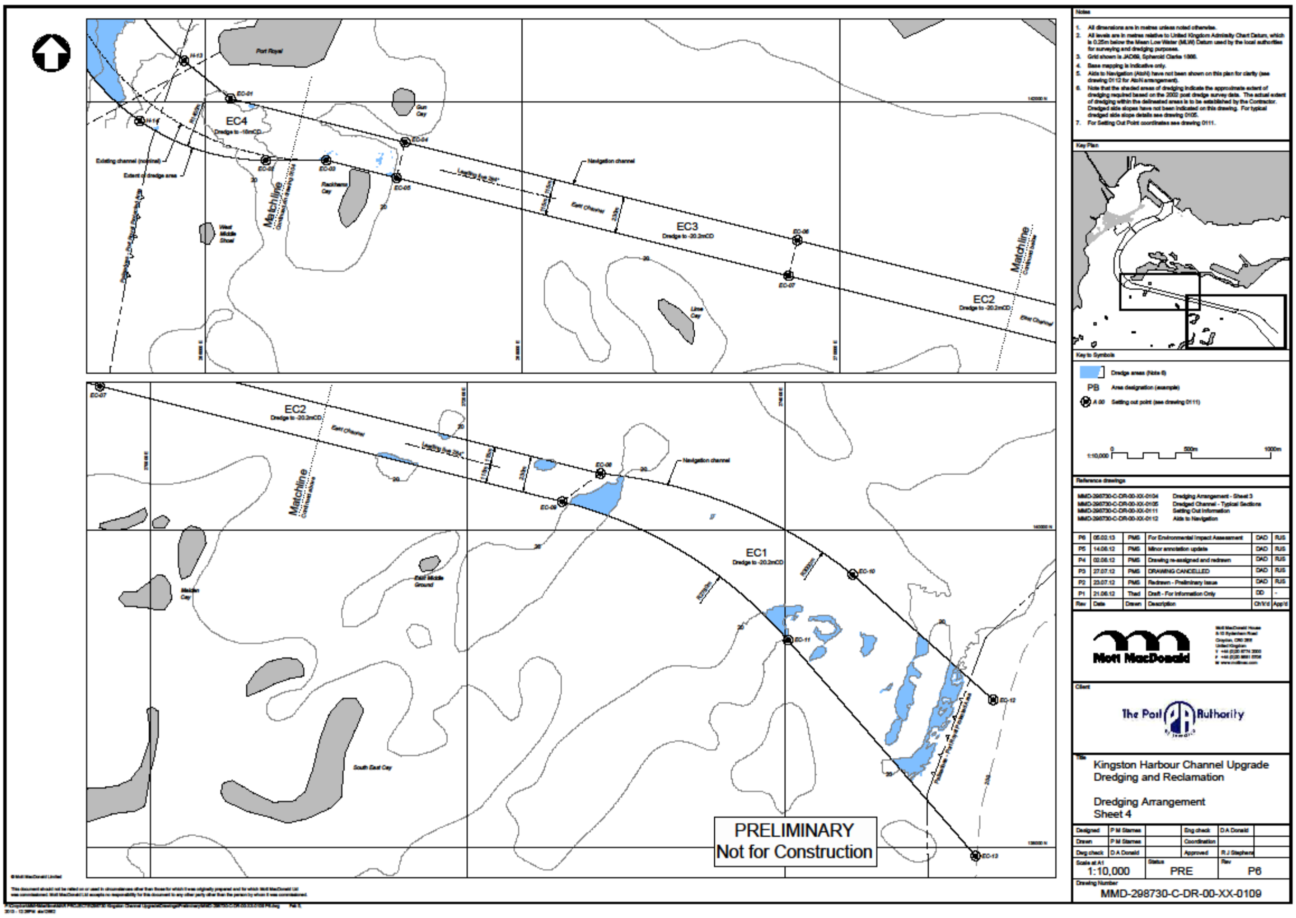

R4
H3
H2
H1
Matchline
Matchline
PRELIMINARY
Not for Construction
Mott MacDonald
The Port Authority
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Dredging Arrangement
Sheet 2
1:5000
PRE
P4
MMD-298730-C-DR-00-XX-0103


H1
Matchline
EC4
EC3
PRELIMINARY
Not for Construction
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Dredging Arrangement
Sheet 3
1:5000
PRE
P4
MMD-298730-C-DR-00-XX-0104


PRELIMINARY
Not for Construction
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Dredged Channel - Typical Sections
Ship Channel
H1, H2, H3, H4
Typical Side Slope
East Channel
EC1, EC2, EC3, EC4
Typical Side Slope
MMD-298730-C-DR-00-XX-0105


Fort Augusta
Reclamation R4
(Terminal FA-1)
R4
H3
H2
PRELIMINARY
Not for Construction
Mott MacDonald
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Reclamation Area R4 (Terminal FA-1)
Plan
1:2500
PRE
P4
MMD-298730-C-DR-00-XX-0106


Typical containment bund and revetment detail for exposed location and shallow water
Typical containment bund and revetment detail for exposed location and deep water
Typical containment bund and revetment detail for sheltered location
Settlement Monitoring Detail
PRELIMINARY
Not for Construction
Mott MacDonald
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Reclamation Area R4 (Terminal FA-1)
Typical Sections
Designed
Drawn
Dwg check
D A Donald
Eng check
Coordination
Approved
Scale at A1
As shown
Status
PRE
Rev
P4
Drawing Number
MMD-298730-C-DR-00-XX-0108


PRELIMINARY
Not for Construction
Kingston Harbour Channel Upgrade
Dredging and Reclamation
Dredging Arrangement
Sheet 4
MMD-298730-C-DR-00-XX-0109
1:10,000
PRE
P6
EC1
EC2
EC3
EC4

APPENDIX 3 – SIA QUESTIONNAIRE

PERSONAL CONFIDENTIAL

Personal Interview Schedule:
Kingston Container Terminal Capacity Expansion Project

Interviewer: ________________ Respondent ID: __________________
Date: ________________ Location __________________

Project Brief:
The Port Authority of Jamaica wishes to develop the infrastructure capacity at the Transshipment Terminal at Port Bustamante by deepening and widening the Ship Channel to handle the large Post-Panamax cargo vessels and the creation of greater berthing capacity and container storage by land reclamation in the Gordon Cay and Fort Augusta areas. This will include dredging to deepen and widen the Ships Channel and reclaim berthing and container storage space in the vicinity of Gordon Cay and Fort Augusta.

In order to determine the social and economic characteristics of the area, and garner your views, perspectives and acceptance of the proposed development I would like to ask you some questions.

Interviewers: Please note that more than one answer can be provided for a particular question

Demography

1. Sex of household head: Male __ Female__

2. To what age group do you belong?
   18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 and over ☐

3. Where do you live? ______________________

4. How long have you lived there? _______________

5. Where are you originally from (town and Parish)? _______________

6. Are you the head of the household? Yes __ No __
If no, what is your relationship to household head? ______________________

7. Including yourself, how many people live in your household? ______
   (a) # of adults _____
   (b) # of children less than 18 years _____

Page **1** of **6**

Education

8. What is the highest level of education you have attained?
   None ___ Primary/All Age ___ Some High School ___
   High School ___ Technical/Vocational ___ College/University ___
   Other, specify ____________________

9. How many children in this household are enrolled in school? ________

10. Where do they go to school (name and location of school) ____________________
    ____
    ____

11. What is the distance your children travel to school? _________

12. How do your children get to school (mode of transportation) ?
    Walk ___ Private vehicle ___ JUTC ___ Other Public Bus ___
    Taxi ___ Other, specify _________________

Employment and Income

13. Are you employed? Yes ___ No ___
    If yes, what type of employment?
    Full-time ___ Part-time ___ Self-employed ___
    Seasonal ___ Other, specify __________________

14. What is your present means of livelihood (occupation)? ________________

15. How far do you travel from home to work? ______________________

16. How do you get to work (mode of transportation)?
    Walk ___ Drive: Private vehicle ___ JUTC ___ Other Public Bus ____

17. What is your weekly/monthly income in Jamaican Dollars (JMD)? (optional)
    Less than $10,000 ☐ $10,001-$30,000 ☐ $30,001-$60,000 ☐
    $60,001-$90,000 ☐ $90,001-$120,000 ☐ $120,001-$150,000 ☐
    Above $150,000 ☐

18. Do you have any additional sources of income?
    Remittances ☐ Spousal support ☐ Family ☐ Savings ☐

19. How much does your household spend on travel to and from work and school each day? ____

Page **2** of **6**

Housing, Amenities and Social Services

20. Do you ______ the land on which your house is located?
    Own ___ Lease ___ Other, specify _________
    Rent ___ Squat on ___

21. Do you _________ your house?
    Own ___ Lease ___
    Rent ___ Other, specify ________________

22. What type of construction material is your residence made from? Observed by Interviewer
    (a) **Walls:** Concrete and blocks ___ Wood ___ Other, specify ___________
    (b) **Roof:** Metal sheeting (zinc) ___ Concrete ___ Other, specify ___________

23. Type of Housing Observed by Interviewer
    Separate House Detached ___ Semi-attached ___ Townhouse ___ Apartment ___
    Other, specify _______

24. What does your household use for lighting?
    Electricity ___ Kerosene ___ Other, specify _____________

25. What type of fuel does the household use most for cooking?
    Gas ___ Electricity ___ Wood ___ Kerosene ___

26. What is the main source of domestic water supply for the household?
    Public piped water into dwelling ___ Private Tank ___
    Public piped water into yard ___ Community Tank ___
    Government Water Trucks (free) ___ Public Standpipe ___
    Private Water Trucks (paid) ___ Spring or River ___
    Other, specify ________________

27. Do you have interruptions in your water supply? Yes ___ No ___
    If yes, how often is it interrupted? _____________

28. What is the main means of communication for your household?
    Land line ___ Mobile (cell) ___ Both ___ Other, specify _________

29. What is the main method of garbage disposal for your household?
    Public Garbage Truck ___ Private Collection ___ Burn ____

30. If public garbage truck, how often do trucks pick up garbage? _______________

Page 3 of 6

31. Do you have access to the following services?

Type of Service	Location	Distance Travelled (km)/miles
Health Care		
Police Station		
Fire Station		
Post Office/Agency		

32. Do you have health insurance? Yes ☐ No ☐

33. What do you value most about your community?

____
____
____

34. What types of recreational resources are available in your community? (Please tick one)

NB administrator: State the location of recreational facilities or resources if not in community

Dance/parties ______
Sports Clubs __________
Church groups __________
Youth Clubs ________
Charity _______________
Other, specify ___________________ Beach _________
River/Stream/Pond _____________

35. If you selected beach and/or river, what is the name of the beach/river you most frequently use?

____

36. Do you use the community centre located in the town? Yes ☐ No ☐
If yes, how often and for what purpose(s)? ________________________

37. Is the community usually affected by Hurricanes/natural disasters (flooding, fire, earthquake etc.,)
How did you fare in the last Hurricane/tropical storm/natural disaster?

____
____
____

38. How long was it before water, power and telephone were restored after each disaster?

____

39. Where do people go in the event of a disaster? ______________________

Housing, Amenities and Social Services

40. Does your community have a citizen's association? Yes ☐ No ☐

41. Are there any other organisations within your community (voluntary or otherwise)? Yes ☐ No ☐
Please state ____

42. What is the role of the church in your community? ____________________

43. Are there outreach programmes/ adult literacy programmes in your community? Yes ☐ No ☐

44. Does your community have sports clubs and/ or teams? Yes ☐ No ☐

45. For construction projects in your community, where do the workers come from?
____

Natural Resources Usage and Management

46. Which of the following natural resource is available in your community?

Water: beach ☐ river ☐ pond ☐ lake ☐ **Vegetation:** plants ☐ fruit crops ☐
Animals: birds ☐ fish ☐ **Land:** Forestry ☐ mangrove ☐ Minerals ☐

47. Do you use any of these resources? Yes ☐ No ☐
If Yes, which ones and for what purpose(s)?
____
____

48. Are there any pollution sources or stress factors affecting these resources? Yes ☐ No ☐
If yes, please state source ____________________

49. What kind of wildlife is there in your community? Birds ☐ Turtles ☐
Other, specify ____________________

Perception of the Proposed Development

50. Are you aware of the proposed capacity of the transshipment terminal at Port Bustamante?
Yes ___ No ___
If yes, through what medium? ____________________

51. Do you think increasing the capacity of the transshipment terminal at Port Bustamante important?
Not important ____ Important ____ Very Important ___

52. Do you support this project? Yes ___ No ____

53. If yes, is it worth:
    a. dredging the harbour to facilitate the expansion? Yes ___ No ____
    b. Changing the use of Fort Augusta Prison to terminal facility? Yes ___ No ___

54. How do you think the project will affect the following?

Which of the following do you think will be most affected by the project? (interviewer: most positive & most negative)	Positively	Negatively	No Effect
Housing			
Environment			
Employment			
Recreation			
Business			

55. Do you think the necessary skills required for the project can be found in your community?
Yes ___ No ___ Explain ____

56. How do you think the community will be affected by the project?

____
____
____

57. Do you think the project will affect you personally? Yes ____ No ____

If yes, how?

____
____
____

58. Do you have any comments on the project?

____
____
____

Thank you for your cooperation and participation in this survey

Page **6** of **6**

APPENDIX 4: LAB REPORTS

July 12, 2013

Service Request No:J1303454

Paul Carroll
Technological & Environmental Management (TEM) Network Ltd
20 West Kings House Rd

Laboratory Results for: Fort Augusta

Dear Paul,

Enclosed are the results of the sample(s) submitted to our laboratory June 18, 2013
For your reference, these analyses have been assigned our service request number **J1303454.**

All analyses were performed according to our laboratory's quality assurance program. The test results meet requirements of the NELAP standards except as noted in the case narrative report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report. In accordance to the NELAC 2003 Standard, a statement on the estimated uncertainty of measurement of any quantitative analysis will be supplied upon request.

Please contact me if you have any questions. My extension is 4409. You may also contact me via email at Craig.Myers@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Craig Myers
Project Manager

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PHONE +1 904 739 2277 | FAX +1 904 739 2011
ALS Group USA, Corp.
dba ALS Environmental

ALS Environmental

9143 Philips Highway, Jacksonville, FL 32256 | 904-739-2277 | www.caslab.com

State Certifications, Accreditations, and Licenses

Agency	Number	Expire Date
Florida Department of Health	E82502	6/30/2014
North Carolina Department of Environment and Natural Resources	527	12/31/2013
Virginia Environmental Accreditation Program	460191	12/14/2013
Louisiana Department of Environmental Quality	02086	6/30/2014
Kentucky Division of Waste Management	63	6/30/2014
Texas Commision on Environmental Quality	T104704197-13-5	5/31/2014
Maine Department of Health and Human Services	2011006	2/3/2015
Department of Defense	66206	5/31/2014
Pennsylvania Department of Environmental Protection	68-04835	8/31/2013

Data Qualifiers

CAS Standard

+	Possible Tedlar bag artifact.
A	TIC is a suspected aldol-condensation product
B	Analyte found in the associated method blank as well as in the sample.
BC	Reported results are not blank corrected.
BH	The back section of the tube yielded higher results than the front.
BT	Results indicated possible breakthrough; back section >=10% front section.
C	Result identification confirmed.
D	Compound identified in an analysis at a secondary dilution factor
D	Spike was diluted out
DE	Reported results are corrected for desorption efficiency.
E	Estimated value. Concentration above calibration range
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
H1	Sample analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.
I	Internal standard not within the specified limits. See case narrative.
J	Estimated Value. Concentration found below MRL.
K	A deflection in the QC ion may indicate interference with the quantitation of this ion. The concentration of this analyte should be considered as an estimate.
K	Analyte was detected above the method reporting limit prior to normalization.
L1	Laboratory control sample recovery outside the specified limits; results may be biased high.
L2	Laboratory control sample recovery outside the specified limits; results may be biased low.
L3	Laboratory control sample recovery outside the specified limits.
M	Matrix interference; results may be biased high.
M	The duplicate injection precision not met.
M1	Matrix interference due to coelution with a non-target compound; results may be biased high.
N	Presumptive evidence of a compound for TICs that have been identified based on a mass spectral library search.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
P	Indicates chlorodiphenyl ether interference present at the retention time of the target compound.
P	Pesticide/Aroclor target analyte > 40% difference for detected concentrations between GC columns
Q	Indicates as estimated value because the P and P + 2 theoretical abundance ratio does not meet method criteria.
R	Duplicate Precision not met.
R1	Duplicate precision not within the specified limits; however, the results are below the MRL and considered estimated.
S	Surrogate recovery not within specified limits.

Data Qualifiers

CAS Standard

S The reported value was determined by the Method of Standard Additions (MSA).
T Analyte is a tentatively identified compound, result is estimated.
U Compound was analyzed for, but was not detected (ND).
V1 The continuing calibration verification standard was outside (biased high) the specified limits for this compound.
V2 The continuing calibration verification standard was outside (biased low) the specified limits for this compound.
W Result quantified, but the corresponding peak was detected outside the generated retention time window.
W The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
X See case narrative.
Y Recovery outside limits
Y The chromatogram resembles a petroleum product but does not match the calibration standard.
Z The chromatogram does not resemble a petroleum product.
i The MRL/MDL has been elevated due to a matrix interference.

ALS Laboratory Group

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Client: Technological & Environmental Management (TEM) Network Ltd **Service Request:** J1303454
Project: Fort Augusta

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
J1303454-001	FA1T	6/12/2013	0854
J1303454-002	FA1B	6/12/2013	0851
J1303454-003	FA2T	6/12/2013	0926
J1303454-004	FA2B	6/12/2013	0915
J1303454-005	FA3T	6/12/2013	0952
J1303454-006	FA3B	6/12/2013	0950
J1303454-007	FA4B	6/12/2013	1037
J1303454-008	FA5	6/12/2013	1026
J1303454-009	FA6	6/12/2013	1016
J1303454-010	FA7	6/12/2013	1006
J1303454-011	C1	6/12/2013	0926
J1303454-012	C2	6/12/2013	0952
J1303454-013	C3	6/12/2013	1041
J1303454-014	FA7T2	6/12/2013	1006
J1303454-015	E1	6/12/2013	1006
J1303454-016	E2	6/12/2013	1006
J1303454-017	E3	6/12/2013	1006

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 08:54
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA1T	**Units:**	mg/L
Lab Code:	J1303454-001	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.204 U	0.667	0.204	1	06/20/13 22:33	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	90	82 - 142	06/20/13 22:33	
n-Nonatriacontane	73	42 - 193	06/20/13 22:33	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 08:54
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA1T	**Basis:**	NA
Lab Code:	J1303454-001		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:30	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 08:51
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA1B	**Units:**	mg/L
Lab Code:	J1303454-002	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.581 U	1.90	0.581	1	06/20/13 23:01	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	92	82 - 142	06/20/13 23:01	
n-Nonatriacontane	95	42 - 193	06/20/13 23:01	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 08:51
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA1B	**Basis:**	NA
Lab Code:	J1303454-002		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:31	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:26
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA2T	**Units:**	mg/L
Lab Code:	J1303454-003	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.568 U	1.86	0.568	1	06/20/13 23:28	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	96	82 - 142	06/20/13 23:28	
n-Nonatriacontane	87	42 - 193	06/20/13 23:28	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:26
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA2T	**Basis:**	NA
Lab Code:	J1303454-003		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.02 J**	ug/L	0.10	0.02	1	06/24/13 13:32	6/21/13	

ALS Group USA, Corp.
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Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:15
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA2B	**Units:**	mg/L
Lab Code:	J1303454-004	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.249 U	0.816	0.249	1	06/20/13 23:55	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	97	82 - 142	06/20/13 23:55	
n-Nonatriacontane	91	42 - 193	06/20/13 23:55	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:15
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA2B	**Basis:**	NA
Lab Code:	J1303454-004		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:36	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:52
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA3T	**Units:**	mg/L
Lab Code:	J1303454-005	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.249 U	0.816	0.249	1	06/21/13 00:50	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	103	82 - 142	06/21/13 00:50	
n-Nonatriacontane	102	42 - 193	06/21/13 00:50	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:52
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA3T	**Basis:**	NA
Lab Code:	J1303454-005		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.02 J**	ug/L	0.10	0.02	1	06/24/13 13:38	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:50
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA3B	**Units:**	mg/L
Lab Code:	J1303454-006	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.242 U	0.792	0.242	1	06/21/13 01:17	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	96	82 - 142	06/21/13 01:17	
n-Nonatriacontane	102	42 - 193	06/21/13 01:17	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:50
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA3B	**Basis:**	NA
Lab Code:	J1303454-006		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:39	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:37
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA4B	**Units:**	mg/L
Lab Code:	J1303454-007	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.421 U	1.38	0.421	1	06/21/13 01:44	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	102	82 - 142	06/21/13 01:44	
n-Nonatriacontane	102	42 - 193	06/21/13 01:44	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:37
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA4B	**Basis:**	NA
Lab Code:	J1303454-007		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.02 J**	ug/L	0.10	0.02	1	06/24/13 13:40	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:26
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA5	**Basis:**	NA
Lab Code:	J1303454-008		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.02 J**	ug/L	0.10	0.02	1	06/24/13 13:41	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:26
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA5	**Units:**	mg/L
Lab Code:	J1303454-008	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.231 U	0.755	0.231	1	06/21/13 02:12	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	91	82 - 142	06/21/13 02:12	
n-Nonatriacontane	74	42 - 193	06/21/13 02:12	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:16
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA6	**Units:**	mg/L
Lab Code:	J1303454-009	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.231 U	0.755	0.231	1	06/21/13 02:39	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	98	82 - 142	06/21/13 02:39	
n-Nonatriacontane	99	42 - 193	06/21/13 02:39	

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dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:16
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA6	**Basis:**	NA
Lab Code:	J1303454-009		

Inorganic Parameters

Analyte Name	Analysis Method	Result		Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02	U	ug/L	0.10	0.02	1	06/24/13 13:42	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA7	**Units:**	mg/L
Lab Code:	J1303454-010	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.249 U	0.816	0.249	1	06/21/13 00:50	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	98	82 - 142	06/21/13 00:50	
n-Nonatriacontane	105	42 - 193	06/21/13 00:50	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA7	**Basis:**	NA
Lab Code:	J1303454-010		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.02 J**	ug/L	0.10	0.02	1	06/24/13 13:43	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:26
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C1	**Units:**	mg/Kg
Lab Code:	J1303454-011	**Basis:**	Dry

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: EPA 3546

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	**6.14 J**	30.2	3.02	1	06/20/13 21:11	6/20/13	

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dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:26
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C1	**Basis:**	Dry
Lab Code:	J1303454-011		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic, Total Recoverable	6010B	**6.64**	mg/Kg	0.71	0.23	2	06/25/13 15:18	6/24/13	
Chromium, Total Recoverable	6010B	**14.4**	mg/Kg	0.36	0.02	1	06/24/13 18:55	6/24/13	
Copper, Total Recoverable	6010B	**10.7**	mg/Kg	0.71	0.13	2	06/25/13 15:18	6/24/13	
Lead, Total Recoverable	6010B	**7.79**	mg/Kg	0.71	0.26	2	06/25/13 15:18	6/24/13	
Mercury, Total	7471B	**0.0649**	mg/Kg	0.0090	0.0014	1	06/24/13 15:48	6/24/13	
Nickel, Total Recoverable	6010B	**6.00**	mg/Kg	0.36	0.04	1	06/24/13 18:55	6/24/13	
Tin, Total Recoverable	6010B	**0.9 J**	mg/Kg	2.9	0.2	2	06/25/13 15:18	6/24/13	
Vanadium, Total Recoverable	6010B	**18.4**	mg/Kg	0.71	0.11	1	06/24/13 18:55	6/24/13	
Zinc, Total Recoverable	6010B	**22.7**	mg/Kg	1.4	0.4	2	06/25/13 15:18	6/24/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:26
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C1	**Basis:**	As Received
Lab Code:	J1303454-011		

General Chemistry Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Q
Solids, Total	160.3 Modified	**70**	Percent	0.10	0.10	1	06/28/13 14:11	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:52
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C2	**Units:**	mg/Kg
Lab Code:	J1303454-012	**Basis:**	Dry

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: EPA 3546

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	2.82 U	28.2	2.82	1	06/20/13 21:39	6/20/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:52
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C2	**Basis:**	Dry
Lab Code:	J1303454-012		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic, Total Recoverable	6010B	**8.10**	mg/Kg	0.42	0.12	1	06/24/13 19:03	6/24/13	
Chromium, Total Recoverable	6010B	**17.6**	mg/Kg	0.42	0.02	1	06/24/13 19:03	6/24/13	
Copper, Total Recoverable	6010B	**35.4**	mg/Kg	0.42	0.07	1	06/24/13 19:03	6/24/13	
Lead, Total Recoverable	6010B	**8.10**	mg/Kg	0.42	0.13	1	06/24/13 19:03	6/24/13	
Mercury, Total	7471B	**0.0736**	mg/Kg	0.0097	0.0015	1	06/24/13 15:50	6/24/13	
Nickel, Total Recoverable	6010B	**8.90**	mg/Kg	0.42	0.04	1	06/24/13 19:03	6/24/13	
Tin, Total Recoverable	6010B	**0.7 J**	mg/Kg	1.7	0.07	1	06/24/13 19:03	6/24/13	
Vanadium, Total Recoverable	6010B	**41.5**	mg/Kg	0.84	0.11	1	06/24/13 19:02	6/24/13	
Zinc, Total Recoverable	6010B	**39.4**	mg/Kg	0.84	0.16	1	06/24/13 19:03	6/24/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 09:52
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C2	**Basis:**	As Received
Lab Code:	J1303454-012		

General Chemistry Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Q
Solids, Total	160.3 Modified	**64**	Percent	0.10	0.10	1	06/28/13 14:11	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:41
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C3	**Units:**	mg/Kg
Lab Code:	J1303454-013	**Basis:**	Dry

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: EPA 3546

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	**5.52 J**	40.1	4.01	1	06/20/13 22:06	6/20/13	

Printed 7/12/2013 1:14:37 PM

Superset Reference:13-0000252653 rev 00

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Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:41
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C3	**Basis:**	Dry
Lab Code:	J1303454-013		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic, Total Recoverable	6010B	**8.61**	mg/Kg	0.50	0.12	1	06/24/13 19:54	6/24/13	
Chromium, Total Recoverable	6010B	**25.3**	mg/Kg	0.50	0.02	1	06/24/13 19:54	6/24/13	
Copper, Total Recoverable	6010B	**60.5**	mg/Kg	0.50	0.07	1	06/24/13 19:54	6/24/13	
Lead, Total Recoverable	6010B	**11.2**	mg/Kg	0.50	0.13	1	06/24/13 19:54	6/24/13	
Mercury, Total	7471B	**0.113**	mg/Kg	0.012	0.002	1	06/24/13 15:51	6/24/13	
Nickel, Total Recoverable	6010B	**12.6**	mg/Kg	0.50	0.04	1	06/24/13 19:54	6/24/13	
Tin, Total Recoverable	6010B	**2.0**	mg/Kg	2.0	0.07	1	06/24/13 19:54	6/24/13	
Vanadium, Total Recoverable	6010B	**58.3**	mg/Kg	1.0	0.2	1	06/24/13 19:54	6/24/13	
Zinc, Total Recoverable	6010B	**62.4**	mg/Kg	1.0	0.2	1	06/24/13 19:54	6/24/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:41
Sample Matrix:	Sediment	**Date Received:**	06/18/13 14:05
Sample Name:	C3	**Basis:**	As Received
Lab Code:	J1303454-013		

General Chemistry Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Q
Solids, Total	160.3 Modified	**52**	Percent	0.10	0.10	1	06/28/13 14:11	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA7T2	**Units:**	mg/L
Lab Code:	J1303454-014	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.226 U	0.741	0.226	1	06/21/13 01:17	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	102	82 - 142	06/21/13 01:17	
n-Nonatriacontane	114	42 - 193	06/21/13 01:17	

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Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	FA7T2	**Basis:**	NA
Lab Code:	J1303454-014		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:44	6/21/13	

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Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	E1	**Units:**	mg/L
Lab Code:	J1303454-015	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.610 U	2.00	0.610	1	06/21/13 01:44	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	97	82 - 142	06/21/13 01:44	
n-Nonatriacontane	112	42 - 193	06/21/13 01:44	

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Analytical Report

Client: Technological & Environmental Management (TEM) Network
Project: Fort Augusta
Sample Matrix: Water

Service Request: J1303454
Date Collected: 06/12/13 10:06
Date Received: 06/18/13 14:05

Sample Name: E1
Lab Code: J1303454-015

Basis: NA

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.04 J**	ug/L	0.10	0.02	1	06/24/13 13:45	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	E2	**Units:**	mg/L
Lab Code:	J1303454-016	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.643 U	2.11	0.643	1	06/21/13 02:12	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	99	82 - 142	06/21/13 02:12	
n-Nonatriacontane	102	42 - 193	06/21/13 02:12	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	E2	**Basis:**	NA
Lab Code:	J1303454-016		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	**0.03 J**	ug/L	0.10	0.02	1	06/24/13 13:47	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	E3	**Units:**	mg/L
Lab Code:	J1303454-017	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.531 U	1.74	0.531	1	06/21/13 02:39	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	100	82 - 142	06/21/13 02:39	
n-Nonatriacontane	119	42 - 193	06/21/13 02:39	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	06/12/13 10:06
Sample Matrix:	Water	**Date Received:**	06/18/13 14:05
Sample Name:	E3	**Basis:**	NA
Lab Code:	J1303454-017		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:51	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Method Blank	**Units:**	mg/L
Lab Code:	JQ1304299-01	**Basis:**	NA

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: Method

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	0.122 U	0.400	0.122	1	06/20/13 19:50	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	92	82 - 142	06/20/13 19:50	
n-Nonatriacontane	85	42 - 193	06/20/13 19:50	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	NA
Sample Matrix:	Sediment	**Date Received:**	NA
Sample Name:	Method Blank	**Units:**	mg/Kg
Lab Code:	JQ1304303-01	**Basis:**	Dry

Petroleum-Range Organics by GC-FID for State of Florida

Analysis Method: FL-PRO
Prep Method: EPA 3546

Analyte Name	Result	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
FL-PRO (C8 - C40)	2.00 U	20.0	2.00	1	06/20/13 19:50	6/20/13	

Surrogate Name	% Rec	Control Limits	Date Analyzed	Q
o-Terphenyl	86	62 - 109	06/20/13 19:50	
n-Nonatriacontane	83	60 - 118	06/20/13 19:50	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Method Blank	**Basis:**	NA
Lab Code:	J1303454-MB2		

Inorganic Parameters

Analyte Name	Analysis Method	Result	Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Mercury, Total	245.1	0.02 U	ug/L	0.10	0.02	1	06/24/13 13:21	6/21/13	

ALS Group USA, Corp.
dba ALS Environmental

Analytical Report

Client:	Technological & Environmental Management (TEM) Network	**Service Request:**	J1303454
Project:	Fort Augusta	**Date Collected:**	NA
Sample Matrix:	Sediment	**Date Received:**	NA
Sample Name:	Method Blank	**Basis:**	Dry
Lab Code:	J1303454-MB1		

Inorganic Parameters

Analyte Name	Analysis Method	Result		Units	MRL	MDL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic, Total Recoverable	6010B	0.12	U	mg/Kg	0.50	0.12	1	06/24/13 18:47	6/24/13	
Chromium, Total Recoverable	6010B	**0.05**	**J**	mg/Kg	0.50	0.02	1	06/24/13 18:47	6/24/13	
Copper, Total Recoverable	6010B	0.07	U	mg/Kg	0.50	0.07	1	06/24/13 18:46	6/24/13	
Lead, Total Recoverable	6010B	0.13	U	mg/Kg	0.50	0.13	1	06/24/13 18:47	6/24/13	
Mercury, Total	7471B	0.0010	U	mg/Kg	0.0067	0.0010	1	06/24/13 15:43	6/24/13	
Nickel, Total Recoverable	6010B	0.04	U	mg/Kg	0.50	0.04	1	06/24/13 18:47	6/24/13	
Tin, Total Recoverable	6010B	**0.1**	**J**	mg/Kg	2.0	0.07	1	06/24/13 18:47	6/24/13	
Vanadium, Total Recoverable	6010B	0.2	U	mg/Kg	1.0	0.2	1	06/24/13 18:47	6/24/13	
Zinc, Total Recoverable	6010B	0.2	U	mg/Kg	1.0	0.2	1	06/24/13 18:47	6/24/13	

ALS Environmental

Cooler Receipt Form

Client: TEMN LTD Service Request #: J1303454
Project: Fort Augusta
Cooler received on 6.18.13 and opened on 6.18.13 By GB
COURIER: ALS UPS FEDEX Client Other DHL Airbill # 1721741464

1	Were custody seals on outside of cooler?	Yes **No**
	If yes, how many and where?	#:___ on lid other
2	Were seals intact and signature and date correct?	Yes No **N/A**
3	Were custody papers properly filled out?	**Yes** No N/A
4	Temperature of cooler(s) upon receipt (Should be > 0°C and < 6°C)	16.1 21.8
5	Thermometer ID	T81
6	Temperature Blank Present?	**Yes** No
7	Were Ice or Ice Packs present	**Ice** Ice Packs No
8	Did all bottles arrive in good condition (unbroken, etc....)?	Yes **No** N/A
9	Type of packing material present	**Netting** Vial Holder **Bubble Wrap** Paper Styrofoam Other N/A
10	Were all bottle labels complete (sample ID, preservation, etc....)?	**Yes** No N/A
11	Did all bottle labels and tags agree with custody papers?	Yes **No** N/A
12	Were the correct bottles used for the tests indicated?	**Yes** No N/A
13	Were all of the preserved bottles received with the appropriate preservative? HNO3 pH<2 H2SO4 pH<2 ZnAc2/NaOH pH>9 NaOH pH>12 HCl pH<2 Preservative additions noted below	Yes **No** N/A
14	Were all samples received within analysis holding times?	Yes No N/A
15	Were all VOA vials free of air bubbles? If present, note below	Yes No **N/A**
16	Where did the bottles originate?	**ALS** + **Client**

Sample ID	Reagent	Lot #	ml added	Initials Date/Time
All metal Samples	HNO_3	me+17208	0.5	GB 6.19.13 1730
All Fl pro Samples	H_2SO_4	Gen807198	1	GB 6.19.13 1730

Additional comments and/or explanation of all discrepancies noted above: ① FA 4T sample was received broken. ② Lids were broken on jars for samples FA1B, FA2T, FA4B, and FA1C. ③ Not all sample times on bottle labels match the COC sample time. ④ No sample left for FA1C

Client approval to run samples if discrepancies noted: Date:

Intra-Network Chain of Custody

9143 Philips Highway • Jacksonville, FL 32256 • 904-739-2277 • FAX 904-739-2011

ALS Contact: Craig Myers

Project Name: Fort Augusta
Project Number:
Project Manager: Paul Carroll
Company: Technological & Environmental Management (TEM) Netw

JL

Lab Code	Client Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Date Received	Send To	Metals Redppt T 200.8
J1303454-001	FA1T	1	Water	6/12/13	0854	6/18/13	KELSO	I
J1303454-002	FA1B		Water	6/12/13	0851	6/18/13	KELSO	I
J1303454-003	FA2T		Water	6/12/13	0926	6/18/13	KELSO	I
J1303454-004	FA2B		Water	6/12/13	0915	6/18/13	KELSO	I
J1303454-005	FA3T		Water	6/12/13	0952	6/18/13	KELSO	I
J1303454-006	FA3B		Water	6/12/13	0950	6/18/13	KELSO	I
J1303454-007	FA4B		Water	6/12/13	1037	6/18/13	KELSO	I
J1303454-008	FA5		Water	6/12/13	1026	6/18/13	KELSO	I
J1303454-009	FA6		Water	6/12/13	1016	6/18/13	KELSO	I
J1303454-010	FA7		Water	6/12/13	1006	6/18/13	KELSO	I
J1303454-014	FA7T2		Water	6/12/13	1006	6/18/13	KELSO	I
J1303454-015	E1		Water	6/12/13	1006	6/18/13	KELSO	I

Special Instructions/Comments	Turnaround Requirements	Report Requirements	Invoice Information
	____ RUSH (Surcharges Apply) PLEASE CIRCLE WORK DAYS 1 2 3 4 5 ✓ STANDARD Requested FAX Date: ________ Requested Report Date: 07/10/13	✓ I. Results Only ____ II. Results + QC Summaries ____ III. Results + QC and Calibration Summaries ____ IV. Data Validation Report with Raw Data PQL/MDL/J Y EDD N	PO# J1303454 Bill to

Relinquished By: [signature] 6.20.13 Received By: K Smith 6/21/13 0950 Airbill Number: ________

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Intra-Network Chain of Custody

9143 Philips Highway • Jacksonville, FL 32256 • 904-739-2277 • FAX 904-739-2011

ALS Contact: Craig Myers

Project Name: Fort Augusta
Project Number:
Project Manager: Paul Carroll
Company: Technological & Environmental Management (TEM) Netw

Lab Code	Client Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Date Received	Send To	Metals Redppt T 200.8
J1303454-016	E2	1	Water	6/12/13	1006	6/18/13	KELSO	1
J1303454-017	E3	1	Water	6/12/13	1006	6/18/13	KELSO	1

Test Comments

Metals Redppt T - 200.8 J1303454-001,2,3,4,5,6,7,8,9,10,14,15,16 ,17 As, Cr, Cu, Pb, Ni, Sn, V, and Zn

Special Instructions/Comments	Turnaround Requirements	Report Requirements	Invoice Information
	____RUSH (Surcharges Apply) PLEASE CIRCLE WORK DAYS 1 2 3 4 5 ✓ STANDARD Requested FAX Date: ______ Requested Report Date: 07/10/13	✓ I. Results Only ____ II. Results + QC Summaries ____ III. Results + QC and Calibration Summaries ____ IV. Data Validation Report with Raw Data PQL/MDL/J Y EDD N	PO# J1303454 Bill to

Relinquished By: 6.20 13 Received By: 6/21/13 0950 Airbill Number: ______

Page 2

ALS

PC Janet

Cooler Receipt and Preservation Form

Client / Project: ALS / JAX Service Request K13 J1303494

Received: 6/21/13 Opened: 6/21/13 By: KD Unloaded: 6/21/13 By: KD

1. Samples were received via? *Mail* *Fed Ex* *UPS* *DHL* *PDX* *Courier* *Hand Delivered*
2. Samples were received in: (circle) *Cooler* *Box* *Envelope* *Other*____ *NA*
3. Were custody seals on coolers? NA Y N NO ICE If yes, how many and where? 1, Top
   If present, were custody seals intact? Y N If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected. Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID NA	Tracking Number NA	Filed
—	—	—	—	—	—		5498 9743 9055	

7. Packing material: *Inserts* *Baggies* *Bubble Wrap* *Gel Packs* *Wet Ice* *Dry Ice* *Sleeves* Absorbant pad
8. Were custody papers properly filled out (ink, signed, etc.)? NA Y N
9. Did all bottles arrive in good condition (unbroken)? *Indicate in the table below.* NA Y N
10. Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
11. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA Y N
12. Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
13. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA Y N
14. Were VOA vials received without headspace? *Indicate in the table below.* NA Y N
15. Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

*Notes, Discrepancies, & Resolutions:*____

*Page*____*of*____

ALS Environmental Services
9143 Philips Highway, Suite 200
Jacksonville, FL 32256
Tel 904-739-2277
Fax 904-739-2011

Appendix A

Subcontracted Analytical Results

July 11, 2013 Analytical Report for Service Request No: J1303454

Craig Myers
ALS Environmental
9143 Philips Highway
Suite 200
Jacksonville, FL 32256

RE: Fort Augusta

Dear Craig:

Enclosed are the results of the samples submitted to our laboratory on June 18, 2013. For your reference, these analyses have been assigned our service request number J1303454.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current NELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. All results are intended to be considered in their entirety, and ALS Group USA Corp. dba ALS Environmental (ALS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please call if you have any questions. My extension is 3375. You may also contact me via Email at Janet.Malloch@alsglobal.com.

Respectfully submitted,

ALS Group USA Corp. dba ALS Environmental

Janet Malloch

Janet Malloch
Project Manager

JM/ln Page 1 of 23

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated value.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.
H	The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
J	The result is an estimated value.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.
Q	See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimated value.
J	The result is an estimated value.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

ALS Group USA Corp. dba ALS Environmental (ALS) - Kelso
State Certifications, Accreditations, and Licenses

Agency	Web Site	Number
~~Alaska DEC UST~~	http://dec.alaska.gov/applications/eh/ehllabreports/USTLabs.aspx	UST-040
Arizona DHS	http://www.azdhs.gov/lab/license/env.htm	AZ0339
Arkansas - DEQ	http://www.adeq.state.ar.us/techsvs/labcert.htm	88-0637
California DHS (ELAP)	http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx	2286
DOD ELAP	http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm	L12-28
Florida DOH	http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm	E87412
Georgia DNR	http://www.gaepd.org/Documents/techguide_pcb.html#cel	881
Hawaii DOH	Not available	-
Idaho DHW	http://www.healthandwelfare.idaho.gov/Health/Labs/CertificationDrinkingWaterLabs/tabid/1833/Default.aspx	-
Indiana DOH	http://www.in.gov/isdh/24859.htm	C-WA-01
ISO 17025	http://www.pjlabs.com/	L12-27
Louisiana DEQ	http://www.deq.louisiana.gov/portal/DIVISIONS/PublicParticipationandPermitSupport/LouisianaLaboratoryAccreditationProgram.aspx	3016
Maine DHS	Not available	WA0035
Michigan DEQ	http://www.michigan.gov/deq/0,1607,7-135-3307_4131_4156---,00.html	9949
Minnesota DOH	http://www.health.state.mn.us/accreditation	053-999-368
Montana DPHHS	http://www.dphhs.mt.gov/publichealth/	CERT0047
Nevada DEP	http://ndep.nv.gov/bsdw/labservice.htm	WA35
New Jersey DEP	http://www.nj.gov/dep/oqa/	WA005
North Carolina DWQ	http://www.dwqlab.org/	605
Oklahoma DEQ	http://www.deq.state.ok.us/CSDnew/labcert.htm	9801
Oregon – DEQ (NELAP)	http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	WA200001
South Carolina DHEC	http://www.scdhec.gov/environment/envserv/	61002
Texas CEQ	http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html	T104704427-08-TX
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C1203
Wisconsin DNR	http://dnr.wi.gov/	998386840
Wyoming (EPA Region 8)	http://www.epa.gov/region8/water/dwhome/wyomingdi.html	-
Kelso Laboratory Website	www.alsglobal.com	NA

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. A complete listing of specific NELAP-certified analytes, can be found in the certification section at www.caslab.com or at the accreditation bodies web site
Please refer to the certification and/or accreditation body's web site if samples are submitted for compliance purposes. The states highlighted above, require the analysis be listed on the state certification if used for compliance purposes and if the method/anlayte is offered by that state.

Intra-Network Chain of Custody

9143 Philips Highway • Jacksonville, FL 32256 • 904-739-2277 • FAX 904-739-2011

ALS Contact: Craig Myers

Project Name: Fort Augusta
Project Number:
Project Manager: Paul Carroll
Company: Technological & Environmental Management (TEM) Netw

Lab Code	Client Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Date Received	Send To	Metals Redppt T 200.8
J1303454-001	FA1T	1	Water	6/12/13	0854	6/18/13	KELSO	I
J1303454-002	FA1B		Water	6/12/13	0851	6/18/13	KELSO	I
J1303454-003	FA2T		Water	6/12/13	0926	6/18/13	KELSO	I
J1303454-004	FA2B		Water	6/12/13	0915	6/18/13	KELSO	I
J1303454-005	FA3T		Water	6/12/13	0952	6/18/13	KELSO	I
J1303454-006	FA3B		Water	6/12/13	0950	6/18/13	KELSO	I
J1303454-007	FA4B		Water	6/12/13	1037	6/18/13	KELSO	I
J1303454-008	FA5		Water	6/12/13	1026	6/18/13	KELSO	I
J1303454-009	FA6		Water	6/12/13	1016	6/18/13	KELSO	I
J1303454-010	FA7		Water	6/12/13	1006	6/18/13	KELSO	I
J1303454-014	FA7T2		Water	6/12/13	1006	6/18/13	KELSO	I
J1303454-015	E1		Water	6/12/13	1006	6/18/13	KELSO	I

Special Instructions/Comments

Turnaround Requirements

____ RUSH (Surcharges Apply)

PLEASE CIRCLE WORK DAYS
1 2 3 4 5

✓ STANDARD

Requested FAX Date: ________

Requested Report Date: 07/10/13

Report Requirements

✓ I. Results Only

____ II. Results + QC Summaries

____ III. Results + QC and Calibration Summaries

____ IV. Data Validation Report with Raw Data

PQL/MDL/J Y

EDD N

Invoice Information

PO# J1303454

Bill to

Relinquished By: 6.20.13 Received By: 6/21/13 0950 Airbill Number:

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Page 1

ALS Contact: Craig Myers

Intra-Network Chain of Custody

9143 Philips Highway • Jacksonville, FL 32256 • 904-739-2277 • FAX 904-739-2011

Project Name: Fort Augusta
Project Number:
Project Manager: Paul Carroll
Company: Technological & Environmental Management (TEM) Netw

Lab Code	Client Sample ID	# of Cont.	Matrix	Sample Date	Sample Time	Date Received	Send To	Metals Redppt T 200.8
J1303454-016	E2	1	Water	6/12/13	1006	6/18/13	KELSO	1
J1303454-017	E3	1	Water	6/12/13	1006	6/18/13	KELSO	1

Test Comments
Metals Redppt T - 200.8 J1303454-001,2,3,4,5,6,7,8,9,10,14,15,16,17 As, Cr, Cu, Pb, Ni, Sn, V, and Zn

Special Instructions/Comments	Turnaround Requirements	Report Requirements	Invoice Information
	____ RUSH (Surcharges Apply) PLEASE CIRCLE WORK DAYS 1 2 3 4 5 ✓ STANDARD Requested FAX Date: ____ Requested Report Date: 07/10/13	✓ I. Results Only ____ II. Results + QC Summaries ____ III. Results + QC and Calibration Summaries ____ IV. Data Validation Report with Raw Data PQL/MDL/J Y EDD N	PO# J1303454 Bill to

Relinquished By: Received By: Airbill Number:

ALS

PC Janet

Cooler Receipt and Preservation Form

Client / Project: ALS / JAX   Service Request *K13* J1303464

Received: 6/21/13   Opened: 6/21/13   By: KB   Unloaded: 6/21/13   By: KB

1. Samples were received via? *Mail* *Fed Ex* *UPS* *DHL* *PDX* *Courier* *Hand Delivered*
2. Samples were received in: (circle) *Cooler* *Box* *Envelope* *Other* ________ *NA*
3. Were custody seals on coolers? NA Y N   If yes, how many and where? 1, Top
   If present, were custody seals intact? Y N   If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID NA	Tracking Number	NA	Filed
—	—	—	—	—	—		5498 9743 9055		

7. Packing material: *Inserts* *Baggies* *Bubble Wrap* *Gel Packs* *Wet Ice* *Dry Ice* *Sleeves* Absorbant pad
8. Were custody papers properly filled out (ink, signed, etc.)? NA Y N
9. Did all bottles arrive in good condition (unbroken)? *Indicate in the table below.* NA Y N
10. Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
11. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA Y N
12. Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
13. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA Y N
14. Were VOA vials received without headspace? *Indicate in the table below.* NA Y N
15. Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, & Resolutions: ________

Page ____ *of* ____

7

ALS Group USA, Corp.
dba ALS Environmental

- Cover Page -
INORGANIC ANALYSIS DATA PACKAGE

Client: Technological & Environmental Management (TEM) Netw
Service Request: J1303454
Project Name: Fort Augusta
Project No.:

Sample Name:	Lab Code:
FA1T	J1303454-001
FA1B	J1303454-002
FA2T	J1303454-003
FA2B	J1303454-004
FA3T	J1303454-005
FA3B	J1303454-006
FA4B	J1303454-007
FA5	J1303454-008
FA6	J1303454-009
FA7	J1303454-010
FA7T2	J1303454-014
E1	J1303454-015
E2	J1303454-016
E3	J1303454-017
Method Blank	J1303454-MB

Comments:

ALS Group USA, Corp.
dba ALS Environmental

Metals
- 1 -
INORGANIC ANALYSIS DATA PACKAGE

Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA1T   Lab Code: J1303454-001

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	4.3		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	3.2	J	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	2.0	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

Comments:

Form I - IN
9

ALS Group USA, Corp.
dba ALS Environmental

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA1B Lab Code: J1303454-002

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	3.4	J	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.4	J	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	2.3	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	1.0	J	

Comments:

Form I - IN

ALS Group USA, Corp.
dba ALS Environmental

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA2T Lab Code: J1303454-003

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	4.1		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	3.5	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	J	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA2B Lab Code: J1303454-004

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	1.4	J	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	3.7	J	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	1.0	U	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA3T   Lab Code: J1303454-005

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	3.5	J	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	4.0		
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA3B Lab Code: J1303454-006

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	5.1		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	2.2	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	3.7	J	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA4B   Lab Code: J1303454-007

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	2.2	J	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	5.8		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	2.7	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	4.5		

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA5 Lab Code: J1303454-008

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	2.8	J	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	3.5	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA6 Lab Code: J1303454-009

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	2.2	J	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	4.9		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	1.0	J	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	3.7	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.8	J	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA7 Lab Code: J1303454-010

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	1.3	J	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	3.4	J	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	3.0	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: FA7T2 Lab Code: J1303454-014

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	4.7		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	2.7	J	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: E1 Lab Code: J1303454-015

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	3.6	J	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	4.6		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	4.5		
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	19.5		
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	1.4	J	

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Client:	Technological & Environmental Ma	Service Request:	J1303454
Project No.:	NA	Date Collected:	06/12/13
Project Name:	Fort Augusta	Date Received:	06/18/13
Matrix:	WATER	Units:	ug/L
		Basis:	NA

Sample Name: E2 Lab Code: J1303454-016

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	4.3		
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	1.4	J	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	23.8		
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	1.0	J	

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INORGANIC ANALYSIS DATA PACKAGE

Client:	Technological & Environmental Ma	**Service Request:**	J1303454
Project No.:	NA	**Date Collected:**	06/12/13
Project Name:	Fort Augusta	**Date Received:**	06/18/13
Matrix:	WATER	**Units:**	ug/L
		Basis:	NA

Sample Name: E3 **Lab Code:** J1303454-017

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.7	J	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	3.4	J	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.3	J	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	37.9		
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.8	J	

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INORGANIC ANALYSIS DATA PACKAGE

Client: Technological & Environmental Ma
Service Request: J1303454
Project No.: NA
Date Collected:
Project Name: Fort Augusta
Date Received:
Matrix: WATER
Units: ug/L
Basis: NA

Sample Name: Method Blank
Lab Code: J1303454-MB

Analyte	Analysis Method	MRL	MDL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Chromium	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Copper	200.7	4.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Lead	200.7	10.0	6.0	1.0	06/29/13	07/01/13	6.0	U	
Nickel	200.7	4.0	0.9	1.0	06/29/13	07/01/13	0.9	U	
Tin	200.7	20.0	2.0	1.0	06/29/13	07/01/13	2.0	U	
Vanadium	200.7	4.0	1.0	1.0	06/29/13	07/01/13	1.0	U	
Zinc	200.7	4.0	0.7	1.0	06/29/13	07/01/13	0.7	U	

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APPENDIX 5: SEAGRASS MITIGATION

Fort Augusta Seagrass ecosystem project

Towards successful relocation of seagrass ecosystems

PORT AUTHORITY OF JAMAICA

May 24, 2013
Authored by: WEBBER, Dale F S G
Director, Centre for Marine Sciences
The University of the West Indies

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1.0 INTRODUCTION

Kingston Harbour is often considered to be one of the finest natural harbors in the world. It is situated on the south coast of Jamaica at Latitude 17°57' North, Longitude 76°48' West. The harbor is an elongated bay, or lagoon, extending 16.5 km from east–west and 6.5 km north–south with a total surface area of approximately 51 km^2 (Wade 1976). The entrance to the harbor is a 2 km wide channel in the south-west corner (Wade, 1976) and this leads naturally into a 12 m deep channel, which curves around the northwest side of the harbor providing navigable access to its inner basins. This channel, usually referred to as 'the ship channel,' is a natural formation, probably maintained originally by natural water circulation (Goodbody, 1968,1970), but in recent years the Port Authority has engaged in maintenance dredging to prevent undue sedimentation and permit the continued access of large ships to the Port of Kingston.

The Port Authority intends to conduct dredging of the ship channel to facilitate the arrival of larger vessels to the Port of Kingston following on the development of the Panama Canal set for completion in 2015. It is proposed that the fill material from this dredging activity be used to expand the shoreline of the western shore of the Harbour adjacent to but not impacting Fort Augusta. The area to be impacted is limited to 50 to 150 m band from the shore at a depth of 2 – 7 m. Preliminary surveys conducted by the Port Authority indicate that 3.18 ha of seagrass will be impacted by this activity and in keeping with the no net loss of marine and coastal ecosystems policy, a removal and replanting exercise is proposed.

Objectives	Activities	Indicators
Determine the amount of seagrass to be impacted by the dredge/fill activities.	• Conduct reconnaissance of coastal area adjacent to Fort Augusta (harvesting area) • Data processing.	• Seagrass areas mapped and identified both on charts and insitu.
Determine the health of the seagrass beds and associated flora and fauna species to be transplanted/translocated.	• Conduct reconnaissance of coastal area adjacent to Fort Augusta (harvesting area). • Data processing.	• Health status of the seagrass bed and associated flora and fauna species.
Determine the health of the	• Field monitoring (water	• Water quality of planting

2.0 OBJECTIVES/INDICATORS/ACTIVITIES

replanting area(s).	quality, seagrass survey etc.). • Data processing.	site. • Health of seagrass beds and associated flora and fauna species of planting site.
Translocate and replant seagrass beds and associated flora and fauna species to temporary holding site then to replanting area.	• Harvest seagrass beds and associated flora and fauna. • Transport harvested beds to holding site • Replant seagrass beds.	•
Establish a land based seagrass nursery	• Create a seagrass nursery using appropriate method.	• Meristematic growth • Number of shoot
Monitor the health of translocated seagrass beds and associated flora and fauna species.	• Field monitoring • Data processing	• Meristematic survival and growth • Number of shoot • Health status of the seagrass bed and associated flora and fauna species.

3.0 METHODOLOGY

3.1 The removal methodology

The marine area designated for fill activities will be surveyed by snorkel/dive activities to determine the extent, health condition and species composition of the seagrass beds adjacent to the Fort Augusta coastal area. Simultaneously all other marine flora and fauna usually associated with seagrass ecosystems will be determined and recorded will be moved manually to a temporary holding site and transported to the nearest identified adjacent site for relocation. Benthic macro fauna or any other sedentary or slow moving marine fauna associated with seagrass beds such as urchins, starfish, conch that require removal and relocating will be done in an approved method. These fauna will be placed into a basket (submerged cage) and moved immediately as they are encountered to areas outside of the harvesting and replanting area. The basket will be transported through the water so that the species remain submerged. There will be no holding time therefore reducing the potential of them becoming stressed.

The **Mat Method** will be used to reap the seagrass for replanting. This proposed harvesting method is universal in that it harvests all flora species as a meso-ecosystem and therefore removes the need for species specific harvesting methods. While the dominant species *Thalassia testudinum* is expected the other seagrass species and associated algae as well as infauna will all receive similar treatment. The **Mat Method** entails digging into the substrate with shovels to an appropriate depth (usual >15 cm) to make manageable sections of the seagrass beds approximately 40cm x 40cm called Planting Units (PU). The sections are removed with the rhizomes and substrate attached for immediate replanting in the designated relocation site. These PU sections will be placed on semi submerged rafts and the PU remain submerged from the harvesting site until they are transferred for replanting within the same day where possible to reduce stress. Keeping the sections submerged from harvesting site until transported to planting site ensures that the leaves are covered with water thereby preventing desiccation and maintaining the same osmotic potential and temperature. This method will not be species specific, as all the species will be transferred within the bed. The area within which the removal will take place will be enclosed with **a turbidity curtain** (screens) which will extend from the shoreline to enclose the activities. Only PU with designated planting areas will be reaped to ensure same day reap and planting exercise. The subsurface rafts will be towed by boat to recommended adjacent planting sites. Where identified planting sites are physically removed from the harvesting sites the PU will be placed in 30 cm deep trays, kept submerged, placed onboard small boats and taken to the pre-identified planting sites.

3.2 The planting methodology

Locations for possible plant of the PU will be identified from the analysis of data from a multiparameter probe deployed in areas suspected of providing planting habitats. Data to be recorded and analysed are Salinity, Temperature, Dissolved Oxygen, pH, Turbidy, Depth, Light penetrations, Nitrate and phosphate, sediment type, particle size, tidal influence and current speed and direction. These parameters will be used to determine areas with greatest probability for successful seagrass growth since these marine plants have specific requirements if they are to be successful. Areas to be surveyed for suitability in order of priority are:

1. The Mammee Shoals
2. The Shallow coastal areas of the Harbour mouth
3. The Shallow coastal areas on the nearby Cays (especially Drunken Man's Cay).
4. Should planting areas be exhausted before the 3.18 ha are successful planted, the UWI will establish a seagrass nursery at the Port Royal Marine Laboratory where seagrass will be held in outdoor tanks (Fig 1.). These tanks will become a nursery source of planting material should other locations/restoration sites require seagrass for coastal restoration.

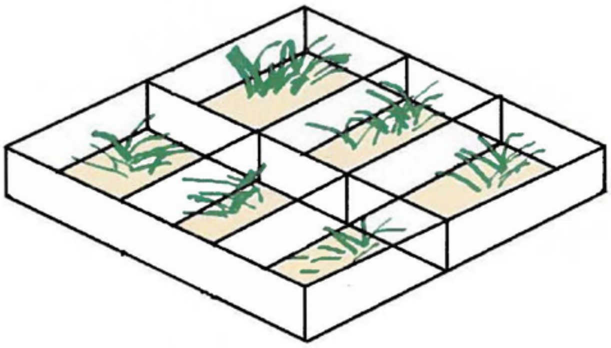

Figure 1. Possible design of seagrass nursery.

At the identified planting site, a turbidity curtain will be deployed depending on prevailing currents and wind. PU will typically be planted at appropriate spacing (ranges from 0.5 to 2.0m). More rapid coalescence of bottom coverage is achieved with higher planting density however if planted too close the seagrasses will show limited development spatially. The need for rapid coalescence will necessitate that the maximum realistic number of Pus that can fit within the replanting area will be used. The identification of bare patches on the seafloor, opportunistic blow outs and areas of boat and propeller damage will be highlighted to secure as much of the 3.18 ha required before new areas are identified.

The method of replanting is known as the **Staple Method**. If planted in a "blow hole" then sediments will be placed around the mat to a level that the original seagrass bed was covered. If planted on a flat area, the sediment will be excavated to a depth equivalent to the original seagrass bed. The PU will be stabilised by "stapling" it to the ground with the use of U-shaped rebars.

3.3 The Periodicity of harvest/planting

The harvesting and replanting will be a daily event. It is anticipated that approximately **50 to 70 m^2** will be harvested and replanted per day by a team of divers/snorkelers. This is dependent on the distance to travel from the reaping site to the replanting site. At this anticipated rate, with a team of 20 divers/snorkelers, approximately two hundred and seventy days **(270)** will be required to complete the process. This is dependent on weather conditions and other unforeseeable problems.

3.4 The monitoring methodology

Points along the turbidity curtain will be monitored to determine if turbidity is escaping and impacting the marine environment outside the isolated area. A turbidity of 10 Nephelometric Turbidity Units (NTU) above background outside (seaward) the turbidity curtain will be used to determine the point at which the seagrass removal processes should be halted and additional corrective and mitigative steps taken. The monitoring regime and reporting will be once per month for the first six (6) months, quarterly for the following twelve (12) months and biannually for the following twenty-four (24) months (See 4.1). This monitoring will look at the condition and growth of the meristems survival, areal coverage and number of shoots per PU. Areal coverage and the number of shoots per PU will be assessed by using a quadrat. Other factors such as water quality parameters (nitrates, phosphates, total suspended solids and depth), erosion and bioturbation impacts will also be assessed. Due to the large area, random sampling will be conducted. Additionally, picture transects will be conducted. These will help in comparing and determining the health of the seagrass replanted. In addition to self-monitoring it is recommended that the National Environment and Planning Agency or Agents conduct a monitoring exercise of their own. The establishment of a nursery at the PRML provides a stock of seagrass in the event of mortality of the replanted seagrass. If any seagrass dies within the designated planting area then stock plants will be taken from the nursery. The PAJ will be required to replant material subject to mortality from the nursery during the first twenty-four months. If serious bioturbation occurs then the planted beds will be fenced to prevent fauna from accessing the seagrass bed until the bed is well established.

TABLE 1 EXAMPLE OF THE SEAGRASS MONITORING SHEET

Project: Fort Augusta Seagrass Relocation	**Date:**
Monitored By:	**Verified By:**

Monitoring Component		**Score**					**Remarks**
		1	2	3	4	5	
Seagrass PUs Conditions	Persistent survival						
	Areal coverage						
	Evidence of new growth						
	Coalescence occurring						
	Increase in animal abundance						
Physical conditions	Sediment stabilization						
	Lack of bioturbation						
	Lack of anthropogenic impact						
	Water quality parameters ideal						

Scoring Key: 1 – Very Poor, 2 - Poor, 3 - Average, 4 - Good, 5- Excellent

4.0 PROJECT IMPLEMENTATION SCHEDULE

NO. (#)	PLANNED ACTIVITIES FOR PROJECT	TIME-LINE (IN MONTHS)											
		1	2	3	4	5	6	7	8	9	10	11	12
1	• Reconnaissance of marine area-source and holding site												
2	• Harvest and translocate seagrass and associated species												
3	• Reconnaissance of marine area-planting sites												
4	• Harvest and translocate seagrass and associated species to planting site												
5	• Establish seagrass nursery												

4.1. MONITORING REGIME SCHEDULE

NO. (#)	PLANNED ACTIVITIES FOR PROJECT	Year 1												Year 2												Year 3											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
6	Monitoring of transplanted seagrass beds and associated flora and fauna species.																																				

Once per month for the first six (6) months, quarterly for the following twelve (12) months and biannually for the following twenty-four (24) month

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4.0 REFERENCES

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