

APPENDIX A LEGISLATION

The list of legislation below provides a summary overview of the Territory and Commonwealth legislation that may be relevant to the East Arm Marine Industry Park and activities undertaken as part of the Project.

A.1 Northern Territory Statutory Requirements

Aboriginal Land Act (NT) provides access to areas which are Aboriginal land, whether it is on land or sea.

Biological Control Act (NT) provides for the biological control of pests in the NT and related purposes.

Bushfires Act (NT) provides for the prevention and suppression of bushfires in the NT.

Control of Roads Act (NT) provides for the administration and control of roads, including the maintenance of roads, construction and opening and closing of roads.

Crown Lands Act (NT) relates to Crown Lands, including the ability to grant occupation licences.

Dangerous Goods (Road and Rail Transport) Act (NT) makes provision for safety in the transport of dangerous goods by road as part of the system of nationally consistent road transport laws and to make provision for safety in the transport of dangerous goods by rail. It establishes common guidelines so that dangerous goods can be transported between states and territories.

Dangerous Goods Act (NT) provide for the safe storage, handling and transport of certain dangerous goods.

Darwin Port Corporation Act (NT) provides for the establishment of the Darwin Port Corporation (DPC), formerly known as the Darwin Port Authority, for the control and management of the Port of Darwin, and for related purposes.

Environmental Assessment Act (NT) provides for the assessment of the environmental effects of development proposals and for the protection of the environment in the NT. The NT Environment Protection Authority (EPA) is responsible for administering the Act. The EPA also determines the appropriate level of assessment for new developments or material changes to existing operations, based on the sensitivity of the local environment, the scale of the proposal and its potential impact upon the environment.

Environmental Offences and Penalties Act (NT) establishes penalties for certain offences under prescribed Acts (such as an environmental offence) and for related purposes.

Fire and Emergency Act (NT) provides primarily for the establishment of the NT Fire and Rescue Service, the operational and emergency response activities of the Service, the protection of life, property and the environment against fires and other emergencies.

Fisheries Act (NT) provides primarily for the regulation, conservation and management of fisheries and fishery resources so as to maintain their sustainable utilisation, to regulate the sale and processing of fish and aquatic life, and for related purposes.

Heritage Act (NT) establishes the Heritage Council and the NT Heritage Register. It sets the process by which places become heritage places, allows for interim protection of places and sets out the process for getting permission to do work to heritage places and allows for fines and imprisonment for offences against the Act.

Land Title Act (NT) provides primarily for the registration of land and interests in land.

Marine Act (NT) regulates shipping within the NT and provide for the application of the uniform shipping laws code and for related matters. All commercial vessels operating within NT waters are required to comply with survey and safety manning requirements under the NT Marine Act and Regulations.

Marine Pollution Act (NT) aims to protect the marine and coastal environment of the NT by minimising intentional and negligent discharges of ship-sourced pollutants into coastal waters. The Act makes provision for dealing with pollution by oil, noxious liquid substances in bulk, harmful substances in packaged form and pollution by garbage.

Mineral Titles Act (NT) regulates the exploration for, and extraction and processing of, minerals and extractive minerals in the NT. Particularly, the Act: establishes a framework for granting and regulating mineral titles that authorise exploration for, and extraction and processing of mineral and extractive minerals; and facilitates the commercialisation of activities conducted under mineral titles.

Northern Territory Aboriginal Sacred Sites Act (NT) establishes the Aboriginal Areas Protection Authority (AAPA) as the body responsible for overseeing the protection of sacred sites in the Northern Territory. The AAPA provides a process for avoidance of sacred sites and entry onto sacred sites and the issue of Authority Certificates which indemnify the holder against prosecution under the Act for damage to sacred sites in the certificate area, provided works or use has occurred in accordance with the conditions of the Authority Certificate.

Planning Act (NT) provides a framework of controls for the orderly use of land.

Plant Health Act (NT) provides the framework to ensure appropriate actions can be taken for the control of pests; and facilitates the production and trading of plants and plant products that are free from pests.

Public and Environmental Health Act (NT) relates to public and environmental health.

Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations (NT) provides for the prevention of mosquito breeding through the appropriate management of identified areas. Measures are to be taken to reduce the areas that are considered potential breeding grounds for mosquitoes. Open containers and areas that can hold water suitable for mosquito breeding are to be covered up, filled in or removed.

Soil Conservation and Land Utilisation Act (NT) make provisions for the prevention of soil erosion and for the conservation and reclamation of soil. It makes provisions for restricting construction activities that may result in land clearing, driving vehicles and causing water or other fluid to be drained or to flow over an area, which may cause further damage to the land that is not environmentally stable, such as areas suffering soil erosion or areas that have the potential to erode.

Territory Parks and Wildlife Conservation Act (NT) makes provision for the establishment of Territory Parks and other Parks and Reserves and the study, protection, conservation and sustainable utilisation of wildlife. It sets aside areas of the Territory as parks and conservation areas that may not be developed.

Waste Management and Pollution Control Act (NT) aims to protect, and where practicable, restore and enhance the quality of the NT environment; encourage ecologically sustainable development; and facilitate the implementation of NEPMs established by the National Environment Protection Council. It is designed to prevent contamination of the surrounding environment, including soil, air, and water, and imposes a general duty on conducting an activity or action that causes or is likely to cause pollution resulting in environmental harm, or that generates or is likely to generate waste.

Water Act (NT) provides for the investigation, allocation, control, protection, management and administration of water resources in the NT. The Act prohibits waste to come in contact with water or water to be polluted unless under authorisation.

Weeds Management Act (NT) aims to protect the NT economy, community, industry and environment from the adverse impact of weeds by preventing the spread of weeds, ensuring community consultation in the creation of weed management plans and ensuring the community has responsibility in implementing weed management plans.

A.2 Commonwealth Statutory Requirements

Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth) preserves and protects from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition.

Aboriginal Land Rights (NT) Act 1976 (Cth) provides for the granting of Traditional Aboriginal Land in the NT for the benefit of Aboriginals.

Assessment of Site Contamination NEPM 1999 (Cth) establishes a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, contaminated land auditors, land owners, developers and industry.

Australian Heritage Council Act 2003 (Cth) establishes the Australian Heritage Council, a statutory body replacing the Australian Heritage Commission as the Australian Government's principal adviser on heritage matters. The Australian Heritage Council is administered by the Department of the Environment and seeks to:

- assess whether a place meets the National Heritage criteria or the Commonwealth Heritage criteria
- advise the Minister on conserving and protecting places included, or being considered for inclusion, in the National Heritage List or Commonwealth Heritage List
- invite public comment on whether a place meets any of the National Heritage criteria or Commonwealth Heritage criteria and whether a place should be included in the National Heritage List or Commonwealth Heritage List
- promote the identification, assessment, conservation and monitoring of heritage, and
- keep the Register of the National Estate.

The Council also makes assessments under the *EPBC Act*, and performs any other functions conferred on the Council by the *EPBC Act*.

Australian Ballast Water Management Requirements 2001 are requirements designed to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ships' ballast water. Australian ballast water management requirements are consistent with International Maritime Organization (IMO) guidelines for minimising the translocation of harmful aquatic species in ships' ballast water.

Energy Efficiency Opportunities Act 2006 (Cth) is designed to encourage more efficient use of energy by large energy using businesses. The Act requires large energy using businesses to identify, evaluate and report publicly on cost effective energy savings opportunities.

Environmental Protection (Sea Dumping) Act 1981 implements Australia's obligations under the London Protocol, which aims to prevent marine pollution by dumping of wastes and other matter. A permit under the *Sea Dumping Act* may be required if dredge spoil from a project undertaken in the Northern Territory, is to be disposed of in Australian waters. The National Assessment Guidelines for Dredging (NAGD) (Commonwealth Government, 2009)

sets out the framework for assessing and permitting offshore disposal of dredged material and the requirements of the *Sea Dumping Act*.

Environmental Protection and Biodiversity Conservation Act 1999 (Cth) provides for the protection of the environment and the conservation of biodiversity, particularly those matters of national environmental significance.

Hazardous Waste (Regulation of Exports and Imports) Act 1989 and Amendment Act 1996 (Cth) provides for the regulation of the export, import and transit of hazardous waste, and for related purposes. The object of this Act is to regulate the export, import and transit of hazardous waste to ensure that exported, imported or transited waste is managed in an environmentally sound manner, so that society and the environment, both within and outside Australia, are protected from the harmful effects of the waste.

Historic Shipwrecks Act 1971 covers shipwrecks in Commonwealth and NT waters and prohibits the interference, damage or removal of a wreck or any artefacts without an appropriate approval. Under this Act, all wrecks that are older than 75 years old are automatically protected, inclusive of those found in Territory waters. Automatic protection occurs regardless of whether a site has been previously recorded. The Minister for the Environment can declare any historically significant wrecks that are less than 75 years old. The Commonwealth administers the Act. Delegation under the Act is vested in the Department of Lands Planning and Environment (DLPE).

Industrial Chemicals (Notification and Assessment) Act 1989 (Cth) relevantly establishes a national system of notification and assessment of industrial chemicals.

National Environment Protection Council Act 1994 (Cth) provides national standards for ambient air quality, movement of controlled wastes, and contaminated sites. This Act is administered by DoE.

National Environment Protection Measures (Implementation) Act 1998 (Cth) enables the implementation of national environmental protection measures.

National Greenhouse and Energy Reporting Act 2007 (Cth) provides for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy production and energy consumption.

Native Title Act 1993 (cth) provides statutory recognition and protection for the concept of native title, including provisions for reaching Indigenous land use agreements.

Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (Cth) relates to the protection of the sea from the effects of harmful anti-fouling systems. It includes application or use of harmful anti-fouling and the required certificates and anti-fouling declarations.

Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth) relates to the prevention of pollution (in any form) from ships.

Quarantine Act 1908 and Quarantine Regulations 2000 (Cth) relates to quarantine, including the quarantine and quarantine procedures of vessels, persons and goods.

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APPENDIX B LAND DEVELOPMENT CORPORATION BROCHURES

B.1 LDC brochure 'East Arm Logistics Precinct'

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Right Place. Right Time.

East Arm Logistics Precinct

Take advantage of the opportunities at East Arm

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LAND DEVELOPMENT
CORPORATION

East Arm Logistics Precinct

We've put all the pieces together. It's your move!



Be part of NT's fastest growing industrial precinct!

The East Arm Logistics Precinct is at the forefront of the Northern Territory's major projects in a region that is rapidly expanding into the resources and logistics industries.

Located in the Northern Territory's capital city, Darwin, 16 kilometres from the CBD, the precinct covers more than 300 hectares and is strategically located close to the Port of Darwin's East Arm Wharf, the Marine Supply Base, the AustralAsia railway and major road and air transport connections.

Darwin is Australia's gateway to Asia and increasingly recognised, nationally and internationally, as a strategic location for servicing the region's expanding oil and gas, marine and logistics industries.

The purpose-built East Arm Logistics Precinct is designed to assist businesses to grow and capitalise on future projects in the region with serviced land available within the Darwin Business Park, Common User Area, Marine Services Area and private developments.



East Arm Logistics Precinct – *Key Precincts*

Darwin Business Park

Darwin Business Park is a 100ha precinct strategically located close to the East Arm Wharf, the AustralAsia railway and Darwin's CBD. Zoned DV for development use, lots at the Darwin Business Park will particularly suit businesses engaged in the NT's growing oil and gas, mining, transport and logistics industries. Land is available for sale, and short and long term lease depending on location, use and size.

Common User Area (CUA)

The CUA is a dedicated area that is ideal for businesses wanting to lease secure hardstand areas on short to medium terms within easy reach of the East Arm Wharf and the AustralAsia railway. Sites at the CUA are available for use by businesses wanting to undertake a variety of economic activities associated with:

- Oil and gas projects service and support
- Engineering, fabrication and assembly of a range of equipment and modules
- Mining industry services, support and maintenance



Multi User Barge Facility

The site has been strategically identified for the planned Multi-User Barge Facility to provide maximum tidal access. This would potentially allow the facility to be operational 24 hours a day. The proposed concept for the Multi User Barge Facility has two components being the Barge Ramp facility and the laydown hardstand areas which is an extension to the current CUA.



Marine Supply Base

The Marine Supply Base is located directly adjacent to the East Arm Wharf and is supported by the Common User Area. The base increases Darwin's capacity to support offshore oil and gas development in northern Australia, including the operations in the Arafura and Timor seas and Browse Basin. The base includes three marine berths with water, fuel, chemical and drilling mud connections, hard stand and lay down areas, warehousing, waste management facility, storage capacity and associated facilities.



Transport Hub

The planned Transport Hub is strategically located outside the East Arm Logistics Precinct on the main arterial links of Wishart Road, Tiger Brennan Drive and Berrimah Road providing a central location for the development of transport services.

Marine Industry Park

The new Marine Industry Park offers 130 hectares of premium waterfront land and will have dedicated areas for marine maintenance, marine logistics and marine related developments. The Marine Industry Park will capitalise on supporting infrastructure and maintenance opportunities for all marine sectors. The marine maintenance area will be the first to be developed, with other stages to follow in line with investment interest.





Invest in the East Arm Logistics Precinct



East Arm Wharf

Marine Supply
Base

Proposed Multi
User Barge Facility

Existing Common
User Area

CUA Expansion
Area

Darwin Business
Park

Berrimah Freight
Terminal

B.2

LDC brochure 'Darwin's Marine Industry Park' concept image / design

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Shipping Times

Fremantle:
3400 kilometres
and about five
days steaming
time for ships.

Cairns:
About 2300
kilometres to
the East and
about four days
steaming time.

Singapore:
3500 kilometres to
the north-west, or
around five days.

Competitive Advantage

Darwin is the Northern Territory's capital city. It is centrally located on the country's northern coastline and is Australia's gateway of choice to Asia. It is fast becoming the location of choice for businesses and service industries looking to profit from Darwin's reputation as a logistics, service and supply hub for Australia's northern off shore oil and gas developments.

DARWIN'S MARINE INDUSTRY PARK

Open for business



Message from the Northern Territory Chief Minister, Adam Giles

The Northern Territory is Australia's trade gateway to Asia and its capital city, Darwin, is Northern Australia's growth engine. Our prosperity is driven by major offshore oil and gas developments, onshore minerals production and export, a strong Defence presence and major infrastructure projects.

As the Federal Government prepares a white paper on realising the potential of Australia's north, never was there a better time to position your business to take advantage of the growing opportunities.

The Darwin Marine Industry Park will be a key address for industries and businesses to profit from the increasing demand for service, supply and logistics support for the oil and gas industry.

A stylized, handwritten signature of Adam Giles in white ink.

The Hon Adam Giles MLA
Chief Minister Northern Territory
Minister for Economic Development
and Major Projects



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East Arm Logistics Precinct
DARWIN,
NORTHERN TERRITORY
OF AUSTRALIA

Marine
Industry Park
Artist Impression



Darwin
Harbour

“This facility will enhance Northern Territory support for the marine and offshore industries complementing services already available from the East Arm Logistic Precinct and the Darwin Marine Supply Base, creating a full-package solution”.

Ashley Harrison
Managing Director
ASCO Australia Pty Ltd
East Arm NT

Marine
Industry Park
Highlights

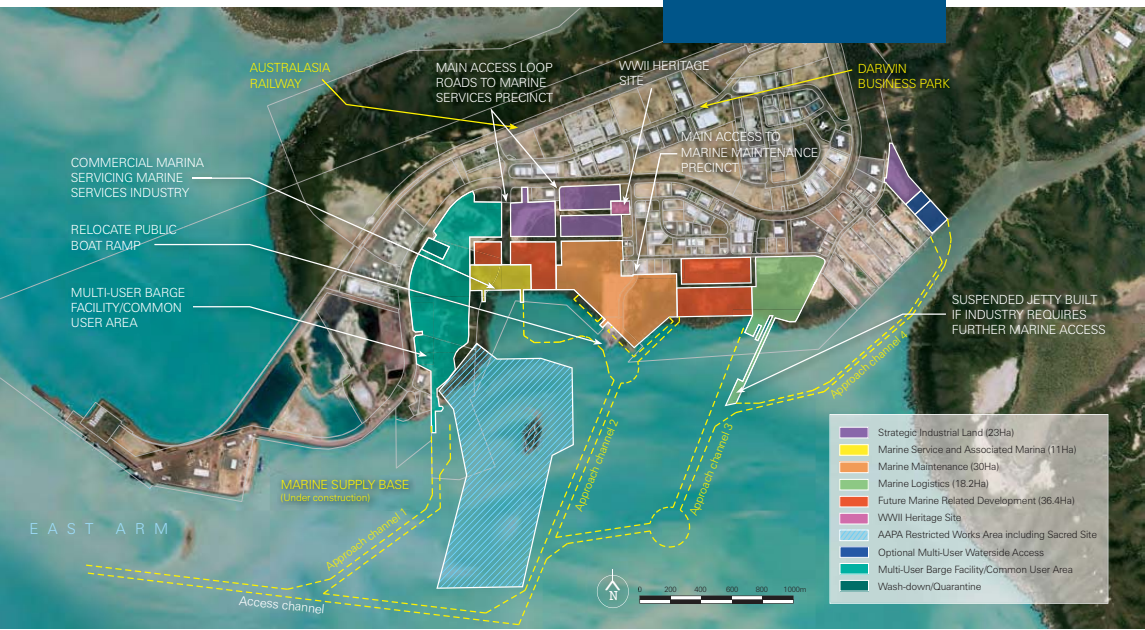
Darwin has a reputation as a logistics, service and supply hub for Australia's North.

The 130-hectare Marine Industry Park will be strategically located on the premium waterfront land in the East Arm Logistics Precinct, with connections to road, rail and sea transport and other supporting infrastructure.

Businesses in Darwin's Marine Industry Park will capitalise on:

- » its proximity to the burgeoning offshore oil and gas industry to the north
- » growing demand for service and supply industries to service the region's oil and gas, marine and Defence industries
- » one operational LNG plant and another under construction
- » a world-class marine supply base, expected to commence operations early in 2014
- » established multi-modal port connected to the AustralAsia Railway
- » competitive advantage as the only city on the north coast of Australia offering marine maintenance capabilities
- » substantial available land for industrial development.

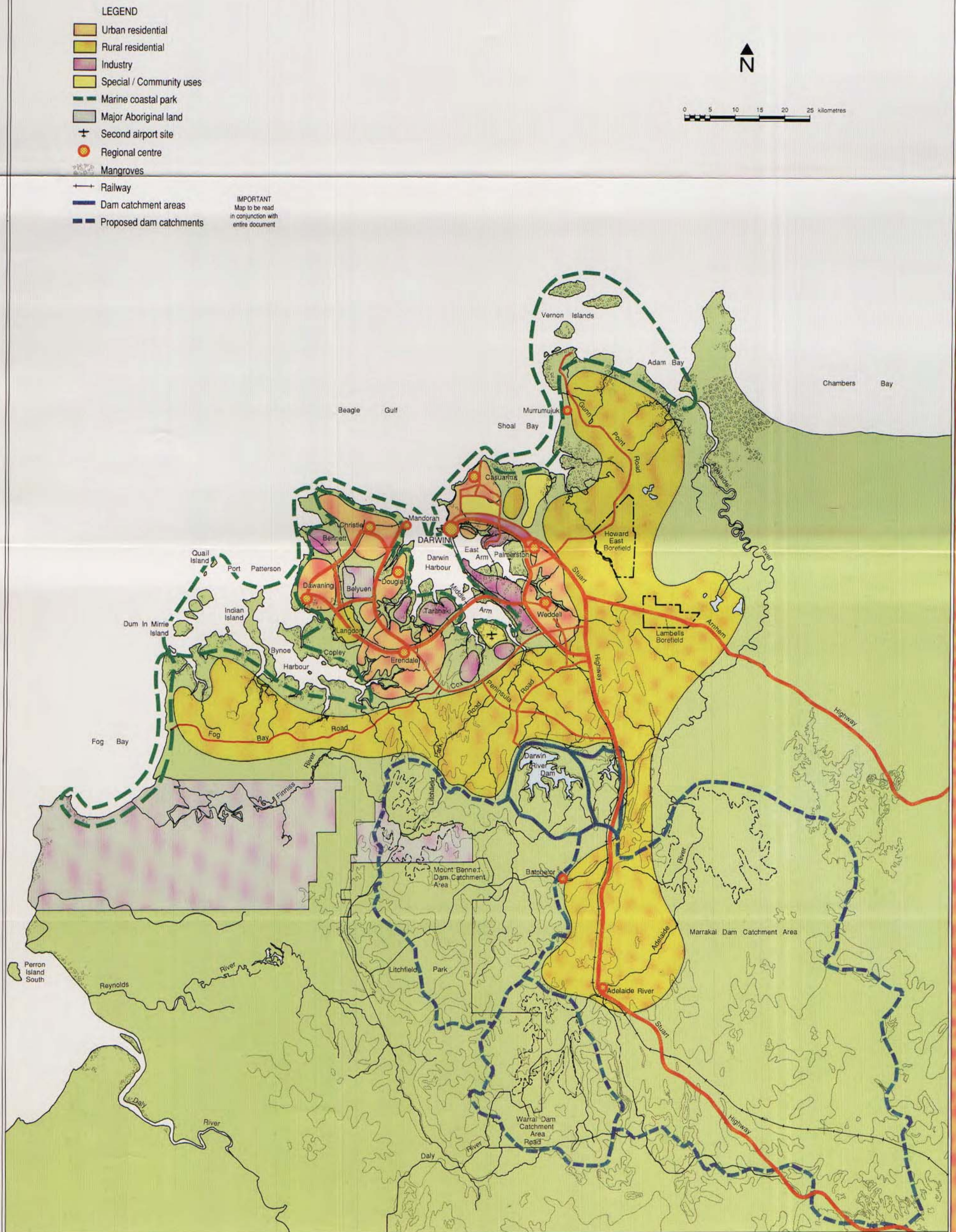
Marine
Industry Park
Feasibility Concept

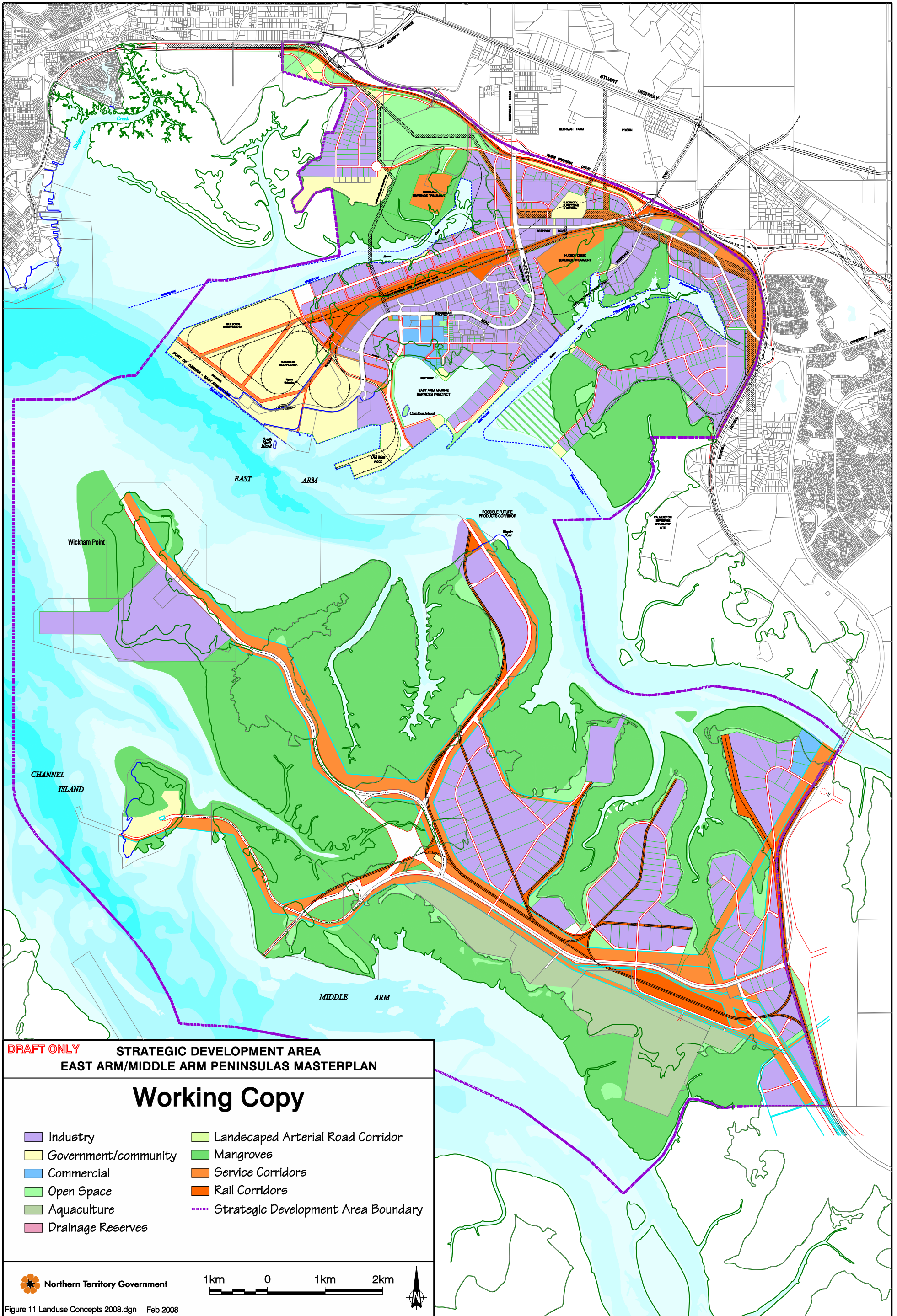


APPENDIX C NT GOVERNMENT LAND USE / MASTER PLANS

- C.1 Darwin Regional Land Use Structure Plan (NTG,1990)**
- C.2 Strategic Development Area, East Arm / Middle Arm Masterplan (NTG, 2008)**

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APPENDIX D PROPOSED MARINE INDUSTRY PARK MODELLING REPORTS

D.1 Task 1 - Dredge Channel and Shoreline Development

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Proposed Marine Industry Park Modelling Report

Task 1 – Dredge channel and shoreline development

Ruth Patterson and David K Williams

PRODUCED FOR

Land Development Corporation, Darwin



Darwin
2013

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1 Introduction

The Land Development Corporation (LDC) have requested hydrodynamic and sediment transport modelling pertaining to the proposed development of the Marine Industry Park at East Arm. This report describes the work done for Task 1 of the modelling investigation. This consisted of running baseline and development hydrodynamic and cohesive sediment modelling for the initial stages of the development. The initial stages of the proposed development are to build the shoreline out from intertidal mangroves to a rock wall and include a ship turning area and dredge channel.

The modelling software used is Resources Modelling Associates (RMA), a two dimensional, depth-averaged, finite element, hydrodynamic, numerical model. Simulations of hydrodynamics and cohesive sediment transport were undertaken using RMA2 and RMA11. The existing model geometry has been refined as discussed with LDC to include the following.

- Structured shoreline
- Ship-turn area surrounding the structured shoreline
- Dredge channel
- Common user area development

This will be done using the list of objectives outlined in Table 1.

Table 1: Task 1 outline and description

Task 1	Description
Baseline model run	Run the existing Darwin Harbour model for a full lunar tide cycle. This will capture the spring and neap tidal conditions.
Modify model to include the proposed development line	Model ebb and flood tidal currents. Compare output with the baseline model run. Report on any differences on the environment and nearby infrastructure paying particular interest to the East Arm Wharf infrastructure and sacred site, Catalina Island.

An Acoustic Doppler Current Profiler (ADCP) was deployed to measure *in situ* velocities in a 2009 study. The data collected was used in this project to validate the model alterations. Figure 1 shows the model mesh, ADCP mooring location, AIMS and NRS real time data collection point at buoy 5 and the development for task 1.

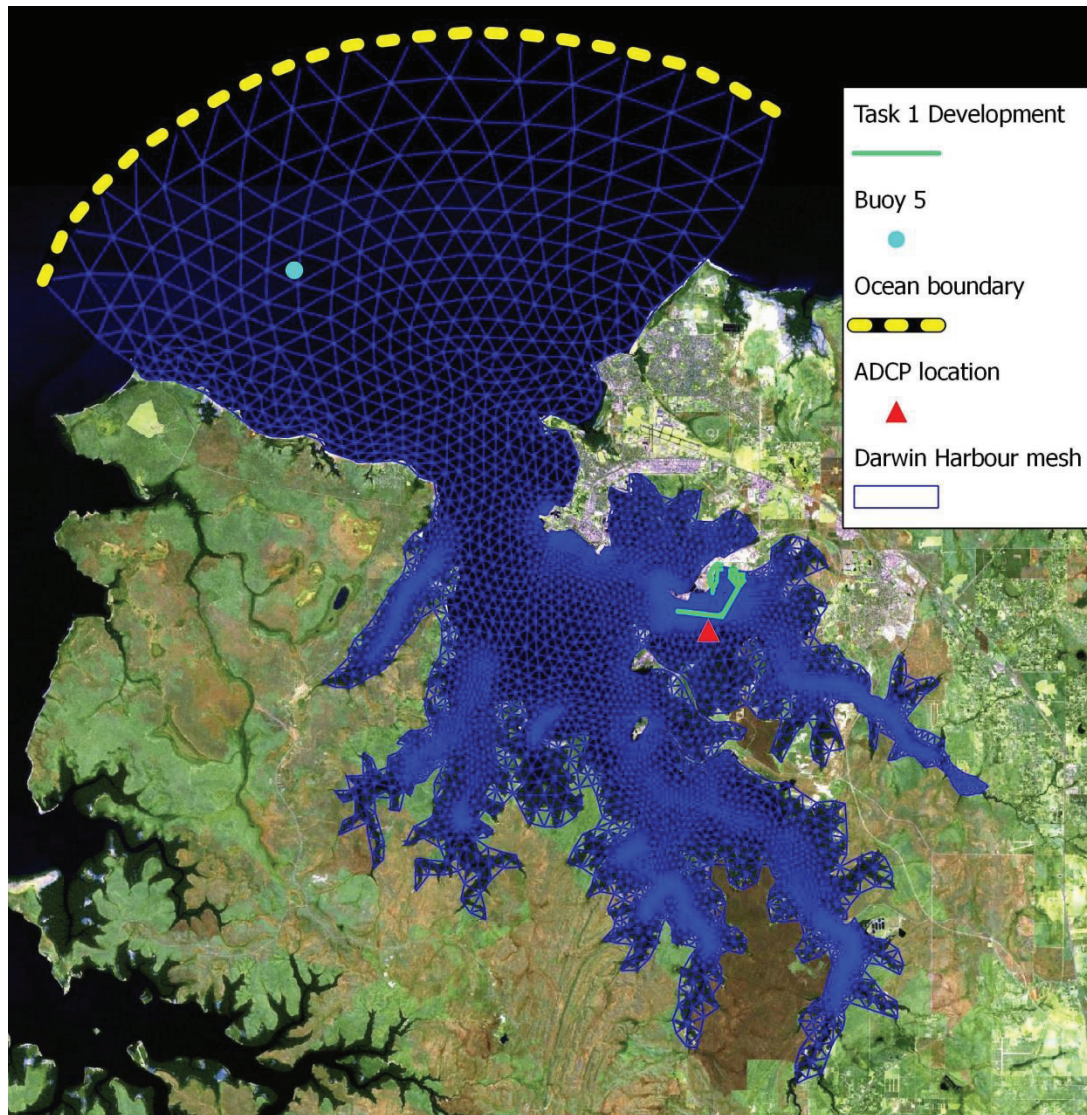


Figure 1 Darwin Harbour model mesh

2 Model Background

The RMA Darwin Harbour model mesh has been developed, refined and validated for more than a decade prior to the work done for this report. In previous industry reports, the Darwin Harbour model has been shown to be reliable by verifying the model data with field data. The following dot points list examples of how the Darwin Harbour model has been used in recent years.

- Marine Supply Base dredging at East Arm Wharf
- Navy base dredging and investigation of extended facilities
- Darwin Water Front development
- Cullen Bay dredging
- Changes to hydrodynamics due to proposed removal of East Arm sandbar
- Development of the satellite city of Weddell

The existing Darwin Harbour model has been used as a platform for this project. The ocean boundary extends between Charles Point and Lee Point and covers the area of the harbour within this ocean line, shown in Figure 1 as a yellow dashed line.

3 Methodology

The model was run three times in total for the purposes outlined in Table 2.

Table 2 Model runs and descriptions

Model Run	Model description	Purpose
1	Existing bathymetry + refined model mesh + 2009 tides (<u>Verification model</u>)	To verify the refinement of the model mesh against ACDP data
2	Existing bathymetry + refined model mesh + 2013 tides (<u>Baseline model</u>)	To compare any effects on the environment due to the structural changes
3	Refined model mesh + structures and elevations (dredge channel and shoreline) + 2013 tides (<u>Development model</u>)	

3.1 Model Mesh Refinement

The most recent Darwin Harbour model mesh is shown in Figure 2(a) to indicate the starting point of the mesh refinement process. This has not been used in any modelling runs in this report. Figure 2(b) and (c) show that the dredge channel has been inserted with 25 x 50 m elements, the shoreline development has been refined and the common use area has been included in the mesh. The mesh bathymetry is shown in Figure 2 in colour, with Figure 2(b) retaining the natural bathymetry, and Figure 2(c) representing the elevation changes for the proposed development. Note that the outline for the proposed common user area (see Figure 4) in the model mesh was based on the previous infrastructure modelling and differs slightly to the outline given in this task. The original consultancy infrastructure was retained for the modelling described in this report.

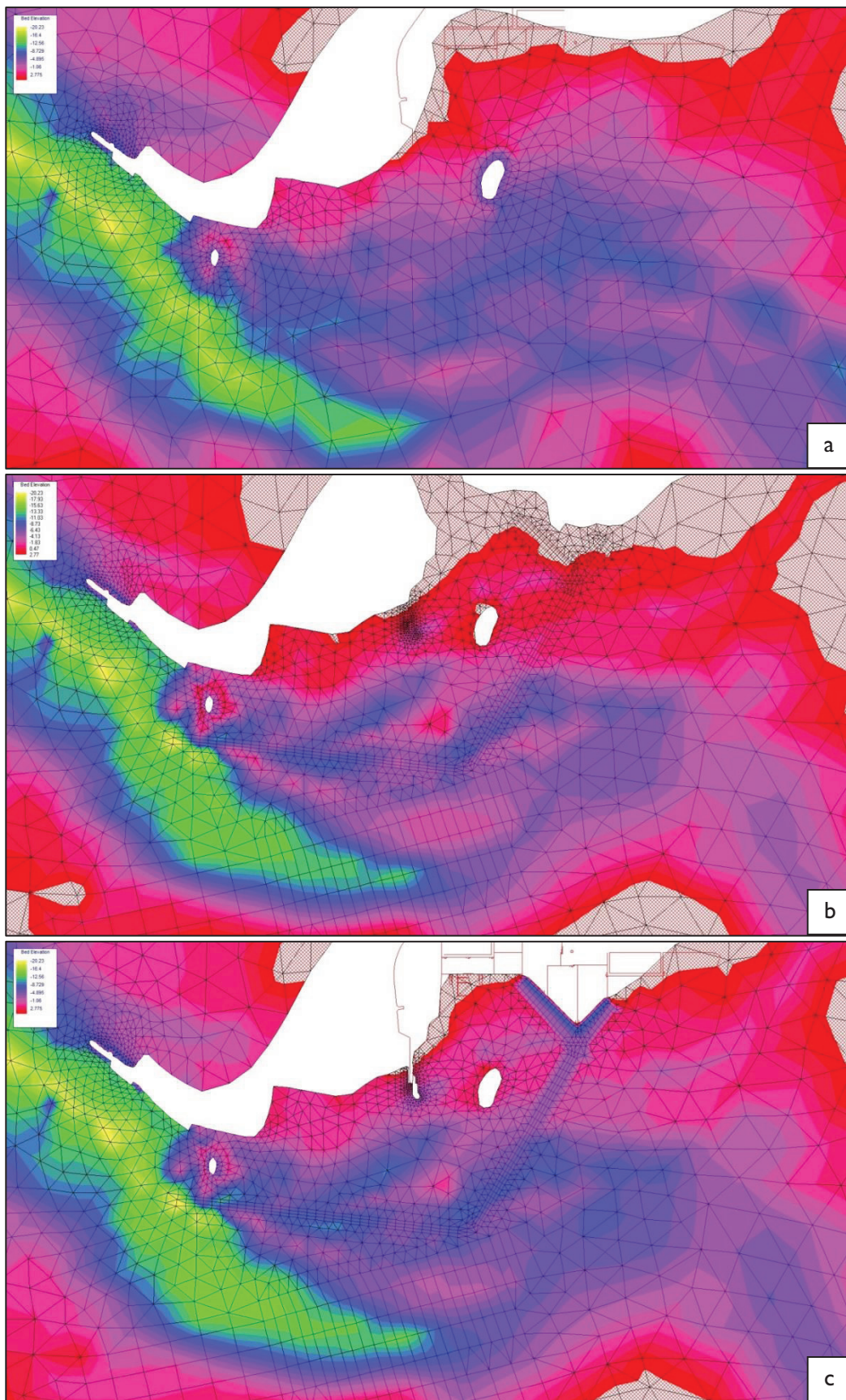


Figure 2 Original model mesh (a) and refined model meshes before (b) and after (c) inserting structural changes

3.2 Acoustic Doppler Current Profiler Measurements

An Acoustic Doppler Current Profiler (ADCP) was placed in the vicinity of East Arm in a previous study in 2009. ADCPs record the current through the water column at regular user defined intervals. The ADCP results showed no vertical stratification, confirming that the harbour is vertically well mixed. This confirms the assumption that Darwin Harbour can be represented well by 2 dimensional, depth averaged modelling. The results were averaged through the water column to give velocity results at the location of the instrument deployment through time. The location of the ADCP deployment is shown in Figure 1.

3.3 Tidal Boundary Conditions

The verification model (see Table 2) was run to cover the period of the ADCP deployment in 2009. The tide predictions have been applied to the ocean boundary of the model (shown in Figure 1). Figure 3(a) shows the tides that were used to drive the verification model. The baseline and development models were driven with the tides derived from the Integrated Marine Observation System (IMOS) National Research Station (NRS) at buoy 5 under AIMS management. The tides used to drive these models are shown in Figure 3(b). The location of buoy 5 is shown in Figure 1.

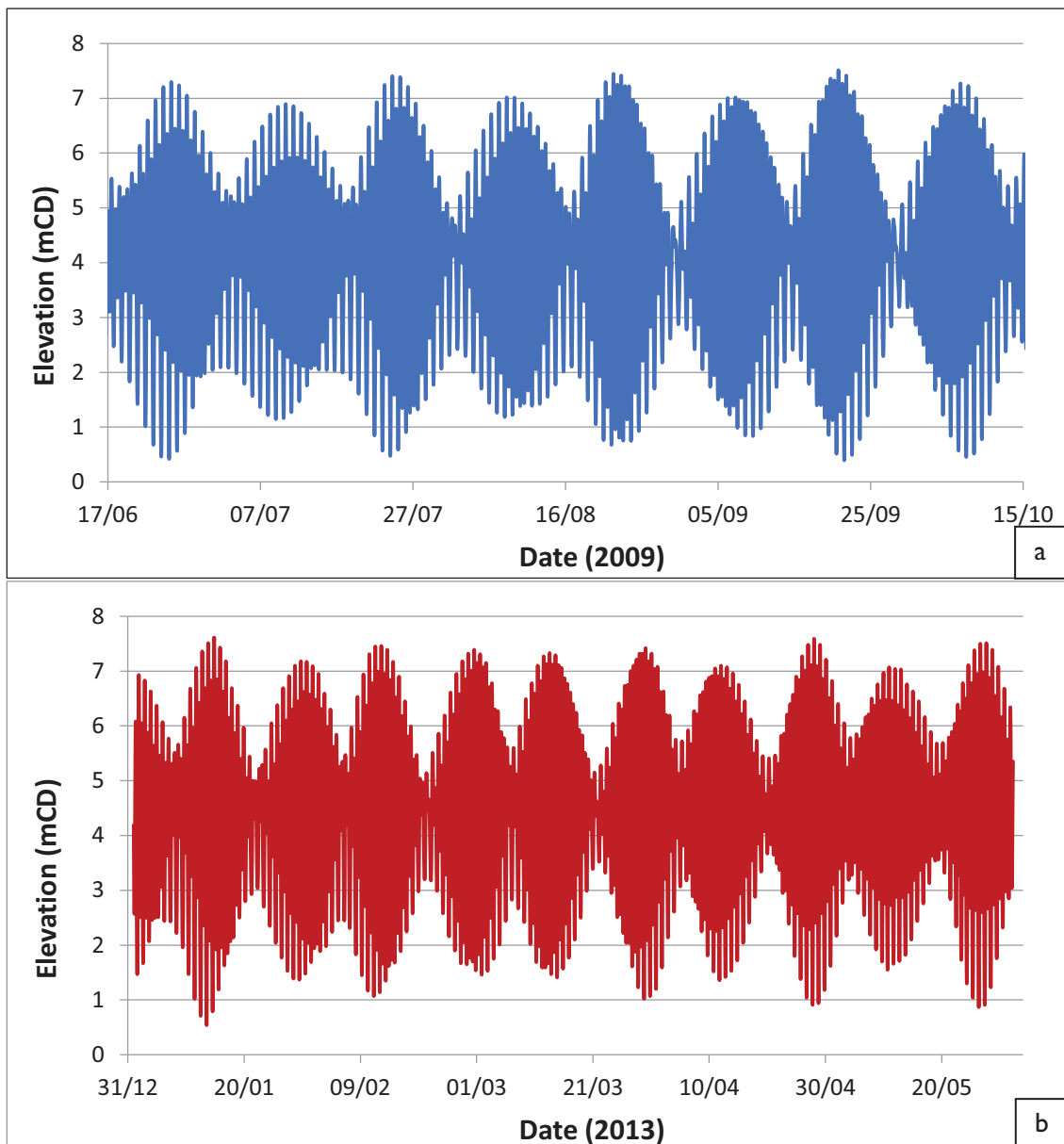


Figure 3 Darwin tide predictions, used to drive the 2009 verification model (a) and the baseline and development models (b) at the ocean boundary

3.4 Sediment modelling

The RMA cohesive sediment model has been run for three months using the results from the 2013 RMA2 hydrodynamic model. A 2011 survey using a multibeam echosounder gives an indication of the bed conditions (Figure 4). The multibeam results show the presence of sand waves and ridges in an around the proposed development and dredge channel. However no survey for unconsolidated bed thickness in East Arm exists to date, therefore the depth and true extent of the material is unknown. This makes the absolute erosion and deposition of cohesive sediment difficult to predict with confidence. Areas of potential deposition and scour can be predicted using cohesive modelling results. Critical erosion and deposition levels in the RMA-II model depend on the shear stress levels of the sediment, and the characteristics of the bed material. An initial suspended sediment concentration of 10 mg/l has been applied to the model, which includes the concentration at the model boundary.

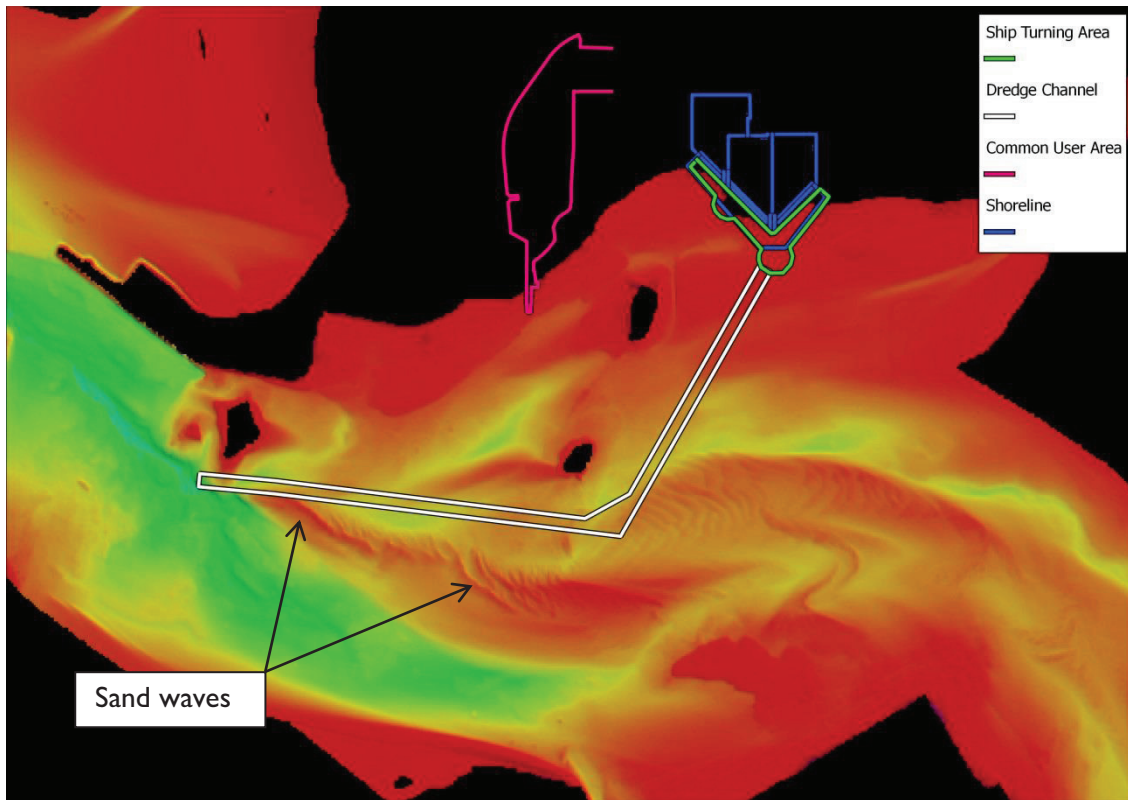


Figure 4 Multibeam echosounder results at East Arm

4 Results

4.1 Model Verification

Figure 5 shows ADCP versus the verification model results at the ADCP location for x, y and total velocity. Both the amplitude and frequency of the x-velocity results match well. The y-velocity results show a noisy signal, which is likely due to turbulence occurring in the environment. Given RMA is a far field model and results in this location are averaged over an area of approximately 0.02km^2 it is expected that the model will not capture the small scale variations. Given that y-velocity values are very small, and account for only a small fraction of the total velocity results, they make negligible difference to the model results, as can be seen in the total velocity comparison time series (Figure 5(c)). The graphs shown in Figure 5 indicate that this model in its current state can be used confidently to predict the currents in this region. It should be noted however that further field measurements and modelling work will contribute to model improvements and this model is being continuously updated and improved.

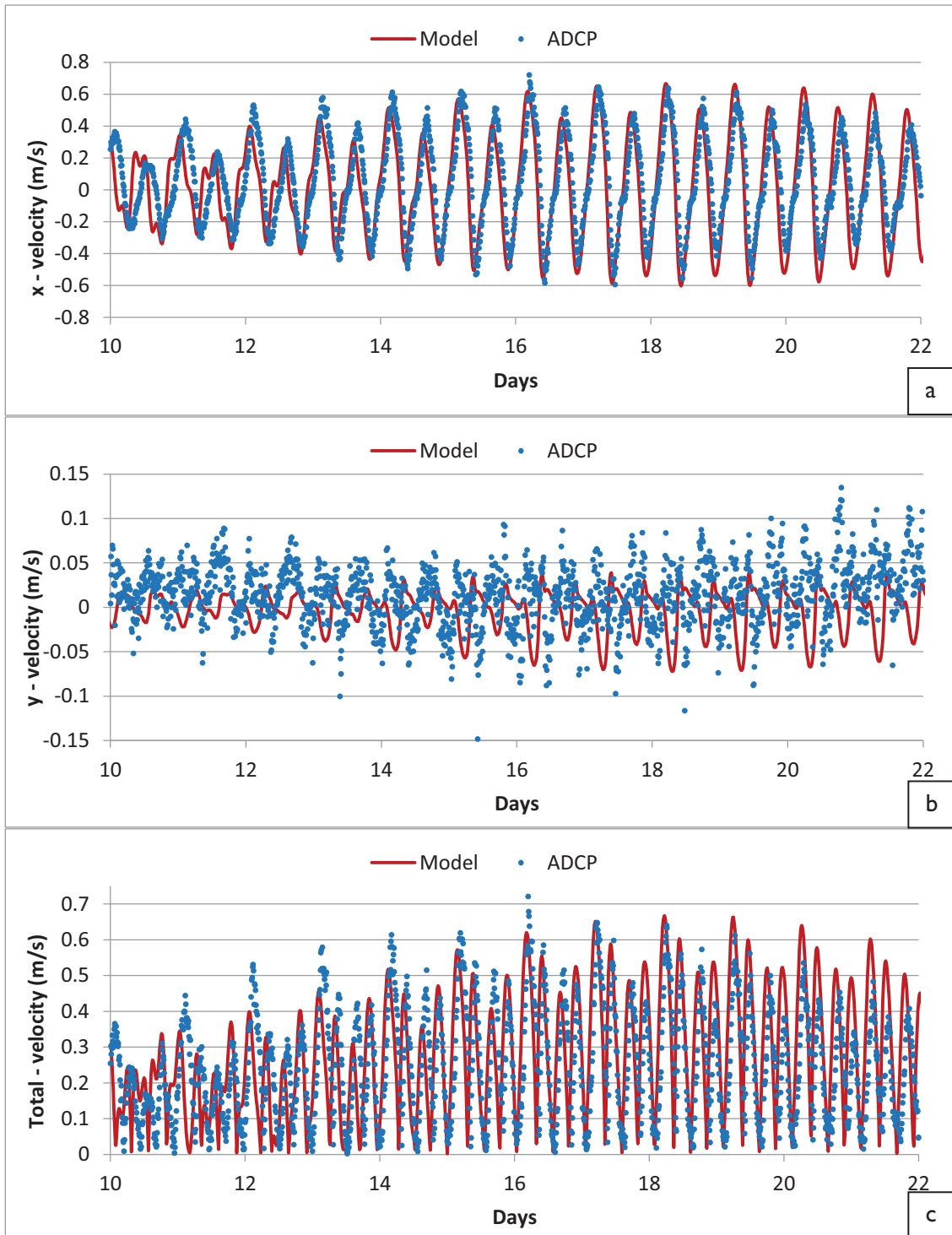


Figure 5 ADCP versus model results for x-velocity (east-west)(a), y-velocity (north-south)(b) and total velocity (c).

4.2 Hydrodynamic modelling

Results from both the baseline model and the development model show little difference in the maximum velocity in proximity to the proposed development. Ebb and flood velocities are shown in Figure 6 and Figure 7 respectively as gridded velocity vectors and magnitude. The maximum velocity does not exceed 0.6m/s 850m from the shoreline development along the shipping channel. The velocities shown in the figures below are based on a 6.9m tide.

Velocities toward the western most end of the shipping channel are shown to reach more than 1m/s. The largest velocities occur on a flood tide at the southern tip of South Shell Island. However velocities during an ebb tide are generally large in the area. Figure 8 shows the areas where ebb velocities dominate (shaded green and blue).

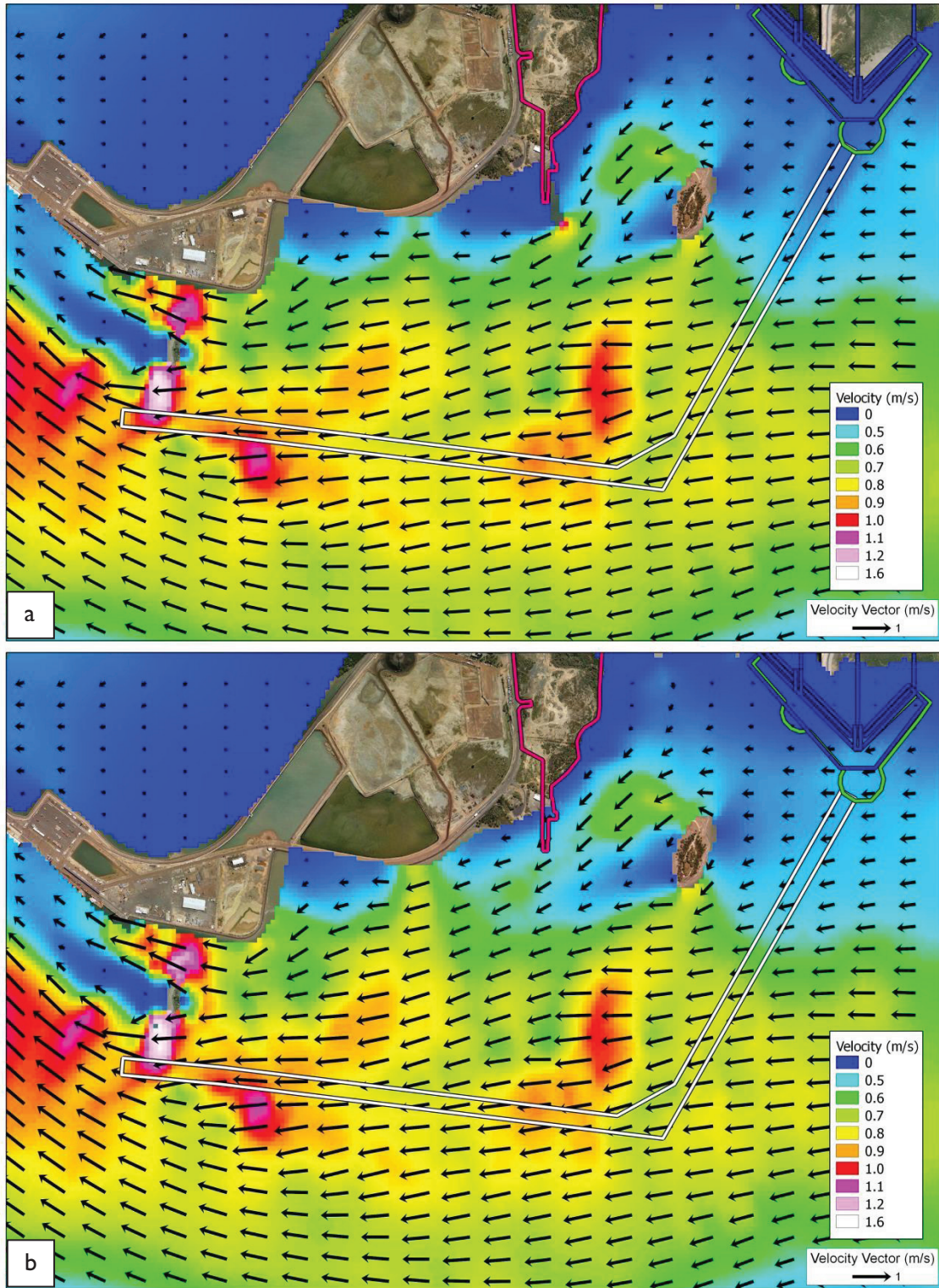


Figure 6 Peak ebb tide velocity vectors and magnitude development (a) and baseline (b) model

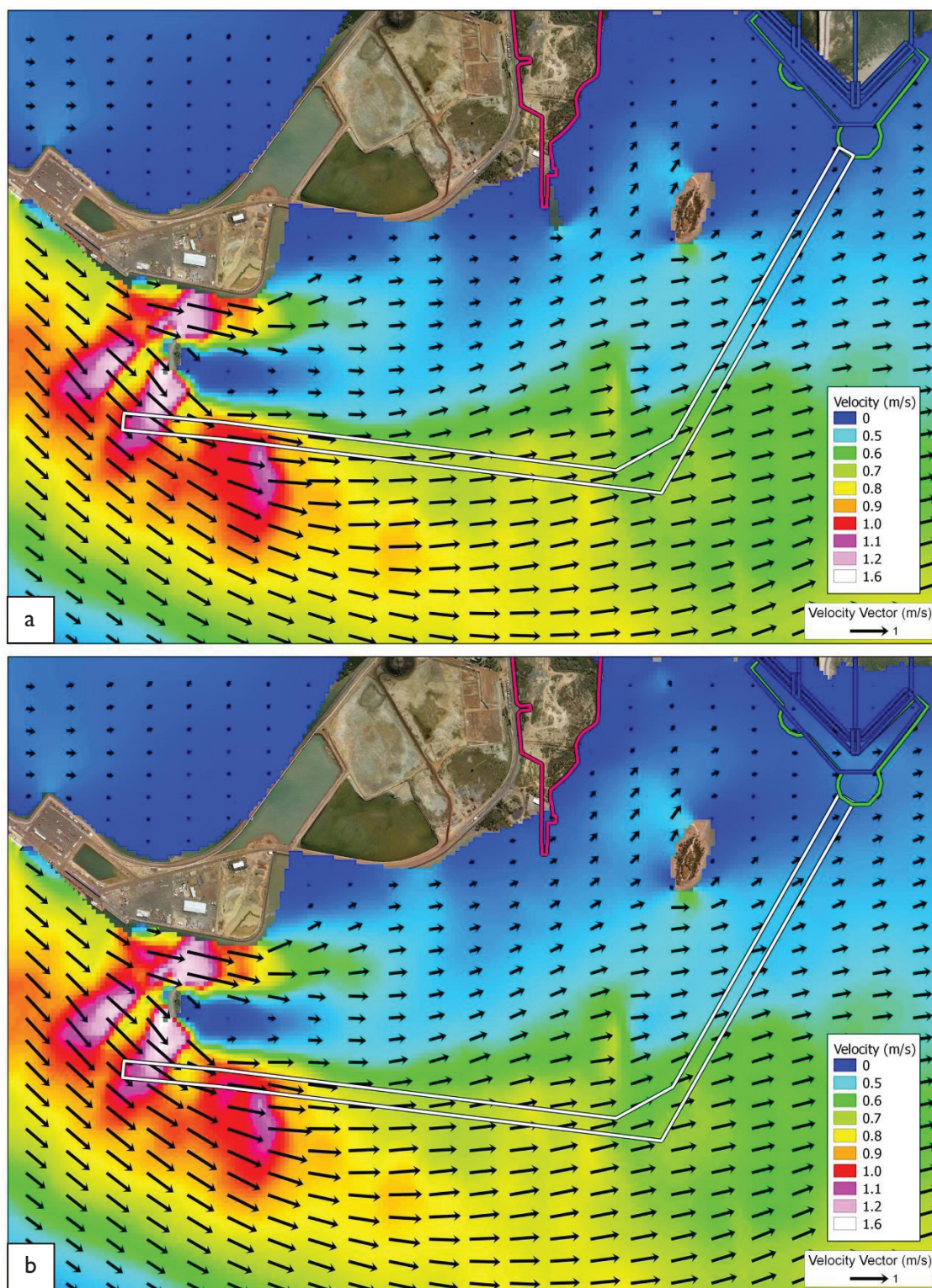


Figure 7 Peak flood tide velocity vectors and magnitude development (a) and baseline (b) models

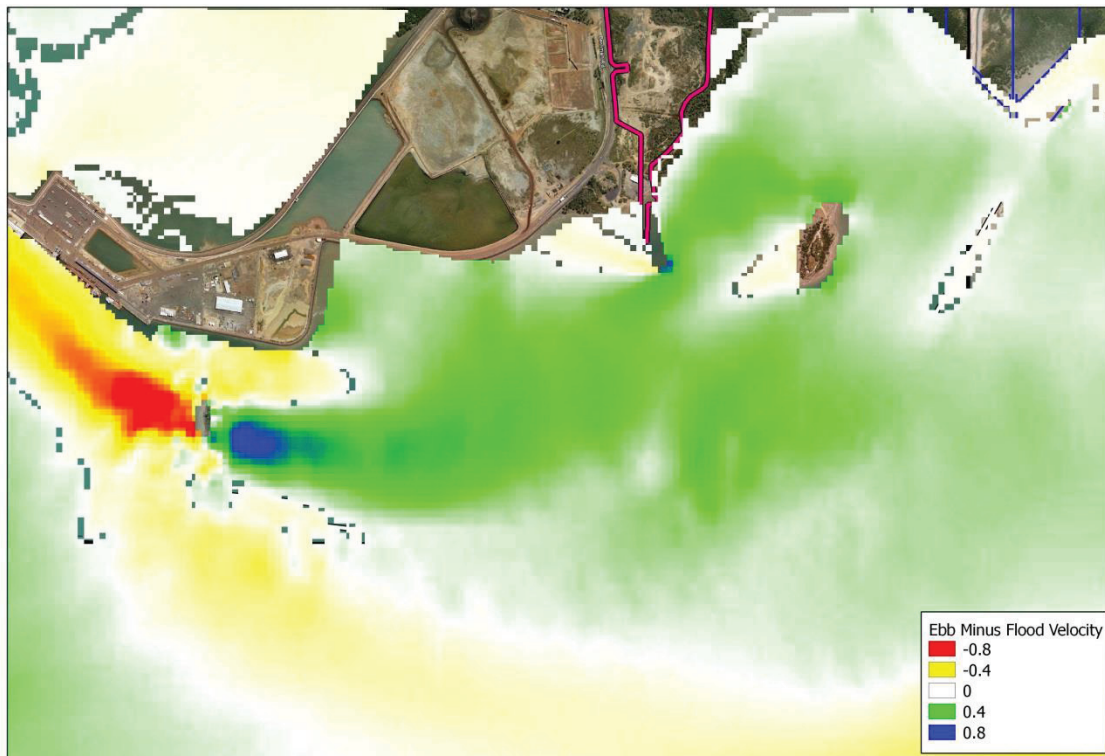


Figure 8 Ebb minus flood velocity magnitudes

4.3 Sediment modelling

Sediment modelling results are shown using shear stress and bed deposition. When the shear stress reaches above a critical level, erosion will occur. Similarly, when the shear stress is insufficient to keep particles suspended in the water column, deposition occurs. The approximate critical shear stress for fine sediment bed erosion is 0.1 N/m^2 , and bed deposition is 0.08 N/m^2 .

4.3.1 Erosion

Figure 9 shows high levels of bed shear stress ($> 4 \text{ N/m}^2$) close to South Shell Island. This area has not been altered significantly in the model mesh except for the reduction in elevation of about 5 nodes within the proposed dredge channel. In this case, the bed material consists mostly of larger grained material such as coarse sand, shell and gravel, which require a larger critical shear stress for erosion. Erosion may occur at the toe of the rock wall connected to the common use task area depending on the extent of the rock wall. Catalina Island displays a maximum shear stress coefficient of around 0.8 N/m^2 . Sediment sampling at Catalina Island has shown bed material consists of around 90% gravel, large smooth shells (indicating long residence times) and coarse sand (pers comm. S. Tonyes). Field results combined with model results shows that the risk of erosion here is low.

4.3.2 Deposition

The model results show that sediment deposition will occur in and around the shoreline development, ship turn area and at the dredge channel close to the shoreline (Figure 10(a) and Figure 11). This is likely due to the cross channel velocities (shown in Figure 6 and Figure 7), transporting sediment across the channel where it drops out in the deeper, low flow region. The bed material in this area is known to consist of sand and fine sediment. Deposition rates are difficult to predict, given that the depth and extent of sediment has not been fully surveyed. The assumptions used in this model are based on grab samples at some locations in the area, however these are not extensive. Sediment build-up is also likely to occur directly to

the west of the common user area and further west in the elbow of the East Arm Wharf site where the road joins at the southern edges of ponds C and K. This is shown by white and yellow shading in Figure 10.

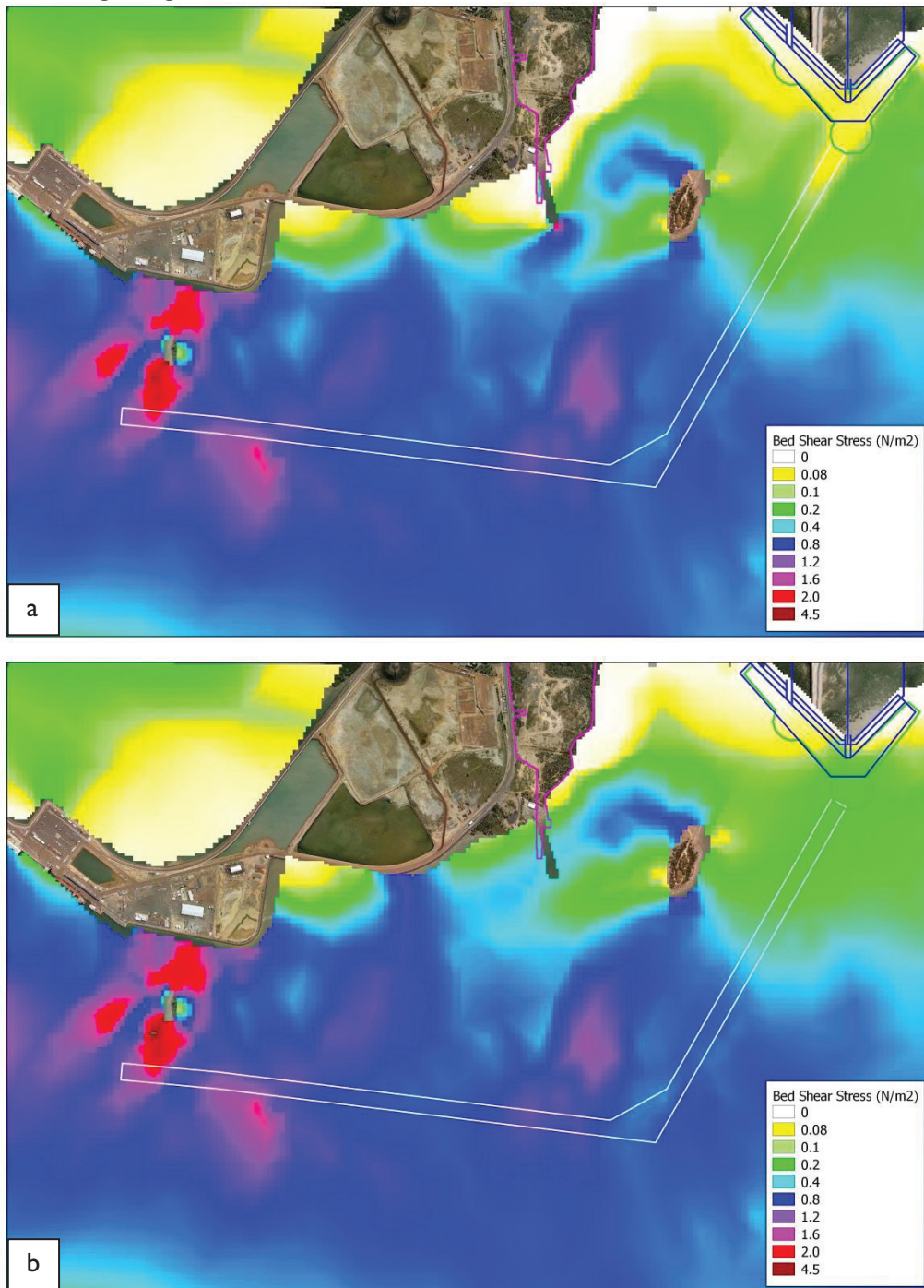


Figure 9 Bed shear stress for the development (a) and baseline (b) models

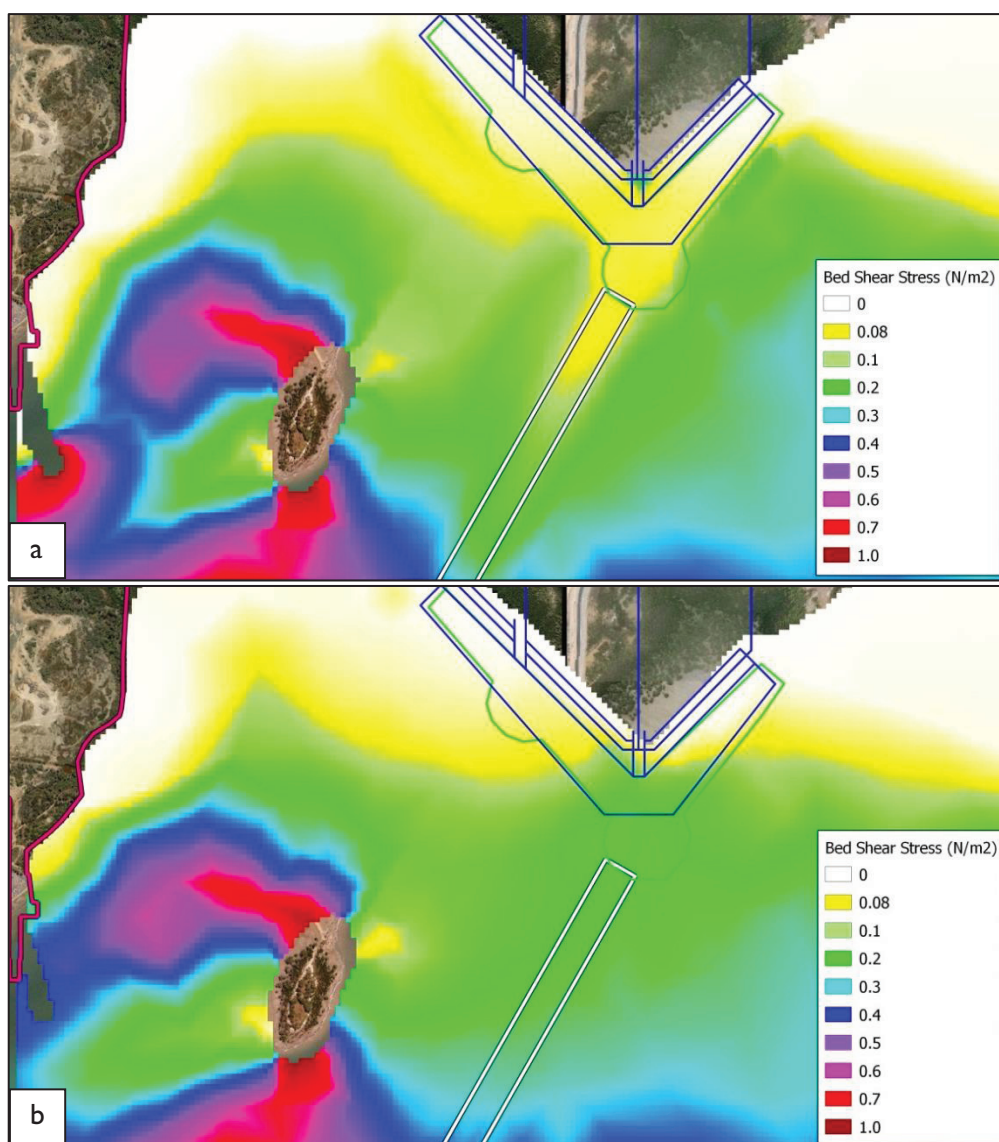


Figure 10 Close up of bed shear stress for the development (a) and baseline (b) models

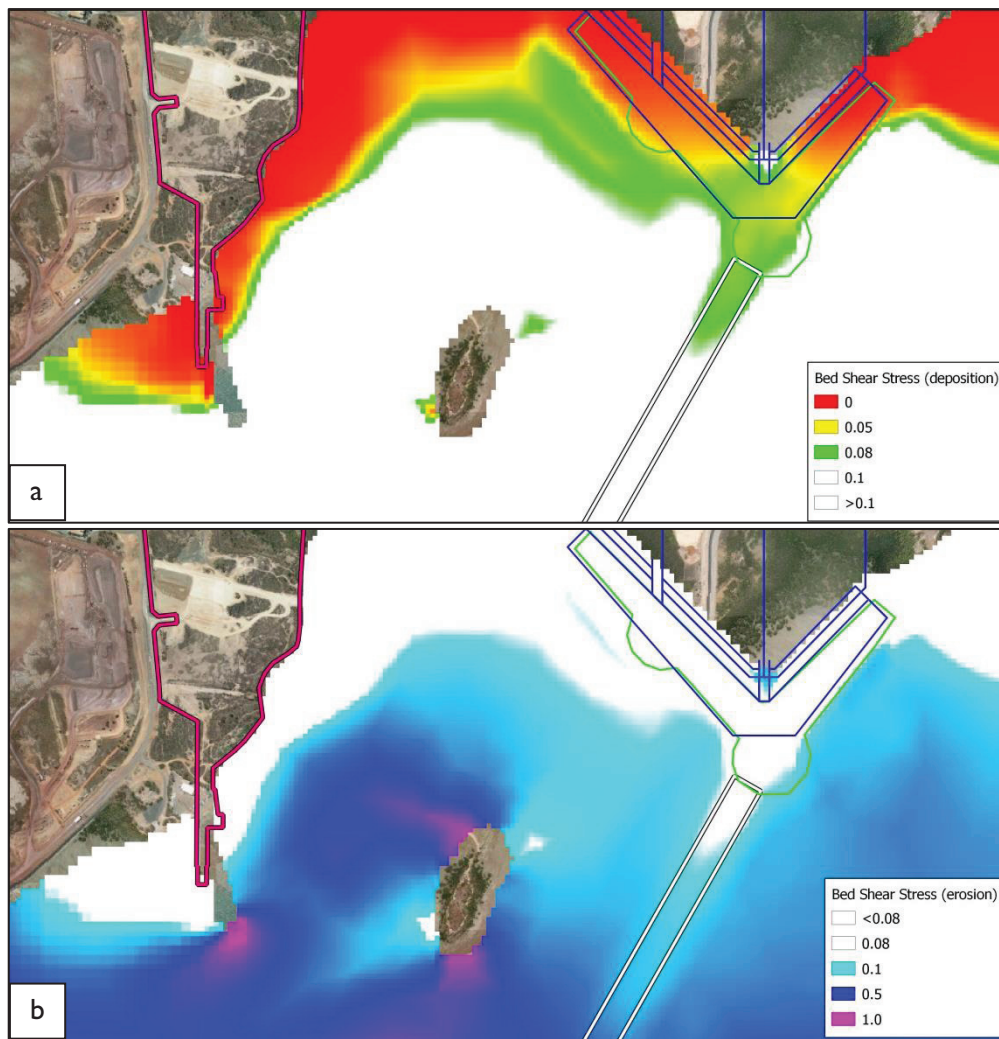


Figure 11 Possible sediment deposition (a) and erosion (b) for the development model

5 Conclusion

The modelling results, combined with known sediment distribution show that little change will occur in and around South Shell and Catalina islands. The proposed dredge channel has been placed in an appropriate location from a physical point of view. It avoids large sand banks at the minimum depth required (-3.4m CD). Bed deposition is predicted to occur in the area of the proposed dredged ship turn area and shoreline structure development. This may occur due to the low velocities in that area and the characteristics of the bed material being fine sediment and sand. The frequency of dredge maintenance cannot be predicted, however given that deposition has occurred at areas surrounding east arm wharf coastline (near the southern edge of ponds C and K) in the past, could be an indication that this may occur similarly near the proposed shoreline development and dredged ship turn area.

Several assumptions have been made during the development of the models described above. Severe weather events have not been taken into account for the modelling. In the event of severe weather currents will be greater than the modelling results predicted in this report. This may contribute to unforeseen scour and/or sediment deposition.

In addition, further sediment sampling and verification of currents and bed surface characteristics in the vicinity are recommended to further support the model calibration and verification process.