APPENDIX Q
MARINE AND COASTAL ENVIRONMENT IMPACT ASSESSMENT

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JACOBS

REPORT

CENTRAL EYRE IRON PROJECT:
PORT SITE
MARINE ASSESSMENT

E-F-34-RPT-0039

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Executive summary

Jacobs was engaged by Iron Road Limited (Iron Road) to undertake an assessment of the physical and biological values within the marine environment at a proposed port development and ship loader facility. The proposed port is located at Cape Hardy, 7 km south west of Port Neill on the Eyre Peninsula of South Australia. The investigation of the marine environment establishes the baseline condition of physical and biological values, determines the anticipated level of impact to the existing environment, and identifies which values require management during construction and / or operation of the proposed port development to minimise impacts wherever practicable. It also identifies legislative obligations that will need to be fulfilled in order to seek approval for proposed construction and operation of the port facility.

Of the existing and proposed export facilities on the Eyre Peninsula, none have the capacity to support the requirements of Iron Roads operations. As such, it was determined that a greenfield port facility would be required to service the export of iron concentrate from Iron Roads proposed Central Eyre Iron Project. The site of the proposed port was selected based upon a multi-criteria analysis, which assessed environmental, physical and social constraints of a number of potential port sites throughout the Eyre Peninsula, and determined that Cape Hardy was the most appropriate location.

A desktop analysis was undertaken in 2011 (updated in 2013) to determine the potential presence of matters of conservation significance within the study area, as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* along with South Australian *National Parks and Wildlife Act 1972, Marine Parks Act 2007, Native Vegetation Act 1991, Fisheries Management Act 2007* and *Environment Protection Act 1993*. Marine surveys were undertaken between November 2011 and August 2012, to record baseline hydrodynamic, bathymetry, water quality and seabed conditions at the study area. The presence of flora and fauna was also recorded.

The location of the proposed port, Cape Hardy, is located within the Spencer Gulf. The marine habitats found at Cape Hardy are typical of the southern Spencer Gulf, with the following key characteristics identified:

- The marine habitats at Cape Hardy were observed to be in generally healthy condition. Shallow sandy areas were generally dominated by mature seagrass meadows. Temperate rocky reef habitat was limited to shallow areas adjacent the rocky headlands and a few sub-tidal rocky ridges.
- Comparison with data from other ports in the region shows that Cape Hardy has similar or lower levels of metals to Spencer Gulf waters, which have high levels of metals when compared with oceanic waters.
- There is relatively deepwater (20m) near to shore (within 800m) across the site with the deepwater areas generally displaying only sparse assemblages of invertebrates. In the deepest areas with the finest sediments, there was some evidence of the formation of microbial matting.
- Shallow sandy areas are inhabited by mature seagrass meadows of predominantly *Posidonia* spp. In deeper waters, “clumps” of invertebrates including large ascidians, sponges and bivalves grow on the silty bottom. Small areas of rocky reef exist only in intertidal areas and adjacent to the headlands within the study area. These habitats generally follow depth and sediment contours, and appear to be stable in their distribution (based on the lack of obvious habitat loss and complexity of the habitats).
- Intertidal communities at Cape Hardy are not considered unique and are comparable with habitats commonly observed in the Spencer Gulf. No rare or protected species known to exclusively occur in the intertidal zones at Cape Hardy were identified.

The iron concentrate intended for shipment by Iron Road is magnetite-based and known to be insoluble in seawater, and are therefore highly unlikely to cause measurable elevation in dissolved iron concentrations in either the water column or surrounding sediment. There are expected to be no impacts to water quality from

iron induced algal blooms as the marine waters surrounding Cape Hardy are neither high in nutrients nor low in iron as required to stimulate iron fertilisation.

The hydrodynamic model developed for the proposed port determined that the embayments of Cape Hardy are already relatively isolated from the longshore drift currents of the Spencer Gulf and that changes to the coastline from the proposed marine infrastructure would not significantly alter coastal processes (less than 1% change in sediment transport per annum). Similarly, the location of the port does not require dredging for access to water of sufficient depth, avoiding large scale impacts to the seabed.

The proposed port is located within the Port Neill Aquaculture Exclusion Zone and approximately 2 km from the Port Neill Aquaculture Zone. There are no active aquaculture leases in either zone, with historically approved leases having been withdrawn or surrendered. The port site is located within a number of areas designated for specific shellfish and finfish fisheries although no conflict with fishery operations is anticipated due to depth requirements for commercial fishing methods.

The design of the marine infrastructure and jetty at the proposed port avoids areas of dense benthic flora which dominate the northern extent of the study area. No breeding colonies or nursery grounds for marine fauna were identified within 5 km of the study area and although eastern Hooded Plover (rated as Vulnerable in South Australia and Vulnerable and Marine under the EPBC Act) were identified using the beach adjacent the proposed jetty, the sandy beach areas of the site will be preserved. The study area is not considered to be a significant shorebird habitat.

A wide range of marine megafauna may be present in the area at different times or for limited periods. Species most likely to occur in the waters around Cape Hardy include the Australian sea lions, New Zealand fur seals, bottlenose dolphins and common dolphins. One whale species, the Southern Right Whale may occur in low numbers on a seasonal basis. A range of fish species are also likely to occur at Cape Hardy including the Leafy seadragon, ornate cowfish, Port Jackson shark, magpie perch, leatherjackets and toadfish; each of which were sighted during the video survey

Piling, drilling and underwater noise represent a potential impact to marine megafauna and fish species, however this impact is for a limited duration and will be mitigated through the establishment of observation and shutdown zones (shutdown of piling/drilling equipment in the event of observing marine megafauna) and soft start procedures to allow fauna to vacate the area.

The introduction of invasive marine species was identified as the greatest risk to the marine environment during construction and operation of the proposed port. Invasive marine species could be introduced to the port site via a range of mediums, including as biofouling on vessel hulls, jack-up barge legs, anchors, anchor chains, mooring lines, internal boat compartments, sediment transported in or on vessels, or in any seawater onboard vessels / barges including ballast water, in bilge, and inside pipes or pumps. Invasive marine species can exist in low numbers or persist as cysts in an area and can rapidly increase in numbers after a disturbance to the environment or removal of competitive indigenous species. Although all vessels utilising the port site will be required to comply with the national guidelines relevant to biofouling and ballast water, the introduction of IMS remains a high risk to the marine and coastal environment.

1 Introduction

Iron Road Limited (Iron Road) is proposing to develop an ironmining and minerals processing operation near Warramboo, approximately 25 km south east of Wudinna on the Eyre Peninsula of South Australia. Significant infrastructure is required to provide the logistics chain to enable export of the iron concentrate from the proposed mine to market. The required ancillary infrastructure includes a deep-water port facility on the east coast of the Eyre Peninsula, a standard gauge railway line from the port to the mine, a water pipeline for process water supplied from a borefield, a 275 kV transmission line, and a long term employee village at Wudinna to provide accommodation for the mine site workforce. The overall project is referred to as the Central Eyre Iron Project (CEIP). The infrastructure components (excluding the proposed mine) are herein referred to as the CEIP Infrastructure.

The proposed port development is at a greenfield site, approximately 7 km south west of Port Neill in an area known as Cape Hardy. The site provides a natural deep-water location with no dredging required. The port will have capacity to export 70 Mtpa of product (including 21.5 Mtpa of iron concentrate by Iron Road). The port is designed to support Panamax and Capesize vessels, with a 1.2 km jetty structure that incorporates a tug harbor, marine offloading facility and cargo wharf. Onshore, the port facility will incorporate materials handling facilities, car parking and internal access roads, stormwater management and ancillary facilities such as an administration building, emergency services building, control room(s), warehouse, ablutions facility and crib room, laboratory and fuel storage. Temporary workforce accommodation will also be located at the port site during construction to service the port and infrastructure corridor works. The proposed port development is to support Iron Road's operations, exporting 21.5 Mtpa of iron concentrate. Any additional infrastructure or activities proposed by third party users of the port facility would be subject to a separate approvals process.

Jacobs was engaged by Iron Road to undertake an assessment of the marine and coastal environment at the proposed port development site. The objectives of this study were to characterise the existing marine and coastal environment so that marine environmental impacts and risks associated with the development of the proposed port could be assessed and appropriate mitigation measures identified.

The Minister for Planning declared the CEIP Infrastructure to constitute a 'Major Development' pursuant to Section 46 of the *Development Act 1993* on 15 August 2013 (republished 22 August 2013 and varied 29 May 2014), following which Iron Road submitted a development application in June 2014. In November 2014, the Development Assessment Commission (DAC) issued the Guidelines for the Cape Hardy deep sea port, infrastructure corridor and long term employee village (the Guidelines), establishing the requirements for the preparation of an Environmental Impact Statement (EIS). The Guidelines outlined the parameters to determine the type, extent and condition of the marine and coastal environment at the proposed port development site and to assess the impacts resulting from the development of the CEIP Infrastructure.

Jacobs has undertaken a range of desktop, field and quantitative studies of the marine and coastal environment at the proposed port development site since 2011. The findings of these investigations have been used to determine the expected and possible impacts from the construction and operation of the CEIP Infrastructure which are presented in this report.

1.1 Regulatory context

The following section provides an overview of the legislative framework relevant to the marine and coastal environment during the construction and operational phases of the project.

1.1.1 Commonwealth legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) prescribes the Commonwealth's role in environmental assessment, biodiversity conservation, and the management of protected areas. Under the provisions of the EPBC Act, actions that are likely to have a significant impact on a matter of National Environmental Significance are identified as "controlled actions" and cannot be undertaken without referral to the Department of the Environment (DoE) for consideration and approval.

With regard to the marine and coastal environment of the CEIP Infrastructure, the EPBC Act provides specific protection for the following Protected Matters:

- *Threatened species and ecological communities* - the EPBC Act lists threatened fauna species under the following categories: extinct in the wild, critically endangered, endangered, and vulnerable. Listed species are afforded protection due to their threatened conservation status. Threatened species which are known to occur or may occur within proximity to the proposed site are highlighted in Section 6 of this report.
- *Migratory species* - including those listed under International Agreements such as the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention). Many of the marine mammals that may potentially occur in the area are listed as migratory and are protected as such within Commonwealth waters; these species are also discussed in Section 6 of this report.
- Some species are listed as *Marine* under the EPBC Act and protected within Commonwealth marine areas. The Commonwealth marine area is defined as any part of the sea, including the waters, seabed and airspace that are between 3 and 200 nautical miles from the coast (that are not otherwise classified as State waters). The Spencer Gulf sits entirely within State waters and as such, Commonweatlh Marine listed species are not subject to Commonwealth marine protection. Despite this, the following report assesses potential impacts to all EPBC listed species, including those not protected within State waters. Marine listed species which could occur in the study area include the following groups:
  - Sea-snakes (Families Hydrophiidae and Laticaudidae);
  - Seals, both eared and true seals (Families Otariidae and Phocidae);
  - Marine turtles (Families Cheloniidae and Dermochelyidae);
  - Seahorses, sea-dragons, pipefish and the ghost pipefish (Families Syngnathidae and Solenostomidae);
  - All bird species that occur naturally in the area; and
  - All cetaceans (whales, dolphins and porpoises).

1.1.2 South Australian legislation and policy

A number of legislative instruments that are specific to South Australia and State waters are also relevant to the marine and coastal environment of the CEIP Infrastructure during the approvals process, construction and operational phases. In general, State legislation is only relevant to State waters. The definition of state waters encompasses all waters within within 3 nautical miles from the coast (including the whole Spencer Gulf).

1.1.2.1 Development Act 1993

The *Development Act 1993* (Development Act) controls development in South Australia, establishing procedures to assess different forms of development. Part 4, Division 2 of the Development Act relates to Major development or projects and is applicable to the CEIP Infrastructure development.

The Minister for Planning declared the CEIP Infrastructure a 'major development' pursuant to Section 46 of the *Development Act 1993* on 15 August 2013 (republished 22 August 2013 and varied 29 May 2014). The DAC issued the Guidelines for the preparation of an EIS in November 2014, requiring an assessment of the relevant environmental impacts associated with the development of the CEIP Infrastructure. The EIS will be made available for public and State agency comment during the assessment period, with the final decision whether or not to approve the CEIP Infrastructure to be made by the Governor of South Australia on the advice of the Department for Planning, Transport and Infrastructure (DPTI) and the Minister for Planning.

1.1.2.2 Harbours and Navigation Act 1993

The *Harbours and Navigation Act 1993* governs the safe, efficient and reliable movement of cargo vessels within South Australia. The Act also controls the efficient and effective administration and management of South Australian harbors and harbor facilities, and the safe movement of shipping within harbors and in South Australian waters. Of specific relevance to the marine environment, the Act also applies to any marine parks, and seeks to further the objectives of the *Marine Parks Act 2007*. To operate a port within South Australia the port area must be declared by the Minister and a Port Operators Agreement approved by DPTI who require a biosecurity plan and Oil Spill Contingency Plan to be provided by the port operator.

1.1.2.3 National Parks and Wildlife Act 1972

The *National Parks and Wildlife Act 1972* (NPW Act) allows for the protection of habitat and wildlife through the establishment of parks and reserves (both on land and in State waters). It also provides for the use of wildlife through a system of permits allowing certain actions, i.e. keeping, selling, trading, harvesting, farming, hunting, and the destruction of native species.

The NPW Act assigns species to state conservation categories; Endangered (Schedule 7), Vulnerable (Schedule 8), and Rare (Schedule 9). These conservation categories are based on the categories and definitions of the International Union for Conservation of Nature (IUCN) red list categories and criteria. A number of marine species identified as potentially occurring at the port site have been defined under the NPW Act and are discussed in Section 6 of this report. Where species protected under the NPW Act are present at the port site, a permit maybe required prior to undertaking any works which may impact the species. The National Parks and Wildlife (Protected Animals – Marine Mammals) Regulations 2010 also provides guidance on how vessels should operate within proximity to marine mammals and will be relevant to vessels during construction and operational phases.

1.1.2.4 Native Vegetation Act 1991

The objectives of the *Native Vegetation Act 1991* (Native Vegetation Act) include the conservation, protection and enhancement of the native vegetation in South Australia and, in particular, remnant native vegetation, in order to prevent further loss of quantity and quality of native vegetation (critical habitat) in the State. The Native Vegetation Act defines native vegetation as "*a plant or plants of a species indigenous to South Australia including a plant or plants growing in or under waters of the sea.*" Under the Native Vegetation Act, marine vegetation such as seagrasses, which are present in the marine study area are protected. Where removal of native vegetation is proposed, consent is required from the relevant authority.

1.1.2.5 Fisheries Management Act 2007

In addition to the management and regulation of commercial fisheries, the *Fisheries Management Act 2007* aims, to provide for the conservation and management of the aquatic resources of the State and the control of exotic aquatic organisms and disease in aquatic resources. The Act includes the prohibition of taking certain marine species such as crabs during spawning and blue groper or seadragons at any time, as well as the protection of marine fishes in Aquatic Reserves.

1.1.2.6 Marine Parks Act 2007

The *Marine Parks Act 2007* covers 19 marine parks around the State with each park consisting of up to four zones - general managed use, habitat protection, sanctuary and restricted access - that afford different levels of protection to the marine environment and organisms. Within general managed use zones there is no change to the existing use of an area. Habitat protection zones are designed to protect the seafloor habitat and biodiversity within a marine park by preventing the removal or damage to, habitat or the functioning of ecosystems. Sanctuary zones, which include approximately 6% of the State coast, are areas of high conservation value and prohibit the removal or harm of plants, animals or marine products as well as prohibiting mining, trawling or recreational fishing activity, however low impact recreation such as boating, swimming or diving are permitted. The highest level of protection is in restricted access zones, which are off limits to the public. When assessing a marine area it is important to understand the existing environment and rules applicable to each park and its zones. Apart from restricted access zones it is not a legislative requirement for shipping to avoid traversing marine parks. The proposed port site is not located within a marine park.

1.1.2.7 Aquaculture Act 2001

The *Aquaculture Act 2001* provides regulation of marine and inland aquaculture. The Act prescribes the classes of aquaculture permitted in the aquaculture zones as well as setting criteria for the determination of applications for licences or in the making of other decisions in relation to the zone. Aquaculture leases are discussed in more detail in Section 6.9.

1.1.2.8 Protection of Marine Waters (Prevention of Pollution from Ships) Act 1987

The *Protection of Marine Waters (Prevention of Pollution from Ships) Act 1987* enacts Australia's commitment to the International Convention for the Prevention of Pollution from Ships (MARPOL) in South Australia. MARPOL governs the following areas: Annex I (Oil), Annex II (Noxious Liquid Substances), Annex III (Harmful Substances in Packaged Forms), Annex IV (Sewage), Annex V (Garbage), and Annex VI (Air Pollution). The Act is applicable to all Annex areas excluding MARPOL Annex IV (sewage), as Commonwealth legislation is applicable. All ships operating in and out of the proposed port will be bound by these commitments.

1.1.2.9 Coast Protection Act 1972

The *Coast Protection Act 1972* provides a legislative framework to make provision for the conservation and protection of the beaches and coast of South Australia. The jurisdiction of the Act includes all land:

- within the mean high water mark and the mean low water mark on the seashore at spring tides, or
- above and within 100 m of the mean high water mark, or
- below mean low water mark and within three nautical miles

The Act is implemented via the Coast Protection Board who is the primary authority and prescribed body in South Australia for the management of the coast including coastal protection and advice on coastal development. The Board has a number of functions including:

- protect the coast from erosion, damage, deterioration, pollution and misuse
- restore any part of the coast that has been subjected to erosion, damage, deterioration, pollution or misuse
- develop any part of the coast aesthetically, or to improve it for those who use and enjoy it
- manage, maintain and develop those coast facilities that the Board is responsible for
- report to the Minister where required
- carry out, or be involved in, research into the protection, restoration or development of the coast

South Australia has been divided into six Coast Protection districts, each with its own specific management plans and policies which are used to guide coastal development decisions. The port site falls within the remit of the Eyre Coast Protection District.

1.1.2.10 Natural Resources Management Act 2004

The *Natural Resources Management (NRM) Act 2004* aims to achieve ecologically sustainable development in the State by establishing an integrated scheme to promote the use and management of natural resources, including coastal resources that recognises and protects the intrinsic natural values. The Act is implemented through the State NRM Council and eight regional NRM Boards who develop and review regional plans for the management of natural resources. Coastal development is reviewed against regional plans, in consultation with the Coast Protection Board.

1.1.2.11 Environment Protection Act 1993

The *Environment Protection Act 1993* provides for the protection of the environment and defines the Environment Protection Authority's (EPA) functions and powers. The Act promotes ecologically sustainable development, the use of precautionary principles to minimise environmental harm, and outlines environmental obligations including responsibilities under the Environment Protection (Water Quality) Policy 2003. The Act requires polluters to bear an appropriate share of the costs and responsibilities for protecting the environment from their activities.

2 Methodology

The following section provides an overview of the methodology employed to meet the requirements of the Guidelines relevant to the marine and coastal environment. The environmental impact and risk assessment process that was undertaken is summarised based on the relevant marine and coastal environment considerations.

2.1 Requirements of Guidelines

The Guidelines establish the requirements to prepare an EIS for all components of the CEIP Infrastructure. Not all aspects of the CEIP Infrastructure and the Guidelines are relevant to the marine and coastal environment. Table 2-1 indicates the requirements outlined in the guidelines relevant to the marine and coastal environment, and where the requirement is addressed in this report.

Table 2-1 Relevant requirements of DAC guidelines

	Item	Requirements	Discussion
Coastal and Marine	4.3.1	Describe the impacts of jetty construction and tug wharf on the foreshore, intertidal, seabed and benthic communities (especially any nursery/spawning areas), and any mitigation measures that may be used.	Section 6
	4.3.2	Describe the coastal engineering requirements for the location, orientation and type of jetty structure.	Section 3
	4.3.3	Describe the impacts of any blasting activities, pile driving or screw piling activities on marine communities, especially turbidity/disturbance, vibration and underwater noise on vulnerable or sensitive receptors (including marine mammals) and any mitigation methods that may be used.	Section 6.7
	4.3.4	Describe the design and operational measures to protect water quality and prevent stormwater and other run-off from the site affecting the coastal and marine environment, during both construction and operation.	Section 4
	4.3.5	Describe the impact of any incidental concentrate spillage and dust emissions (point source and fugitive) during ship loading operations on the marine environment, especially water quality.	Section 5.4
	4.3.6	Describe how ship loading operations will minimise incidental concentrate spillage and dust emissions (point source and fugitive) during loading operations to avoid causing harm to marine or coastal flora or fauna species, and any mitigation measures that may be used.	Section 4
	4.3.7	Describe the potential impacts of increased shipping traffic and activities in the Spencer Gulf from offshore anchoring, transhipment or pilotage (especially on marine fauna, water quality, recreational activities and amenity), including effects on commercial and recreational fishing and aquaculture.	Section 6
	4.3.8	Describe how marine pests on the jetty will be monitored and managed. Detail the response procedure that will be followed in the event of a new pest record.	Section 6.8
	4.3.9	Investigate the sedimentary profiles in the area of construction and associated ship docking/manoeuvring areas, to determine if there are risks from the exposure of fine sediments or clays that would impact adversely on water quality (turbidity) and contribute to the production of sediment plumes in the region.	Section 5.4

	Item	Requirements	Discussion
	4.3.10	Detail measures to protect nearby beach and/or rocky foreshore areas during and after construction, including potential marine and terrestrial protection areas or associated buffers.	Section 4
	4.3.11	Describe existing sand movement and water flow characteristics through and around the jetty structure area, to identify any possible changes to beach profiles or sedimentation on sensitive flora and fauna, and to determine sand management requirements.	Section 5.2
Native Vegetation (Marine)	4.3.12	Quantify and detail the extent, condition and significance of native vegetation (individual species and communities) that currently exist at the Cape Hardy site	Section 6
	4.3.13	Quantify and detail the extent, condition and significance of native vegetation (individual species and communities) that may need to be cleared or disturbed during construction and the ability of communities or individual species to recover, regenerate or be rehabilitated.	Section 6
	4.3.14	Describe measures to deliver any significant environmental benefit that is required by the Native Vegetation Act 1991. Identify measures to minimise and mitigate vegetation clearance, including incorporating any remnant stands in the layout design, and to compensate for any loss of native vegetation and habitat.	Section 6
	4.3.15	Describe strategies to manage and monitor invasive weed species to protect terrestrial (particularly the Hambidge Wilderness Protection Area), coastal and marine species.	Section 6.8
	4.3.16	Identify impact avoidance, minimisation and mitigation measures and their effectiveness.	Section 4
	4.3.17	Describe how the proposal is not inconsistent with any relevant EPBC Act guidelines, conservation advice and/or recovery plans. For instance, the conservation advice for the Eyre Peninsula Blue Gum (Eucalyptus petiolaris) Woodland Threatened Ecological Communities	Section 6
Native Fauna (Marine)	4.3.18	Quantify and detail the extent, condition and significance of native fauna (individual species and communities) that currently exist at the Cape Hardy site, the infrastructure corridors and the long term employee village. Identify sensitive receptors (i.e. species or lifehistory stages with particular sensitivity to construction or operational processes).	Section 6
	4.3.19	Quantify and detail the extent, condition and significance of potential native fauna habitat loss or disturbance during construction and operation and the ability of communities and individual species to recover, especially for resident or migratory shore birds, and Threatened, Endangered and Protected Species (TEPS) under the EPBC Act and the South Australian National Parks & Wildlife Act 1972 (NP&W).	Section 6
	4.3.20	Describe the measures taken to address displaced native fauna (if any).	Section 4
	4.3.21	Detail appropriate buffer distances that will be required between the proposed development and TEPS, including feeding areas, nesting sites and roosting sites.	Section 4
	4.3.22	Outline the effect of light pollution, noise emissions and vibrations on TEPS (including those listed under the EPBC and NPW Act's) and how these will be managed.	Section 6

	Item	Requirements	Discussion
	4.3.23	Describe the impacts of introduced species, especially vermin and nuisance species that can be attracted to port facilities.	Section 6.8
	4.3.24	Consider the potential cumulative impacts on marine fauna as a result of the proposed development and other planned or existing port facilities in the Spencer Gulf region.	Section 6
	4.3.25	Identify impact avoidance, minimisation, mitigation and offset (where appropriate) measures and their effectiveness.	Section 4
	4.3.26	Describe how the proposal is not inconsistent with any relevant EPBC Act guidelines, conservation advice and/or recovery plans. For instance, the recovery plan for the endangered Southern Right Whale	Section 6

2.2 Investigations Undertaken

A comprehensive suite of nine environmental characteristics were assessed to provide an overview of the existing environment at the proposed port site to provide a basis for the subsequent environmental impact assessment. The methods used to identify environmental values and conduct the impact assessment ranged from desktop literature review, to in-field survey or sampling and detailed modelling based upon existing or collected data. The environmental parameters and methods of investigation applied to each are summarised in Table 2-2 below. A detailed overview of the methods employed in assessing existing values and impacts to the marine and coastal environment is outlined in the following Section.

Table 2-2 Data sources to assess the port site environment

	Environmental Characteristic	Data Sources and study method
Physical Environment	Bathymetry	• Marine navigation charts from the Australian Hydrographic Office (AHO) • Personal communications with Captain Walter Ferrao (DPTI) • High-resolution site specific bathymetric survey (Hydro Survey 2012)
	Hydrodynamic Environment	• Available data and literature from relevant local authorities, including the CSIRO, SARDI and BOM • Port Spencer marine baseline quantitative surveys (Golder Associates, 2012) • Site-specific surveys including Acoustic Doppler Current Profiling (ADCP) and temperature, salinity, tide and wave climate logging • Hydrodynamic and wave modelling (Jacobs 2014d)
	Seabed Conditions	• Towed video survey of seabed and mapping of seabed features • Seabed sediment sampling to ascertain particle size distribution, and chemical analysis and detection of contaminants • Cape Hardy geophysical surveys including side scan sonar, sub-bottom profiling, continuous marine seismic refraction and geotechnical borehole calibrations (MES, 2012)
	Water Quality	• Publically available published literature including data from the EPA • Port Spencer marine baseline quantitative surveys (Golder Associates, 2012) • Water sampling and analysis of surface and bottom waters

	Environmental Characteristic	Data Sources and study method
Biological Environment	Marine and Benthic Habitats and Flora	• Publically available published literature • National and State benthic habitat map (Nature Maps) • EPBC Protected Matters database • Biological Database of South Australia • Atlas of Living Australia online database • Towed video benthic habitat survey
	Benthic Fauna, Fish Species and Marine Megafauna	• Publically available published literature • EPBC Protected Matters database • National and State benthic habitat map • Atlas of Living Australia online database • Towed video benthic habitat survey • Incidental sightings during benthic habitat surveys
	Noise and vibration	• Underwater noise modelling report (Sonus, 2014) • Marine fauna species noise threshold based on existing published literature
	Fisheries and Aquaculture	• Aquaculture Zones – Port Neill Policy 2008 • PIRSA Aquaculture Public Register • Publically available published literature – SARDI fisheries reports • Incidental sightings during benthic habitat surveys
	Invasive Marine Species	• Global Invasive Species Database • Australian Government Department of Agriculture resources (including interactive map of known IMS) • Publically available published literature. • EPBC Protected Matters Database • Biological Database of South Australia • Atlas of Living Australia online database • Opportunistically during review of video tow survey (none identified)

2.2.1 Bathymetry

In addition to a desktop review of the bathymetry of the site, a detailed site survey was undertaken. The bathymetric survey was completed by Hydro Survey Australia (Flinders Ports), a registered hydrographical surveyor. Swath coastal survey vessels covered all areas between the shallowest safely navigable depth along the coast and the outer extents of the study area (Figure 3-4). Data was analysed by Hydro Survey and utilised in the production of nautical charts referring to the Australian Height Datum (AHD) and offset for LAT using tide data collected over a complete lunar cycle at Tumby Bay and calibrated by the National Tide Centre (NTC).

2.2.2 Hydrodynamic Environment

In order to understand the local characteristics of tidal fluctuations, currents and stratification at Cape Hardy, site-specific oceanographic surveys were undertaken. Jacobs commissioned oceanographic contractors ASR Ltd and HOV Environment Ltd in conjunction with Dive Connect Ltd to deploy an array of oceanographic sensors at the site. The sensor array included an Acoustic Doppler Current Profiler (ADCP), temperature and salinity probes, the setup of which is indicated in Figure 2-1 (below). The ADCP logged current flow, current direction and wave height, whilst the temperature and salinity probes characterised water column mixing and stratification.

The oceanographic monitoring arrays were deployed for a total of six months of data collection within the study area, over a period beginning on 31 January 2012 with final retrieval of the equipment on 22 September 2012. The data collection covered summer, autumn and winter into early spring of 2012. There were periods of no data collection when the array was retrieved to download data, replace batteries and recalibrate the instruments.

Hydro Survey Australia deployed a tide gauge at a site approximately 2 km south of Cape Hardy. The tide gauge recorded 34 days of tide level data. The NTC undertook an analysis of this data to produce tidal planes at Cape Hardy, which are summarised in the Hydrodynamic Modelling report (Jacobs, 2014d).

On completion of the ADCP deployment, Jacobs (2014d) developed hydrodynamic modelling that included a wave model, bed shear stress analysis and a sediment transport model, to describe changes in sediment movement and coastal waves that may occur with the construction and operation of the proposed port. This hydrodynamic modelling aimed to predict the effects of the proposed wharf facility and vessel moorings within the study area, and the geographical extent of any impact on coastal processes. When coupled to water quality and sediment sampling data, the hydrodynamic modelling aimed to determine sediment movement during construction as well as potential changes to coastal sand movement due to the introduction of physical structures.

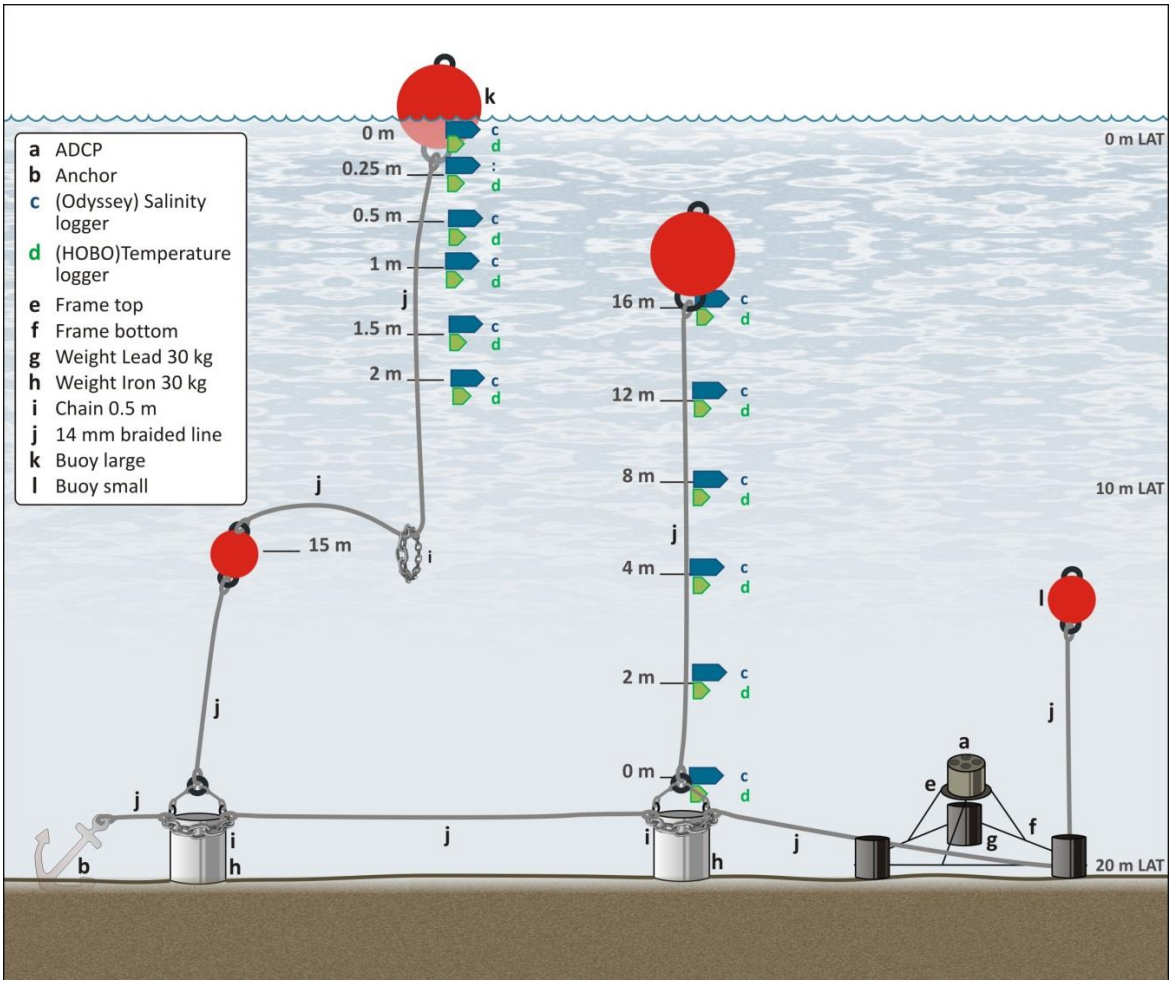


Figure 2-1 Diagram of oceanographic sensor array

2.2.3 Seabed Conditions

Visual observations of seabed geomorphology were made from a towed video survey on a grid of transects that extended 10 km along the coast out to a depth of over 20 m (Figure 2-2). Altogether, transects totalling 47.5 km in length were surveyed in the study area. A small, lightweight, high definition video camera was deployed from the survey vessel at 90 degrees from the seafloor to achieve the optimum view of the seabed and towed at a constant speed and height above the seabed. The video footage was recorded to two hard drives (one as a back-up) for post-field processing and analysis of substrate morphology. Images from the video were geo-referenced with the latitude and longitude coordinates of the vessel's position using a differential global positioning system (DGPS) mounted on the survey vessel, allowing for the production of geo-referenced seabed maps.

Substrate morphology was classified and described for all transects from the video footage. All transect footage was reviewed and stills of bare or visible substrate extracted for detailed review and classification. Substrate was visually classified as silt, sand or reef. Layers were created using the Kriging function in the interpolation tool in ArcMap (v10). This function creates a raster surface from point data. Outputs were transformed into vector data layers and draft maps reviewed by the video analysts. Where necessary the maps were manually adjusted. Additional polygon layers were created to ensure features that were rarely recorded along each transect were included on the maps as the interpolation tool smooths data to produce the layers and consequently can dropout data.

The sampling design included 16 sediment sample locations in a strategic grid pattern across the study area (Figure 2-3). A boat-deployed Petite Ponar grab sampler was utilised for sampling the sediment, however due to site A6 having very dense seagrass coverage and matting remote sediment sampling was not possible. Particle size distribution (PSD) samples were taken from a total of 15 sites (Figure 2-3). Samples for PSD analysis were stored in sealed plastic jars and chilled before transport to the University of South Australia for analysis using a Mastersizer 2000 laser diffractometer.

Sediment chemical composition was also sampled at the aforementioned 15 sites (Figure 2-3). Samples were stored in glass containers, chilled, and sent to the laboratory for analyses of arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), copper (Cu), cobalt (Co), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), vanadium (V) and zinc (Zn), organochlorin pesticides, total recoverable hydrocarbons, phosphorus organophosphorus pesticides, total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN) and tributylin. All analysis of sediment chemical composition was completed by ALS Environmental Laboratories and results presented as either the measured values for each analyte or as the level of detection (LOD) for analytes below the LOD of the instrumentation.

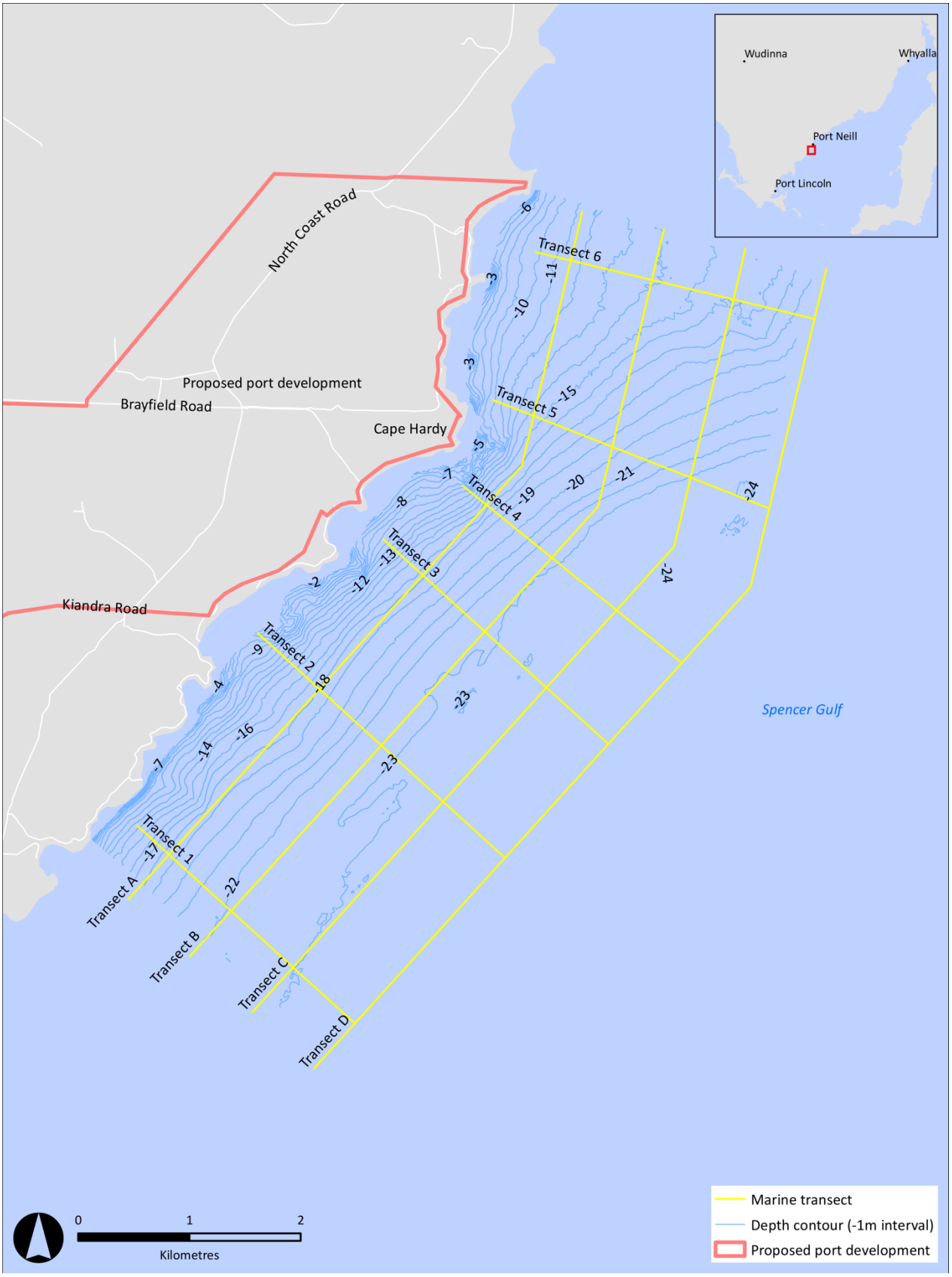


Figure 2-2 Video transects

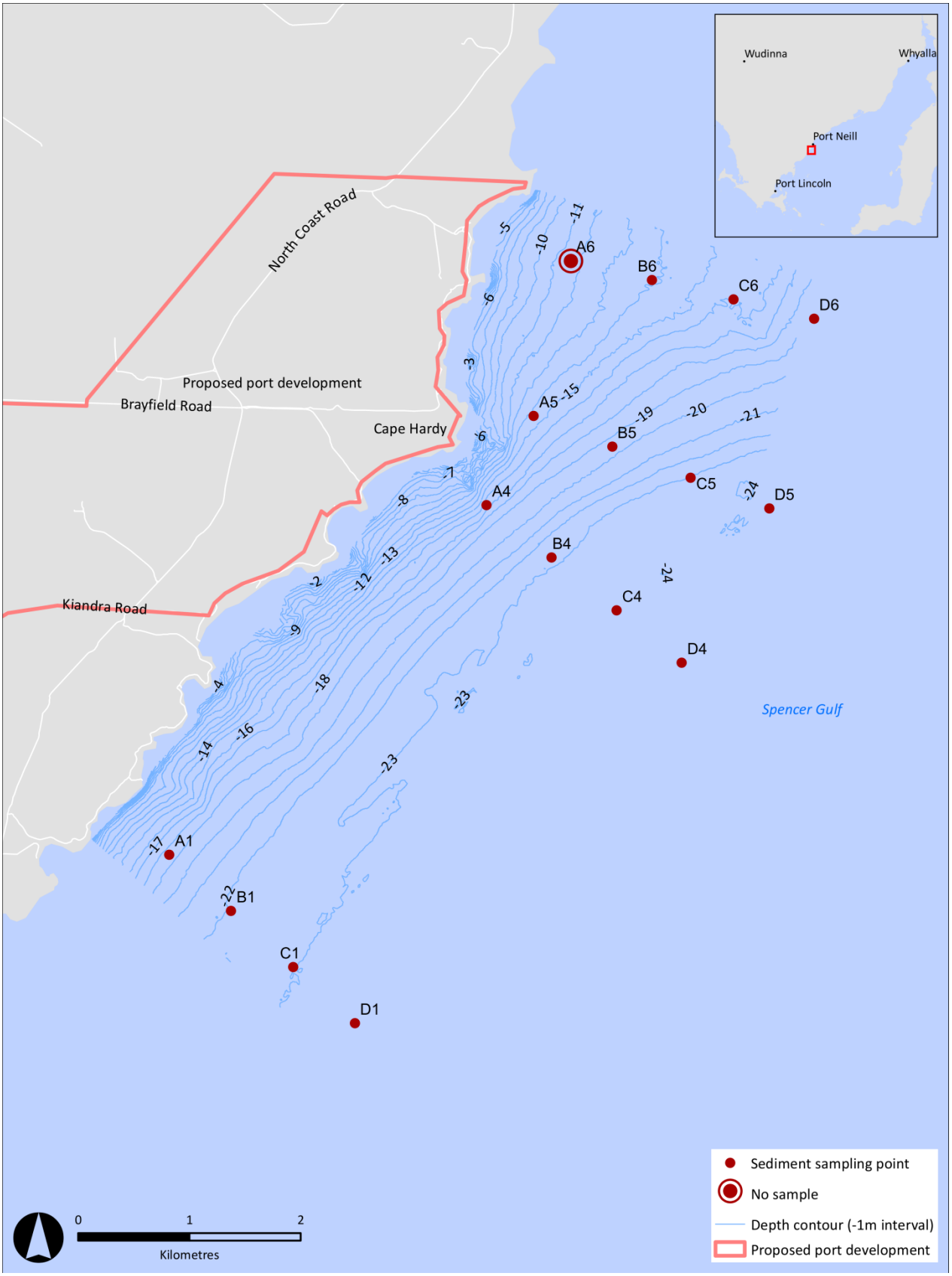


Figure 2-3 Sediment sample locations

Sediment sampling was intended to provide a snapshot of sediment composition for description of the study area. As not all analytes tested are covered by a single relevant standard for marine sediments, the South Australian EPA standard for the production of waste derived fill (WDF) (EPA, 2013) was used in conjunction with the National Assessment Guidelines for Dredging (NAGD) (NAGD, 2009). It should be noted that the NAGD are specific for dredging projects within Commonwealth waters and the WDF are intended for the reuse of excavated sediments; and therefore not required for this project; however, these values have been used along with the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines as these guidelines provide the highest level of scrutiny for marine sediments.

Although the NAGD screening levels and ANZECC guidelines relate to dredge related spoil disposal, the guidelines were developed on the basis of the effects of these substances on marine organisms and provide a conservative approach to the potential impacts of construction, which may disrupt, suspend or otherwise cause the movement of sediments at the site. The proposed development would occur within State waters and dredging or dredge disposal is not required for this project, however construction works will generate localised sediment plumes.

The detailed methodology and findings of the offshore geophysical investigation are provided in the MES (2012) report.

2.2.4 Water Quality

In addition to a desk-based review of local water quality information for the region, a detailed site survey of levels of metals and nutrients in the water column was also undertaken. Thirty water samples were collected from 1 m below the surface water at the sampling points indicated on Figure 2-4. Thirty samples were also taken at the same locations from approximately 2 m off the seabed. Samples were taken using a 2.2 L van Dorn water sampler. All water sample collection was undertaken by Jacobs' marine scientists on-board a vessel supplied and operated by Dive Connect. At all sampling locations, plastic sample containers for total metal and nutrient concentrations (total nitrogen (N), nitrite (NO_2), nitrate (NO_3), ammonia (NH_3), total Kjeldahl nitrogen (TKN) and total phosphorus (P)) were filled directly from the van Dorn, chilled in coolers and sent to ALS Environmental Laboratories within 24 hours of collection for analysis. The phytoplankton pigments chlorophyll-*a* and pheophytin were also analysed at the sites described above for surface water samples only.

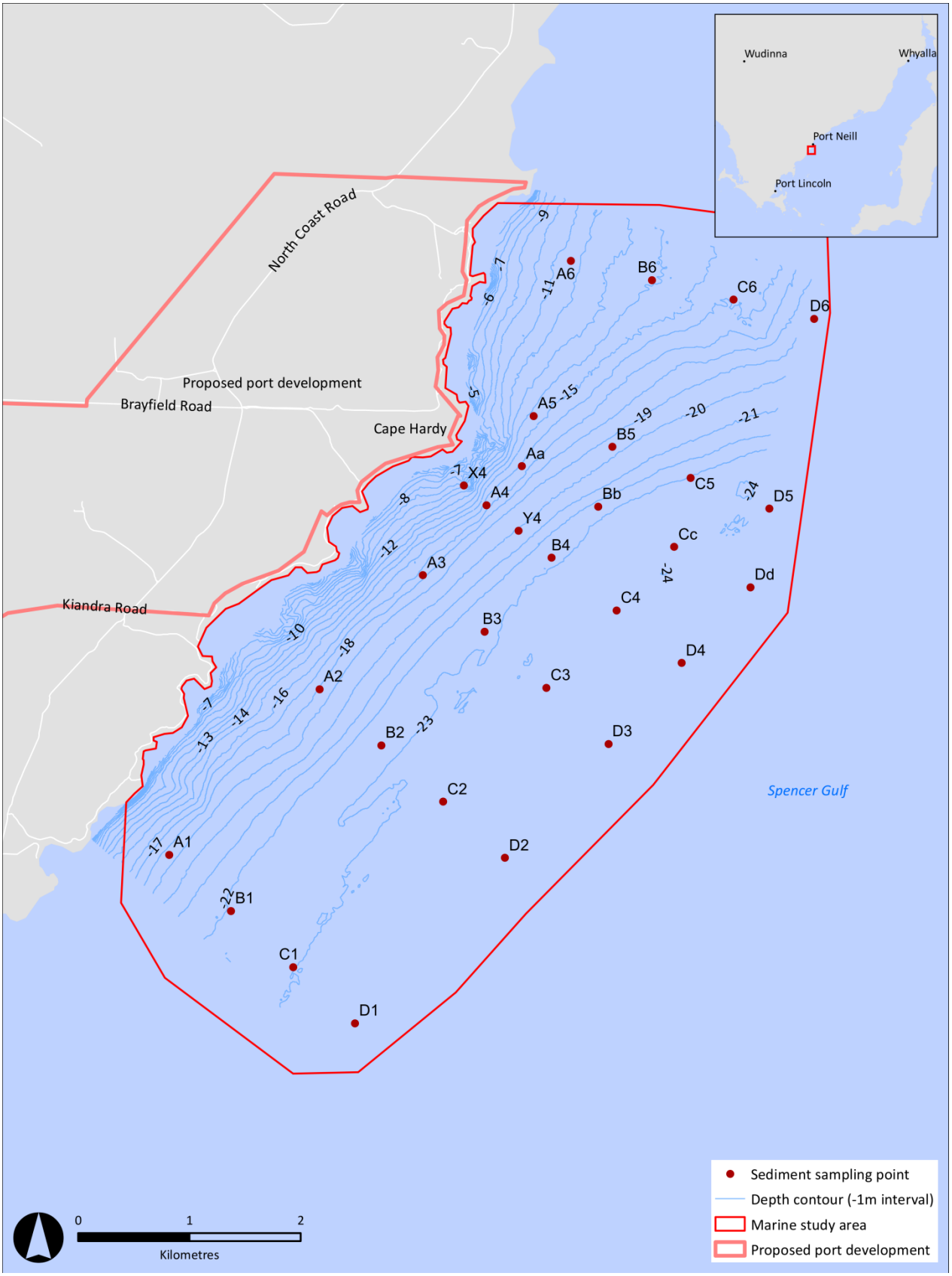


Figure 2-4 Water sampling locations within study area

2.2.5 Habitats, Flora and Fauna

A desktop review of all available habitat data sources using a 10 km search area from Cape Hardy was undertaken including the State Habitat Map (Nature Maps) and the EPBC Protected Matters Search Tool (PMST). The EPBC Protected Matters database is maintained by the Australian Department of the Environment (DoE). This database includes likely distribution of EPBC-listed species, ecological communities and protected areas. This was supported by a search of published literature relevant to the Spencer Gulf, including the Eyre Peninsula Coastal Action Plan, state and national herbarium, and museum records.

Key steps in assessing whether the proposed development would pose significant risks to Protected Matters are assessed in accordance with DoE (2013). In determining significance of impacts, consideration was given to species and habitat abundance within and outside the impact area, sensitivity of the Protected Matter to the proposed action, and the condition and importance of habitat impacted. In addition to total species or habitat abundance, the presence of critical or core habitat areas were also considered such as:

- key breeding or foraging grounds
- population strongholds
- interruptions to migratory pathways
- exclusions to adjoining foraging grounds

Coastal habitat can provide key breeding or foraging areas for shorebirds and these areas may be protected under State or Commonwealth legislation. The widely accepted and applied approach to identifying internationally important shorebird sites throughout the world has been through the use of criteria adopted under the Ramsar Convention on Wetlands. According to this approach, a wetland is considered internationally important if it regularly supports:

- >1% of the population of one of the species migrating to Australia each year, or
- >20,000 shorebirds

A shorebird area is nationally significant if it supports:

- Regularly at least 0.1% of the population of one species of shorebird migrating to Australia each year, or
- Regularly >2,000 shorebirds (any mix of species), or
- At least 15 species of shorebirds

The BDBSA and Atlas of Living Australia (ALA) database were reviewed with a 50 km buffer from the study area. The larger search buffer was used for the BDBSA and ALA search in order to capture as many recorded sightings as possible and assist with determining key areas for species distribution.

Aerial imagery (visible bands only) was reviewed for the nearshore areas of the study area in order to determine the extents of intertidal reef areas. The following assumptions were made when designating reef areas:

- Areas of potential intertidal reef were identified visually (without spectral analysis)
- Where possible, bathymetry data (Hydro Survey, 2012) was used to assist in determining reef areas, basing reef extent on sudden changes in the seabed slope
- The marine geophysical report (MES, 2012) was also used to cross-check the likely extents of reef
- Reef extent was also cross-checked with towed video footage
- The shore line was based on the current watermark in the imagery

Examples of intertidal 'habitats of importance' include seagrass beds or temperate reef systems (including EPBC or NPW listed species), while 'species of interest' could include the seagrass species garweed (*Zostera muelleri ssp. mucronata*), protected under the NPW Act or leafy seadragons (*Phycodurus eques*), protected under the EPBC Act.

High resolution benthic habitat mapping was undertaken to improve understanding of the habitats present within the study area and enable a comprehensive assessment of the potential impacts. Towed video transects were conducted following a grid pattern (Figure 2-2). Tows were undertaken by Dive Connect in November 2011. A small, lightweight, high definition video camera was deployed to run parallel with the seafloor and towed at a constant speed and height above the seabed. The video footage was recorded to two hard drives (one as a back-up) for post-field processing and more detailed analysis including taxa identification. Images from the video were geo-referenced with the latitude and longitude coordinates of the vessel's position using a DGPS mounted on the survey vessel, allowing for the production of geo-referenced benthic habitat maps. Video footage from each transect was analysed to quantify percentage coverage of benthic flora and describe the dominant habitat types. As footage was time stamped and geo-referenced, transects were divided up into 10 m blocks to classify dominant habitat types for each metre (point data) of transect. Image classification first assessed key features in the field of view (i.e. bare substrate, seagrass, rocky reef and sediment type) to determine dominant habitat types. The footage was then reviewed by a second analyst to verify classifications and document secondary features such as percent coverage and density of flora or fauna assemblages and identification of taxa. The image classifications were used to map the benthic habitat within the study area using GIS techniques.

When species or habitat types of conservation significance were observed along the video transects (including EPBC or NPW listed species identified in the desktop assessment), their position and extent were logged. Examples of 'habitats of importance' include seagrass beds and temperate reef systems, while 'species of interest' include the seagrass species garweed (*Z. muelleri* ssp. *mucronata)* protected under the NPW Act and leafy seadragons, protected under the EPBC Act.

Jacobs undertook a baseline terrestrial flora and fauna survey at the proposed port to improve understanding of the coastal habitats in the study area and enable a comprehensive assessment of the potential impacts. A detailed report of port site terrestrial flora and fauna survey is provided by Jacobs (2014a). As the port site terrestrial flora and fauna survey focused on terrestrial animals (e.g. mammals, birds and reptiles) the marine assessment also reviewed the likelihood of protected marine bird and marine reptile species occurring in the study area. In addition to the terrestrial survey at the port site, opportunistic sightings of marine birds along the Cape Hardy coast made during the subtidal marine surveys were also recorded.

Information on infauna assemblages was obtained from sediment samples collected from a total of 15 sample sites across the study area in a strategic grid arrangement (Figure 2-3). Sample volumes of at least 400 ml per sample were obtained at each site and samples were sent off to separate labs for assays of sediment analysis, PSD, as well as infauna counts. All collection and sample preparation was completed by Jacobs' staff on a vessel supplied and operated by Dive Connect in November 2011. A boat-deployed Petite Ponar grab-sampler was utilised for sampling the sediment. For the infauna analysis, samples were sieved through a 500 micrometre sieve to remove fine sediment, and organisms retained on the sieve transferred to plastic jars, chilled, and fixed in 10% buffered formalin for 24 hrs before being transferred to 95% ethanol for shipment to a laboratory for identification. Benthic Australia undertook taxonomic identification and counting of the samples, to provide the total number of infauna species and abundance of infauna per cm^3 per sampled

transect (for raw results see Appendix E). The towed video footage collected from the study area was also reviewed for the presence of epifauna (those animals living on the seabed) species and communities.

The distribution of many marine organisms is governed by the tide, where an organism's physiological tolerance to desiccation and exposure or submergence and salinity dictate where an organism can survive. As such, findings from investigations were separated into marine habitats based on their geographic location within the natural tidal range (refer to Figure 2-5):

- Areas above the high tide mark were deemed to be coastal habitats and classed as the 'coastal zone'
- Areas below the high tide mark but above the low tide mark are classed as the 'intertidal zone'
- Areas below the low tide mark are classed as the 'subtidal zone'

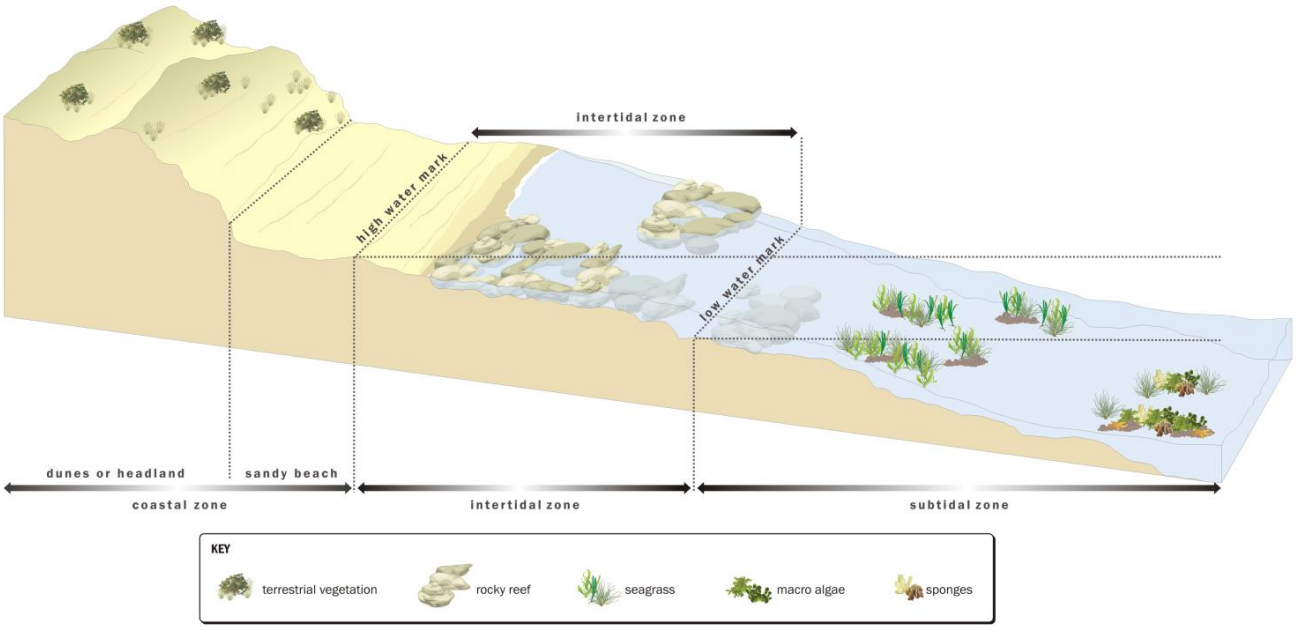


Figure 2-5 Conceptual cross section of marine habitat zones discussed in this report

The likelihood of occurrence and impact to each of the species identified by desktop and field investigations as potentially occurring within the marine or coastal environment are discussed in:

- Section 6.1 – Coastal habitats, fauna and marine birds
- Section 6.2 – Intertidal habitats
- Section 6.3 – Subtidal habitats
- Section 6.4 – Benthic fauna and invertebrate species
- Section 6.5 – Marine megafauna
- Section 6.6 – Fish species

2.2.6 Noise and Vibration

In addition to a desktop-based review of the current guidelines and literature for the effects of noise on marine fauna, a site-specific underwater noise modelling study was commissioned to better understand sound propagation and sensitive receivers at Cape Hardy. The site-specific underwater noise modelling and assessment was undertaken by Sonus (2014). The assessment considered the impacts of noise on marine mammals, turtles, penguins, fish and cephalopods (e.g. cuttlefish).

Noise predictions were conducted using the RAMGeo acoustic model in the AcTUP acoustic "toolbox". The RAMGeo acoustic model considers the bathymetry, profile of speed of sound in water and interaction with the different materials in the seabed. Underwater acoustic noise models calculate the transmission loss as a function of distance and frequency for a single direction. The overall noise at a distance is then calculated by subtracting the transmission loss from each of the noise sources. A detailed description of the underwater noise modelling methodology is presented in Sonus (2014).

2.2.7 Invasive Marine Species

A search of the online databases, registers and relevant published peer reviewed papers was undertaken for known IMS within Spencer Gulf and South Australia, along with a desktop assessment of threats posed by IMS to commercial fishery interests, aquaculture and the marine environment of the study area. Species considered were limited to those that have either previously been detected within South Australia or are highlighted by the National or State biosecurity authorities as a high priority species for their potential impacts and risk of establishing themselves in South Australia. No IMS were recorded during review of the video tow benthic habitat data.

2.2.8 Fisheries and Aquaculture

A search of the online PIRSA Aquaculture Public register (on 1 December 2013) for aquaculture interests around Cape Hardy was undertaken, along with a desktop assessment of registered commercial fishery interests in the area and SARDI stock assessment reports for all commercial species dating back to the 1990s. The data review included data collected during the site-specific towed video surveys as well as review of published peer reviewed papers relevant to area.

2.3 Approach to Impact and Risk Assessment

The approach to the assessment of impacts and risks to the marine environment as a result of the proposed Cape Hardy development aligns with the broader approach to impact and risk assessment employed for the whole of the CEIP Infrastructure. The environmental impact assessment for the CEIP Infrastructure focuses on the major issues associated with the project, being those impacts identified as either medium or high. The impacts identified as low or negligible have been addressed only to the extent necessary to demonstrate that they have been considered. Where identified, benefits associated with construction and operation of the project have also been identified and described, as required by the Guidelines. The identified impacts and benefits were categorised as being negligible, low, medium or high. Criteria were developed to standardise the assessment and categorisation of impacts and benefits for the project. An overview of this process is discussed in further detail below.

2.3.1 Impact Assessment

The impact assessment process recognises that, even with controls in place, normal or planned construction and operation of the project will result in changes to environmental, community and economic values. These changes may be positive (benefits) or negative (impacts). The identified impacts and benefits were categorised as being negligible, low, medium or high based on extent and duration of the predicted impacts. Criteria were developed to standardise the assessment and categorisation of impacts and benefits for the project (Table 2-3).

Table 2-3 Criteria for categorising residual project impacts and benefits

Category	**Residual Impacts** Legislative criteria exist	**Residual Impacts** Legislative criteria do not exist	**Residual Benefits**
Negligible	A negative change below detectable limits.	A negative change below detectable limits. OR No change to protected environmental value(s)[3].	A positive change below detectable limits.
Low	Detectable negative change that is within regulatory limits/standards.	A short term (< 3 y) negative change affecting receivers located within the project area[2] boundary (local receiver) only.	A short term (<3 y) positive change experienced within the project area[2] only.
Medium	A periodic and temporary non-compliance of a regulatory limit/standard[1]	A long term (>3 y) negative change affecting receivers located within the project area[2] boundary (local receiver) only. OR A short term (<3 y) negative change affecting receivers outside of[4] the project area[2] boundary, but not regionally	A long-term (>3 y) positive change experienced within the project area[2] only. OR A short term (<3 y) positive change experienced outside of[4] the project area[2] boundary (local receiver), but not regionally.
High	A regular or consistent non-compliance.	A negative change affecting regional receivers (Eyre Peninsula), state-wide receivers or protected environmental value(s)[3]	A positive change experienced by the region (Eyre Peninsula), the state or by protected environmental value(s)[3]

[1] Periodic and temporary impact is defined as a daily exceedance of a specified limit occurring no more than once every two weeks.
[2] Project area is defined as the proposed port site boundary, and the marine study area
[3] Protected environmental value is an element of the environment that is afforded protection under legislation, including through licensing and permitting (e.g. listed species, native vegetation, groundwater abstraction, level of service for roads).
[4] Outside of the project area but not regionally is considered to be receiving environments within 5 km of the project area.

The impact assessment was an iterative process. Residual impacts categorised as 'negligible' or 'low ' were considered as low as reasonably practicable and not warrant specific control measures, other than standard environmental management measures. 'Medium' and 'High' residual impacts required review, modification, redesign and/or control measures in order to reduce the impact to as low as reasonably practicable.

2.3.2 Risk Assessment

Faults, failures and unplanned events may occur with the potential to cause environmental impact despite best efforts to avoid or mitigate impacts. The impact assessment process has accounted for the possibility of such events occurring via an environmental risk assessment. A key distinction from the impact assessment process is that the consequences of the identified risks may or may not eventuate.

Risk criteria were developed for the project to standardise the assessment and categorisation of risks (see Table 2-4 to Table 2-6). The risk assessment process integrates approaches from the following sources:

- AS 31000: 2009 Risk Management - Principles and Guidelines
- HB 203: 2012 Managing Environment Related Risk

Table 2-4 CEIP Infrastructure risk matrix

			Consequences				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Catastrophic
Frequency	A	Almost certain	Low	Medium	High	Extreme	Extreme
	B	Likely	Low	Medium	High	Extreme	Extreme
	C	Possible	Low	Low	Medium	High	Extreme
	D	Unlikely	Low	Low	Medium	High	High
	E	Rare	Low	Low	Low	Medium	High

Table 2-5 Criteria for categorising likelihood

Descriptor	Level	General Description	Chance p.a.	Frequency
Almost certain	A	This event is expected to occur in most circumstances. *Expected to occur at least once each year*	>90%	1/year
Likely	B	This event may occur in some given circumstances *May occur during any given year*	20%	1/5 years
Possible	C	This event might occur at some time during the project life *Not likely to occur in any given year, but is possible*	5%	1/25 years
Unlikely	D	This event could occur at some time *Very unlikely to occur in any given year*	0.5%	1/200 years
Rare	E	This event may only occur in very exceptional circumstances *Examples of this have occurred historically, but is not anticipated*	<0.5%	<1/200 years

Notes: The intention is to describe the probability or frequency of an event on an annualised basis such that the impacts or exposure (risks) faced by society and the environment are recorded as those present during any given year of the life of the project, including the construction phase.

Table 2-6 Criteria for categorising consequence

Category	Effect on behaviour of listed fauna	Effect on viability of listed species	Effect on behaviour of fauna (non-listed)	Effect on benthic flora or fauna communities	Marine Water Quality	Landform / Bathymetry
Minimal	Insignificant effect	Insignificant effect	Local short term behavioural effect	Local short term decrease in abundance of some species without reduction in local community viability	Minimal change with no significant loss of quality	Insignificant effect
Minor	Local short term behavioural effect	Local short term decrease in abundance with no lasting effects on local population.	Local long-term behavioural effect that does not unduly affect the ecology of the population	Local long-term decrease in abundance of some species resulting in little or no change to community structure	Local minor short term reduction or change in quality	Minor change in bathymetry within localised portions of landform
Moderate	Local long-term behavioural effect with no significant effects on the ecology of the species	Local long-term decrease in abundance without reduction in local population viability	Local long-term behavioural impact that significantly affects the ecology of the population	Regional long-term decrease in abundance of some species and / or local loss of some species diversity resulting in some change to the community structure	Local minor long term or widespread short term reduction or change in water quality	Widespread minor changes in bathymetry Localised major changes in bathymetry
Major	Local long-term behavioural effect that significantly effects the ecology of the species	Regional long-term decrease in abundance and/ or local loss resulting in reduction in regional viability	Local long term behavioural impact that significantly affects the ecology of the species	Regional long-term decrease in abundance of numerous species and / or some loss of species diversity resulting in significant changes to community structure	Widespread (regional) major short term reduction or change in water quality	Major changes in bathymetry result in effects beyond footprint
Catastrophic	Regional extinction of the species	Regional extinction of the species		Regional long-term loss of numerous species resulting in the dominance of only a few species	Regional long term reduction or change in water quality	Widespread and ongoing major changes in bathymetry resulting in effects beyond footprint

3 Proposed Development

The following section details the proposed CEIP Infrastructure (specifically the proposed port development components) and its relationship with the existing marine and coastal environment. An overview of the site selection process for the proposed port is provided, detailing the environmental, social and economic factors considered.

3.1 CEIP Infrastructure

The port, infrastructure corridor and long term employee village are ancillary infrastructure required to support the operation of the proposed CEIP mine which plans to export 21.5 Mtpa of magnetite concentrate for 25 years. The proposed port and associated shipping movements are the components of the CEIP Infrastructure most relevant to the marine and coastal environment and are discussed in detail below.

3.1.1 Port Facility

The proposed port site at Cape Hardy is located approximately 5 km south of Port Neill. The proposed port will operate 24 hours a day, seven days a week and export 21.5 Mtpa of iron concentrate. An overview of the port site is shown on Figure 3-1. The port will include:

- Rail unloading facility
- Stockpile, conveyors, and bulk materials handling facilities
- Jetty structure which commences from an abutment located on the outer end of the tug harbour breakwater and connects to the ship loading wharf
- Wharf structure for supporting the rail mounted ship loader, conveyors, roadway and services deck areas
- Module offloading facility (MOF) to facilitate the offloading of heavy modules and bulk cargo during project construction and will remain for the duration of the project
- Tug harbor to accommodate tugs and other small service vessels
- Plant and equipment workshop and facilities
- Ancillary port administration, customs and stevedoring facilities car parking and internal access roads
- Stormwater management
- Water supply and wastewater treatment facilities
- Road upgrades and realignments, including secure access gates
- Emergency services facility
- Berthing and mooring structures
- Navigational markers

A ship loader will be located at the end of the jetty. The ship loader is designed to load both Panamax and Cape size vessels on either side of the wharf. The ship loader is able to manoeuvre to reach loading hatches on any of the vessels serviced by the port facility. The ship loader's travel limits will be approximately 240 m, with a radial reach of approximately 50 m. During ship loading, the ship loader boom will be positioned over the loading hatch of the vessel. The ship loader design includes a flared telescopic chute that will extend into the loading hatch to be a short distance above the surface of the hold as the concentrate begins to load. As the hold fills, the chute will rise to maintain this short separation. This will minimise dust emitted during ship loading.

Figure 3-1 Port site overview

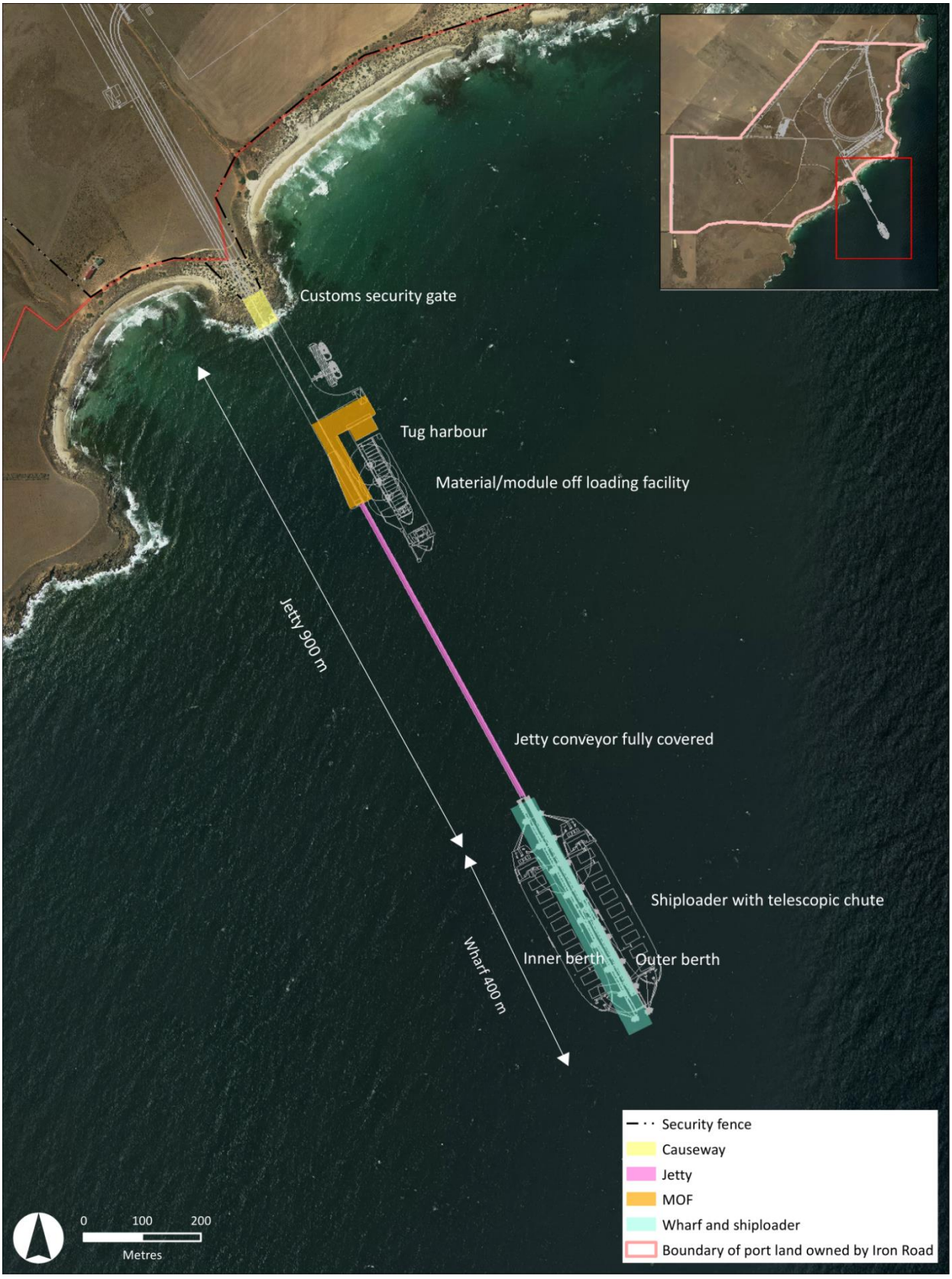


Figure 3-2 Offshore infrastructure

3.1.1.1 Tug Harbour

A sheltered tug facility is proposed to accommodate tugs and the other small vessels needed to operate the proposed port. The tug harbour is required for the tugs to moor safely when not in use during extreme wave conditions. Within the tug harbour, a sheltered tug jetty approximately 36 m long and 8 m wide will be constructed perpendicular to the main jetty. The tug jetty will have a steel-piled concrete deck and provide sheltered berthing for the safe mooring of harbour tugs and pilot boats. The tug jetty will be connected to the main jetty via an 18 m long, 4 m wide access way.

3.1.1.2 Module Offloading Facility

The module offloading facility will be located to the east of the main jetty and to the south of the tug harbour. Similar to the tug harbour, it will also incorporate the jetty causeway and the causeway hook in order to provide a secure berth for heavy lift ships.

The roll on, roll off berth will enable heavy modules and other project cargo to be unloaded. The cargo will be driven off the stern ramp of a heavy lift vessel using a self-propelled module transporter. The lift on / lift off wharf (approximately 20 m wide and 80 m long) will enable smaller cargo units to be lifted ashore directly onto road trucks using the heavy lift ship's onboard cranes. The single berth at the module offloading facility will provide for a range of vessel types and sizes and will be able to accommodate a heavy lift ship up to 217 m in length.

3.1.1.3 Jetty and Wharf

A co-linear jetty and wharf alignment is proposed. The jetty and wharf have been orientated to minimise the maximum vertical motion of the vessels as it aligns with the average direction of the long period, large wave height.

The required berth depth for the port facility is approximately -20.1 m Chart Datum, which allows for the draft of a fully laden Capesize vessel, vessel motion and a safety clearance of 10% under keel between the vessel hull and the sea floor. To reach the required water depth, the outer end of the wharf is approximately 1300 m from the shore line.

The jetty will provide access to the shiploading wharf for the iron concentrate, operational personnel and maintenance equipment. The proposed jetty deck is approximately 13 m wide. This provides sufficient width for a 3.6 m wide single lane roadway, jetty conveyor and walkway. The roadway will generally be used by small vehicles but will occasionally be transited by small commercial vehicles and mobile cranes. Lighting, power and telecommunications outlets will be provided at intermittent locations along the jetty.

The jetty links to the wharf deck which will be approximately 24 m wide. The roadway will generally be 4.2 m in width, except for at the end of the wharf where it will be wider to provide a vehicle turn around. The wharf deck will have a height of approximately 11.2 m AHD. This will give the shiploader enough height to be clear of the hatch of an empty Capesize vessel.

Berthing and mooring dolphins will be provided on each of the two berths. The wharf design includes a total of nine dolphins on each of the two berths. The mooring and berthing dolphins maintain berthed and moored vessels at a suitable distance from the wharf structure.

3.1.1.4 Port Approaches

The port site will receive approximately 145 vessels per year, which on average will be three vessels per week (or six vessel movements in / out). With an arrival and departure movement for each ship that visits the port site, this equates to a large vessel movement at the port facility on most days.

Ships will enter Spencer Gulf and then proceed directly to the port site at Cape Hardy. Ships would approach and depart from the port facilities via a preferred approach route from the main Spencer Gulf shipping channel. The fairway (approach and departure vector) is of sufficient natural depth so as not to require dredging. A designated anchorage area located approximately 3 km from shore is proposed for ships waiting to berth and load cargo at the port site (Figure 3-3). The fairway will be marked on charts but is not expected to be delineated in the field by navigation beacons or buoys, unless specifically required to mark navigational obstructions.

Subject to agreement with DPTI, the proposed port operating limit would be designated as the limit of jurisdiction of the port operator. It is anticipated that this will encompass the waters in the immediate area of the port site, but may not encompass the anchorage area as well. The port operator will ensure that vessels bound for Port Neill or other destinations can freely pass the port site.

Navigation lights and day marks will be provided to indicate the preferred approach route to the facility. It is proposed to include a sector light on the outer end of the wharf indicating the alignment of the loading wharf for vessels approaching from the south-east. Another set of sector lights will be positioned on the shoreward end of the wharf to indicate the limits of navigable depth and preferred alignments for vessels approaching from the north-east or at the Inner Berth.

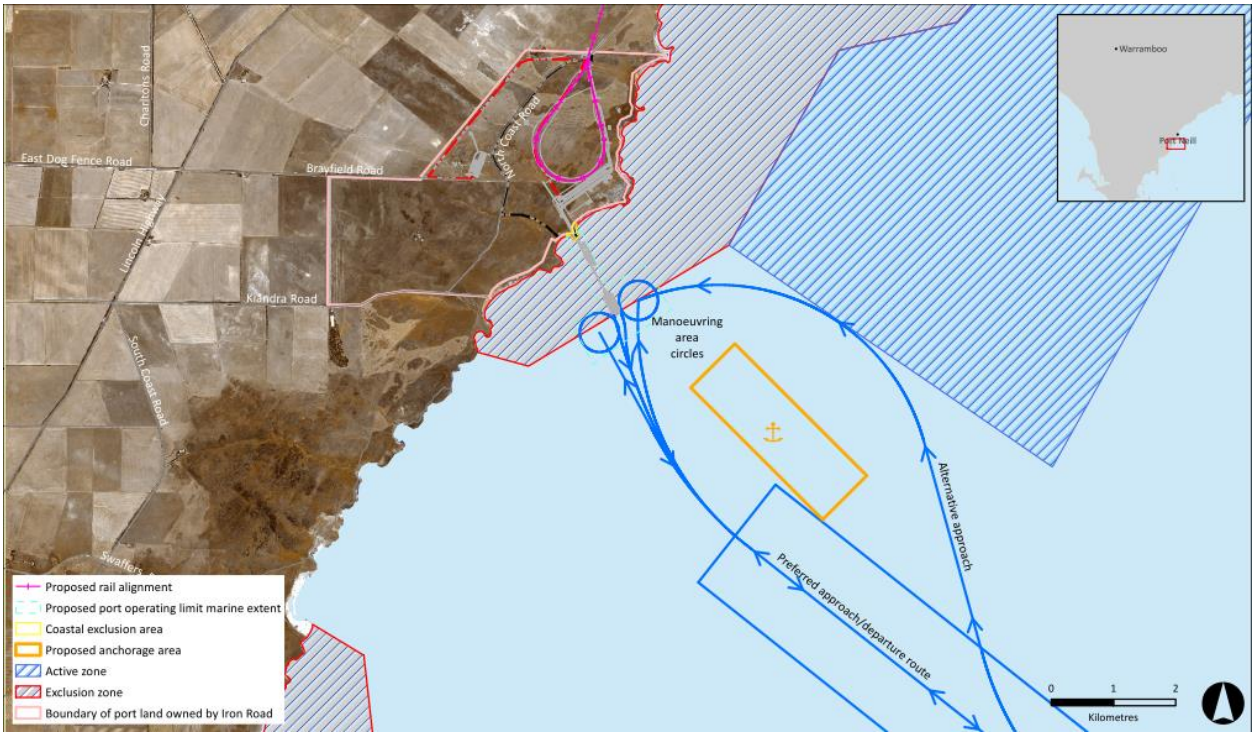


Figure 3-3 Proposed Port layout depicting preferred vessel approach vectors, anchorage areas and turning basins

3.1.1.5 Ship Arrival

Pilotage will be provided for ships arriving at the port site. If the berth is occupied, it is expected that ships will make their way to the anchorage area without needing a pilot. The pilot will board near the anchorage area to bring the ship in along the final part of the approach route, turn the ship with tug assistance, and berth it alongside the wharf. Moored vessels would be facing offshore when at berth.

3.1.1.6 Ship Departure

At completion of loading, a marine surveyor will undertake a draft survey to calculate the total tonnage of product loaded which will then be certified in consultation with the ships master. The associated maximum loaded draft will be agreed given the state of the tide at departure, sea and swell and minimum under keel clearance conditions (allowing for a minimum 10% clearance). Large laden capsize vessels will be restricted from departing during periods of peak ebbing tidal currents.

Tugs will assist vessels to depart from the port facility by pulling the loaded ships off the berth after line release and providing escort until the ship gains sufficient speed.

3.2 Port Site Selection Process

The selection of a preferred port site to export iron concentrate from the CEIP was a three stage process (SKM, 2010). The first stage considered existing export facilities and other proposed export facilities on the Eyre Peninsula. The second stage sought to identify potential greenfield port locations which satisfied environmental, social and engineering design site selection criteria (refer to Table 3-1 for a summary of the site selection criteria). Three broad port zones which could be suitable for a deep-water port were identified from the analysis. These zones were then refined into six port site options, specifically:

- Upper West Eyre Peninsula
  - greenfield location near Elliston
- Lower West Eyre Peninsula
  - greenfield location near Drummond Point
  - greenfield location near Coles Point
- Spencer Gulf
  - greenfield location at Cape Hardy
  - greenfield location near Arno Bay
  - greenfield location near Gibbon Point

The third stage of the study compared the six port options to each other for development suitability based on a set of evaluation criteria. Like the site selection criteria used in Stage 2, the evaluation criteria addressed environmental, social, design and economic aspects of the development (refer to Table 3-1). The evaluation identified Cape Hardy as the most preferred location for a port facility for Iron Road. A summary of the evaluation of the existing export facilities and for each of the greenfield options is provided below.

Table 3-1 Summary of port option site selection and site evaluation criteria

Category	Site selection criteria (Stage 1 – Existing facilities)	Site selection criteria (Stage 2 – greenfield port locations	Site evaluation criteria (Stage 3 – greenfield port options)
Environment	• Proximity to Conservation Parks • Proximity to Marine Parks	• Proximity to Conservation Parks • Proximity to Marine Parks	• Impact to known habitat of EPBC listed species • Impact to native vegetation and areas of high biodiversity value
Social	• Proximity to built up urban areas	• Proximity to sites of recognised heritage value • Proximity to aquaculture zones	• Impact to aquaculture • Proximity to homesteads, dwellings, schools, churches, cemeteries and townships. • Impact to cultural heritage sites or areas • Impact to tourist areas • Impact to visual amenity
Design	• Capacity to export an additional 21.5 Mtpa • Sufficient depth of water for Capesize vessels	• Proximity to deep water (a natural water depth of 20 m within reasonable proximity to the shore is preferred to accommodate Capesize ships without the need to undertake significant dredging) • Exposure risk (sites with low exposure risk to the prevailing wave/swell are preferred)	• Need for dredging to provide vessel access to the berth area • Topographical features (avoid areas with cliffs that require extensive engineering) • Suitable for exporting a minimum of 21.5Mtpa
Economic	• Certainty that the facilities would be available within Iron Road's project timeframes	• Proximity to Warramboo (sites with a shorter distance to the proposed mine site are preferred)	• Length of trestles to the berth area • Need for breakwaters to provide adequate shelter for berth areas • Ease of access for workforce and port services

3.2.1 Existing Export Facilities

There are four existing ports in the Eyre Peninsula region; Port Thevenard, Port Bonython, Port Lincoln and Whyalla. The Port of Thevenard, located 3 km from Ceduna, is managed by Flinders Ports and exported approximately 3 million tonnes of produce in 2011. Additional capacity for export is constrained by the depth of water and the site has limited room for expansion as it abuts residential and recreation areas. Due to the water depth, Thevenard is not capable of accommodating the required Capesize vessels for the CEIP.

Port Bonython, located at the head of the Spencer Gulf, is owned by the State Government and operated by Santos for the export of approximately 250,000 tonnes per annum including crude oil, naphtha, propane and butane. A proposal for an expanded operation to support the export of bulk commodities through construction of a new jetty is under consideration by the State Government. The expansion would initially provide for the export of up to 25 Mtpa, and could be expanded to be capable of export of up to 50 Mtpa. If the project goes ahead, the initial 25 Mtpa export capacity may be operational by 2018. The Port Bonython expansion is subject to Government approval and finance. Therefore this option does not provide certainty to Iron Road around when the facility could be available.

Port Lincoln is managed by Flinders Ports and exports between 1-3 Mtpa, dependent on the amount of agricultural product harvested in a given year. Expansion of Port Lincoln to meet the required tonnages is constrained by the need to move product through the township, impacts to the amenity of the community, congestion at the port as a result of existing grain export and potential land use conflicts with nearby fisheries and aquaculture industries.

The Port of Whyalla is South Australia's largest export facility, exporting approximately 6 Mtpa. The Port is owned by the State Government and operated by Arrium who recently expanded the facility to double its capacity to 12 Mtpa. However the increase capacity is already allocated to Arrium and is significantly less than the 20 Mtpa required by Iron Road for export of its iron concentreate. Further expansion of Whyalla to accommodate Capesize vessels would require large scale dredging and/or extension of the wharf facilities and would not represent an economic or environmentally viable solution.

A greenfield port facility is proposed at Port Spencer by Centrex Metals. The facility is proposed to export up to 20 Mtpa, over a four stage development. To date, only the first stage of the development (capable of exporting up to 2 Mtpa of iron ore and grain) has been designed and received Development Approval by the State Government. The anticipated timing for subsequent stages of development is currently unknown, and Iron Road are unable to rely upon the successful approval of third party projects for their own development.

The existing and proposed export facilities on the Eyre Peninsula do not provide sufficient capacity for the export of 21.5 Mtpa from the CEIP or have uncertain timing. They also do not represent an economic solution to be upgraded to meet Iron Road's requirements. Therefore a new greenfield port site is required for the CEIP.

3.2.2 Greenfield Export Facility Options Considered

As no existing port facilities were identified as suitable for Iron Road's purposes, a multi-criteria analysis was undertaken to identify a preferred greenfield site. Each of the key sites assessed as part of the multi-criteria analysis are discussed below.

3.2.2.1 Near Elliston, Upper West Eyre Peninsula

A location in the southern corner of Anxious Bay, to the north of Elliston was considered as a port option. This option was not preferred as it is subject to moderate to high wave exposure and would therefore involve the construction of an offshore breakwater. It would also require substantial piling work over potentially hard reefs. The site is in relatively close proximity (<2 km) to the Lake Newland Conservation Reserve and the Waldegrave Islands Conservation Park. The wharf and breakwater would be approximately 1 km from the Anxious Bay Aquaculture Zone. For these reasons the site ranked poorly against the environmental, social and engineering criteria.

3.2.2.2 Drummond Point and Coles Point, Lower West Eyre Peninsula

Two potential port locations were identified on the lower west Eyre Peninsula, Drummond Point and Coles Point. Both sites did not offer safe shipping navigation without substantial engineering modifications such as breakwaters or dredging and were therefore not preferred locations for a deep-water exporting port.

The Drummond Point port option site offers no natural protection from dominant waves. Therefore a breakwater to provide protection would be essential. Even with the breakwater, arrivals and departures during bad weather would be difficult and could lead to delays and increase the risk of vessel collisions or environmental damage due to navigational hazards.

The Coles Point port option would also require a significant breakwater, even though it has some indirect protection from south-west waves provided by Point Sir Isaac. The adjacent land side topography is also not ideal, with cliff faces in some locations.

3.2.2.3 Near Arno Bay, Spencer Gulf

A site approximately 4.5 km north of Arno Bay was considered as a port option. The Arno Bay option did not score well against the environmental, social and engineering criteria compared to the other site options in Spencer Gulf. The Inner Arno Bay Aquaculture zone is located approximately 3 km off the coast in this location. Although the jetty and wharf could be located outside the aquaculture zone, vessels arriving and departing from the port would have to traverse the zone. Heritage agreement areas, which protect vegetation, also adjoin the site to the north, east and west. The distance to deep water at the site is approximately 2.5 km, which is relatively long. The construction of a jetty at least 2.5 km posed too many environmental risks, along with engineering challenges. For these reasons this port option was discounted.

3.2.2.4 Gibbon Point, Spencer Gulf

The Gibbon Point port option was discounted as it is located on the southern boundary of the Franklin Harbour Marine Park. The jetty for the port would be located within the Marine Park; however the wharf and berth for vessels would be located outside of the Park. In this location there is also only a small area of land that is likely to be suitable for port infrastructure.

3.2.2.5 Cape Hardy, Spencer Gulf

The option evaluation identified the Cape Hardy port option as the most appropriate location for a port. The option scored well against the environment criteria as it is not in close proximity to a marine park or a conservation reserve and the port land area has been predominantly cleared of native vegetation for farming. The option also scored well against the engineering criteria as deep water is located relatively close to shore (approximately 1.5 km based on historical charts) and the site has some protection from ocean swells and waves. This option also scored well against the social criteria, as it is not located in close proximity to towns or registered heritage sites.

3.3 Marine Study Area

For the purpose of this baseline characterisation of the marine environment and impact assessment, a marine "study area" was identified as the area being potentially impacted by the construction and operation of the proposed port development. The marine study area surrounds the proposed port site at Cape Hardy covering approximately 2870 Ha (refer Figure 3-4). While the marine study area is assessed in this report, flora and fauna records have been sourced from a wider area (up to 50 km from the site) due to the paucity of records in the region.

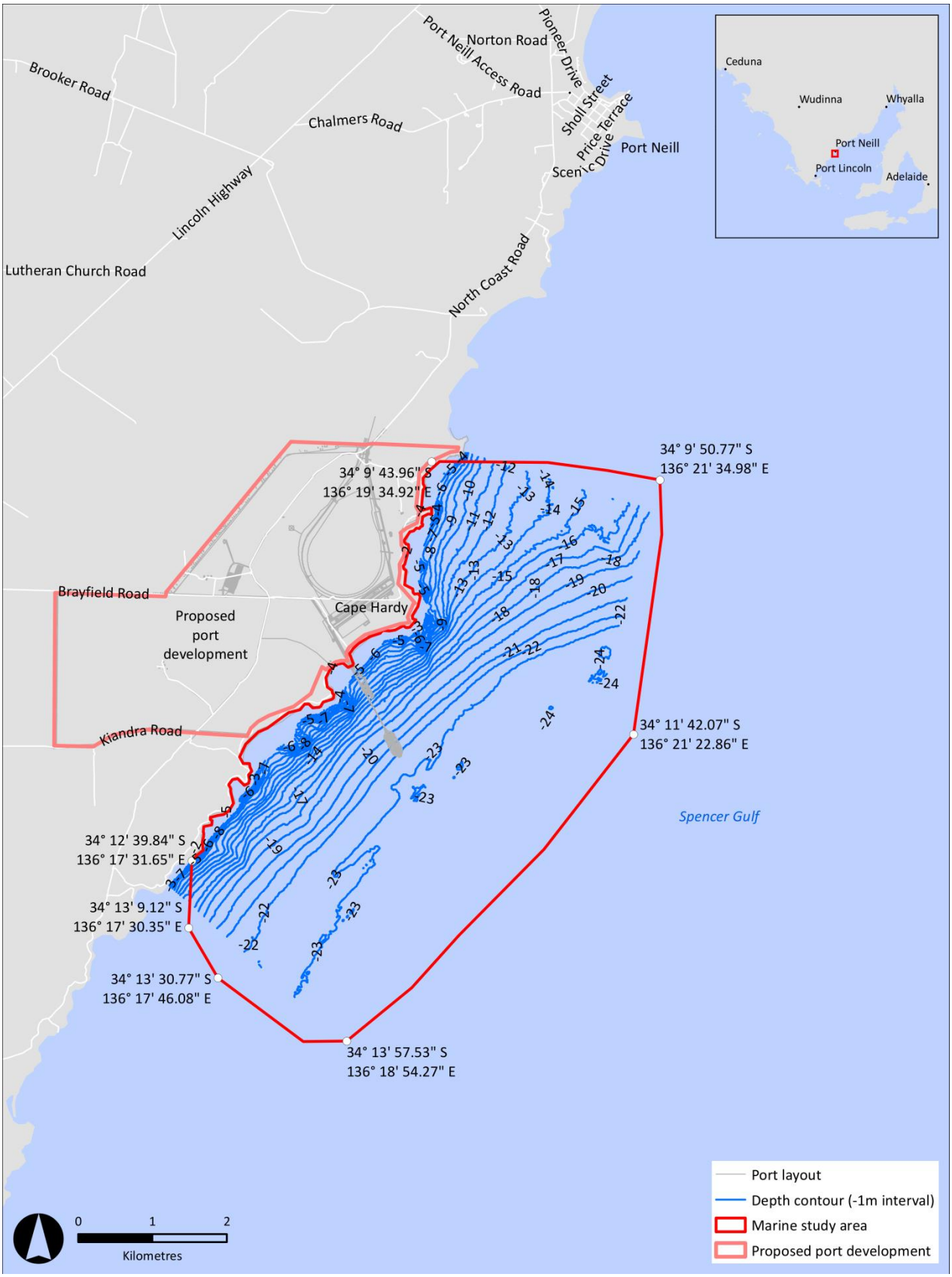


Figure 3-4 Marine study area

4 Design Measures and Mitigation Strategies

The following section identifies measures that have been incorporated into the design of the proposed port development to minimise impacts to the marine and coastal environment. Management strategies that have been committed to by Iron Road to further minimise the risk of additional impact are also outlined.

4.1 Site Selection and Alignment of Infrastructure

A key consideration in finalising the port site selection process (Section 3.2) was the minimisation of physical and biological alterations to the existing marine environment. The selected site at Cape Hardy is readily accessible to deep water and does not require dredging (or subsequent disposal of dredge spoil) to make the site suitable for larger vessels. Similarly, no blasting within the marine environment is proposed which may alter the benthic substrate. As such, no major changes to the existing bathymetry will be required that may alter local currents. Avoiding the need for dredging and blasting will also:

- Minimise increased sedimentation and turbidity during construction which in turn minimizes potential impacts to water quality
- Minimise increased sedimentation that could smother seagrasses and other habitat areas
- Minimise noise and vibration emissions (particularly associated with blasting) within the marine environment that could impact marine fauna

The design and alignment of the jetty was refined in conjunction with hydrodynamic modelling (Jacobs, 2014d) to minimise changes to sediment deposition across the study area. The use of a pylon structure for the jetty significantly reduces potential effects to hydrodynamics as opposed to a rock armoured or earthen structure. As a result, the predicted rate of increased sediment deposition due to changes in the hydrodynamics is less than 1% per annum. This is considered to be within the range of natural fluctuation and readily incorporated by the seagrass meadows that naturally accrete sediments (refer to Section 5.2 for more information).

The vessel turning basins are located in areas of greater than 10% under-keel clearance over areas of sparse or no sea grass coverage. As such, vessel movements will minimise damage to seagrass meadows as a result of anchoring or vessel scour.

The proposed port site selection avoids known critical habitat, breeding colonies, foraging grounds and haul out areas for coastal fauna, fish species, benthic fauna and marine megafauna. Similarly, the port site is not within any known migration paths for whale. The site selection also provides an adequate separation distance to sensitive industries such as aquaculture areas and commercial fishing grounds. Conflict with existing aquaculture or fisheries operations is not anticipated.

The marine infrastructure has been aligned to minimise footprint within coastal, intertidal, subtidal and seagrass areas that may represent habitat for marine fauna. Less than 0.1 Ha of rocky intertidal shore will be affected by the proposed development. As a result, 99% of the study area's intertidal habitat and 100% of sandy intertidal areas will remain intact. Similarly, the alignment avoids areas of dense flora coverage (providing >50% seagrass coverage), with areas of dense seagrass in the north of study area outside of the construction footprint. As such, only 2.65 Ha of predominantly sparse seagrass is proposed to be cleared. Areas of sandy beach which may be utilised by protected species such as the Hooded Plover, Beach Slider or Bight Coast skink have also been avoided. This was achieved through the minimisation of the projects footprint within sandy beaches and the marine environment. The jetty, tug harbour and MOF infrastructure occupy a footprint less than 17 Ha.

Avoiding the northern parts of the study area that support dense sea grass also resulted in the avoidance of identified areas with high metal concentration, thereby minimising the likelihood of releasing metals from sediments.

As the port site is relatively isolated from a hydrodynamic perspective (refer Section 5.1), any IMS that may colonise the area would not be readily transported by currents beyond the study area and into new regions.

4.2 Construction Techniques

The rock armour for the MOF and tug harbour will be built out from a small headland (Figure 3-2) using roughly 1 m^3 boulders and reclaimed clean fill from the landside construction area. By not relying on large sea based equipment for construction, there is no requirement for dredging and therefore impacts from mobilisation of sediments associated with these large vessels are removed. Similarly, avoiding the use large of sea based construction equipment will reduce the number of vessels needing to access the near shore area, minimising vessel scour, propwash and anchoring impacts. Vessel scour, propwash and anchoring can resuspend sediments and cause turbidity which would result in diminished water quality, coastal erosion and damage to habitats.

The jetty itself will be constructed in stages using a jack-up barge for impact piling to minimise disturbance to the seabed. The staged construction will also minimise long term alterations to site hydrodynamics and bathymetry to localised areas, with construction equipment in place for short durations only.

Heavy vehicle traffic, machinery movement, excavation, and construction of the MOF and tug harbour have the potential to crush habitat or disturb the flightless juvenile hooded plover, species that forage amongst the seagrass wrack, or nesting areas. To minimise adverse effects to coastal habitat, vehicle access to the beach areas will be restricted, with no storage or laydown areas for equipment on beach areas to protect the habitat of the hooded plover, beach slider and Bight Coast skink.

Construction of the marine infrastructure will be staged over an approximate 18 month period which will provide mobile animals an opportunity to vacate the immediately impacted area and re-enter the study area once construction activities have ceased.

Impact piling using a jack-up barge is the proposed method of construction and will avoid disturbance of the seabed as a result of dredging or blasting. Hollow pilings of 700mm diameter will be driven until resistance into the seabed and then filled with concrete to provide structural strength. As the hollow pilings will be easier to drive into the seabed, minimal disturbance to sediments is expected. As such, there will not be widespread disturbance of sediments that could be colonised by IMS. Disturbed areas during construction will be limited to the anchoring and securing of the jack-up barge and support vessels. As the jack-up barge legs will have only localised disturbance to the seabed this will minimise areas of disturbed substrate that could be colonised by IMS.

4.3 Stormwater and Runoff

It is expected that the majority of rainfall at the port site will infiltrate the sandy soils, rather than running off into the marine environment. Where possible, existing permeable areas covered by vegetation will be maintained and supplemented as described in Jacobs (2014a). However, run-off at the site will be altered by the construction of non-permeable infrastructure including roadways, hardstands and buildings at the site (Figure 3-1). The run-off from this infrastructure will be captured and either directed into evaporation / infiltration ponds with capacity to capture up to a 90th percentile of run-off events with any over flow from

greater events discharged into vegetated swales away from the marine environment. No wastewater discharge into the marine environment is proposed with full containment of all wastewater and sewage on site.

The capture and treatment of stormwater at the site is to eliminate the negative effects to water quality from an increase in fresh water run-off, and / or the release of potential contaminants or sediments within stormwater. This will also prevent high sediment loads, pollutants or high velocity flows from entering the marine environment or creating erosion of the coast and subsequent impacts to benthic coastal, intertidal and subtidal areas, fauna, and fish species.

4.4 Environmental Management Procedures

A CEMP and OEMP will be developed for the CEIP Infrastructure, including the proposed port. All staff and vessels will be required to comply with the CEMP / OEMP, and will be obliged to implement the following procedures:

- Vessels and staff will be prohibited from bringing their pets onto site to prevent disturbance or predation of native animals
- Procedures for managing fuel and chemical storage and distribution areas at both land and marine based sites. An OSPC will also be developed as required under the Port Operators Agreement to prevent either direct spills into the marine environment or seepage of spilled fuel into soil or groundwater subsequently entering the marine environment
- Establishment of a safety zone around piling activities to monitor the movement and behavior of marine mammals
- Establishment of shut down procedures should a marine mammal be identified within 500 m of piling activities
- Notification and demarcation of navigational hazards at the site in accordance with the Harbours and Navigation Act
- IMS control procedures incorporating:
    - enforcement of Commonwealth guidelines for ballast water management keeping vessels and equipment clean and well maintained
    - ensuring antifouling is up to date
    - reporting any suspected IMS to the Project Manager who will inform the relevant state authority
    - All vessels and staff will comply with all Commonwealth or State regulations relating to marine pests
    - The importation of all materials and goods to South Australia for the construction of this project is to comply with relevant Australian legislation

IMS control procedures will form part of their CEMP and OEMP. All vessels and equipment entering the construction site will adhere to the CEMP for procedures to mitigate importation or transfer of IMS to the site.

Spills of contaminants from vessels are often considered a major source of water pollution at port sites (OECD, 1997). In practice, such spills are often small and difficult to track. The release of potential pollutants by marine vessels is governed by Commonwealth (*Protection of the Sea Act 1981* and subsequent amendments) and International Marine Organisation (IMO) guidelines and legislation. As with any operational port all vessels accessing the wharf are required to comply with IMO Ballast water management plans (BWM) and MARPOL controls for marine pollution.

The proposed port site is not located within critical habitat, breeding colonies, foraging grounds or migration parts for marine megafauna. Despite this, a megafauna management plan will be developed that will cover both the construction and operational phases of the project to minimise impact. The megafauna management plan will include:

- A description of all threats to the megafauna species expected in the area
- A plan to monitor megafauna habitat use and behaviour, using appropriate survey techniques for mapping of potential threats to the expected whale species arising from the port construction and operations
- Identification and indication of noise sources and strategies to manage/mitigate noise impacts
- Mitigation measures to manage the impact of port operation and shipping, arising from port construction and operation activities, including underwater noise and the risk of vessel strike
- Set up of megafauna safety zone around piling activities to include an observation and exclusion zone, with the following activities undertaken prior to commencement of piling:
    - Designated megafauna observers will monitor for animals within the observation zone 30 minutes prior to commencing piling
    - Provided no animals were sighted within the 30 minutes soft start piling procedures would commence
    - Soft start piling would involve slowly ramping up of impact piling – this slow build up in impact piling will allow animals within the wider area the opportunity to move away from the noise source and avoid potential noise impacts
    - The designated megafauna observers will continue to observe for megafauna within the observation zone and call for a stop works if an animal is sighted within the designated exclusion zone

A waste management plan will be developed to identify, separate and provide adequate waste disposal for all waste streams including kitchen wastes, soil (from foundations and clearance), hazardous items (e.g. sewage) and hydrocarbons. All waste will be sorted and stored within controlled contained areas until it can be removed from site by a suitable waste disposal company. Bunding will be used to prevent leaching of soluble waste or stormwater run-off carrying pollutants into drains or groundwater, and ultimately the marine environment.

Vessel speed will be restricted within the port by using tugs for manoeuvring large vessels to minimise vessel scour and changes to sediment PSD or damage to identified seagrass habitat that helps to stabilise sediment. Vessel movements will also be restricted to designated areas with sufficient depth / under keel clearance to avoid vessel scour and reduce the risk of vessels running aground. Anchorage areas for large cargo vessels are located in deep water (>20 m) and away from reefs and dense seagrass.

4.5 Noise

The following measure will be implemented during underwater piling to minimise adverse affects to marine fauna:

- Pre-start procedure – The presence of marine mammals, turtles and penguins will be visually monitored by a suitably trained crew member for at least 30 minutes before the commencement of the soft start procedure.
- Soft start procedure – If marine mammals, turtles or penguins have not been sighted within, or are unlikely to enter, the shut down zone during the pre-start procedure, the soft start procedure may commence in which the piling impact energy is gradually increased over a 00 minute time period. Visual monitoring should continue during the soft start procedure. Where visibility is poor or when it

is dark, the soft start procedure should be postponed until visual inspections of the safety zones can be made.

- Normal operation procedure - If marine mammals, turtles or penguins have not been sighted within or are unlikely to enter the shut down or observation zone during the soft start procedure, piling may be increased to full impact energy. Visual monitoring should continue during normal operation. The soft start procedure should be repeated where piling is stopped for more than 30 minutes.
- Stand-by operations procedure - If a marine mammal, turtle or a penguin is sighted within the observation zone during the soft start or normal operation procedures, the operator of the piling rig should be placed on stand-by to shut-down the piling rig. Visual monitoring should continue during stand-by operation.
- Shut-down procedure – If a marine mammal, turtle or a penguin is sighted within or about to enter the shut-down zone, the piling activity should be stopped. Visual monitoring should continue and where these marine fauna are observed to move out of the shut-down zone, or it has not been seen for 30 minutes, the piling activities should recommence using the soft start procedure.

An observation zone and shutdown zone will be implemented for each stage of construction within the marine environment in accordance with Sonus (2014). An example of the observation and shut down zones for the wharf are depicted in Figure 4-1.

4.6 Dust

The risk of iron ore entering the marine environment from dust emissions or an accidental spill is expected to be largely mitigated via the use of covered conveyors, telescopic shiploader and veneering of stockpiles. It is reasonable to assume that there will always be some level of dust emission, which has been modelled (Jacobs 2014b) and discussed further below in Section 5.4.

4.7 Monitoring

Iron Road have committed to minimising impacts to the marine environment, marine fauna and habitats (i.e. water quality) by monitoring for impacts, including regular monitoring and establishing reference sites. Monitoring programs will be based on reference sites north and south of the port and will include:

- Ongoing monitoring of the intertidal habitat, subtidal habitat, water quality and for the presence of IMS in conjunction with State and Commonwealth biosecurity authorities
- Monitoring for changes in benthic habitat health and navigational safety
- Monitoring habitat health at the site that will be able to identify any divergences from the anticipated negligible impacts during construction and operation

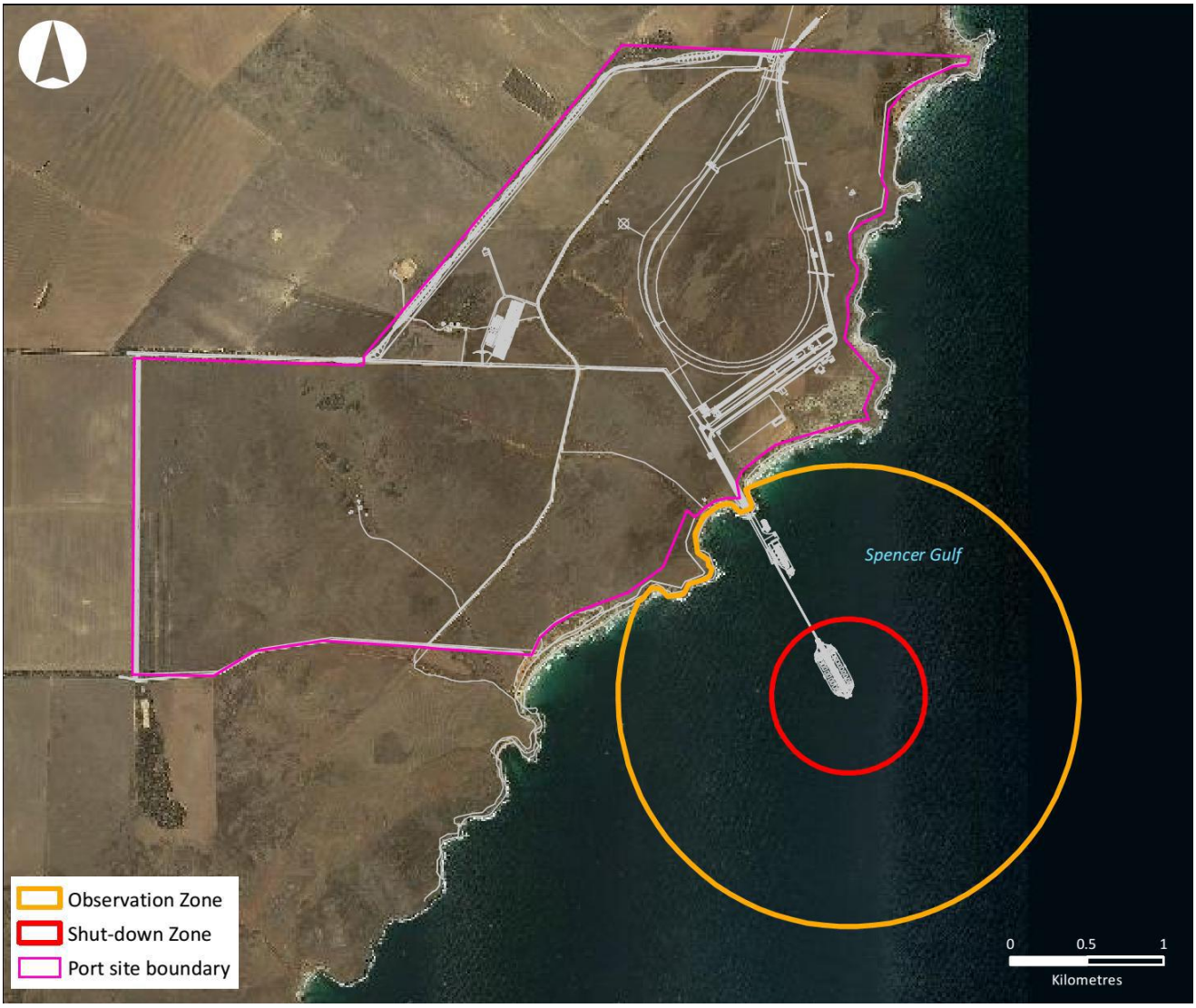


Figure 4-1 Example of observation and shutdown zones – wharf (Sonus 2014)

5 Physical Environment

Registered hydrographic surveys were conducted to obtain accurate data of the bathymetry and to produce nautical charts of the Cape Hardy study area for navigation and engineering design purposes. Offshore geophysical investigations were undertaken to characterise the seafloor geomorphology and depth of soft sediment. Water and sediment chemistry and composition were also characterised and were used to develop a hydrodynamic model for the area (Jacobs, 2014d).

The hydrodynamic model predicts that the embayments of Cape Hardy are already relatively isolated from the longshore drift currents of the gulf, and that changes to the coastline from the proposed infrastructure would not significantly alter coastal processes (Jacobs, 2014d). In deeper water the soft bottom substrate layer becomes consistently thicker, with finer sediments, moving from a sandy environment overlying gneiss or gneiss gabbro, outcropping nearshore to a silty environment at the deepest extent of the surveyed area. The silt environments typically supported sparse mixed small algae and aggregations of invertebrates (sponges, ascidians and both motile and sessile crustaceans). The water quality and seabed conditions within the study area indicate the site is similar to other uncontaminated coastal areas within the Spencer Gulf, with generally low nutrient availability and naturally elevated levels of metals.

5.1 Bathymetry

The bathymetry of the proposed port site is of key importance as the wharf must be able to accommodate Capesize vessels at all states of the tide. Based on previous wharf development proposals and discussions with the Department of Transport Planning and Infrastructure (DPTI) Principal Advisor for Navigation Captain Walter Ferrao, the minimum Lowest Astronomical Tide (LAT) depth required for safe anchorage and passage of a Capesize vessel would be 20 m. In order to select a jetty alignment that would provide suitable depth and access for vessels, a review of the bathymetry of the area was required. Although marine charts are available for the area, the resolution of these charts is insufficient for adequate navigational and engineering design purposes so additional bathymetric surveys were undertaken.

5.1.1 Existing Environment and Key Findings

The Spencer Gulf has a length of 300 km and maximum width of 130 km, and is semi-enclosed by the Eyre Peninsula to the west and Yorke Peninsula to the east. The gulf has a typical depth of 40 to 60 m near the mouth, in the south. In the northern reaches of the gulf, and north of Cape Hardy, maximum depths reduce to 7-20 m (Bullock, 1975). The existing charts indicate that Cape Hardy would provide depths of around 20 m at a distance of 1.5 km from shore. However the resolution of the historic charts could not be used for a detailed assessment as they were last surveyed in the 1960s with a resolution of +/- 2 m.

The key findings of the detailed hydrographic survey at Cape Hardy (Appendix A) include:

- Sub-tidal bathymetry at Cape Hardy generally has low relief and is free of significant navigational hazards.
- Rocky projections within the study area are restricted to the in-shore areas close to headlands and intertidal zones.
- The 20 m LAT depth contour is generally at 750 to 1200 m from shore.

A detailed hydrographic map of the study area with local benchmarks and sounding charts is available in the full report from Hydro Survey Ltd attached as Appendix A.

5.1.2 Impacts and Risks: Bathymetry

Impacts and risks to the bathymetry at the site (and surrounds) could potentially occur as a result of:

- Construction of rock armour walls of the MOF and tug harbour
- Construction of infrastructure such as pylons, buoys and navigational markers resulting in erosion / build up of sediments
- Vessel scouring and anchoring
- Dredging
- Invasive marine species (IMS) build-up, or loss of benthic habitat resulting in erosion of sediments
- Alteration of hydrodynamic environment

An assessment of these potential impacts and risks is provided below.

5.1.2.1 Impacts

The construction of the MOF and tug harbour will permanently alter the bathymetry within the project area as they will be physical structures in the environment. This is considered to represent a medium impact on the bathymetry as the effects will be long term and confined to the footprint of the infrastructure.

The hydrodynamic modelling undertaken at the site to assess the potential impacts from development of the marine infrastructure at the Cape Hardy port predicts minimal changes to existing natural sediment dynamics (approximately 1%), and therefore on the bathymetry within the study area (Jacobs, 2014d). As no erosion of the coastline or silting of the tug harbour is expected based on the hydrodynamic model, impacts to bathymetry are considered negligible.

Operational ports have the potential to introduce invasive marine species (IMS). Some IMS such as mussels have the potential to build up biological reefs and change the bathymetry of an area, or smother benthic habitat (in the case of some algae) causing seagrass loss that could alter the bathymetry of an area by destabilising sediment and causing sediment loss. The OEMP for the port will outline monitoring and management measures to assess and control the introduction and build-up of IMS, and as such the impacts to bathymetry at the site as a result of IMS are not expected and considered to be negligible. The possibility of management measures failing is not a planned event and is therefore covered as a risk below.

As site selection and alignment of the jetty will avoid areas of dense seagrass (Section 6.3) and provide adequate depth for vessels maintenance, dredging is not required for vessel access. As such, no impacts to bathymetry are expected as a result of dredging.

5.1.2.2 Risks

Changes due to scour around jetty pilings, vessel scour or sedimentation inside the tug harbour, or other structure effects on sedimentation represent a risk to the bathymetry of the site. Vessel scour and hydrodynamic changes can not only change turbidity and sedimentation rates, but also PSD and total organic carbon (TOC). This could subsequently result in flow-on changes in benthic community composition which may influence bathymetry. The likelihood of changes to the bathymetry as a result of scour and sedimentation is considered possible and the consequence of any change is considered minor, resulting in a low risk rating.

Spills of product, loss of cargo or vessel sinking could also alter the bathymetry of the site, however these risks are considered to be low as the likelihood of occurrence of these events is unlikely (rare for vessel sinking) and the consequence on bathymetry is minor (moderate for vessel sinking).

As mentioned above operational port facilities have the potential to introduce IMS and some of these (e.g. mussels) have the potential to build up and to form biological reefs, therefore changing the bathymetry of an area. In addition, if left unmanaged, some IMS (e.g. algae) can smother benthic habitat causing seagrass loss that could alter the bathymetry of an area by destabilising sediment and causing sediment loss. Active monitoring and management of IMS will be included in the OEMP for the site. As with any operating port, the introduction of IMS is considered possible, and there is a risk that management measures fail to keep IMS from building up at the site and altering the bathymetry. The likelihood of management measures failing is considered to be possible, and the consequence to bathymetry of failure is considered to be moderate. The risk to bathymetry from IMS is therefore considered to be medium.

5.1.3 Conclusions

The hydrographic survey of Cape Hardy identified no significant navigational hazards within the study area. The hydrographic survey was used in conjunction with the ecological surveys to select an alignment for the jetty which avoids the need for dredging to achieve adequate depth. No blasting for placement of the pilings is required. As dredging or blasting will not be required to construct the marine infrastructure, impacts to the bathymetry as a result of construction are considered negligible. Scour around the site will be minimised during construction and operation by restricting vessel movements to areas of adequate depth. Hydrodynamic modelling of the site indicated negligible impacts to natural sediment movements at the site as a result of the development, largely because of the predominantly open piling structure. The development avoids seagrass areas and as a result erosion impacts to the bathymetry of the area are not anticipated.

Impacts to the bathymetry of the site are anticipated as a result of the construction of the MOF and tug harbour as these permanent structures will affect a physical change to the seabed floor. The OEMP is expected to mitigate impacts to bathymetry from IMS, either from the formation of biological reefs, or the destruction of seagrass.

The risks to bathymetry as a result of the project include unanticipated sedimentation or erosion due to scour around jetty pilings, vessel scour or sedimentation inside the tug harbour. Product spillage, loss of cargo and vessel sinkage is considered a low risk to bathymetry. Inappropriate management of IMS is considered a medium risk to bathymetry at the site

5.2 Hydrodynamic Environment

Investigation of the hydrodynamic conditions in the Spencer Gulf and the waters around Cape Hardy was undertaken to gain a better understanding of the wind, waves, tides and currents in the Cape Hardy area. Baseline investigations and field data collection were undertaken to develop and calibrate a numerical hydrodynamic model, allowing an assessment of the likely effects of the proposed port facility and moored vessels on the seabed and adjacent coastline and beaches (Jacobs, 2014d).

5.2.1 Existing Environment and Key Findings

The Spencer Gulf is a semi-enclosed body of water extending approximately 300 km inland from the Southern Ocean. It is an inverse estuary, meaning that evaporation exceeds the minimal freshwater input. This results in a trend of increasing temperature and salinity towards the upper reaches, particularly in summer months. Changes in upper gulf waters transport highly saline water out of the gulf along the eastern edge (Middleton *et al.,* 2013). Spencer Gulf also has an eccentric tidal regime, with large diurnal tidal ranges and null or neap tides roughly every fortnight (Harvey *et al.,* 1995). The tidal ranges are from 0.0 to almost 4 m (BOM, 2014).

Spring tides have a large tidal range and occur fortnightly on a full or new moon. The maximum spring tide range is over 3 m, compared to the mean tide range of approximately 1.5 m (DEH, 2003). During null or neap tides, known locally as “dodge tides”, the tidal range is 0.0 m and all tidal movements cease for a period of two to three days (Lennon *et al.,* 1987). Tidal, thermohaline, wind, and wave-driven currents play a major role in the gulf’s circulation with diffusion in the upper gulf driving water mixing rather than turbulence (Middleton *et al.*, 2013). In the gulf, funnelling tidal movement also affect tidal amplitude; thus the spring tide range at Port Lincoln is 2.0 m, while at Port Augusta (at the head of the tapering Spencer Gulf) it is 3.9 m. As Cape Hardy lays roughly half way up the gulf it is subject to increased tidal amplitude, especially during major storms, which can raise tides 1.0 to 1.5 m above predicted heights (Harvey and Caton, 2010; Jacobs, 2014d).

The results of the oceanographic ADCP monitoring indicated that the site is exposed to both ocean swell and wind-generated waves. The oceanic swell energy appears to approach Cape Hardy from the south-south-east while the sea waves can approach from a wider range of directions (Jacobs 2014d) as they are influenced by prevailing winds. The largest wind-generated wave heights at the site were generally associated with south easterly storms (Jacobs 2014d). Hydrodynamic modelling of the study area (Jacobs 2014d) predicts that the highest current flows and bed shear are generally experienced at the Cape Hardy point proper with a second, slightly weaker area of high current and bed shear located at a southern headland (Figure 5-1). The proposed jetty and MOF alignment sits between these two areas and modelling has predicted that the structures will have minimal impact on the current flows or bed shear across the site (Figure 5-2). The hydrodynamic modelling predicted the proposed jetty and MOF would cause no significant changes to the hydrodynamics at the site, with only minor reductions in current flow, wave energy, bed shear and sediment transport from south to north (Jacobs, 2014d). The hydrodynamic model indicated that the study area is relatively isolated from the greater gulf longshore drift processes.

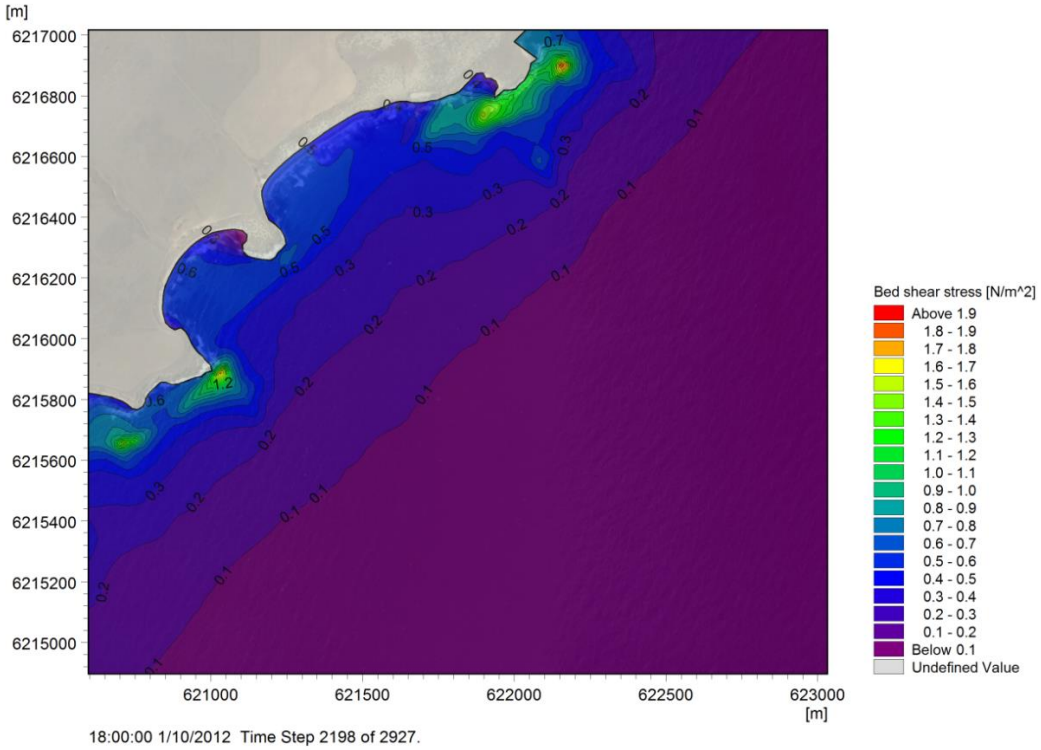


Figure 5-1 Baseline bed-shear stress for easterly wave conditions (Jacobs, 2014d)

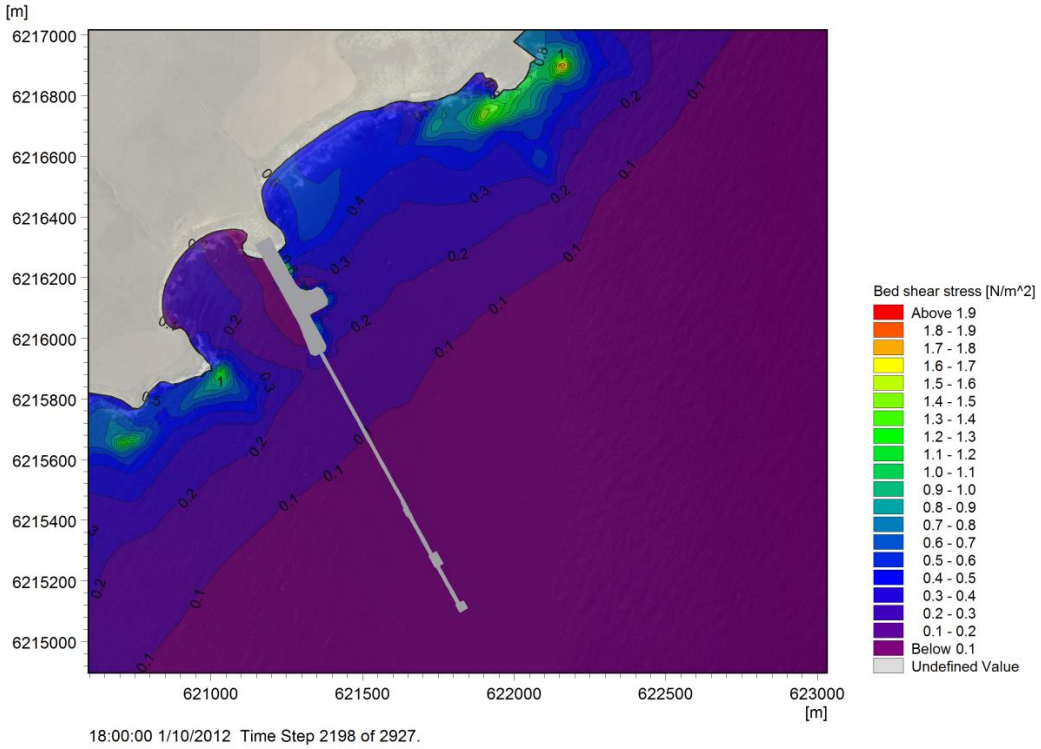


Figure 5-2 Infrastructure scenario bed-shear stress for easterly wave conditions (Jacobs, 2014d)

5.2.2 Impact and Risk: Hydrodynamics

As dredging will not be required during construction or operation, impacts and risks to the hydrodynamics at the site (and surrounds) could potentially occur as a result of:

- Construction of the rock armour walls of the MOF and tug harbour
- Construction of infrastructure such as pylons, buoys and navigational markers
- Potential alteration of the bathymetry in the project area via:
  - Vessel scouring and anchoring
  - Sediment build up and coastal erosion
  - IMS build-up, or loss of benthic habitat i.e. seagrass loss leading to runaway coastal erosion
- Large cargo spills or vessel run aground

An assessment of these potential impacts and risks is provided below.

5.2.2.1 Impacts

Since no dredging or associated spoil disposal is proposed as part of the construction process, no impacts to hydrodynamics are expected as a result of these activities. Piling construction is only a temporary disturbance resulting in localised, but short term changes to the hydrodynamics of the study area. As such, piling activities are expected to result in a low impact to the hydrodynamics of the site.

During construction and once constructed, the MOF and tug harbour will result in some minor but permanent alterations to the hydrodynamic processes at the site. The presence of marine structures at the Cape Hardy site, particularly the tug harbour and MOF, is expected to result in only localised and minor changes to the hydrodynamics, as detailed by the hydrodynamics modelling undertaken by Jacobs (2014d). Changes would include low-level reduction in the rates of sediment transport and bed shear which will generally follow the existing natural dynamics within the Cape Hardy area, resulting in increased sedimentation around the MOF of less than 1%. Therefore significant changes in broader coastal processes such as erosion or sediment dynamics are not expected. As such, alterations to the hydrodynamic environment as a result of the proposed development a considered to represent a medium impact; long term but localised to the marine study area.

5.2.2.2 Risks

The presence of marine structures at the Cape Hardy site, particularly the tug harbour and MOF, is expected to result in only localised changes to the hydrodynamics as discussed above and in detail by Jacobs (2014d). Changes would include low-level reduction in the rates of sediment transport and bed shear which will generally follow the existing natural dynamics within the Cape Hardy area. Therefore significant changes in coastal processes such as erosion or sediment dynamics are not expected. There is a risk that unanticipated changes to hydrodynamics could occur, for example the build-up of seagrass wrack along the MOF. OEMP monitoring would identify unpredicted build-up and mechanical removal may be undertaken if required. The risk of unanticipated changes to the hydrodynamic environment at the proposed port site are considered low, unlikely, and minor in consequence due to the ability for mechanical management if required.

Some IMS such as mussels have the potential to build up biological reefs consequently changing the bathymetry and therefore ultimately the hydrodynamics of an area. Seagrass has also been shown to influence the hydrodynamics of coastal areas by physically slowing currents. Therefore if a reef-building IMS, seagrass pest or smothering IMS such as *Caulerpa taxifolia* were introduced to the site it could cause seagrass loss, which could in turn lead to alterations in hydrodynamics and sediment dynamics. As with any operating

port the introduction of IMS is considered possible, and the consequences of such an introduction to the hydrodynamics of the site are considered moderate. Therefore, the risk of IMS to hydrodynamics is considered medium. IMS impacts and risks are further discussed in Section 6.8.

Iron ore spills, loss of cargo or vessel sinking pose risks of localised impacts to the hydrodynamics at the site. However these risks are considered low as both iron ore spills and loss of cargo are considered unlikely and expected to have only minor impacts on the hydrodynamics of the site. A vessel sinking is considered a rare event which would have a moderate consequence on the hydrodynamics of the Cape Hardy site Therefore the overall risk associated with a vessel sinking is considered to be low.

5.2.3 Conclusions

By considering the hydrodynamic environment during the design of the port infrastructure and selecting a predominantly pylon jetty, large scale changes to the hydrodynamic environment at Cape Hardy have been avoided. The alignment and location of the MOF and tug harbour mean there is no requirement for dredging, and impacts as a result of these physical structures are predicted to be insignificant to the regional hydrodynamics within Spencer Gulf (Jacobs, 2014d). Only minor, localised reductions in bed shear and current speeds in the nearshore areas of Cape Hardy are expected and these minor changes to the site hydrodynamics will not pose a significant risk to marine ecology or the marine environment.

- Localised sediment movements or seabed scour could occur from shipping activities in the nearshore environment. Effective implementation of a considered CEMP and OEMP would minimise potential effects to the marine environment.
- The increased rates of sedimentation and/or decreases in light penetration of the water column due to scouring and sediment suspension could have an effect on the ecology at Cape Hardy, depending on the sensitivity of the habitat to changes in both light penetration and in sedimentation rates. Impacts and risks to ecological habitats are discussed in more detail in Section 6

The site selection, design and targeted environmental management plans are expected to result in low to medium level impacts to the hydrodynamics at Cape Hardy. Similarly, risks to the hydrodynamic environment at Cape Hardy are expected to be low to medium

5.3 Seabed Conditions

Seabed conditions are determined by local geology, oceanographic processes, climatic conditions and ecological interactions. The coast at Cape Hardy is generally considered ‘moderate energy’, being within the Spencer Gulf, protected from oceanic swell and with a moderate tide range. The site is located in a long-term geologically stable area and there are no significant waterways discharging nearby to supply terrigenous sediments or nutrients.

An understanding of the seabed conditions at the site is important to inform or identify:

- preferential locations for siting and routing of jetty and berths
- the sediment type and suitability as habitat
- the potential contaminated or naturally toxic sediments with the potential to be re-mobilised during construction
- the effects of construction activities on sediment movement and transport along the coast

5.3.1 Existing Environment and Key Findings

The nature of the seabed is illustrated in Figure 5-3 and the following points are highlighted:

- The surface sediments generally changes from sandy to silty substrate at between 19-21 m of depth.
- Rocky reef was observed in a discrete, shallow-water patch close to the point of Cape Hardy. It is worth noting that transects avoided shallow water and rocky projections for vessel and equipment safety. Based on aerial imagery and the MES (2012) report it is likely that additional rocky reef substrate is present along the near-shore areas associated with the capes and intertidal zones.
- Toward the north of the sampled areas, sand substrate was observed to extend the full distance of the areas, with no silt observed within the northern extent of the study area.
- The sub-bottom profiling survey and seismic refraction profiles from the study area are consistent with the observed surface morphology indicating that gneiss and gneiss gabbro outcropping occurs near shore adjacent to and in line with the headlands (MES, 2012).
- The thickness of hard substrate gneiss and gneiss gabbro outcropping increases with distance from shore, as the overlying soft-bottom layers increase in thickness to around 20 m at roughly 1000 m from shore (MES, 2012). This indicates the rock outcropping occurs around the headlands and near shore with deep-water sediments dominated by soft silt layers up to 20 m thick overlying a weathered rock profile..

Detailed PSD results are presented in Appendix B and include:

- Sites to the south of the study area (Transect 1) had a greater proportion of fine sediments than those from the north (Transect 6; Figure 5-4).
- Dominant particle sizes increased closer to shore (Transect A; Figure 5-5) compared to sites sampled further offshore (Transects B, C and D), which generally had a greater portion of fine sediments.

These patterns in PSD are consistent with the visible substrate characteristics noted during the video survey, as represented in Figure 5-3.

The sediment composition is likely to be related to the bathymetry of the study area, and level of seagrass cover. Areas of no seagrass generally consist of fine sands or silt and areas of seagrass cover composed of unsorted shell grit and sands. This is consistent with many seagrass beds acting as both a trap for sediments and wave energy dissipater preventing sorting of sediments. The distribution of seagrass can also be dependent on depth as a function of light requirements in deeper waters and exposure/high wave energy in the intertidal zone. In areas of no or little seagrass cover (i.e. the intertidal zone) wave energy is able to remove fines in shallow areas and deposit the fine sediment offshore in deeper waters where less energy reaches the bottom.

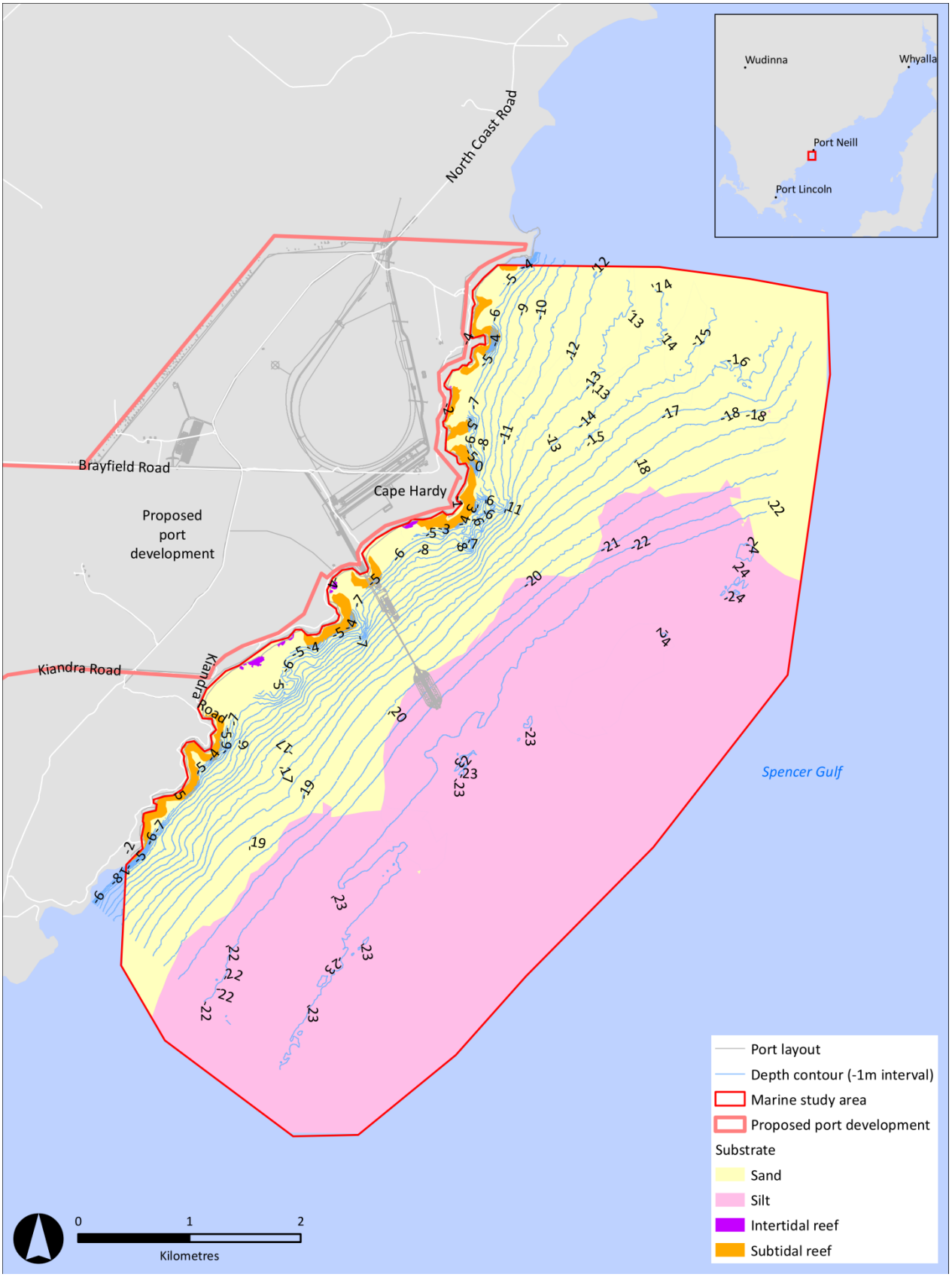


Figure 5-3 Seabed substrate type, determined from video imagery and sediment grabs

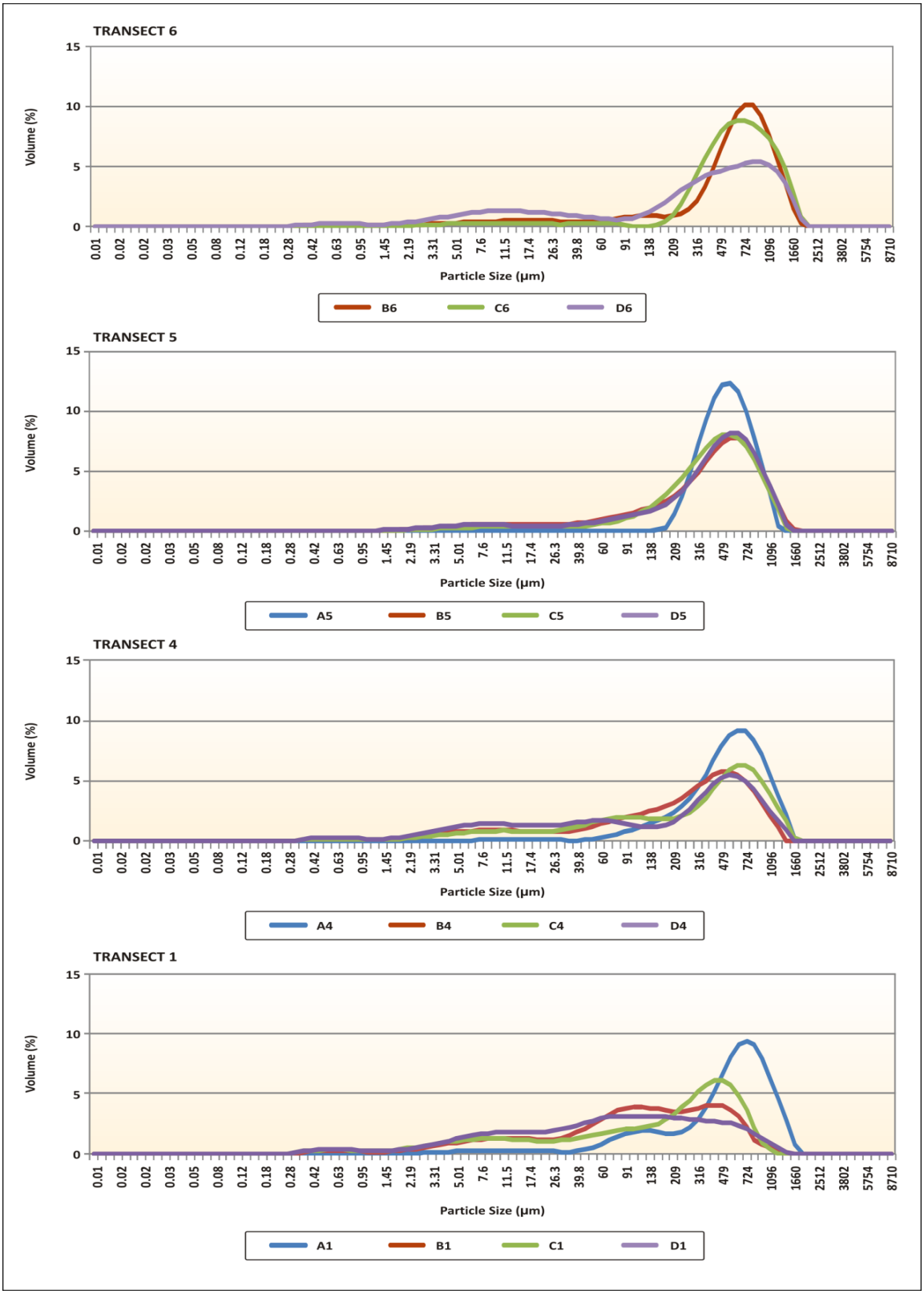


Figure 5-4 Particle size distribution measured north to south across the Cape Hardy study area

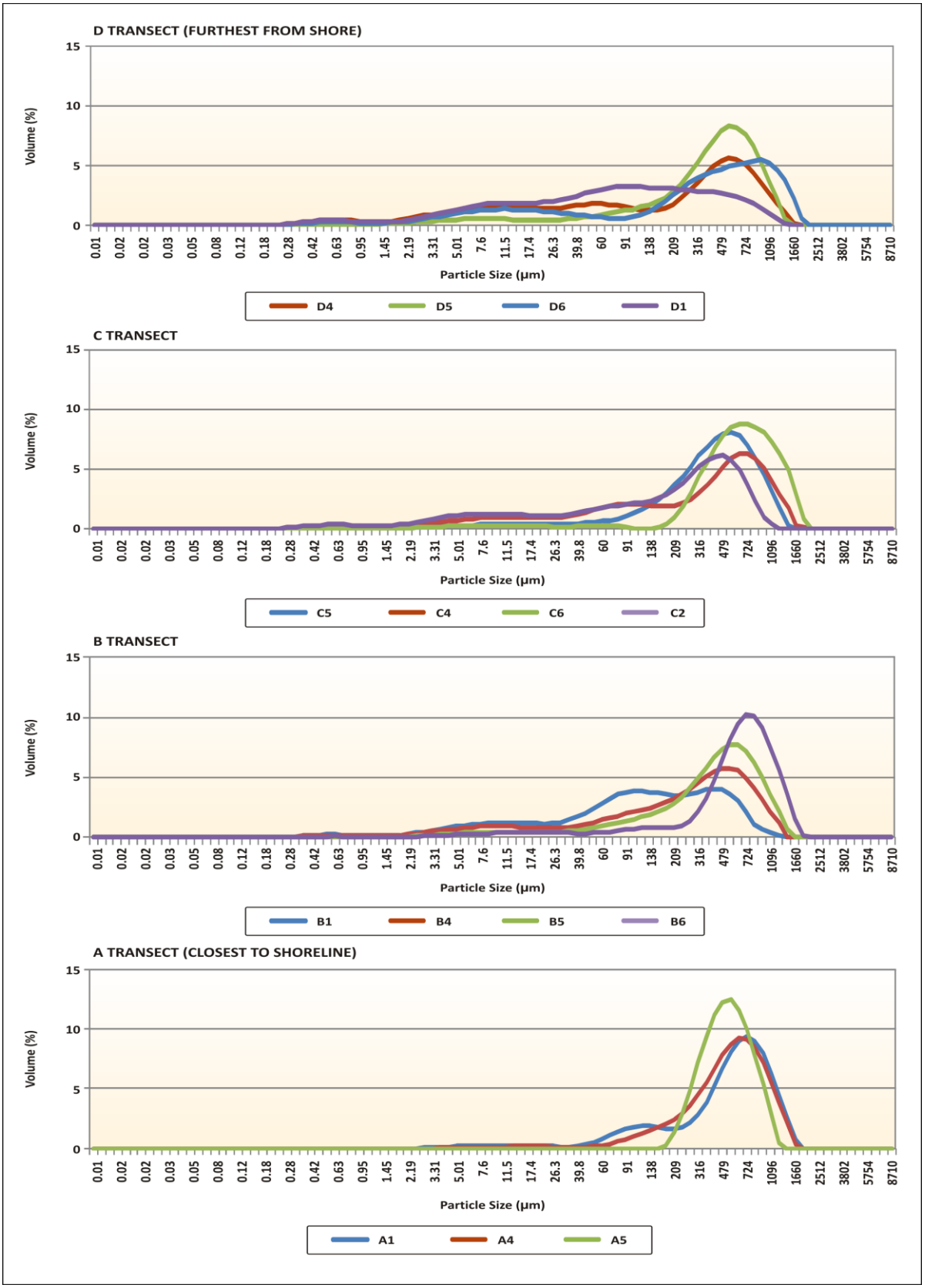


Figure 5-5 Particle size distribution out from shore at the Cape Hardy study area (transects parallel to coast at increasing depth)

Results of the metal and organic contaminant analysis of the sediments are presented in Table 5-1 and Table 5-2. Results for metals were as follows:

- Across the study area, a large range of values was detected for each metal
- With the exception of As, for which two samples were above NAGD/ANZECC guidelines found in the far north eastern extent of the study area all other samples were below NAGD/ANZECC guideline levels of high and low effects on organisms (Table 5-1)
- It should be noted that Australian sediments are commonly naturally high in As and Ni (NAGD, 2009)
- Across the study area the concentrations of As, Cr and V increased with depth into the north-east
- In the most northerly and offshore area, two sites (C6 and D6) showed significantly elevated concentrations of the metals (As, Cr, Fe and V). These areas had quite coarse sediments compared to other areas at the same distance offshore, which is likely to reflect that these sites had more bio-turbation compared to southern sites. It was noted during the sample collection that sediments at these sites had a strong sulfurous odour along with visible organic matter in the form of algal matting, tunicates and polychaetes. This combination of benthic fauna and anoxic sediments can be responsible for the higher concentration of metal ions via 'metal scavenging', a common product of sediments with decreased redox potential. This phenomenon is discussed further in Appendix C

Table 5-1 Study area sediment composition: total metals summary compared with NAGD/ANZECC Guidelines

					ANZECC*		Results			
Analyte Metals	**units**	**LOD****	**SA EPA WDF**	**NAGD guideline***	**Low**	**High**	**Min**	**Max**	**Mean ± SE**	**Median**
Arsenic (As)	mg/kg	1	20	20	20	70	2.08	51.1	10.4 ± 3.6	5.9
Barium (Ba)	mg/kg	10	300	n/a	n/a	n/a	10	10	10 ± 0.0	10
Beryllium (Be)	mg/kg	1	20	n/a	n/a	n/a	1	1	1 ± 0.0	1
Cadmium (Cd)	mg/kg	0.1	3	1.5	1.5	10	0.1	0.1	0.1 ± 0.0	0.1
Chromium (Cr)	mg/kg	1	400	80	80	370	5.5	24	12.1 ± 1.5	10.5
Copper (Cu)	mg/kg	1	60	65	65	270	1	2.4	1.5 ± 0.1	1.3
Cobalt (Co)	mg/kg	0.5	170	n/a	n/a	n/a	0.5	0.8	0.6 ± 0.0	0.5
Iron (Fe)	mg/kg	50	n/a	n/a	n/a	n/a	2460	14000	5645 ± 968.7	4545
Lead (Pb)	mg/kg	1	300	50	50	220	1	2.9	1.8 ± 0.2	1.9
Manganese (Mn)	mg/kg	10	500	n/a	n/a	n/a	10	14	11.4 ± 0.4	11
Mercury (Hg)	mg/kg	0.01	1	0.15	0.15	1	0.01	0.01	0.01 ± 0.0	0.01
Nickel (Ni)	mg/kg	1	60	21	21	52	1	3.2	1.5 ± 0.2	1.2
Vanadium (V)	mg/kg	2	n/a	n/a	n/a	n/a	2	57.4	15.3 ± 4.6	10.5
Zinc (Zn)	mg/kg	1	200	200	200	410	1.2	3.6	2.2 ± 0.2	2.1

NOTE: *As not all analytes have SA EPA standards the NAGD/ANZECC guidelines for sediments have also been referenced as a guide.
**Level of Detection (LOD) is the level of detection in the case of Cd and Hg the sampled values were below the LOD. S.E. = standard error of the mean.

The levels of organic contaminants in marine sediments within the study area were below the detection level of the laboratory analysis (Table 5-2; Appendix B). As such, results were below relevant SA EPA standards and NAGD/ANZECC guidelines.

The results of analysis for which NAGD/ANZECC guidelines exist have been presented in Table 5-2, with a complete listing of all results presented in Appendix B.

- The mean levels of organochlorin pesticides detected at Cape Hardy were consistently below the maximum concentrations for the SA EPA WDF standards and ANZECC guidelines of high levels of contamination. It should be noted that the limit of detection (LOD) of the analysis was often above the NAGD/ANZECC guidelines for low levels of contamination and therefore apparent exceedances of these guidelines may occur as a result of the limitations of the testing method. It is recognised that the ANZECC guidelines are of uncertain ecological relevance
- The mean concentration of total petroleum hydrocarbons (sum C6-C36) was 34.4 mg/kg, which is substantially lower than the NAGD screening level and below the SA EPA WDF acceptable levels in sediments.
- Similarly, levels of the BTEXNs Benzene, Toluene, Ethyl benzene and Total Xylenes were below SA EPA WDF standards
- Tributyltin, an organotin compound, was below NAGD/ANZECC guidelines

Table 5-2 Study area sediment composition: other components compared with NAGD/ANZECC Guidelines

Analyte	units	LOD**	SA EPA WDF guidelines *	ANZECC* Low	ANZECC* High	Sample values Min	Max	Mean ± SE		Median
Organochlorin pesticides (OCs)										
cis-Chlordane	mg/kg	0.05	**2**	**0.5**	**0.5**	**6**	<0.05	detected	0.05	± 0.0	0.05
Dieldrin	mg/kg	0.05	**2**	**280**	**0.02**	**8**	<0.05	detected	0.05	± 0.0	0.05
4.4`-DDE	mg/kg	0.05		**2.2**	**2.2**	**27**	<0.05	detected	0.05	± 0.0	0.05
Endrin	mg/kg	0.05		**10**	**0.02**	**8**	<0.05	detected	0.05	± 0.0	0.05
4.4`-DDD	mg/kg	0.05		**2**	**2**	**20**	<0.05	detected	0.05	± 0.0	0.05
4.4`-DDT	mg/kg	0.2	**2**	**1.6**	**1.6**	**46**	<0.2	detected	0.2	± 0.0	0.2
alpha-BHC	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Hexachlorobenzene	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
beta-BHC	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
gamma-BHC	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
delta-BHC	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Heptachlor	mg/kg	0.05	**2**				<0.05	detected	0.05	± 0.0	0.05
Aldrin	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Heptachlor epoxide	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
trans-Chlordane	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
alpha-Endosulfan	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
beta-Endosulfan	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Endrin aldehyde	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Endosulfan sulfate	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Endrin ketone	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Methoxychlor	mg/kg	0.2					<0.2	detected	0.2	± 0.0	0.2
OC surrogate Dibromo-DDE	%								89.3	± 6.8	91
Organophosphorous pesticides (OPs)										
Dichlorvos	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Demeton-S-methyl	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Monocrotophos	mg/kg	0.2					<0.2	detected	0.2	± 0.0	0.2
Dimethoate	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Diazinon	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Chlorpyrifos-methyl	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Parathion-methyl	mg/kg	0.2					<0.2	detected	0.2	± 0.0	0.2
Malathion	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Fenthion	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Chlorpyrifos	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Parathion	mg/kg	0.2					<0.2	detected	0.2	± 0.0	0.2
Pirimphos-ethyl	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Chlorfenvinphos	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Bromophos-ethyl	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Fenamiphos	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Prothiofos	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Ethion	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Carbophenothion	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
Azinphos Methyl	mg/kg	0.05					<0.05	detected	0.05	± 0.0	0.05
OP surrogate DEF	%	0.1							85.1	± 9.0	87

Analyte	units	LOD**	SA EPA WDF guidelines *	ANZECC*		Sample values				
				Low	High	Min	Max	Mean ± SE		Median
Hydrocarbons										
Total petroleum hydrocarbons	mg/kg		**65**	**550**				34.4	±10.8	32
Total recoverable hydrocarbons	mg/kg							45.8	±12.1	43
BTEXN										
Benzene	mg/kg	0.2	**1**			<0.2	detected	0.2	± 0.0	0.2
Toluene	mg/kg	0.2	**1.4**			<0.2	detected	0.2	± 0.0	0.2
Ethyl benzene	mg/kg	0.2	**3.1**			<0.2	detected	0.2	± 0.0	0.2
meta- & para-Xylene	mg/kg	0.2				<0.2	detected	0.2	± 0.0	0.2
ortho-Xylene	mg/kg	0.2				<0.2	detected	0.2	± 0.0	0.2
Total Xylenes	mg/kg	0.5	**14**			<0.5	detected	0.5	± 0.0	0.5
Sum of BTEX	mg/kg	0.2				<0.2	detected	0.2	± 0.0	0.2
Naphthalene	mg/kg	0.2				<0.2	detected	0.2	± 0.0	0.2
Organotin compound										
Tributyltin	µgSn/kg	0.5		**9**	**5**	**70**	0.5	0.5	0.5	± 0.0	0.5
organotin surrogate Tripropyltin	%	0.1						102	± 23.7	107

Note: * As not all analytes have SA EPA standards the NAGD/ANZECC guidelines for sediments have also been referenced as a guide.

**LOD is the level of detection in all cases the sampled values were below the LOD, as per the NAGD guidelines reporting results for substances below LOD is either 'detected' or 'not detected'. S.E. = standard error of the mean.

In contrast to other areas within Spencer Gulf (Ward, 1987; EPA, 2004; Sinclair Knight Merz, 2010) the marine sediments within the study area are considered to be low in metals and uncontaminated.

5.3.2 Impacts and Risks: Seabed conditions

Changes to sediment structure or levels of contaminants in sediments could have an effect on the distribution and abundance of organisms, along with potentially influencing seagrass survival at the site. Sediment redistribution could potentially occur due to alterations in hydrodynamic conditions at the jetty tug harbour and MOF (Jacobs, 2014d).

Impacts to the seabed conditions could occur as a result of the following construction and operational activities, which are individually assessed in further detail below:

- Pile driving techniques to place the jetty pylons will cause suspension of fine particles or redistribution of sediments
- The jack-up barge and other construction equipment could transport contaminated sediment from other areas into the site
- Suspension or exposure of contaminated sediments could potentially occur during piling activities.
- The construction of the tug harbour and MOF could introduce contaminants and increase turbidity during construction
- Vessel scour and anchoring impacts from vessels involved in the marine infrastructure construction have the potential to alter the PSD distribution of sediments

- During construction and operation, equipment and fuel loading have the potential to spill hydrocarbons and other chemicals into the marine environment that could contaminate sediments
- Run-off from land based construction or port operation has the potential to introduce contaminants into the marine sediments at the site
- Iron ore handling and stockpiling pose the risk of generating dust which could enter the marine environment and impact on seabed sediments

5.3.2.1 Impacts

There will be a permanent change to the existing seabed as a result of introducing the tug harbour and MOF into the existing environment. Although the footprint of these structures is relatively small, the impact from these structures on the seabed conditions is considered to be medium (due to the permanent nature of the change). Hydrodynamic modelling at the site (Jacobs, 2014d) has predicted that there will be no significant departures from the natural sediment transport processes across the site.

Shipping operations are expected to modify the seabed to a small degree due to the installation of navaids, anchor drops, propwash (in the intertidal) and vessel scour. Standard vessel management plans are part of CEMP and OEMP would control vessel movements and restrict impacts to the seabed conditions from these activities to low.

The sediments are not expected to significantly change as a result of the port development at the site. Dust emissions are proposed to be controlled via engineered solutions on the landward side and the use of chemical veneering of ore concentrate stockpiles. Air quality modelling has shown dust emission into the marine environment will be negligible (Jacobs, 2014b) and it is expected that dust will be dispersed by consistent breezes and strong currents in the marine environment or incorporated into the seagrass meadows via natural sediment trapping processes. The effect of the release of iron into the marine environment is discussed in more detail in Section 5.4, and is considered highly unlikely to cause a measurable change in iron concentration in marine sediments or have toxic effects as iron ore is biologically inert.

5.3.2.2 Risks

If there was a large scale loss of seagrass at the site, sediment transport processes would be at risk of substantial change, which could result in the redistribution of sediment, or changes to seabed conditions. However, the likelihood of widespread seagrass loss at the site is considered to be unlikely with only minor changes to seagrass coverage confined to the infrastructure footprint anticipated. The consequences of widespread seagrass loss to the seabed conditions would be minor (a local long term decrease in abundance of some species) meaning the overall risk to seabed condition is considered low. Impacts and risks to seagrasses are discussed further in Section 6.3.

The creation of hardstand areas for the land based facilities creates the risk of increased flows of run-off channelling into the marine environment that could change the sediment loading and distribution at the site. Run-off from the land based operations also has the risk of introducing contaminants into marine sediments. Run-off risks will be mitigated via the landside stormwater capture design which is proposed for the development. As such, the likelihood of stormwater run-off into the marine environment is considered to be unlikely with minor consequences. The risk to seabed condition is therefore considered to be low.

There is a risk that seabed conditions could be impacted as a result of spills and leakages during fuel loading or refuelling, oil change or lubricant escape from the shiploader, anti-fouling paints or escape of iron ore into

the marine environment. An effectively implemented OEMP would reduce the likelihood and consequences of a spill. A minor spill event is considered to be possible (i.e. a 5% chance per annum), the consequences to seabed conditions are considered to be minor (local effects only), the risk of spills and leaks to seabed conditions would be considered to be low. A major spill event would be considered unlikely rather than possible, with elevated consequences of a moderate rating due to the more widespread implications. In this instance, a major spill event would be considered a medium risk to seabed conditions.

5.3.3 Conclusions

The substrate characteristics and geochemistry at Cape Hardy are typical of similar Spencer Gulf green-field sites.

- The design and location of the port will not require dredging which will avoid large scale impacts to the seabed.
- The substrate in shallow water areas is generally sandy, becoming coarser closer to shore in the northern areas. The sandy surface substrate is not expected to be a source of long-term re-suspension due to the type of construction activities in the shallow water. In the areas of deeper water the sediment becomes increasingly fine, and is expected to be more easily suspended in the water column. However the impact piling method planned for construction (hollow steel tubes to be later filled with concrete) will result in only localised, negligible impacts.
- While impacts from vessel scour in deep water are considered low, propwash and vessel scour from tug movements during operation are expected to have medium impacts to the nearshore areas of the seabed.
- There will be a permanent impact on the seabed from the placement of the MOF and tug harbour. Although the area of the impact will be small scale due to the footprint of the structures, the permanent nature of the change escalates this impact to medium.
- Effective CEMP and OEMPs would minimise the risk of accidental releases into the marine environment but there remains a low risk from minor spills and a medium risk from major spills to the seabed condition as a result of the introduction of shipping activities into the environment.
- As the areas of elevated metals are restricted to the north of the study area outside the development footprint and all Cape Hardy samples were below guideline levels, sediments are considered to be uncontaminated, and therefore the redistribution of contaminants due to sediment movement during construction and operation is unlikely to be of concern. There is only a low possibility that sediments with elevated metals or contaminants will be exposed during construction and transported across the site. A suitable CEMP would reduce risks from sediment resuspension should they arise.

5.4 Water quality

Water quality is driven by the natural biogeochemistry of the environment as well as anthropogenic activities. Ultimately, water quality conditions drive the ecology of the broader marine environment by determining the availability of light, nutrients, oxygen and other parameters, as well as the exposure of organisms to pollutants. This makes water quality a valuable indicator of the condition of the marine system. Small disruptions to the dynamics of variables such as temperature, salinity, pH or light penetration can trigger a biological response. The following section describes the results of a survey which aimed to characterise the water quality at the site, and to assess potential impacts upon water quality as a result of the development.

5.4.1 Existing Environment and Key Findings

South Australian marine waters are characterised by low levels of dissolved nutrients, which is supported by the results of the water quality surveys at Cape Hardy. This is due to its physical isolation from strong oceanographic currents and minimal terrestrial runoff from rivers or creeks into the gulf that could supply

nutrients. The existing water quality conditions for Cape Hardy described in this section are based on publicly available data as well as spot samples for metals and nutrients collected from Cape Hardy in November 2011. Concentrations of total metals at Cape Hardy were compared against EPA data from other locations in Spencer Gulf i.e. Port Augusta, Port Germein, Port Pirie, Whyalla, and Port Hughes (EPA, 2004; EPA, 2009). A plot of this data comparison can be seen in Figure 5-6. From this comparison, it is clear that the concentrations of the measured metals at Cape Hardy are below or at similar levels to existing port locations within Spencer Gulf.

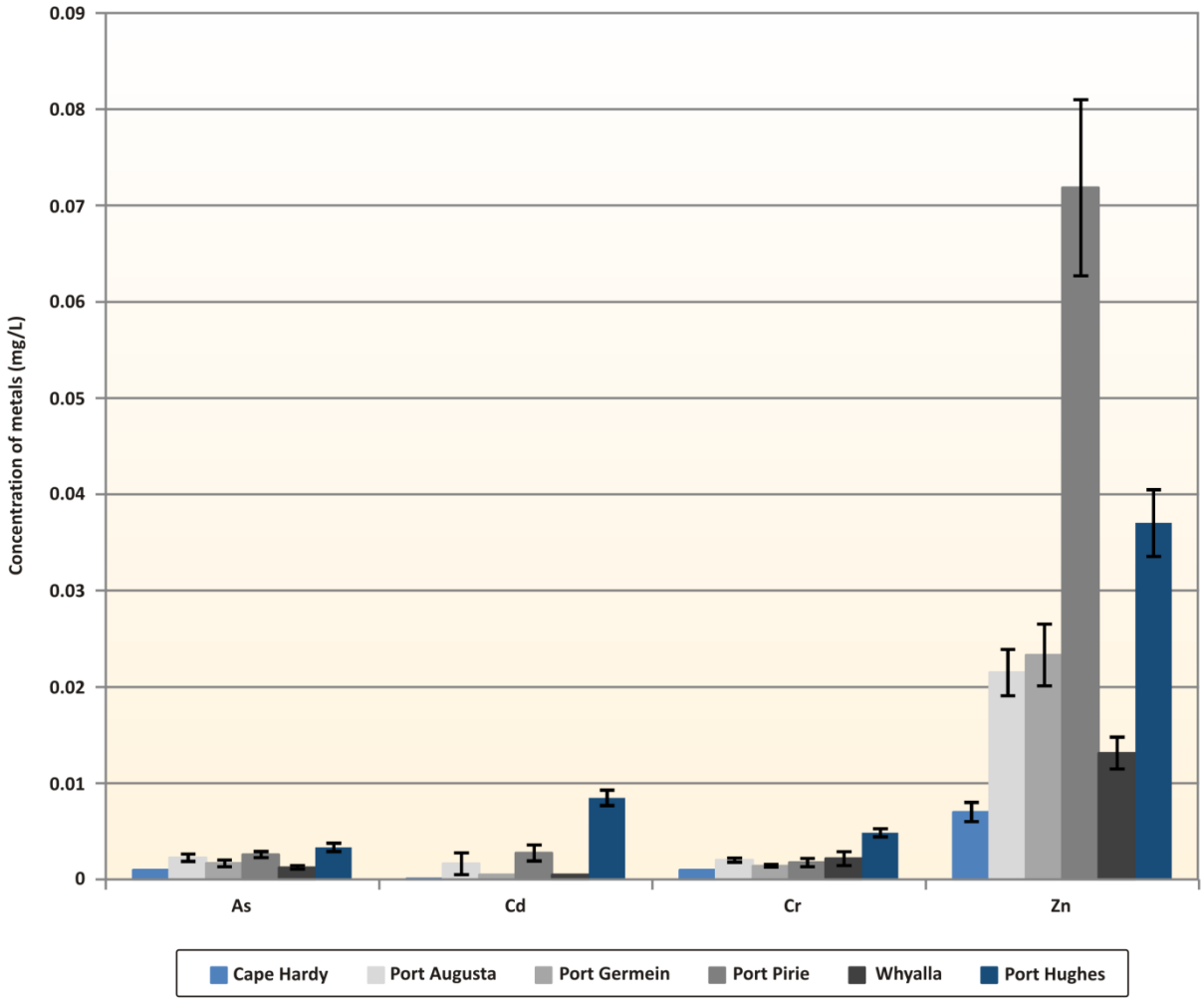


Figure 5-6 Comparison of metal concentrations in Spencer Gulf waters

EPA trigger guidelines for metal contaminants were used for comparison as a guide to ascertain if levels were above those considered to be of concern however guidelines are not available for all analytes. For some of the analytes, the sampled values were below the LOD of the laboratory, and in those cases to be conservative, values were presented as the LOD rather than zero. Results from metal analysis are presented in Table 5-3 andTable 5-4. A summary of the results is bulleted below and the full ALS Environmental Laboratory results are included in Appendix D.

- With the exception of Cu, the levels of metals in surface and bottom water samples taken within the study area were all below EPA trigger values (Table 5-3, Table 5-4)

- Cu values were consistently at or just above the EPA trigger value of 0.01 mg/L
- Concentrations of Fe in surface waters were all at the LOD, hence there is no variation in the data and no median was presented (Table 5-3)
- Concentrations of Fe in bottom waters were higher than surface water concentrations

Table 5-3 Surface water composition: summary in comparison with EPA Water Quality Guidelines

Analyte Total Metals	Unit	LOD	SA EPA Trigger	**Surface Water -** Sampled Values				
				Lowest	Highest	Average	± SE	Median
Arsenic (As)	mg/L	0.001	0.05	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Barium (Ba)	mg/L	0.001	n/a	0.006	0.007	0.006	± 0.000	0.006
Beryllium (Be)	mg/L	0.001	n/a	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Cadmium(Cd)	mg/L	0.0001	0.002	0.0001	0.0006	0.0001	± 0.0000	0.0001
Cobalt (Co)	mg/L	0.001	n/a	0.001	0.001	0.001	± 0.000	0.001
Chromium (Cr)	mg/L	0.001	n/a	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Copper (Cu)	mg/L	0.001	0.01	0.01	0.02	0.010	± 0.002	0.01
Iron(Fe)	mg/L	0.05	n/a	**0.05**	**0.05**	**0.05**	**± 0.000**	**n/a**
Manganese (Mn)	mg/L	0.001	n/a	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Mercury (Hg)	mg/L	0.0001	0.0001	**0.0001**	**0.0001**	**0.0001**	**± 0.0000**	**0.0001**
Nickel (Ni)	mg/L	0.001	0.015	0.002	0.004	0.002	± 0.001	0.002
Lead (Pb)	mg/L	0.001	0.005	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Vanadium (V)	mg/L	0.01	n/a	0.01	0.01	0.01	± 0.000	0.01
Zinc (Zn)	mg/L	0.005	0.05	0.005	0.028	0.007	± 0.001	0.005

NOTE: SE = standard error of the mean. EPA guidelines for total metals trigger where used. n/a = no trigger. Values in **bold** are at or below the LOD i.e. As, Be, Cr, Fe, Hg, Mn and Pb were all below the LOD for all samples.

Table 5-4 Bottom water composition: summary in comparison with EPA Water Quality Guidelines

Analyte Total Metals	Unit	LOD	**SA** EPA Trigger	**Bottom Water -** Sampled Values				
				Lowest	Highest	Average	± SE	Median
Arsenic (As)	mg/L	0.001	0.05	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Barium (Ba)	mg/L	0.001	n/a	0.005	0.007	0.006	± 0.000	0.006
Beryllium (Be)	mg/L	0.001	n/a	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Cadmium (Cd)	mg/L	0.0001	0.002	0.0001	0.0001	0.0001	± 0.0000	0.0001
Cobalt (Co)	mg/L	0.001	n/a	0.001	0.001	0.001	± 0.000	0.001
Chromium (Cr)	mg/L	0.001	n/a	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Copper (Cu)	mg/L	0.001	0.01	0.01	0.012	0.01	± 0.00	0.01
Iron (Fe)	mg/L	0.05	n/a	0.05	0.17	0.081	± 0.043	0.055
Manganese (Mn)	mg/L	0.001	n/a	**0.001**	0.001	0.001	± 0.000	0.001
Mercury (Hg)	mg/L	0.0001	0.0001	**0.0001**	**0.0001**	**0.0001**	**± 0.0000**	**0.0001**
Nickel (Ni)	mg/L	0.001	0.015	0.003	0.006	0.004	± 0.001	0.005
Lead (Pb)	mg/L	0.001	0.005	**0.001**	**0.001**	**0.001**	**± 0.000**	**0.001**
Vanadium (V)	mg/L	0.01	n/a	0.01	0.01	0.01	± 0.0000	0.01
Zinc (Zn)	mg/L	0.005	0.05	0.005	0.014	0.008	± 0.004	0.006

NOTE: SE = standard error of the mean * there are no EPA guidelines for these dissolved metals in marine waters, total metals trigger where used instead. n/a = no trigger Values in **bold** are at or below the LOD i.e. As, Be, Cr, Fe, Hg, Mn and Pb were all below the LOD for all samples.

The nutrient compositions of surface and bottom water samples at Cape Hardy are presented in Table 5-5 . The full laboratory results are presented in Appendix D with a summary of key findings below.

Concentrations of nutrients in surface and bottom waters at Cape Hardy were quite low, and often at or below the LOD (Table 5-5). The low nutrient levels measured around Cape Hardy is typical of Spencer Gulf which has been shown to be nutrient poor, including phosphorous (Middleton et al., 2013)

There was little difference in concentrations between surface and bottom waters, suggesting that the water column was well mixed and homogeneous in nutrient composition (Table 5-5)

All sample averages were below EPA trigger values for ammonia, total oxidised nitrogen (sum of nitrite and nitrate), total nitrogen, and total phosphorus. The concentrations of chlorophyll a (and pheophytin) were low at Cape Hardy, with the average concentration in surface waters 1.4 mg/m^3, and ranged from 1 to 3 mg/m^3. The low levels of chlorophyll a and nutrients suggest that the Cape Hardy site is oligotrophic, which is characteristic of waters in Southern Australia (Russell et al., 2005) and particularly Spencer Gulf (Middleton *et al.*, 2013)

Table 5-5 Surface and bottom water nutrient and chlorophyll a summary in comparison with EPA Water Quality Guidelines

Analyte	Unit	LOD	SA EPA Trigger*	Sampled Values				
				Min	Max	Average ± SE		Median
Surface water samples								
Ammonia as N	mg/L	0.01	0.2	0.08	0.12	0.1	± 0.0	0.1
Nitrite as N	mg/L	0.01	n/a	0.01	0.01	0.01	± 0.00	0.01
Nitrate as N	mg/L	0.01	n/a	0.01	0.02	0.01	± 0.00	0.01
Nitrite + nitrate (oxidised nitrogen) as N	mg/L	0.01	0.2	0.01	0.02	0.01	± 0.00	0.01
Total Kjeldahl nitrogen (TKN) as N	mg/L	0.1	n/a	0.1	0.6	0.2	± 0.0	0.2
Total nitrogen as N	mg/L	0.1	5	0.1	0.6	0.2	± 0.0	0.2
Total phosphorus as P	mg/L	0.01	0.5	0.01	0.09	0.02	± 0.00	0.02
Chlorophyll-a + pheophytin	mg/m³	1	n/a	1	3	1.4	± 0.1	1
Bottom water samples								
Ammonia as N	mg/L	0.01	0.2	0.08	0.16	0.11	± 0.00	0.105
Nitrite as N	mg/L	0.01	n/a	0.01	0.01	0.01	± 0.00	0.01
Nitrate as N	mg/L	0.01	n/a	0.01	0.04	0.01	± 0.00	0.01
Nitrite + nitrate (oxidised nitrogen) as N	mg/L	0.01	0.2	0.01	0.04	0.01	± 0.00	0.01
Total Kjeldahl nitrogen (TKN) as N	mg/L	0.1	n/a	0.1	1	0.2	± 0.0	0.1
Total nitrogen as N	mg/L	0.1	5	0.1	1	0.2	± 0.0	0.1
Total phosphorus as P	mg/L	0.01	0.5	0.01	0.14	0.03	± 0.00	0.02

NOTE: SE = standard error of the mean * values of n/a indicates no EPA guidelines for marine waters

5.4.2 Impacts and Risks: Water quality

Water quality could potentially be affected by alterations to the chemical dynamics of nutrients, contaminants or suspended particles. Even slight alterations to water quality can cause disproportionate biological responses by impacting on phytoplankton or epiphytic algae and, over long periods the loss of habitat-forming macrophytes such as seagrass or macroalgae. Changes in water quality, particularly from pollution can also directly impact on fauna, including habitat forming species, which can lead to habitat loss or changes of species composition within the ecological community of a site.

Impacts could potentially occur to water quality as a result of the following, which are individually assessed in further detail below:

- Dredging / blasting during construction
- Leakage or spills of stored fuels, waste and chemicals used on site
- Chemical or waste spills from the jack-up barge (during construction) or vessels (construction and operation)
- Erosion caused by earthworks and road building during construction
- Alterations to drainage due to construction of hardstand areas increasing run-off of freshwater and input of nutrients, suspended solids or other contaminants
- Wastewater and stormwater from the landside construction site which potentially carry contaminants into the marine environment
- Oil spill during fuel loading of vessels or fuel transfer
- Nutrient or iron stimulation of phytoplankton communities
- Introduction of IMS algae
- Elevated turbidity as a result of piling during construction or vessel scour

5.4.2.1 Impacts

The iron concentrate intended for shipment by Iron Road is magnetite-based and known to be insoluble in seawater, and is therefore highly unlikely to cause a measurable elevation in dissolved iron concentrations in either the water column or surrounding sediment in the event of dust or accidental release to the marine environment. For there to be an iron 'fertilisation' effect on phytoplankton or algae, the receiving waters need to be very low in iron but high in other nutrients. Such environments are referred to as High-Nutrient Low-Chlorophyll (HNLC) environments (Bowie et al., 2001). From previous surveys of the gulf it is clear that the Spencer Gulf environment has relatively high levels of metals including iron (Table 5-3 and Table 5-4) when compared with oceanic waters (Martin et al., 1994; Thompson et al., 2008). The marine environment in the Lipson Island to Port Neill area is considered low in dissolved and total nutrients based on previous sampling (Table 5-5 ; Golder Associates, 2012; Middleton et al., 2013). Middleton et al. (2013) noted that concentrations of all macronutrients within the Spencer Gulf are limited and primary productivity within the gulf is restricted by these nutrient limitations. As the marine waters surrounding Cape Hardy are neither high in nutrients nor low in iron, they do not fit the definition of a HNLC system (Hutchins et al., 1999). Therefore it is considered highly unlikely that iron fertilisation could occur as a result of air-borne emissions or an iron ore spill. There are expected to be no impacts to water quality from iron induced algal blooms.

Increased current and wave energy during storm conditions is an important part of nutrient dynamics, resuspending nutrient-rich sediments, but also resulting in elevated turbidity close to shore for a series of days after storm events. The solid tug harbour and MOF may influence how sediments are redistributed nearshore by causing settlement adjacent to the leeward side of the harbour and MOF. The impacts to water

quality following storm events as a result of the MOF and tug harbour are considered low (short durations following storm events in a localised area).

Minor (low) impacts to water quality are expected from temporary increases in turbidity as a result of vessel movements and vessel scour (localised and temporary in nature).

As a result of the mitigation measures designed for containment of run-off and wastewater at the site impacts on water quality as a result of surface water run-off during construction and operation are expected to be negligible. There is a risk of surface water run-off during extreme storm events, which is discussed further below.

5.4.2.2 Risks

The containment of stormwater and wastewater within the port site in all but the most extreme storm events means that the risk to water quality as a result of sediments or contaminants within run-off is considered low; an unlikely event with minor consequences.

As the sediments in the study area were found to be uncontaminated, it is considered unlikely that the proposed development will disturb or cause the redistribution of any contaminated sediments. Appendix C discusses the ability of sediments and infauna / epifauna to accumulate metals and the effects of sediment re-suspension on water chemistry. Consequences of any resuspended contaminants on water quality are considered minor – local and short term. It is therefore considered a low risk that existing metals or other contaminants would be released from marine sediments and impact water quality.

An effective CEMP and OEMP would reduce the likelihood of oil spill and leaks during construction and operation which could degrade water quality at the site. A minor spill would be considered possible, but with only minor consequences. As such, the risk to water quality from a minor spill or leak would be considered low. A major spill or leak would have moderate consequences for water quality, but are considered to be an unlikely event. As such, the risk from a major oil spill or leak is considered to be medium.

As with any operating port the introduction of IMS is a possibility, however the likelihood of introducing an algal species that could have an affect on water quality is considered unlikely due to the Commonwealth requirements for vessels to discharge ballast water in open waters and the requirement for operators to adhere to a CEMP and OEMP for the port. Given the consequences of such an introduction on water quality would be considered minor (localised and short term), the risk to water quality from IMS is considered to be low.

5.4.3 Conclusions

Water quality and chemistry at Cape Hardy is typical for the Spencer Gulf as a region. Nutrient concentrations are low, as expected in this system (Russell *et al.* 2005). Comparison with data from other ports in the region shows that Cape Hardy has similar or lower levels of metals to Spencer Gulf waters (Figure 5-6), which have high levels of metals when compared with oceanic waters (Martin *et al.*, 1994; Thompson *et al.*, 2008). The Spencer Gulf system does not fit the requirements for iron fertilisation to take place.

Combining the knowledge gained from investigations into the substrate geomorphology, chemistry and water quality, it is considered that the site at Cape Hardy is uncontaminated, and that contamination is unlikely to occur as a direct result of incidental emissions, sediment movement or redistribution during the construction and operational phases of this development.

The key risks to water quality at the Cape Hardy site include:

- Elevated turbidity and/or redistribution of contaminants due to construction
- Elevated turbidity and/or redistribution of contaminants due to ship movements and/or altered hydrodynamic conditions
- Vehicle and equipment maintenance and operations, vehicle washing, possible dust control chemicals, storage of fuel, lubricants, other chemicals, various aerial emissions including dust are all risks to the water quality at the site
- Stormwater and wastewater entering the marine water quality during extreme storm events
- Alterations to drainage due to construction of hardstand areas resulting in increased run-off of freshwater and input of nutrients, suspended solids or other contaminants

It is expected that the majority of these risks are mitigated to medium or less, due predominantly to the site selection and the design standards used for capture and minimisation of run-off emissions from the port site. Due to these measures impacts to the water quality from waste water or run-off are expected to be low. The planned construction methods for the marine infrastructure and adherence to standard mitigation strategies outlined within a comprehensive CEMP and OEMP will further mitigate risks.

6 Biological Environment

The assessment of the biological environment commenced with a desktop study of marine flora and fauna, to determine the potential presence of species and habitats of conservation value within the study area. The EPBC Act and NPW Act were utilised as the major reference points in this component of work. Key species of concern identified during the investigation included protected marine mammals, birds, seahorses, pipefish, and habitats such as seagrass meadows. Seagrass areas are of high conservation value and are protected under the Native Vegetation Act.

A number of EPBC listed species were sighted during field investigations including the hooded plover, common dolphin and leafy seadragon. Other sightings of interest include juvenile Port Jackson sharks (*Heterodontus portusjacksoni*) and a long-snouted boarfish (*Pentaceropsis recurvirostris*).

The key benthic marine habitats and species of interest or conservation value were mapped and identified during December 2011 field expeditions within the study area.

The Cape Hardy biological environment is typical of the Spencer Gulf region. The shallow sandy areas are inhabited by mature seagrass meadows, predominantly *Posidonia* spp. In deeper waters, “clumps” of invertebrates including large ascidians, sponges and bivalves grow on the silty bottom. Small areas of rocky reef exist in rocky areas adjacent to the headlands and the intertidal zones of the study area. These habitats generally follow depth and sediment contours, and as such appear to be stable in their distribution (based on the lack of obvious habitat loss and relative age of the habitats). In the deepest areas with the finest sediments, there is evidence of the formation of microbial matting.

The marine habitats throughout the study area were observed to be in generally healthy condition. Shallow sandy areas are generally dominated by mature seagrass meadows. Temperate rocky reef habitat was limited to shallow areas adjacent the rocky headlands and a few sub-tidal rocky ridges.

6.1 Coastal Habitats

The coastal habitat of the Spencer Gulf is varied, supporting a wide range of habitats and species groups. In the upper reach of the gulf, tidal flats and mangroves are key habitats. In the lower reaches of the gulf sandy beaches backed by dunes or rocky cliff coasts tend to dominant. There are a number of species known to be endemic to the Spencer Gulf. Each of these species has been identified in the upper gulf, as many ecological investigations have focused on this area, whereas information on the southern reaches of the gulf (including the study area) is limited. To assess the biological importance of the Cape Hardy site it was necessary to determine which habitats and species exist at, or utilise the study area, as well as identify any species that are protected by legislation and may trigger further regulatory requirements. Rocky shores or sandy beaches with seagrass provide essential habitat to a wide range of bird species as well as some reptiles and mammals.

6.1.1 Existing Environment and Key Findings

The EPBC Act Protected Matters Search Tool (PMST) found no Threatened Ecological Communities that occurred within 10 km of the study area. However, 56 birds of national conservation significance and two skink species of state significance were identified as having the potential to occur, based upon records from the Biological Database of South Australia (BDBSA), as well as results from the EPBC PMST. In addition to the desktop study, species of conservation significance were also identified at the site during the marine surveys and the terrestrial flora and fauna survey (Jacobs, 2014a).

During the marine field surveys, a total of 14 bird species listed under the EPBC Act were observed within the study area, four of which are also listed under the NPW Act schedules. Unlike many areas in the northern regions of Spencer Gulf, the Cape Hardy coastal area contained no mangrove trees and no flora species listed under the EPBC Act. The dune habitat at Cape Hardy was not considered suitable for conservation significant samphire species such as *Tecticornia flabelliformis*.

For the purposes of this report only the 56 conservation listed marine bird species and two lizard species identified as potentially occurring within the coastal habitat are further considered, as the terrestrial flora and fauna report (Jacobs, 2014a) assesses the on-shore native vegetation and terrestrial mammals, reptiles and birds. Of the 56 protected bird species, 30 are considered unlikely to occur within the study area, 12 are considered to potentially occur in the study area and 14 were actually observed in the study area by survey teams (Table 6-1). While the site contains suitable habitat for the two lizard species they are only considered as potentially occurring at the study area as all known populations are found on the west coast of the Eyre Peninsula.

Based on the desktop reviews of the available literature, BDBSA, EPBC, ALA and field surveys at the port site there are no known large breeding or roosting sites for any shorebird species within the study area with only one species of shorebird (hooded plover) known to nest at the site. Therefore the study area is not considered an internationally or nationally significant shorebird area. Furthermore, of the nationally and internationally significant shorebird areas on the Eyre Peninsula only Franklin Harbour and Sleaford Bay are on the east coast of the Eyre Peninsula (Caton *et al.*, 2011a). As both these locations are greater than 50 km from the study area, it is unlikely those colonies of shorebirds would rely on habitat within the study area. All of the other nationally and internationally significant shorebird areas on the Eyre Peninsula: Baird Bay, Sceale Bay (including Seagull Lake), Streaky Bay (including Acraman Creek), Lake Newland Conservation Park including the ocean beach), Tourville Bay, Murat Bay, Eyre Island, St Peter Island, Coffin Bay (Point Longnose and Gunyah Beach) and Venus Bay (including the islands within the bay) are on the western coast of the Eyre Peninsula (Caton *et al.*, 2011a).

6.1.2 Impacts and Risks: Coastal Habitats

Impacts and risks to the landside coastal environment associated with the proposed port facility have been discussed in detail by Jacobs (2014a). The following section discusses the impact on coastal habitats of fauna, marine bird species and reptiles that have the potential to be impacted by the construction and operation of the proposed development.

The impacts and risks involved with the proposed development are short-term impacts during the construction phase, such as noise impacts from piling, as well as long-term impacts throughout the ongoing presence of structures and operations at the site. Impacts to coastal habitats could occur as a result of:

- Habitat loss or exclusion
- Trampling
- Entanglement in debris or infrastructure or ingestion of non-biological waste such as plastics
- Artificial lighting at night has the potential to disturb nesting birds or interfere with their navigation and foraging
- Stormwater runoff (including erosion)
- Coastal erosion from vessel scour or propwash
- Run-off including pesticides, herbicides, spills (e.g. oil) or other pollutants
- Introduction or increased attraction of invasive, feral or pest species.

6.1.2.1 Impacts

As previously outlined, a number of design and mitigation strategies have been implemented to minimise disturbance of coastal habitat including remnant vegetation and sandy beach areas. The coastal habitat at Cape Hardy is not considered to be core habitat for any EPBC or NPW listed species. CEMP and OEMP procedures will restrict access to sandy beach areas and the engineering design has avoided this habitat. As such, no significant change to the protected environmental values associated with coastal fauna and habitats will occur, with the overall impact considered to be negligible.

Noise impacts from construction vessel movements and construction activities (such as piling) have the potential to disturb fauna utilising coastal habitats, as well as marine fauna (detailed in Section 6.5) that may be prey for coastal species. Coastal fauna known or likely to frequent the port site such as the Hooded Plover, are susceptible to disturbance by noise. There are no large breeding colonies of birds that utilise the port site for habitat or foraging purposes, however, Hooded Plovers are known to frequent the port site and were identified during field surveys. Hooded Plovers are known to have territorial ranges of over 30 ha with several nesting beaches several kilometres apart within their territory (SPRAT, 2014). As such, it is expected breeding pairs disturbed by construction could readily relocate to nearby beaches and be able to return once construction has ceased. Shorebird prey species such as fish or cephalopods will be temporarily displaced from the port site as a result of underwater noise emissions (refer Section 6.7.2). Displacement of species will be localised (around noise sources) and on a temporary short term basis. As such, local populations of protected coastal fauna will experience short term disturbance during construction, considered to be a low impact. Feeding or foraging behaviour of seabirds will not be significantly affected, nor will key habitat be unusable as a result of construction noise emissions.

The introduction of artificial light sources during construction and operation of the proposed port will be required for safe night-time operations and way finding. Artificial light sources attract a number of marine species which may be suitable prey for coastal fauna, thus attracting additional marine birds and affecting the abundance of resources for resident species. As light spill will be minimised through the use of directional lighting (i.e. oriented to a specific area) and the port site is not utilised by any large breeding colonies no change to protected environmental values is anticipated and the overall impact is considered to be negligible.

An assessment of the likelihood of occurrence and impacts to each of the 56 protected bird species and 2 protected lizards species identified as potentially present at the port site is provided in Table 6-1 below.

Table 6-1 Bird and reptile species: likelihood of occurrence and potential impacts

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Birds						
Acanthiza iredalei iredalei	Slender Billed Thornbill	Vulnerable (EPBC); Vulnerable (NPW)	**Unlikely** to occur at the port. This species prefers dense samphire, dense chenopod shrubland, or other low shrubland habitat not present within the project area. This species was not recorded during Jacobs' site surveys. No records occur in a BDBSA 10 km buffer search from site (BDBSA, 2013). This species has potential to overfly the development.	Loss of habitat through clearance	As the preferred habitat for this species is not found at this site, it is highly unlikely that the development area would disturb a significant area of the foraging grounds or range of this species. The species range is extensive, including inland and coastal areas of Australia (SPRAT, 2014). Therefore, any potential impacts to this species from the construction and operation of the port at Cape Hardy are **not considered significant.**	N
Anthus novaeseelandiae	Australasian Pipit, Richard's Pipit	Marine (EPBC)	**Present.** This species was sighted within the study area during the 2011 Jacobs port site flora and fauna surveys and was sighted at road sidings beside farmland during 2012 Jacobs site visits. BDBSA records exist at Port Neill and near Lipson Cove from 2000-2008 (BDBSA, 2013. The species is found across Australia (Simpson and Day, 1999) as well as New Guinea, New Zealand, as well as being widespread across Africa and Asia.	Loss of habitat through clearance; oil spill impacts to intertidal; entanglement in marine debris; vehicle traffic	As the geographic range of this species covers the entire Australian continent this development would not pose any significant loss to habitat or foraging area for this species. Therefore, any potential impacts to this species from the construction and operation of the port at Cape Hardy are **not considered significant.**	N
Apus pacificus	Fork-tailed Swift	Migratory, Marine (EPBC)	**Unlikely** to occur at the port. There are no known nesting sites are within 5 km of the proposed development with the nearest recorded sightings near Port Neill in 1988 and 1998 (BDBSA, 2013). While this species was not observed during Jacobs' site surveys it may overfly the study area but given the species has not be recorded in the area for over decade it is unlikely to be a frequent visitor to the port.	Loss of habitat through clearance	The development represents only a small part of the migratory range of this species, which extends over most of the Australian continent (SPRAT, 2014). As such there would be no significant loss of habitat for this species and therefore impacts to this species from habitat loss are **not considered significant.**	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Ardea alba	Great Egret, White Egret	Migratory, Wetland, Marine (EPBC)	**Unlikely** to occur at the port. Although this species may have the potential to overfly the area, this species was not sighted during Jacobs' surveys, and the preferred habitat of this species is floodplains, rivers, shallow wetlands and intertidal mudflats (Simpson and Day, 1999). Considering that no preferred habitat exists within the development area (i.e. no tidal creeks or mudflats) there is low potential for the species to occur within the study area.	Loss of habitat through clearance; oil spill impacts to intertidal; entanglement in marine debris	The development represents only a small part of the migratory range of this species, which extends over the entire Australian landmass including offshore islands (SPRAT, 2014). As such there would be no significant loss of habitat for this species and therefore impacts to this species from habitat loss are **not considered significant.**	N
Ardea ibis	Cattle Egret	Migratory, Wetland, Marine (EPBC); Rare (NPW)	**Unlikely** to occur at the port as the species preferred habitat of mudflats or tidal creeks does not exist within 10 km of the port (BDBSA, 2012). There are no records for this species in the area and it was not sighted during Jacobs' site surveys.	Loss of habitat through clearance; oil spill impacts to intertidal; entanglement in marine debris	This species is migratory and has a large range covering most of the Australian continent (SPRAT, 2014). As such there would be no significant loss of habitat for this species and therefore impacts to this species from habitat loss are **not considered significant.**	N
Arenaria interpres	Ruddy Turnstone	Migratory, Marine (EPBC); Rare (NPW)	**Possible** species will forage within the study area. The PMST did not identify this species for the area however it has been recorded at Port Neill from 1998-2009 (BDBSA, 2013), 7 km north-east of the development. The species is considered moderately common with a preference for rocky shores with seagrass wrack which it forages amongst (Simpson and Day, 1999). The species was not sighted during the site surveys but as there are small areas of rocky shore within the study area it is possible that this species will occur at the port site.	Loss of habitat through clearance; oil spill impacts to intertidal; entanglement in marine debris	This species is migratory and has a large range covering most of the Australian coastline (SPRAT, 2014). Therefore, despite the likelihood of the species being found at the site its critical habitat would not be affected, nor would the development represent a significant area of the species foraging grounds or range. Therefore impacts to this species from habitat loss are **not considered significant.**	N
Calidris acuminata	Sharp-tailed sandpiper	Migratory, Wetland, Marine (EPBC)	**Possible** species will forage within the study area, as the port area offers coastal shore areas and the species has been recorded at Port Neill in 2000, 7 km north-east of the development (BDBSA, 2013).	Loss of habitat through clearance; oil spill impacts to intertidal; entanglement	This species is migratory and has a large range covering large areas inland Australian and coastline (SPRAT, 2014) therefore despite the likelihood of the species occurring at the port, its critical habitat would not be affected nor would the development represent a significant area of the species foraging grounds or range. Impacts	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				in marine debris	to this species from the port are **not considered significant.**	
Calidris ruficollis	Red-necked stint	Migratory, Marine (EPBC)	**Possible** will forage within the study area. This species is considered common or abundant across most of Australia and found in very large flocks in coastal and inland shores (Simpson and Day, 1999). There are no known breeding colonies on Eyre Peninsula, however as the port area offers coastal shore areas and the species has been recorded between the years 1998-2009 at Port Neill, 7 km north-east of the development (BDBSA, 2013).	Loss of habitat through clearance; oil spill impacts to intertidal; entanglement in marine debris	This species is migratory and has a large range covering numerous sections of the Australian coastline and some inland sites (SPRAT, 2014). Therefore, despite the potential for this species to occur at the port, its critical habitat would not be affected nor would the development represent a significant area of the species foraging grounds or range. Impacts to this species from the port are **not considered significant.**	N
Catharacta skua	Great skua	Marine (EPBC); Vulnerable (NPW)	**Unlikely** to occur at the port site**.** This species was not observed during port site surveys, and no records of this species occur within 10 km of the study area (BDBSA, 2013). The species uses open-ocean habitats as well as coastal habitats (Simpson and Day 2004). This species has a large feeding range covering the entire southern Australian coastline and offshore in the Southern Ocean (SPRAT, 2014). Therefore although it may have the potential to overfly the development, the area would not represent a significant area of the species foraging grounds or range.	Loss of habitat through clearance or disturbance, oil spill impacts to foraging areas; entanglement in marine debris	It is known to visit southern Australian waters but is highly mobile and ranges widely. It is not expected that the Great skua is reliant upon any habitat resources located within the study area or surrounding habitats. Consequently, it is not expected that the construction and operation of a port facility at Cape Hardy will significantly impact this species. Impacts to this species from the port are **not considered significant.**	N
Coracina novaehollandiae	Black-faced cuckoo-shrike	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site flora and fauna survey (Jacobs, 2014a). The species prefers most wooded areas including suburban areas (SPRAT, 2014). This species is common throughout Australia with a range including all of Australia including Tasmania (Simpson and Day, 2013).	Loss of habitat through clearance or disturbance	Despite this species existing in the area of the port site, the site does not represent critical habitat for the species as its habitat and range is extensive and (SPRAT, 2014). The species is considered common throughout its range; the development would not pose any significant threat to the species due to its known ability to adapt to human settlements. Impacts to this species from the port are **not considered**	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
					significant.	
Corvus mellori	Little raven	Marine (EPBC)	**Present.** This species was sighted within the development area during the site flora and fauna survey and previously recorded in the surrounding areas at Port Neill, Lipson Island and Lipson Cove from 1998-2008 (BDBSA, 2013). This species is common across farmlands and suburban areas in South Australia, Victoria and NSW (SPRAT, 2014). This species readily exploits human developments for habitat and food sources.	Loss of habitat through clearance or disturbance; Attraction to development and subsequent entanglement in marine debris; pollution	Due to the distribution and adaptability of this species, any potential impacts to this species from the construction and operation of the port are **not considered significant.**	N
Coturnix pectoralis	Stubble quail	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site flora and fauna survey (Jacobs, 2014a). This species can be found in many grassy areas with a widespread distribution across Australia including many inland areas (Simpson and Day, 1999). This species is not considered threatened in any region across Australia (SPRAT, 2014).	Loss of habitat through clearance or disturbance; vehicle traffic; predation from feral pests or dogs; pollution; entanglement with debris	As the development does not represent a significant geographic area of habitat any potential impacts to this species from the construction and operation of the port are **not considered significant.**	N
Chalcites basalis = Chrysococcyx basalis	Horsfield's bronze-cuckoo	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site flora and fauna survey (Jacobs, 2014a). This species is common throughout Australia with its range covering all of Australia and offshore islands including Tasmania. This species is found in wooded areas including farmlands and suburban areas as long as there are some trees (SPRAT, 2014).	Loss of habitat through clearance or disturbance	Despite this species being known to exist in the area of the port site, its range is extensive and the species common (SPRAT, 2014). The development does not represent critical habitat for this species. Given its ability to adapt to human settlements any potential impacts to this species from the construction and operation of the port are **not considered significant.**	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Charadrius ruficapillus	Red-capped plover	Marine (EPBC)	**Likely** that species occurs in the area. The species was recorded 1 km away from the study area in 2009 and on numerous occasions at both Lipson Island to the South and Port Neill to the north (Golder Associates, 2012; BDBSA, 2013).	Loss of habitat through clearance or disturbance; oil spill impacts to intertidal; vehicle traffic; predation from feral pests or dogs; pollution; entanglement with debris	This species is migratory and has a large range covering numerous sections of the Australian coastline and some inland sites (SPRAT, 2014). Therefore, despite the high potential for this species to occur at the port, its critical habitat would not be affected nor would the development represent a significant area of the species foraging grounds or range. Impacts to this species from the construction and operation of the port are **not considered significant.**	N
Charadrius veredus	Oriental plover, Oriental dotterel	Migratory, Wetland (EPBC)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). Males of this species are conspicuous with red breasted breeding plumage (Simpson and Day, 1999), and would be expected to be easily identified if they were present in the wider area. The lack of sightings of this bird in the greater area suggests it is unlikely it would occur at the port site.	Loss of habitat through clearance or disturbance; oil spill impacts to intertidal; entanglement with debris	This species is migratory and has a large range covering numerous sections of the Australian coastline and inland sites (SPRAT, 2014). Therefore, given the specie's extensive range and the development would not represent critical habitat or a significant area of the species foraging grounds or range. Impacts to this species from the construction and operation of the port are **not considered significant.**	N
Diomedea epomophora epomophora	Southern royal albatross	Vulnerable, Migratory, Marine (EPBC); Vulnerable (NPW)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). This species does not breed in Australia, with all recorded breeding pairs nesting on islands offshore of New Zealand (SPRAT, 2014). This species is capable of global circumnavigation and therefore could in theory overfly the area but as they prefer open oceanic areas any visiting birds would be transients (SPRAT, 2014). Low potential to be present with no nesting sites in the area.	Entanglement in marine debris; disturbance; oil spills; pollution	As no critical habitat is present within the development area there is a low potential for this species to occur near the development area. The port site does not represent a significant area of the species foraging grounds or range. Impacts to this species from the construction and operation of the port are **not considered significant.**	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Diomedea epomophora sanfordi	Northern royal albatross	Endangered, Migratory, Marine (EPBC); Endangered (NPW)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). The species does not breed in Australia, all breeding pairs nest on offshore New Zealand islands (SPRAT, 2014). The species range is wide covering the Southern Ocean from 36° S to at least 49°, including Australia and South America (SPRAT, 2014). This species is known to forage offshore in South Australian and Tasmanian using updrafts from open ocean wave fronts for lift (SPRAT, 2014). With no nesting sites in the area and its preferred foraging in open waters this species is therefore unlikely to frequent Spencer Gulf	Entanglement in marine debris; disturbance; oil Spills; pollution	As no critical habitat is present within the development area there is a low potential for this species to occur near the development area. The port site does not represent a significant area of the species foraging grounds or range. Impacts to this species from the construction and operation of the port are **not considered significant.**	N
Diomedea exulans amsterdamensis	Amsterdam albatross	Endangered, Migratory, Marine (EPBC)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). There is a low potential for this species to be present, as no suitable nesting sites exist in the area. According to SPRAT (2014) the main habitat range is in south-west Western Australia. Therefore it is unlikely this species would occur in the development area.	Entanglement in marine debris; disturbance; oil Spills; pollution	This species is not considered to frequent the Spencer Gulf area as its primary habitat is in south-western Western Australia and therefore its presence is unlikely. As the development does not represent critical habitat impacts to this species from the construction and operation of the port are **not considered significant.**	N
Diomedea exulans antipodensis	Antipodean albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). The Antipodean albatross is endemic to New Zealand, and forages widely in open water in the south-west Pacific Ocean, Southern Ocean and the Tasman Sea, notably off the coast of NSW (SPRAT, 2014). This species is not known to frequent South Australian waters and it unlikely to be present at the port site, as no suitable nesting sites exist in the area.	Entanglement in marine debris; disturbance; oil spills; pollution	This species is not considered to frequent the Spencer Gulf area as its primary foraging habitat is in south-eastern Australia and New Zealand therefore its presence is unlikely. As the development does not represent critical habitat impacts to this species from the construction and operation of the port are **not considered significant.**	N
Diomedea exulans exulans	Tristan albatross	Endangered, Migratory, Marine (EPBC)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). This species has a large feeding range covering the sub Antarctic and Southern Ocean with breeding occurring only on Gough Island and Inaccessible Island in the Atlantic Ocean, with its main foraging area in open water near Cape of Hope, South Africa	Entanglement in marine debris; disturbance; oil spills; pollution	This species has a large range covering the entire southern Australian coastline and offshore in the Southern Ocean. Therefore, while it may have the potential to overfly the development, the area will not represent a significant area of the species' foraging grounds or range. Impacts to this species from the construction and operation	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			(SPRAT, 2014). The species is very large with a wingspan of 3.5 m making it rather conspicuous, given there are no records of the species near the development area and its preferred habitat is the Southern Ocean, it is unlikely to frequent Spencer Gulf.		of the port are **not considered significant.**	
Diomedea exulans gibsoni	Gibson's albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a).According to SPRAT (2014) distribution of this species is predominantly the Tasman Sea between NSW and New Zealand with all breeding occurring on offshore islands south of New Zealand. With no breeding sites in Australia and foraging areas around New Zealand it is considered highly unlikely this species would be found near the development area.	Entanglement in marine debris; disturbance; oil Spills; pollution	This species is not considered to frequent the Spencer Gulf area as its primary habitat is in south-eastern Australia and offshore islands near New Zealand. Therefore as its presence is unlikely impacts to this species from the construction and operation of the port are **not considered significant.**	N
Diomedea exulans (sensulato)	Wandering albatross	Vulnerable, Migratory, Marine (EPBC); Vulnerable (NPW)	**Unlikely** to occur at port site. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a).This species has a large feeding range as a circumpolar species nesting on Macquarie and Herald Island, Antarctic (SPRAT, 2014). This species prefers pelagic areas for foraging (SPRAT, 2014). Therefore, it is unlikely this species would frequent Spencer Gulf or overfly the development area.	Entanglement in marine debris; disturbance; oil Spills; pollution	This species has a large feeding range covering the entire southern Australian coastline and offshore in the Southern Ocean. Therefore, the port area will not represent a significant area of this species' foraging grounds or range. Impacts to this species from the construction and operation of the port are **not considered significant.**	N
Eudyptula minor	Little penguin	Marine (EPBC)	**Likely** that species occurs in the area**.** This species is known to nest on Lipson Island (Edyvane 1999a; b; Madden-Hallett *et al*., 2011) 5 km to south of the development area. The BDBSA indicates a sighting in 1999 at Port Neill to the north (BDBSA, 2013). Given that the adult birds' foraging range is up to 20 km (Seraux *et al*., 2011) it is likely that the species will frequent the port site from the Lipson Island colony**.** This species is distributed along the southern coast in Australia from Perth to Brisbane, including Tasmania and offshore islands. Little Penguins are also found in New Zealand (SPRAT, 2014). Breeding burrows are found on rocky cliffs and vegetated sand dunes, usually on islands but also along remote beaches (Simpson and Day, 1999).	Disturbance of foraging during construction; underwater noise impacts during construction; entanglement with marine debris; feral predators or dogs; oil spills;	The population at Lipson Island is likely to be impacted by the presence of the port. However the species is found along Australia's southern coast and New Zealand (SPRAT, 2014) with breeding colonies in several other areas. The port site does not represent a significant area of habitat or foraging area and therefore impacts from the development on this species as a whole **are not expected to be significant**.	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				pollution		
Falco cenchroides	Nankeen kestrel	Marine (EPBC)	**Present.** This species was sighted within the development area in 2011 during the Jacobs port site flora and fauna survey. There are also a number of records of this species both at Port Neill and near Lipson Cove from 1998-2008 (BDBSA, 2013). This species is widespread across all of Australia including Tasmania and other offshore islands (SPRAT, 2014).	Loss of habitat through clearance or disturbance	This species breeds throughout Eyre Peninsula, Kangaroo Island, most of eastern SA, VIC and NSW and sparsely in WA, QLD, NT and TAS with a preference for most terrestrial habitats except dense woodland (Simpson and Day, 2010). As the port site does not represent a large geographic area of critical habitat for the species, impacts from the development on this species **are not expected to be significant**.	N
Haematopus fuliginosus	Sooty oystercatcher	Rare (NPW)	**Likely** that species occurs in the area. There is the potential for this species to overfly or forage within the development area. This species was recorded during the Lipson Island flora and fauna study (Madden-Hallett *et al.*, 2011). While it was not sighted during the flora and fauna survey at the site (Jacobs, 2014a) it has been recorded at Port Neill and Lipson Island in the years 1982-2008 (BDBSA, 2013) north and south of the development area. This species prefers rocky coastline; Cape Hardy includes some rocky outcrop areas that this species may use for foraging. Therefore the presence of this species at the port is considered likely.	Entanglement in marine debris; loss of habitat through clearance or disturbance; oil spills; pollution; feral predators or dogs	This species is distributed across all coastal areas of Australia (Simpson and Day, 1999). It nests on offshore islands and forages on adjacent rocky shores (Caton *et al.*, 2011a). Despite the potential for this species to be present at the port site it is highly unlikely the port site would represent a significant area of this species' foraging grounds or range. Therefore, despite its potential presence there will be no significant impact on it or its habitat. This species is not an EPBC listed species and therefore not a matter of National environmental significance. Impacts from the development on this species **are not expected to be significant**	N
Haematopus longirostris	Pied oystercatcher	Rare (NPW)	**Likely** that species occurs in the area. There is the potential for this species to overfly or forage within the development area as sightings have been recorded at Port Neill between 1998-2001 (BDBSA 2013) along the coast, north-east of the development. This species prefers sandy beach coastline or estuaries; Cape Hardy includes sandy beach areas that this species may use for foraging.	Entanglement in marine debris; loss of habitat through clearance or disturbance; oil spills; pollution; feral	The distribution of this species includes southern New Guinea and all coastal areas in Australia except the rocky cliffs of the Great Australian Bight (Geering *et al.*, 2008). The species is found along most sandy beaches on Eyre Peninsula (Caton *et al.*, 2011a). Despite the potential of this species to be present at the port site it is highly unlikely the port site would make up a significant area of its foraging grounds or range. This species is not an EPBC listed species, and	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				predators or dogs	therefore despite its likely presence, disturbance to this species is not considered a matter of National environmental significance. Impacts from the port on this species **are not expected to be significant**	
Haliaeetus leucogaster	White-bellied sea-eagle	Migratory, Marine (EPBC); Endangered (NPW)	**Present.** This species was recorded by Jacobs during the 2011 port site survey, overflying the development area. The BDBSA also has a number of records for this species in 1998-2008 at locations north and south of the port site at Port Neill, Lipson Island and Lipson Cove. Therefore, it is highly likely that this species will be seen in the vicinity of the harbour. The nests of this species are conspicuous as it prefers nesting on elevated platforms, poles or trees and there are no known breeding sites for this species within 10km of the port (BDBSA, 2013).	Entanglement in marine debris; loss of habitat through clearance or disturbance; oil spills; pollution	This species is migratory and has a large range covering the entire Australian coastline and many inland areas (SPRAT, 2014; Simpson and Day, 1999). The species is not known to nest in the port area and does not tend to establish new nests near settlements. Therefore the port site does not represent critical habitat or significant areas of its geographical range. Impacts from the development on this species **are not expected to be significant**	N
Halobaena caerulea	Blue petrel	Vulnerable, Marine (EPBC)	**Unlikely** that species occurs in the area. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). This species is known to predominantly occupy sub-Antarctic open-ocean habitats, and does not tend to range far from breeding colonies in sub-Antarctic territory. This species is an uncommon visitor to Australian waters (Simpson and Day 2004, DEWHA 2010) with just a few records of sightings in the Great Australian Bight between Kangaroo Island and Esperance (SPRAT, 2014). Therefore, it is unlikely this species would frequent Spencer Gulf or overfly the development area.	Entanglement in marine debris; loss of habitat through disturbance; oil spills; pollution	This species is not considered to be directly reliant upon habitat near the port site as this species is an uncommon visitor to Australia and has a large feeding range in sub-Antarctic open-ocean. This species is unlikely to overfly the port and therefore the port site would not represent a significant area of its foraging grounds or range. Impacts from the development on this species **are not expected to be significant**	N
Hydroprogne caspia	Caspian tern	Migratory; Marine (EPBC)	**Present.** There are no known nesting sites for this species at the port site however this species was sighted in the development area during the 2011 port site flora and fauna survey (Jacobs, 2014a), and a number of BDBSA records show sightings both at Port Neill and Lipson Cove from 1966-2009 (BDBSA, 2013).	Entanglement in marine debris; oil spills; pollution; loss of habitat	This species is found across Australia's coastal areas including inland waterways (Simpson and Day, 1999). Breeding of this species is known to occur in all Australian States and NT with breeding colonies found in SA from the Coorong to Ceduna and inland at Lake Eyre and Lake	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				through clearance or disturbance	Goyder (SPRAT, 2014). Given the extent of the species' distribution and breeding sites in Australia and the lack of identified breeding sites at Cape Hardy, the port site does not represent critical habitat or significant areas of its geographical range. Impacts from the development on this species **are not expected to be significant**	
Tringa brevipes listed marine as *Heteroscelus brevipes*	Grey-tailed tattler	Migratory, Wetland, Marine (EPBC); Rare (NPW)	**Unlikely** that species occurs in the area. There is one recorded sighting for this species at Port Neill in 2000 (BDBSA, 2013) but species was not sighted during the flora and fauna surveys at the port site in 2011 (Jacobs, 2014a). According to the SPRAT fact sheet for the species "the species is uncommonly recorded along the coasts..." of South Australia (SPRAT, 2014). This species' preferred habitat is tidal creeks and mudflats. Therefore, as there is no suitable habitat at Cape Hardy, the species is unlikely to frequent the port site and any individuals that visit the area would be transients merely overflying the site.	Entanglement in marine debris; disturbance; oil spills; pollution	As a migratory species it has a large range covering numerous sections of the Australian coastline. Despite the potential for this species to occur near the development, the species has an extensive range of habitat. The development will not represent a significant area of the species with no suitable foraging grounds. Impacts from the development on this species **are not expected to be significant**	N
Hirundapus caudacutus	White-throated needletail	Migratory, Marine (EPBC)	**Unlikely** that species occurs in the area This species was last sighted in 1984 at Port Neill, north of the site (BDBSA 2013) and was not observed during the port site flora and fauna surveys. This species' range is extensive in the east of Australia but is unlikely to occur on the Eyre Peninsula (SPRAT, 2014). The Australian distribution of this species is generally further east along the eastern seaboard (Simpson and Day 2004). This species uses forested coastal and mountain habitats, as well as farmland and orchards. This species is not considered to be directly reliant upon habitat near the study area and therefore is unlikely to be present.	Disturbance; pollution	This species is not considered to exist in the development area due to its preferred habitat not being present. Considering the extensive habitat range in eastern Australia for this species; Impacts from the development on this species **are not expected to be significant**	N
Larus novaehollandiae	Silver gull	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site survey (Jacobs, 2014a) and is known to breed on Lipson Island (Madden-Hallett *et al*., 2011). There are numerous BDBSA records for the species inland and along the coast from Port Neill to Lipson Cove dating from 1947-2009 (BDBSA, 2013). The species is extremely common across Australia, New Zealand and New Caledonia (Simpson and Day, 1999). This	Attraction to infrastructure for roosting or foraging; leading to entanglement in marine	This species is widespread and there are no nesting sites within 5 km of the development area. Even though this species is likely to forage in the area, it is known to exploit wharfs and even rubbish grounds for roosting and foraging, impacts from the development on this species **are not expected to be significant**	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			species will utilise virtually any well-watered habitat and is highly adapted to exploiting human settlement, nesting on offshore islands or isolated cliffs (Simpson and Day, 1999).	debris; loss of habitat through clearance or disturbance; oil spills; pollution		
Larus pacificus	Pacific gull	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site survey (Jacobs, 2014a). There are also a number of records for this species inland and along the coast from Port Neill to Lipson Cove from 2000-2009 (BDBSA, 2012). This species is endemic to southern Australia, occurring along the coast from Exmouth in WA to Newcastle in NSW and TAS including offshore islands, with an isolated population in southern QLD and is considered moderately common (Simpson and Day, 1999). They generally nest on islands or headlands but their nesting is easily disturbed by human activities.	Attraction to infrastructure for roosting or foraging; leading to entanglement in marine debris; loss of habitat through clearance or disturbance; oil spills; pollution	There are no known breeding sites for this species within 5 km of the port site. This species is known to exploit wharfs and even rubbish grounds for roosting and foraging, so impacts from the development on this species **are not expected to be significant**.	N
Leipoa ocellata	Malleefowl	Vulnerable, Migratory (EPBC); Vulnerable (NPW)	**Unlikely** to occur in area. Suitable habitat (large areas of mallee canopy coupled with sandy soils and dense leaf litter) is not found within the port site. Even inactive malleefowl mounds are easily identified and persist in the environment for several years, so their absence during the Jacobs port flora and fauna surveys along with the review of BDBSA records indicate it is unlikely the species utilises the area. The nearest record of species was over 12 km north-east from the site in 1999 (BDBSA, 2013).	Disturbance; vehicle strike, pollution	Suitable habitat for this species does not exist within the development area. Therefore, no loss of habitat will occur through development clearance. Impacts from the development on this species **are not expected to be significant**.	N
Macronectes giganteus	Southern giant-petrel	Endangered, Migratory, Marine (EPBC); Vulnerable (NPW)	**Unlikely** to occur in area. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a).This species is commonly seen in Australian oceanic waters and following ships (Simpson and Day, 1999). Therefore, given the existing ship traffic in Spencer Gulf the lack of records for the species in the gulf indicates that it is unlikely to be present at the	Entanglement in marine debris; loss of habitat through disturbance; oil spills;	This species is migratory and has a very large range covering the Southern Ocean, all Australian coastline and offshore areas (SPRAT, 2014). There is no known breeding occurring on the Australian mainland, rather all breeding occurs on sub-Antarctic islands (SPRAT, 2014). Therefore, the development will not represent	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			port site.	pollution	critical habitat or a significant area of the species foraging grounds or range. Impacts from the development on this species **are not expected to be significant**.	
Macronectes halli	Northern giant-petrel	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur in area. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a).This species has an extensive range covering Australia's temperate coastal and offshore regions (SPRAT, 2014) with similar habitat and behaviour to the Southern species. (Simpson and Day, 1999). This species is considered to have only a low potential to overfly the development area.	Entanglement in marine debris; loss of habitat through disturbance; oil spills; pollution	This species is migratory and has a very large range covering the Australian coastline and offshore areas (SPRAT, 2014). Despite the potential for this species to over fly the development, the development will not represent a significant area of the species foraging grounds or range. Impacts from the development on this species **are not expected to be significant**.	N
Merops ornatus	Rainbow bee-eater	Migratory, Marine (EPBC)	**Unlikely** to occur in area. This species has extensive migratory range and passes over much of Australia (excluding Tasmania) (SPRAT, 2014).These birds are vividly coloured making them quite conspicuous (Simpson and Day, 1999). There are no known nesting sites within 10 km of the development area (BDBSA, 2013). However, the species has been recorded in 1988 and 1998 in Port Neill. The species was not observed during Jacobs site surveys. The lack of records for the species in the last decade in the greater area indicates that this species is unlikely to be present in the development area.	Loss of habitat through disturbance; pollution	The proposed activities will not impact on this species or species habitat due to lack of suitable habitat in the development area. This species may have the potential to overfly the port site however it is highly unlikely the development would make up a significant area of its foraging grounds or range as this species range is extensive including most of Australia therefore impacts from the development on this species are **not expected to be significant**.	N
Neophema petrophila	Rock parrot	Marine (EPBC); Rare (NPW)	**Present.** This species was sighted within the development area during the 2011 site survey (Jacobs, 2014a) with two records at Port Neill in 2000-2001 (BDBSA, 2013). This species is listed as Rare in SA but is considered reasonably common throughout its range (Simpson and Day, 1999).	Loss of habitat through clearance or disturbance; pollution	This species' population is distributed along Australia's coast from Exmouth in WA to the WA-SA border and from Fowlers Bay to Fleurieu and Kangaroo Island in SA including both gulfs (SPRAT, 2014). The species nests on offshore rocky islands and cliffs, visiting the adjacent coast (Simpson and Day, 1999). Despite the presence of the species at the site, critical habitat for this species exists outside of the development area and as the port will not directly impact on any coastal/offshore islands impacts from the development on this species is	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
					not expected to be significant.	
Nycticorax caledonicus	Nankeen night heron	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site survey (Jacobs, 2014a). These birds roost in trees or under wharfs by day and fish at night (Simpson and Day, 1999). The construction of the port may benefit the species by providing additional roosting areas (thus increasing the likelihood of occurrence at the site).	Attraction to infrastructure for roosting; leading to entanglement in marine debris; clearance of habitat; oil spills; pollution	This species is distributed along most of the Australian coast (except the Great Australian Bight) and eastern Australian inland areas (Simpson and Day, 1999). While there may be impacts on individuals of this species due to port operations, the species is common and its range large therefore impacts from the development on this species its habitat is **not expected to be significant**.	N
Pandion haliaetus	Osprey	Marine (EPBC); Endangered (NPW)	**Possible** that species occurs in the area. There is potential for this species to be in the area as a juvenile bird was recorded in 2009 within 2 km of the port site and sighting records of the species exist from 2001 at Port Neill (BDBSA). There are no known breeding sites for this species within 10 km of the development area (BDBSA, 2013). These individuals can have a large feeding range of up to 80 km (SPRAT, 2014). It is therefore likely that visiting birds to the site would be vagrants or transient juveniles.	Loss of habitat through clearance or disturbance; entanglement in marine debris; oil spills; pollution (e.g. pesticides)	This species has an extensive habitat range including most of coastal Australia (Simpson and Day, 1999) and extending into New Guinea, Solomon Islands, Indonesia, Philippines, Palau Islands, and New Caledonia (SPRAT, 2014). This species has a large feeding range and although it may have the potential to overfly the development site it is unlikely the site would make up a significant area of its foraging grounds or range. Impacts from the development on this species or its habitat are **not expected to be significant**.	N
Pelecanus conspicillatus	Australian pelican	Marine (EPBC)	**Present.** This species was sighted within the development area during the 2011 site survey (Jacobs, 2014a) with multiple records from 1998-2009 at Port Neill (BDBSA, 2013). This species is found throughout Australia, Papua New Guinea and western Indonesia, with occasional reports in New Zealand and various western Pacific islands. The Australian Pelican utilises diverse habitats including inland fresh and saline lakes, dams, rivers, suburban ponds, swamps, estuarine, wetlands, coastal shores and islands	Loss of habitat through clearance or disturbance; entanglement in marine debris; oil	This species is not considered threatened. Apart from habitat destruction the biggest threats to this species are oil spills, pesticide poisoning and damage breeding sites, which are sensitive to destruction by even a single dog (Barbara - personal observation 1993 at Outer Harbour, SA). The species has previously bred on the sand-spit isle at Outer Harbour, Port Adelaide	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			(Australian Museum, 2013). Breeding colonies are widespread across Australia (Simpson and Day, 1999). The species breeding is dependent on environmental conditions with one of the largest ephemeral breeding areas being Lake Eyre during years of heavy rainfall. This species also breeds on several offshore islands.	spills; pollution (e.g. pesticides)	opposite the active port (Barbara -personal observation) and is commonly found at all ports throughout Australia. Therefore, the presence of a port does not adversely impact on its behaviour. As the species is capable of co-existing with human developments **the construction and operation of the port at Cape Hardy is unlikely to significantly impact on the species**.	
Phalacrocorax fuscescens	Black-faced cormorant	Marine (EPBC))	**Likely** that species occurs in the area**.** Several BDBSA records of this species exist south and north of the development area at Lipson Island and Port Neill from 1982-2008. Breeding for this species occurs on Lipson Island (Madden-Hallett *et al.*, 2011) and foraging is likely to occur in the area of the port site. Breeding colonies for this species are widespread across Australia (Simpson and Day, 1999). The species' largest breeding colony is at South Australia's largest operating port, Port Adelaide on the Outer Harbour breakwater (Zoo SA, 2013). Therefore the presence of an active port is unlikely to negatively impact on the species. The species is known to exploit man-made constructions in the marine environment, utilising them for both roosting and fishing locations (Simpson and Day, 1999).	Interactions with vessels and construction machinery due to attraction to infrastructure for roosting; entanglement in marine debris; loss of habitat through clearance; oil spills; pollution	This species is not considered threatened and is found along much of Australia's southern coast (except perhaps the Great Australian Bight) (Simpson and Day, 1999). Considering the active breeding colony at Port Adelaide, this species is able to coexist with large operating ports without adversely impacting on its behaviour. Therefore, construction and operation of the port at Cape Hardy is **unlikely to significantly impact on the species.**	N
Psophodes nigrogularis leucogaster	Western whipbird (eastern)	Vulnerable (EPBC); Endangered (NPW)	**Unlikely** to occur in area. The SA Museum has carried out targeted surveys for the Western-Whip bird on Eyre Peninsula in 2006-2007 to determine the species distribution and abundance (ZooSA, 2013) and did not identify the area as habitat for the species. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site (Jacobs, 2014a). The Western Whipbird (eastern) inhabits mallee and thicket vegetation in coastal and inland areas of southern South Australia and. is said to associate with the Red-lored Whistler (*Pachycephala rufogularis*) which is	Pollution	The population on the Eyre Peninsula is restricted to sites around Coffin Bay National Park and Lincoln National Park (EPBC, 2013; SPRAT, 2014). The Western Whipbird (eastern) is a sedentary bird (Condon 1966) that is capable of making only short-distance flights (Condon 1966). Its inability to traverse long distances in flight probably limits or prevents its dispersal across areas that have been cleared of suitable habitat (SPRAT, 2014). Therefore the species is	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			listed as Vulnerable under the EPBC Act. It also occurs in areas inhabited by the Malleefowl (*Leipoa ocellata*) and Regent Parrot (eastern) (*Polytelis anthopeplus monarchoides*) both listed as Vulnerable under the EPBC Act and the Black-eared Miner (*Manorina melanotis*) and Mallee Emu-wren (*Stipiturus mallee*) listed as Endangered under the EPBC Act (SPRAT, 2014). Therefore as there are no records for the species in the greater area, its inability to fly great distances, no suitable floral habitat, nor associated avian species known to occur in the development area, it is considered unlikely the species would occur in the area.		not considered to occur in the area and impacts from the construction and operation of the port at Cape Hardy are **unlikely to significantly impact on the species.**	
Pterodroma mollis	Soft-plumaged petrel	Vulnerable, Marine (EPBC)	**Unlikely** to occur in area. There are no records for this species within 10 km of the study area (BDBSA, 2013) nor was it observed during the flora and fauna survey at the site ((Jacobs, 2014a). This species is not known to breed in Australian territory and inhabits sub-Antarctic oceanic areas (Simpson and Day 2004; Shirihai, 2007; DEWHA, 2010). This species is not considered to be directly reliant upon habitat near the study area.	Entanglement with marine debris; oil spills; pollution (e.g. poisoning from pesticides)	This species has a large feeding range covering temperate and sub Antarctic waters in the South Atlantic, southern Indian and western South Pacific Oceans (SPRAT, 2014) therefore the species has the potential to overfly the development area. However the only known breeding colony of the species is on an offshore island south of Tasmania with all other colonies spread across islands in the Southern Ocean from South Africa to South America (SPRAT, 2014). Given the extent of the species range and its absence of breeding colonies in South Australia, is unlikely that the port site would make up a significant area of its foraging grounds or range. Impacts from the construction and operation of the port are **unlikely to significantly impact on the species.**	N
Puffinus carneipes = Ardenna carneipes	Flesh-footed Shearwater, Fleshy-footed Shearwater	Migratory, Marine (EPBC)	**Unlikely** to occur in area. This species was not observed during the flora and fauna survey at the site (Jacobs, 2014a). One log describing a group of 15 birds of unknown *Puffinus* sp. was recorded in 2009, with behaviour described as "feeding near dolphins", approximately 10 km south of the development area (BDBSA 2013). As the sighting did not identify the birds beyond genus it is possible the *Puffinus* sp. recorded were Fleshy-footed shearwaters, however it is considered unlikely as the nearest colony is over 90 km away and a similar species the Short-tailed	Entanglement with marine debris; oil spills; pollution (e.g. poisoning from pesticides)	The *Puffinus carneipes* or *Ardenna carneipes* is a trans-equatorial migrant widely distributed across the Indian and Pacific Oceans with a global population of up to 380000 pairs nesting throughout the globe (SPRAT, 2014). This species is considered abundant throughout its range in Australia (Simpson and Day, 1999). The species is known to breed on 41 offshore islands within Australia with South Australia's key	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			Shearwater is thought to roost on Lipson Island (Madden-Hallett *et al*., 2011) and is therefore a more likely candidate for the sighting		breeding site located on Smith Island near Port Lincoln (SPRAT, 2014) > 90 km to the south of the development area. As the species has a large feeding range it has the potential to overfly the development area however it is unlikely that the port site represents a significant area of this species' foraging grounds or critical habitat. Impacts from the construction and operation of the port are **unlikely to significantly impact on the species.**	
Puffinus tenuirostris = Ardenna tenuirostris	Short-tailed shearwater	Migratory, Marine (EPBC)	**Possible** that species occurs in the area**.** This species was not observed during the flora and fauna survey at the site (Jacobs, 2014a) however there is a log describing a group of 15 birds of unknown *Puffinus* sp. was recorded in 2009, with behaviour described as "feeding near dolphins", approximately 10 km south of the development area (BDBSA 2013). It is possible the *Puffinus* sp. recorded were Short-tailed Shearwaters that are thought to roost on Lipson Island (Madden-Hallett *et al*., 2011).	Entanglement with marine debris; oil spills; pollution (e.g. poisoning from pesticides)	The species is found from Perth to Brisbane in coastal and offshore waters and is classified as abundant in Australia (Simpson and Day, 1999). This species is thought to roost and potentially breed on Lipson Island (Madden-Hallett *et al*., 2011) 5 km south of the development area. As the species has a large feeding range it has the potential to overfly the development area however it is unlikely that the port site represents a significant area of the species' global foraging grounds or range. Impacts from the construction and operation of the port are **unlikely to significantly impact on the species.**	N
Rostratula australis	Australian painted snipe	Endangered Migratory, Marine (EPBC); Vulnerable (NPW)	**Unlikely** to occur in area**.** The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps as well as inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (SPRAT, 2014), habitat that is not present at the port site. There are no records for this species within 10 km of the development (BDBSA, 2012) and the species was not observed during the flora and fauna survey at the site (Jacobs, 2014a). As there are no records for the species in the wider area and with no suitable habitat at the port site the species is not expected to occur in the area.	Entanglement with marine debris; oil spills; pollution (e.g. poisoning from pesticides)	The species' range includes the Pilbara, Kimberley's, most of NT, QLD, NSW, Victoria and eastern South Australia to the Eyre Peninsula, with an isolated population in south west WA (SPRAT, 2014). Breeding occurs in Victoria, NSW and South Australia's south east its range does not include Eyre Peninsula (Simpson and Day, 2010). As the port site does not include suitable habitat and given the species prefers eastern and northern areas of Australia it is not expected to frequent the development area and therefore impacts from the construction and operation of the port are **unlikely to significantly impact on**	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
					the species.	
Haematopus fuliginosus	Crested tern	Migratory, Marine (EPBC); Rare (NPW)	**Likely** that species occurs in the area**.** This species is known to nest on Lipson Island (Madden-Hallett *et al*., 2011), and sightings records have been logged at Port Neill and the Lipson Cove area from 1982-2009 (BDBSA, 2012). The species is known to use coastal seas and continental shelf habitats (Simpson and Day 2004) with an extensive range it is likely the species will be found at the port site.	Loss of habitat through clearance or disturbance; entanglement with marine debris; oil spills; pollution (e.g. poisoning from pesticides)	This species is considered common throughout its range in all Australian coastal waters and into South East Asia (Simpson and Day, 1999). This species is known to congregate on coastal shores and intertidal zones. Although the species was not observed during the field survey (Jacobs, 2014a), suitable habitat occurs within the coastal zones of the port site and it is considered likely that this species uses habitat available in the area. The species is highly mobile and is not considered likely to rely solely on habitat present within the port area. Therefore given its extensive range it is expected that impacts from the construction and operation of the port are **unlikely to significantly impact on the species.**	N
Sterna fuscata = Onychoprion fuscata	Sooty tern	Marine (EPBC); Rare (NPW)	**Unlikely** to occur in the area. No records of sightings of this species have been submitted to the BDBSA within 10 km of the development area (BDBSA, 2013). This species was not observed during the flora and fauna survey in 2011 (Jacobs, 2014a) or the targeted flora and fauna survey of Lipson Island (Madden-Hallett *et al*., 2011) where it was thought to breed (EPBC search results Nov., 2013). This species is generally pelagic but also occupies islands. In Australia this species' distribution is concentrated on the northern aspects of the continent, outside of Spencer Gulf or southern Australia (Simpson and Day 2004).	Entanglement with marine debris; oil spills; pollution	There is no evidence that this species has been sighted within 10 km of the development area (BDBSA, 2013). The species' range includes coastal and offshore waters of Australia but excludes southern coasts (Simpson and Day, 1999). Its presence in the development area is therefore unlikely. Impacts from the construction and operation of the port are **unlikely to significantly impact on the species.**	N
Sternula nereis nereis	Fairy tern (Australian)	Vulnerable (EPBC); Endangered (NPW)	**Possible** to occur in the area. This species was not observed during Jacobs' port site surveys in 2011, or the flora and fauna survey of Lipson Island (Madden-Hallett *et al*., 2011). However the species is thought to breed on Lipson Island Conservation Park 5 km to the south of the development area despite recent surveys failing to find the species (Madden-Hallett *et al*., 2011).There is only one record submitted to the BDBSA from Port Neill, north of	Loss of habitat through clearance or disturbance; entanglement with marine	Although there is potentially suitable habitat at the port site for this species there are other suitable beaches within Spencer Gulf and across Australia. While presence of this species at the site is considered possible and due to the geographic range of the species, the port site does not represent a significant area of critical	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			the development area in 1998 (BDBSA, 2013). This species nests on sheltered sandy beaches, sand spits and banks between the high tide line and vegetation along Southern Australia from Victoria and Tasmania to as far up as Dampier in Western Australia (SPRAT, 2014). The habitat type exists at the port site along with several nearby locations within Spencer Gulf. Given the threatened status of this species and suitable habitat in the area it is considered possible the species occurs in the area.	debris; oil spills; pollution; predation by feral animals or dogs	habitat or known breeding location. Impacts from the construction and operation of the port are considered **unlikely to significantly impact on the species.**	
Thalassarche bulleri	Buller's albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur in area. This species was not observed during Jacobs port site surveys in 2011 and no records have been submitted to the BDBSA within 10 km of the development (BDBSA, 2012). This species has a large feeding range from New Zealand to the coasts of south eastern Australia (Simpson and Day, 1999). Therefore the range of this species is outside of the development area it is unlikely that the port site would represent critical habitat for this species.	Entanglement with marine debris; oil spills; pollution	This species is endemic to New Zealand where it breeds (SPRAT, 2014) and has a very large foraging range covering the south-eastern Australian coastline including Tasmania. The location of the development does not represent a significant area of the species foraging grounds or range. Impacts from the construction and operation of the port are considered **unlikely to significantly impact on the species**	N
Thalassarche cauta cauta For marine and migratory listed as *Thalassarche cauta (sensustricto)*	Shy albatross, Tasmanian shy albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur in area. This species was not observed during Jacobs' port site surveys and no sighting records have been submitted to the BDBSA within 10 km of the development (BDBSA, 2012). The recent separation of the Shy albatross from other closely related taxa confounds the current understanding of its at-sea distribution; it appears to occur over all Australian coastal waters below 25° S (SPRAT, 2014). However this species is most commonly observed over the shelf waters around Tasmania and south-east Australia, with all breeding occurring around Tasmania (SPRAT, 2014). The development area is unlikely to represent a significant area of its range or critical foraging grounds and it is considered unlikely the species would occur at the port.	Entanglement with marine debris; oil spills; pollution	This species is endemic to south-eastern Australian and Tasmania where it breeds (SPRAT, 2014) and has a very large foraging range covering the south-eastern Australian coastline. The location of the development area of the port is not within the known range and does not represent key habitat type for the species. Impacts from the construction and operation of the port are **unlikely to significantly impact on the species.**	N
Thalassarche cauta steadi	White-capped albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur in area. No records have been lodged with the BDBSA within 10 km of the development (BDBSA, 2012) and the species was not observed during Jacobs' 2011 port site surveys. This species is similar in appearance to the Shy albatross, so sightings of the two are difficult to assign (SPRAT, 2014) however there are no records for either species in the area. This species is	Entanglement with marine debris; oil spills; pollution	This species is endemic to New Zealand where it breeds (SPRAT, 2014) and has a very large foraging range covering the Southern Ocean and Australian coastline including Tasmania. The location of the development does not represent a significant area of the species foraging grounds	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			thought to be common off the coast of south-east Australia (SPRAT, 2014) and has a large range extending from South Africa to New Zealand where it breeds on offshore islands. No breeding occurs in Australian waters (SPRAT, 2014).		or critical habitat. Impacts from the construction and operation of the port are considered **unlikely to significantly impact on the species**	
Thalassarche melanophris	Black-browed albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur in area. This species breeds on sub-Antarctic islands and is confined to the waters surrounding those islands during the breeding season with less than 1% of the global population breeding within Australian jurisdiction (SPRAT, 2014). In the non-breeding season it migrates north and its range expands to be truly circumpolar, and it is a common visitor to the continental shelf and shelf break in southern Australia (SPRAT, 2014). Only one 20 year old record has been submitted to the BDBSA, at Port Neill in 1989 (BDBSA, 2012) indicating the record is for a transient or lost individual. Any individual of this species in the port area would be considered a transient visitor.	Entanglement with marine debris; oil spills; pollution	This species has a large feeding range covering the Southern Ocean (Simpson and Day, 1999) and although it may have the potential to overfly the development area it is unlikely that the port site would make up a significant area of its foraging grounds or represent critical habitat. Impacts from the construction and operation of the port are considered **unlikely to significantly impact on the species**	N
Thalassarche melanophris impavida For marine and migratory listed as *Thalassarche impavida*	Campbell albatross	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** to occur in area. This species is a migratory non-breeding visitor to Australian waters only breeding on the sub-Antarctic Campbell Island south of New Zealand (SPRAT, 2014). Its non-breeding range is very large extending into the sub-tropics including offshore waters from Rockhampton south around to Exmouth (SPRAT, 2014). However there are no records for the species within 10 km of the development area (BDBSA, 2012). This species would be considered a transient visitor to the area.	Entanglement with marine debris; oil spills; pollution	This species has a large feeding range (SPRAT, 2014) and although it may have the potential to overfly the development area it is unlikely that the port site would make up a significant area of its foraging grounds or represent critical habitat. Impacts from the construction and operation of the port are **unlikely to significantly impact on the species**	N
Thinornis rubricollis rubricollis	Hooded plover (eastern)	Vulnerable, Marine (EPBC); Vulnerable (NPW)	**Present.** A hooded plover pair was observed on the southern end of the Cape Hardy beach during the port site survey (Jacobs, 2014a). This species has also been recorded on beaches north and south of the development area (BDBSA, 2013; Madden-Hallett et al., 2011). There is suitable habitat for this species in a number of beach areas within Spencer Gulf including Lipson Island. The birds nest at the high tide mark on sandy beaches, laying usually two eggs in a sand scrap and foraging for invertebrates at the water's edge and amongst seagrass wrack. Pairs are known to have breeding territories over 30 ha in size with several nesting beaches within a territory (SPRAT, 2014). This species' range in Australia is generally along coastal sandy beaches from Victoria	Loss of habitat through clearance or exclusion; predation by feral animals or pet dogs; marine debris; off road vehicles, oil spills;	The construction of the wharf and MOF will impact on the head land at Cape Hardy removing intertidal habitat for this species. Given the species preference for remote beaches, mitigation measures to minimise disturbance to the beach habitat during construction of the port will be required, with exclusion zones on the southern extent of the Cape Hardy beach to be included in the CEMP and OEMP to be developed. Given the species ability to relocate to alternate beaches within their territory during construction disturbance	N

Protected Species potentially present at the port			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			and Tasmania, throughout South Australia and including some inland salt-lakes populations in WA (Simpson and Day, 1999). The Eyre Peninsula population is not considered an important population by the Threatened Species Conservation Committee (SPRAT, 2014).	pollution, noise	and the limited footprint of the MOF, **the development is not expected to have a significant impact on this species.**	
Reptiles						
Lerista arenicola	Beach slider	Rare (NPW)	**Possible** to occur in area. There are no known sightings for this species in the area; all sightings have been recorded on the far west coast of the Eyre Peninsula (Caton *et al.*, 2010). However, the species is inconspicuous and easily missed amongst the seagrass wrack and other detritus around the high tide mark where they forage therefore the lack of records cannot be considered confirmation of presence or absence for this species. As this species is known to inhabit the seaweed wrack found on sandy beaches and that habitat is known to occur at Cape Hardy beach the EP Coastal Action Plan 2010 potential habitat for this species (Caton *et al.*, 2010a)	Loss of habitat through clearance or exclusion; predation by feral animals or pet dogs; marine debris; off road vehicles, oil spills; pollution	Given the species is not known from the area and is has been recorded predominantly on the west coast of Eyre Peninsula the development is not considered to represent a significant area of critical habitat and therefore **impacts from the development on this species are not considered to be significant.** As a precaution to protect this species and similar intertidal foragers such as the Hooded Plover and Bight Coast skink, a CEMP and OEMP will be developed to protect these species.	N
Pseudemoia pagenstecheri	Bight Coast skink	Rare (NPW)	**Possible** to occur in area. There are no known sightings for this species in the area; all sightings have been recorded on the far west coast of the Eyre Peninsula (Caton *et al.*, 2010). However, the species is inconspicuous and easily missed amongst the seagrass wrack and other detritus around the high tide mark where they forage therefore the lack of records cannot be considered confirmation of presence or absence for this species. As this species is known to inhabit the seaweed wrack found on sandy beaches and that habitat is known to occur at Cape Hardy beach the EP Coastal Action Plan 2010 potential habitat for this species (Caton *et al.*, 2010a)	Loss of habitat through clearance or exclusion; predation by feral animals or pet dogs; marine debris; off road vehicles, oil spills; pollution	Given the species is not known from the area and is has been recorded predominantly on the west coast of Eyre Peninsula the development is not considered to represent a significant area of critical habitat and therefore **impacts from the development on this species are not considered to be significant.** As a precaution to protect this species and similar intertidal foragers such as the Hooded Plover and Beach slider, a CEMP and OEMP will be developed to protect these species.	N

6.1.2.2 Risks

There is a risk that the introduction of artificial light sources will result in altered behavioural patterns amongst coastal and marine fauna through the attraction of higher levels of marine prey species and marine birds than anticipated. The level of attraction and subsequent effect on resident species as a result of greater utilisation of habitat and foraging resource is largely unknown. It is considered possible that despite design measures to limit artificial light spill (refer Section 4), additional marine fauna will be attracted to the site. However, the port site does not represent a key habitat or large breeding colony for any bird species with resident populations limited to isolated pairs and individuals. As such, the introduction of artificial light sources is considered unlikely to affect the viability of any species. The artificial light sources may however result in a non-significant alteration to the behaviour of fauna at the port site which is considered to be of minor consequence. As such, the overall risk associated with the introduction of artificial light sources at the port site is considered to be low.

Construction and operation of the proposed port will result in the generation of a number of waste streams that may enter the marine environment. Marine debris can significantly affect marine birds and fauna as a result of pollution, injury through collision, entanglement or ingestion of non-biological products. The Silver Gull, Black-faced Cormorant and Nankeen Night Heron along with several other species considered “likely or possible” to occur in the area (refer Table 6-1) have all be highlighted as having the potential to be attracted to the port activities. Due to these species’ characteristics of exploiting human activities in the marine environment, they are considered particularly susceptible to debris within the marine environment.

Waste management and handling procedures developed as part of the CEMP and OEMP will control waste streams with the overarching aim of no waste products entering the marine environment. Despite the implementation of control measures, it is considered almost certain that some form of waste / debris will enter the marine environment during construction and operation of the port. As the port site is not a key habitat or breeding area, the consequences of debris entering the marine environment are considered to be minimal; insignificant to the overall viability of marine birds and fauna. As such, the overall risk is considered to be low.

Marine birds and coastal species are also at risk from the unintended discharge of pollution in the form of site run-off, wastewater, hydrocarbons or chemicals. With any marine activity there is potential for waste or spills to enter the marine environment. The implementation of design measures (refer Section 4) will control hazardous pollutants from entering the marine environment. There remains a risk that a major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be rare. As previously outlined, the port site does not represent a critical habitat or breeding colony for any marine bird. The nearest bird colonies are located on Lipson Island, approximately 5 km south of the port site, and foraging birds from these colonies (e.g. little penguins) are likely to use the waters around the port. The consequences of a major spill event are considered to be moderate, resulting in a long term decrease in the local abundance of fauna. As such, the overall risk of a major spill event affecting marine birds is considered to be low.

6.1.3 Conclusions

- The EPBC and NPW Vulnerable species eastern hooded plover are known to utlise the site. The majority of the bird’s habitat is preserved by the design of the port which avoids the majority of the sandy beach habitat, thereby minimising risks to these species. Hyrdodynamic modelling predicts little change to the existing beach environment. CEMP and OEMP control strategies and measurement measures will minimise access to the beach
- While it is possible for the two NPW protected lizard species (beach slider and Bight Coast skink) to be present due to suitable beach habitat, the design of the port avoids the majority of the beach habitat thereby mitigating risks to these species
- No EPBC listed flora species were recorded during the field survey

- In total, 56 bird species of conservation significance were identified during the desktop study as potentially occurring in the project area, including species listed under the EPBC Act and the NPW Act. Thirty of these species are considered unlikely to occur in the area due to a lack of suitable habitat, or a known distribution that is distant from the proposed development area. Twelve species have potential to occur in the development area and surrounding region due to the presence of suitable habitat, regional BDBSA records or recent regional studies/biodiversity planning. Fourteen protected bird species were observed during the field surveys
- None of the 12 bird species of conservation significance with potential to occur in the development area are expected to be significantly impacted. If local individuals occur they may be displaced however all of these species are highly mobile and unlikely to be solely reliant on habitat within the study area.
- As several species of marine birds may be attracted to the port operations there is a potential for impacts on individual birds, impacts to these populations are considered low
- Of the 14 bird species of conservation significance recorded in the study area, two are listed as Migratory under the EPBC Act (Caspian tern and common sandpiper) and one is listed as Vulnerable (Hooded Plover). The 11 other species are listed as "Marine" of which two other species (rock parrot and white-bellied sea-eagle) are also listed as threatened under the State NPW Act
- There are no known large breeding colonies within 5 km of the proposed development area and only the one species of shorebird (hooded plover) is known to nest at the site. Therefore this site is not considered an internationally or nationally significant shorebird habitat under the Ramsar Convention

6.2 Intertidal Habitats

The intertidal marine environment of the Spencer Gulf is varied, supporting a wide range of habitats and species groups. Species in the lower reaches of the gulf are generally associated with three key intertidal habitat groups: seagrass meadows, rocky reefs and soft substrates. A clear understanding of which of these habitats and species are present is necessary to assess the biological importance of the site, identify any species that trigger further regulatory requirements, and any species or habitats requiring implementation of specific management or mitigation measures. Reefs and seagrass meadows provide essential habitat to a wide range of marine species such as fish, crabs and sea urchins, while mature seagrass meadow also stabilise the seabed to prevent erosion and sand movement.

Previous studies indicate that within the intertidal zone, Spencer Gulf seagrass meadows are dominated by *Zostera* spp. and *Heterozostera nigricaulis*, with other areas either bare or dominated by macroalgal assemblages including areas of rocky shores (Edyvane, 1999a; 1999b). The intertidal extents of the coastline from Port Neill to Tumby Bay are known to include sandy and rocky substrates, moderate wave exposure, and no mangroves; with estuary and saltmarsh habitat restricted to the Tumby Bay area. Rocky substrates occur predominantly at headlands, but also as discrete boulder areas scattered around sandy beaches. Sandy substrates in the area were reported to support seagrasses of varying density (Nature Maps), between approximately 19 m of depth and the near-shore up to the intertidal zone with areas of macroalgae.

A desktop study characterised the intertidal habitats present at the site to inform the assessment of the range of associated species likely to be present at the site.

6.2.1 Existing Environment and Key Findings

The results of the EPBC PMST found that no Threatened Ecological Communities occurred within 10 km of the study area. Previous literature reviews did not highlight any significant or unique intertidal habitats as being likely at Cape Hardy (Caton *et al*., 2011a; 2011b). The desktop review suggested that the intertidal area of Cape Hardy is likely to be typical of southern Australia and in particular the Spencer Gulf. As noted in Section 6.1, there are no mangrove communities within the Cape Hardy study area.

The intertidal habitat at Cape Hardy contains both sandy beaches and rocky intertidal zones both as gneiss and gabbro outcroppings on the sandy beaches and rocky intertidal reefs extending from the headlands into the subtidal zone (MES, 2012). Marine flora and fauna of the lower Spencer Gulf is typical of transitional warm to cool temperate waters (i.e. Flindersian Province). In sheltered areas of Spencer Gulf, intertidal flats are typically dominated by *Hormosira banksii* and potentially the seagrasses, *Zostera (Heterozostera) nigricaulis* and *Zostera muelleri*. (Note: *Heterozostera nigricaulis* was distinguished from *Heterozostera tasmanica* in 2005 based on morphological features and distribution (Kuo, 2005) with some taxonomists preferring to retain the subgenus *Zostera* (Jacobs and Les, 2009). For the purposes of this assessment we have used the *Heterozostera nigricaulis* classification). The areas of rocky reef and shore are typically dominated by macroalgal communities including *Scaberia agardhii*, *Osmundaria* spp., *Lobophora variegata* and *Sargassum* spp. in low wave energy areas, and species of *Cystophora* (e.g. *C. expansa*) on moderate-energy coasts. Sandy areas are either bare or dominated by additional algal species such as *Caulocystis* spp., *Cystoseira* spp., *Ecklonia radiata* and *Sargassum* spp., usually with an understorey of coralline algae (Edyvane, 1999a, 1999b).

The macroalgal habitats and rocky areas also support invertebrate demersal species including relatively sedentary chitons and gastropods as well as highly mobile foragers including crabs and fish species. Other invertebrates may exist either permanently attached to surfaces such as barnacles, sponges, bryozoans or as infauna species such as cockles, clams, tube worms or small arthropods. Typical invertebrate species previously identified along the Spencer Gulf Eyre Peninsula coast include *Austrocochlea* spp., *A. unifasciata*, *Bembicum* spp., *Notocamea* spp., *Patellaida latisrigata*, *P. alticostata*, *Patella chapmanii*, *Plaxiphora albida*, *Siphionaria diemenensis* and *S. zelandica* (Golders, 2012).

The EPBC search and desktop literature review did not identify any rare or protected species known to occur in the intertidal zones at Cape Hardy. The seagrass subspecies *Zostera muelleri* ssp*. mucronata* is listed as rare and protected under the NPW Act, however it is considered unlikely to exist at the Cape Hardy site as there are no records of it within 50 km and its preferred habitat is very low-energy intertidal sandy beaches which are not found in the study area.

As the intertidal reef and rocky shore can provide habitats for species the extent of these areas within the marine study area was estimated using a conservative approach (i.e. erring on the side of overestimation) as 2.3 ha, based on the aerial imagery and bathymetry data from the study area. This approach allowed a buffer around these habitat extents and guided design of the port site infrastructure to avoid as much of these habitats as practicable.

6.2.2 Impacts and Risks: Intertidal Habitats

Most of the intertidal rocky shore and sandy beaches in the study area are outside the port infrastructure footprint and not expected to be directly impacted by the development. The area of intertidal habitat to be impacted is all rocky shore and will be permanently covered by the MOF and tug harbour which incorporates the entire footprint including the road landing beginning of the jetty. A conservative estimate of intertidal zone to be lost beneath the MOF is 0.09 ha.

Impacts to intertidal habitats associated with the proposed port facility could occur as a result of:

- Habitat loss or exclusion – due to the construction of the rock armouring
- Erosion (from stormwater and vessel wakes/propwash, changes to hydrodynamics)
- Spills (e.g. oil), pesticides, herbicides, or other pollutants
- A build-up of contaminants (e.g. anti-foulants)
- Vehicle traffic on the shore
- Marine debris
- The introduction of IMS
- Vessel run aground

6.2.2.1 Impacts

As the construction of the jetty and wharf, and covering of seabed by the MOF and tug harbour, will extended directly from the headland there is no intertidal zone within the footprint. The existing substrate in the adjacent area is predominantly rocky reef and although the MOF footprint will completely and permanently cover this substrate in the subtidal zone, the material of the MOF will provide alternative hard surfaces and crevices for flora and fauna to colonise. As there are expected to be no direct loss or clearance of intertidal zone the small area of adjacent disturbance and provision of alternate substrates results in a negligible impact to intertidal habitat. Hydrodynamic modelling predicts limited changes to the oceanographic conditions at the port site as a result of the proposed infrastructure (Jacobs, 2014d). The existing site hydrodynamics confine the majority of longshore sediment drift to the two embayments either side of the proposed jetty and MOF structure.

The changes to the hydrodynamic conditions at the site (as discussed in Section 5.2) are generally associated with the construction of the MOF and pylon structure. As indicated by the hydrodynamics modelling (Jacobs, 2014d), alterations to the maximum currents and bed shear across the site are not significant. The predicted increase in sedimentation rate around the MOF is less than 1% (Jacobs, 2014d); and it is anticipated that the existing seagrass beds in the area will be able to adsorb this additional sediment. As such, alterations to the hydrodynamic conditions at the port site are not considered to affect intertidal habitats within the port site, representing a negligible impact.

Construction of the jetty includes impact piling and building the MOF outward from the headland will result in silt and sediment suspension into the water column. Increased turbidity can affect water quality and benthic intertidal communities as a result of decreased light penetration and silting in the intertidal zone. The existing wave climate at the port site regularly transports and resuspends sediment along the coast (Jacobs, 2014d). As such, localised turbidity during construction is considered to represent a low impact, with short term localised impact to intertidal flora during construction activity, but no longer term effects.

Tug vessels will be utilised for all large vessel movements in depths less than 23 m within the port site (including large vessel approaches and turning basins) to minimise propwash and subsequent sedimentation. Despite the utilisation of tugs, the repeated manoeuvring of large vessels will result in ship scour; destabilising sediments and resulting in short term turbidity. The increased turbidity will result in decreased light penetration to intertidal flora following large ship movements. Approximately 1 cargo ship movement per day is anticipated during operation of the proposed port. As such, localised impacts to intertidal flora within the port site as a result of sediment suspension will occur on a daily basis for the life of the port facility, and is considered to represent a medium impact.

Recovery of intertidal habitats is anticipated to occur slowly post-construction, with intertidal rocky shore flora and fauna colonising suitable areas of substrate on the MOF. Many species of macroalgae (and some encrusting invertebrates) have generation times rapid enough to recolonise disturbed areas once construction has ceased. However, recovery will be inhibited by changes in any factor which restricts the growth of macroalgae or encrusting fauna, including increased sediment transport, turbidity or pollution (i.e. contamination from anti-foulants).

6.2.2.2 Risks

The identification of IMS during construction and operation of the proposed port is considered likely despite the implementation of control measures. As Cape Hardy is isolated from a hydrodynamic perspective (refer Section 5.2) IMS that may colonise the area would not be readily transported by currents beyond the study area and into new regions. As such, most IMS would rely on vessel movements for transportation to areas beyond the study area. To minimise the likelihood of spreading IMS in Spencer Gulf waters, measures will be developed and implemented to prevent settlement of IMS, prevent the growth of settled IMS and / or the

removal and disposal of IMS if established. As such, the consequences of IMS are considered to be isolated to the Cape Hardy study area and are not considered likely to affect the marine environment at a regional level. IMS may result in the long term local decrease in abundance of marine species, considered to be a moderate consequence. As such, the overall risk associated with IMS is considered to be high.

Waste management and handling procedures developed as part of the CEMP and OEMP will control waste streams with the overarching aim of no waste products entering the marine environment. Despite the implementation of control measures, it is considered almost certain that some form of waste / debris will enter the marine environment during construction and operation of the port. As the port site is not a key habitat or breeding area, the consequences of debris entering the marine environment are considered to be minimal; insignificant to the overall viability of species utilising the intertidal habitat. As such, the overall risk is considered to be low.

Species in the intertidal habitat are also at risk from the unintended discharge of pollution in the form of site run-off, wastewater, hydrocarbons or chemicals. With any marine activity there is potential for waste or spills to enter the marine environment. The implementation of design measures (refer Section 4) for the control of surface and waste water at the port site will limit the majority of hazardous pollutants from entering the marine environment. There remains a risk that a major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be rare. As previously outlined, the port site does not represent a critical intertidal habitat for protected species. The consequences of a major spill event are considered to be moderate, resulting in a long term decrease in the abundance of local marine flora and fauna. As such, the overall risk of a major spill event is considered to be low.

6.2.3 Conclusions

The intertidal communities at Cape Hardy are not considered unique with comparable habitats commonly observed in this region of the Spencer Gulf. The EPBC PMST, BDBSA search and desktop literature review did not identify any rare or protected species known to exclusively occur in the intertidal zones at Cape Hardy.

The total area of intertidal zone expected to be removed due to the construction of the MOF is less than 0.1 ha. As the majority of the intertidal zone within the study area will not be directly impacted from the development the 0.1 ha loss below the MOF and tug harbour is not considered significant. The MOF and tug harbour itself will provide additional rocky habitat in the intertidal zone for organisms to colonise.

After taking into consideration the mitigation measures proposed during the construction and operation phases of this development, the introduction of IMS remain a high risk to the intertidal habitat of Cape Hardy.

The majority of the intertidal zone is expected to be conserved and affected areas are expected to recover over time following construction. However the potential impacts from marine debris, chemical spills and IMS will have to be continually managed.

6.3 Subtidal Habitats and Flora

The subtidal marine environment of the Spencer Gulf is varied, supporting a wide range of habitats and species groups. Species in the lower reaches of the gulf are generally associated with three key habitat groups: seagrass meadows, rocky reefs and soft substrates. A clear understanding of which subtidal habitats and species are present at the port site is necessary to assess the biological importance of the site, identify any species that trigger further regulatory requirements, and any species or habitats requiring implementation of specific management or mitigation measures. Reefs and seagrass meadows provide essential habitat to a wide range of marine species such as fish, crabs and sea urchins; while mature seagrass meadows also stabilise the seabed to prevent erosion and sand movement.

Studies by Edyvane in the 1980s and 90s synthesised the available information relating to the marine biogeography and conservation values of Spencer Gulf (Edyvane, 1999a; b). A comprehensive study of the gulf benthos has not occurred since the late 1990's and the overall coverage of gulf benthos is based on calculations from Edyvane's work (DEWNR, 2011; Nature Maps, 2013). There is approximately 552,000 Ha of seagrass within the Spencer Gulf; representing approximately 60% of seagrass in South Australia, and 10% of all seagrass habitat in Australia (Edyvane, 1999a). Within the Gulf, the Cape Hardy study area falls within the 'Southwest Spencer Gulf' bioregion (between Cape Catastrophe and Tumby Bay), which itself supports an estimated seagrass coverage of 137,700 Ha (Edyvane, 1999a).

Typically, Spencer Gulf seagrass meadows are dominated by *Zostera* spp. and *Heterozostera nigricaulis*. A species shift to *Posidonia* spp. occurs in the few metres below the low tide mark, with *P. australis* dominating in shallower waters, while *P. sinuosa* and *P. angustifolia* become more dominant with increasing depth (Seddon, 2000). Other species such as *Amphibolis antarctica*, *A. griffithii,* and *H. nigricaulis*have been found to occupy edges, blowouts, and smaller areas within *Posidonia* spp. meadows (Edyvane, 1999a). The local distribution and abundances of these species are affected by numerous factors, including wave energy, tidal velocity, sediment stability, and light availability (Shepherd and Robertson, 1989).

Existing data for the study area identified the presence of sandy and rocky substrates, at depth ranging from the low water mark in the intertidal to 25 m at the outer extents. Moderate wave exposure, no mangrove or saltmarsh habitat, and no nearby estuaries were identified (Nature Maps, 2013 – National Benthic layer; DEWNR, 2011). Estimates of coverage from the National Benthic layer (Nature Maps, 2014) were based on aerial imagery with limited ground-truthing, and showed that sandy substrates were expected to be inhabited by seagrasses (predominantly *Posidonia* spp.) of varying density, between approximately 19 m of depth and the near-shore up to the intertidal zone (Figure 6-1). Given the physiological requirements *Posidonia* spp. for minimum water depth and light availability it was considered unlikely that dense seagrass would exist from the intertidal to out beyond 20 m.

6.3.1 Existing Environment and Key Findings

The desktop review suggested that the subtidal area of Cape Hardy is typical of southern Australia and in particular the Spencer Gulf. A review of the National Benthic habitat data indicated that the study area was predominantly covered by dense seagrass, though the rocky headlands were likely to provide rocky reef habitat (see Figure 6-1). This mapping was undertaken between the late 1990s and 2000s, using satellite imagery to detail any underwater features discernible on 1:100,000 scale prints and supported in places by a range of other data sources (Nature Maps, 2013). It is unknown whether ground-truthing of the satellite imagery was undertaken for the National Benthic habitat mapping of the study area, so Nature Maps was only used during the desktop portion of the study to inform the likely habitat types.

The only previously existing data which ground-truths against the state/national benthic habitat maps comes from benthic surveys carried out as part of two expired aquaculture lease applications in the area. These leases have since been surrendered (Section 6.9). The surveys undertaken for the lease application showed sparse

biota including small clumps of green and brown algae (Chlorophyta and Pheophyta), with no seagrass or benthic community identified (PIRSA, 2008). Review of the aerial imagery indicates little coverage of seagrass in the nearshore. These finding were in contradiction to the National Benthic Habitat maps (Figure 6-1; Nature Maps, 2013), which predicted dense seagrass, highlighting the need for ground-truthing of the study area, as undertaken using towed video.

An EPBC Protected Matters search was undertaken covering the study area and an additional buffer of 10 km. The PMST did not identify any Threatened Ecological Communities, National Heritage Places or EPBC-listed marine flora. However a number of protected fauna species commonly associated with seagrass beds were identified in the search, including seahorses and pipefish from the family Syngnathidae. These species are discussed in more detail in Section 6.6. The full EPBC PMST search results are presented in Appendix F.

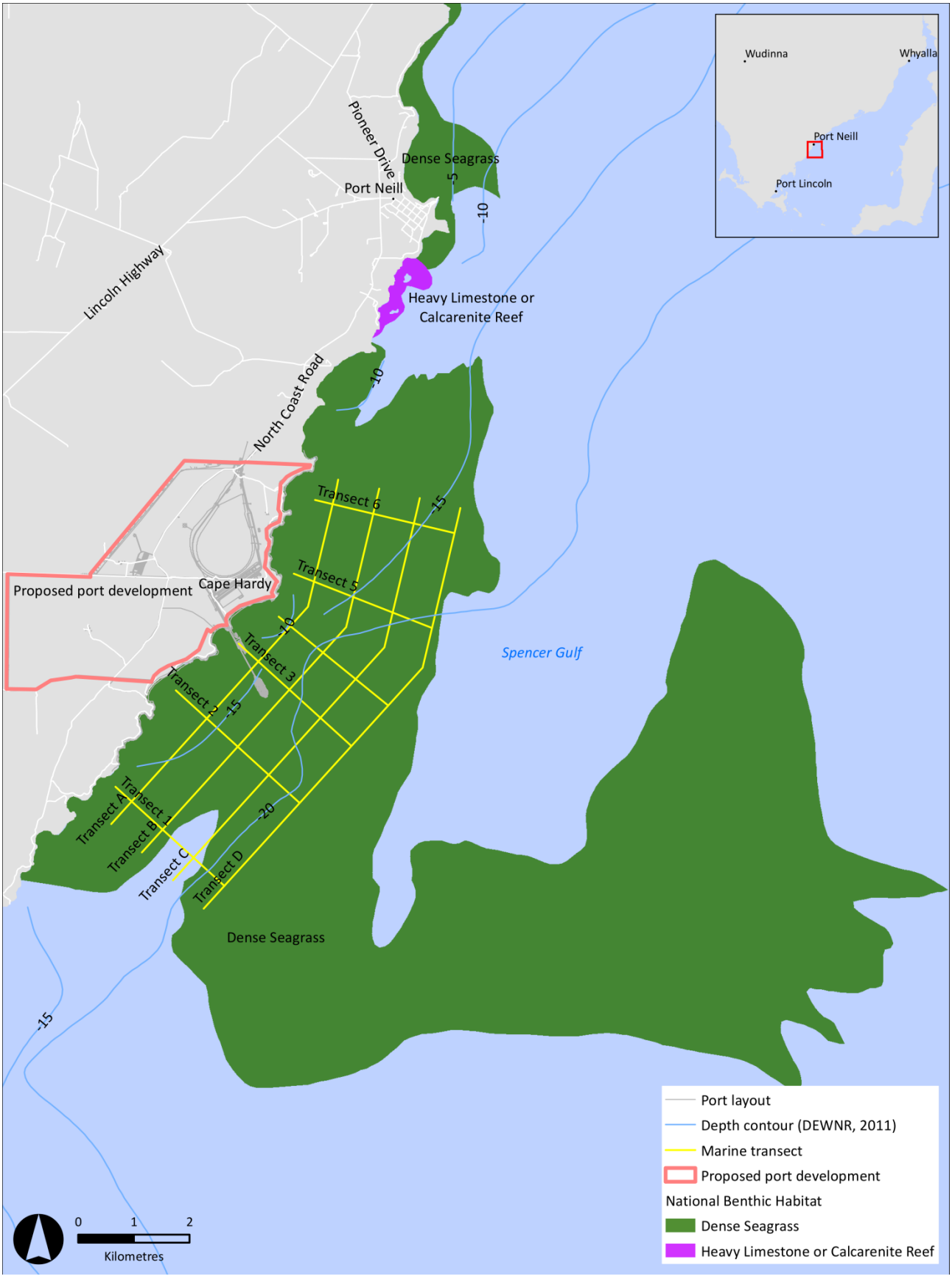
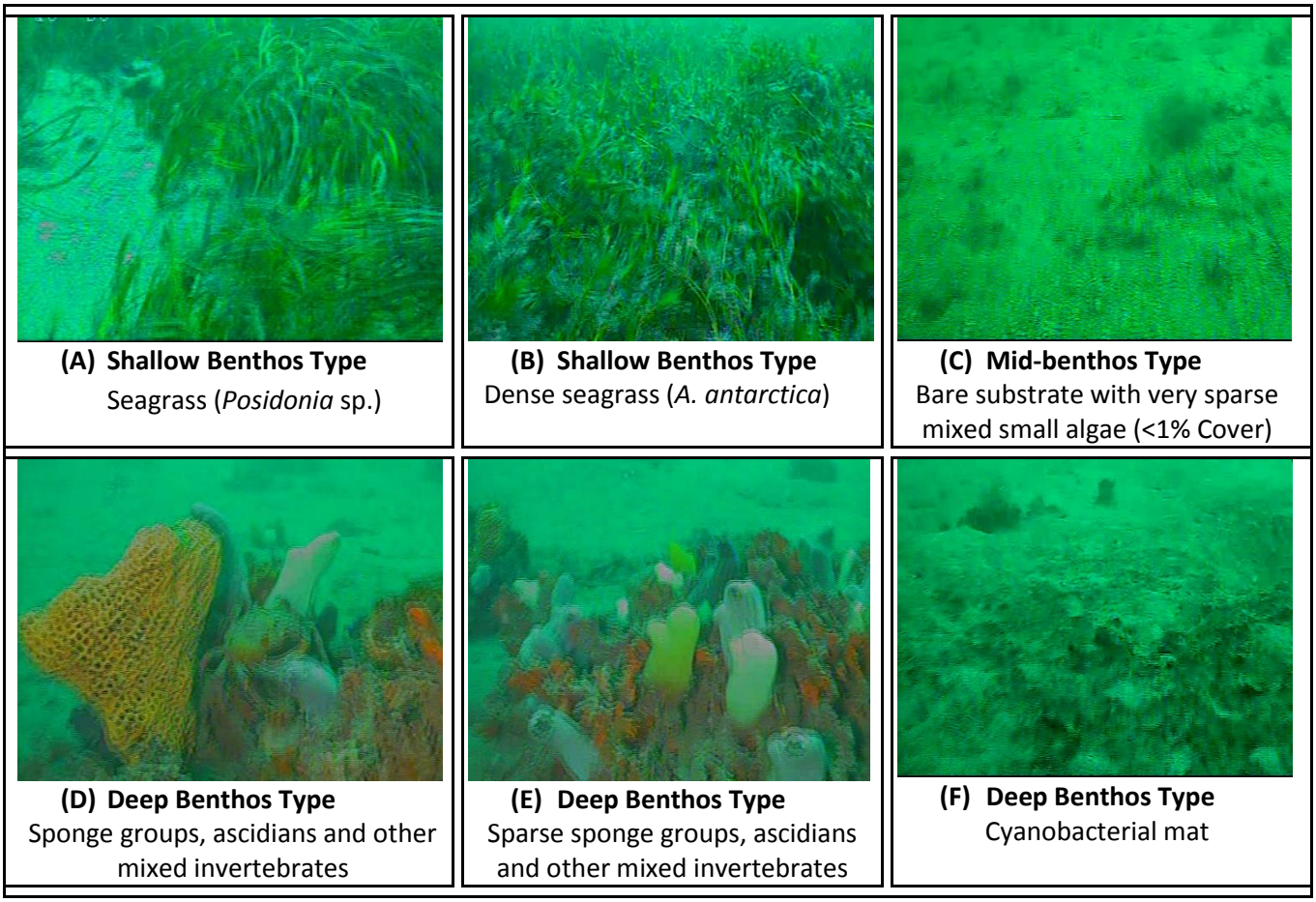


Figure 6-1 State / National benthic habitat maps across the area

Three primary habitat types were recorded in the study area, including (see video stills in Figure 6-2):

- The 'Shallow Benthos' (<16 m depth) is largely inhabited by seagrass meadows (predominately *Posidonia* spp., with some *A. antarctica* patches restricted to shallower waters (<12 m depth)). Figure 6-2 images (A) and (B). The northern nearshore extent of the study area contained the greatest coverage of seagrass with densities over 50%
- The 'Mid-benthos' (depth 16 – 18 m) comprises predominantly bare fine sand and silty sediment with very sparse mixed small algae, very sparse *Posidonia* sp.(<5 % coverage) and occasional scattered invertebrates Figure 6-2 image (C)
- The 'Deep Benthos' (>20 m Depth), comprises bare silt with clumps of mixed invertebrates (sponges, ascidians and both motile and sessile crustaceans), Figure 6-2 images (D) and (E). Very sparse, mixed small algae were also present along with some evidence of cyanobacterial matting in deeper water Figure 6-2 image (F)
- No dense seagrass beds were observed beyond 19 m depth and macroalgae became uncommon after 21 m depth (Figure 6-3)



(A) Shallow Benthos Type
Seagrass (*Posidonia* sp.)

(B) Shallow Benthos Type
Dense seagrass (*A. antarctica*)

(C) Mid-benthos Type
Bare substrate with very sparse mixed small algae (<1% Cover)

(D) Deep Benthos Type
Sponge groups, ascidians and other mixed invertebrates

(E) Deep Benthos Type
Sparse sponge groups, ascidians and other mixed invertebrates

(F) Deep Benthos Type
Cyanobacterial mat

Figure 6-2 Study area benthic habitat types

GIS analysis of the towed video survey data generated a benthic habitat map for the study area (Figure 6-3). The map shows that benthic flora followed depth and substrate contours, with a higher density of flora coverage in water less than 16 m deep, where light is generally limited (dependent on water clarity) and the sediment was found to be coarser.

The benthic flora throughout the study area when present was intact with no signs of scouring or removal. No IMS were recorded during the video survey. There were large areas of discontinuous vegetation, with isolated patches of benthic vegetation generally found in waters deeper than 10 m. Within the study area the denser coverage (>50%) of seagrass or macroalgae was confined to the northern areas and shallow waters around the headlands south of the proposed marine infrastructure. These areas of denser seagrass coverage in particular provide habitat opportunities for fauna, and may provide habitat for conservation significant species that occur in the area.

The video survey also observed scattered small patches of rocky reef habitat in shallower waters. The near-shore areas were not surveyed due to the draft clearance requirements of the survey vessel, and safety constraints related to towing the camera over shallow reef. It is expected from analysis of aerial imagery that more complex rocky reef habitat exists along the shoreline of the cape, including the intertidal substrates discussed in Section 6.2. The patches of rocky reef and nearshore rocky substrates are considered to be related to boulder fields or outcroppings of rock that were identified during the nearshore geophysical surveys (MES, 2012).

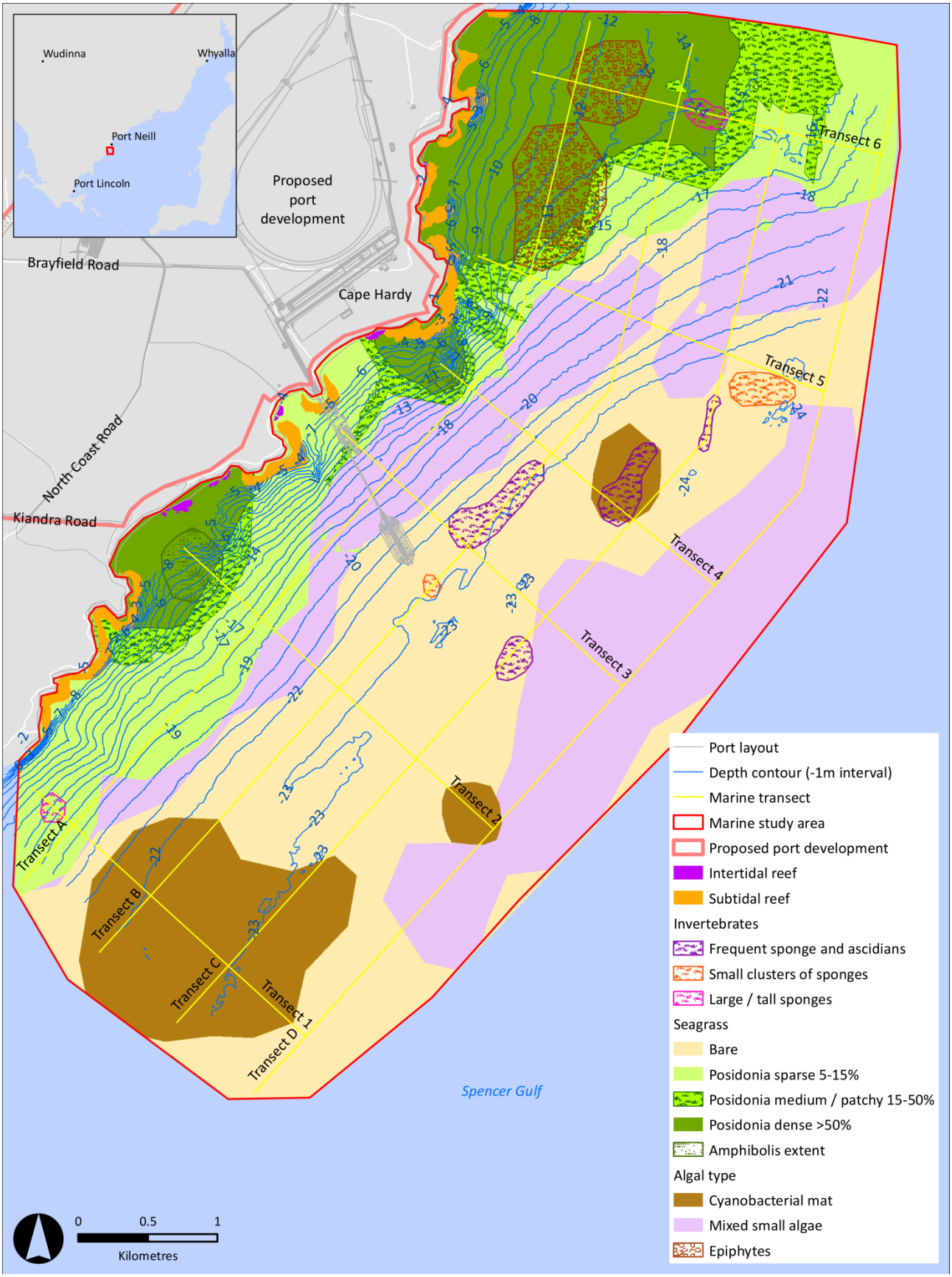


Figure 6-3 Benthic habitat map of study area developed from towed video

A review of the publicly available literature for the wider area (Edyvane, 1999a; PIRSA, 2008; Golders Associates, 2012; BDBSA, 2013) and benthic species noted during the video tow were used to compile a table of likely habitat-forming marine flora (Table 6-2).

Table 6-2 Habitat-forming marine flora likely to occur at Cape Hardy

	Scientific Name	Common Name	Legislative Protection*
Seagrasses	***Amphibolis antarctica***	**Wire weed**	NV Act
Division: Magnoliophyta	*Amphibolis griffithii*	Wire weed	NV Act
	Halophila spp.	Paddleweed	NV Act
	Heterozostera nigricaulis	Eelgrass	NV Act
	***Posidonia* spp.**	**Tapeweed**	NV Act
	Zostera spp.	Garweed	NV Act
	Zostera muelleri subsp. mucronata	Garweed	Rare (NPW), NV Act
Brown algae	*Caulocystis* spp.		NV Act
Division: Heterokontophyta Class: *Phaeophyceae*	*Corynophlaea cystophorae*		NV Act
	Cystophora expansa		NV Act
	Cystophora moniliformis		NV Act
	Cystophora polycystidea		NV Act
	Cystophora subfarcinata		NV Act
	***Cystophora* spp.**		NV Act
	Cystoseira spp.		NV Act
	Ecklonia radiata	**Common kelp**	NV Act
	Hincksia spp.	Snot algae	NV Act
	Hormosira banksii	Neptune's necklace	NV Act
	Pachydictyon paniculatum		NV Act
	Ralfsia verrucosa		
	Sargassum decipiens		NV Act
	Sargassum paradoxum		NV Act
	***Sargassum* spp.**		NV Act
	Scaberia agardhii		NV Act
	Zonaria spiralis		NV Act
Red Algae *Division: Rhodophyta*	*Capreolia implexa*	Red turf alga	NV Act
	Rhabdonia clavigera		NV Act
Green Algae *Division: Chlorophyta*	*Cladophora feredayi*		NV Act
	Cladophora lehmanniana		NV Act

*The Native Vegetation Act regulates actions which may involve *'a plant or plants of a species indigenous to South Australia including a plant or plants growing in or under waters of the sea…'.* Whilst algae are not strictly plants, the Native Vegetation Council often includes terrestrial mosses and lichens (which are not plants) as vegetation.List of species likely to occur were developed from literature searches (not underlined) and survey records. **Bold** entries represent species or groups observed during habitat surveys at the site. Underlined entries are taken from the BDBSA search records.

6.3.1.1 Ecological Significance of the Subtidal Habitat Present in the Study Area

The benthic habitat survey of the study area detailed the distribution and range of habitat present at the site. The majority of the inshore (<16 m depth) areas of the site are covered by varying densities of seagrass, which is of high conservation value. Deeper areas are generally not vegetated and involve scattered filter feeders and other invertebrates. While the rocky reef areas within the study area are small, they may still provide niche or refuge areas from which species can forage in the wider area. The findings are consistent with current knowledge about the ecological significance of subtidal habitats within the wider Spencer Gulf.

Seagrass beds (along with all marine benthic flora) are a protected habitat in South Australian waters under the Native Vegetation Act, and are considered a habitat of high conservation value. Seagrass beds are associated with a host of secondary benefits including playing key roles in carbon and nutrient cycling (Duarte and Cebrian, 1996), sediment stabilisation (de Boar, 2007), supporting biodiversity (Edgar *et al.,* 1994) and providing nursery habitats for many commercially fished species (Beck *et al.,* 2001; Jackson *et al.,* 2001, Heck *et al.,* 2003). A wide range of South Australian fish and crustacean species of commercial and recreational fishery importance rely on seagrass habitats, including anchovy (*Engraulis australis*), snapper (*Pagrus auratus*), western king prawn (*Melicertus latisulcatus*) and blue swimmer crab (*Portunus armatus*) (Edyvane, 1999a; b; Bryars, 2003).

Rocky reefs support a diverse food web based on filter feeders and mobile species including commercial fish and crustaceans that use the reef habitat as a refuge to forage from. The weathering pattern of the underlying rock can support a high complexity of habitat types and ecological niches that can be available for species inhabiting the area.

6.3.2 Impacts and Risks: Subtidal habitats

Impacts and risks to subtidal habitats associated with the construction and operation of the proposed port facility involve immediate short-term impacts during construction such as clearance of habitat, and long-term processes during operations, such as hydrodynamic changes, smothering, long-term shading, ship scour, anchor damage, changes in water quality from run-off or stormwater, spills or the introduction of IMS.

Impacts to subtidal habitats associated with the proposed port facility could occur as a result of:

- Habitat loss or exclusion
- Erosion (from stormwater and vessel wakes/propwash, changes to hydrodynamics)
- Spills (e.g. oil), pesticides, herbicides, or other pollutants
- A build-up of contaminants (e.g. anti-foulants)
- Marine debris
- The introduction of IMS
- Vessel run aground or sinking
- Shading effects - from vessels, structures and increases in turbidity or spills

6.3.2.1 Impacts

There will be minimal direct loss of seagrass arising from the proposed jetty/wharf structure as seagrass was identified at depths greater than 10 m within the infrastructure footprint. The major disturbance in the proposed jetty/wharf footprint will occur from placement of the jack-up pile drivers, the laying of anchors and chain to hold the barge on location, and from driving piles into the seabed. While these construction activities will occur in depths >10 m, they are not expected to cause permanent loss of seagrass.

A conservative estimate of the area of each benthic habitat type impacted by the proposed port footprint has been calculated, referred to as the construction footprint. The footprint has been estimated based on conservative estimates of total clearance incorporating the areas of jetty/wharfpiling, MOF facility and tug

harbour, the vessel mooring areas, turning basins and anchorage area. All clearance footprints and disturbance areas have been conservatively calculated with an additional 5 m buffer. These estimates are presented in Table 6-3.

Table 6-3 Esimated area of subtidal substrate affected by marine infrastructure in the study area

	Areas Likely to be Disturbed		Areas to be cleared	
Substrate Type	**Anchorage area** (299.9 Ha)	**Port Area** (147.1 Ha)	**MOF & Tug Harbour** (2.6 Ha)	**Jetty** (14 Ha)
Bare sediment	58.9 Ha	131.6 Ha	0 Ha	6.49 Ha
Seagrass habitat	0 Ha	14.7 Ha	2.49 Ha	0.16 Ha
Macroalgal habitat	241.2 Ha	2.98 Ha	0.51 Ha	2.1 Ha
Total Subtidal Habitat Impacted (vegetated áreas)	258.7 Ha		5.26 Ha	

Note: All disturbed or cleared areas include a 5 m buffer. Total Subtidal Habitat does not include bare sediment substrates.

The total area of seagrass to be cleared is 2.65 Ha, based on the footprint of the entire MOF, tug harbour and jetty area including vessel loading areas (with an additional 5 m buffer around areas for a conservative estimate). This calculation includes areas where seagrass will be only partly impacted by shading from fixed infrastructure and vessels. Only the area immediately beneath the MOF will suffer permanent loss, with the habitat beneath the jetty considered unlikely to be lost as a direct result of shading due to the jetty alignment. Allowing for the turning basins and anchorage areas associated with the port the total area of impacted seagrass would be 14.7 Ha (Table 6-3). Based on Edyvanne (1999a) the estimated area of impact represents <0.003% of the total known seagrass from within Spencer Gulf.

Calculation for the combined intertidal and near-shore subtidal environment around the headlands in the study area to be cleared have been based on the geophysical surveys (MES, 2012) and aerial imagery. A conservative (i.e. biased toward over-estimation) estimate of 48 Ha of intertidal rocky reef exists in the study area. The combined intertidal and near-shore subtidal environment is dominated by rocky substrates, to a depth of approximately 8 m. Some areas of subtidal rocky reef will be subject to direct impact from the MOF and piling activity with permanent loss of macroalgal habitat (0.51 Ha from Table 6-3). There are expected to be no loss of intertidal rocky reef habitat.

The the majority of the roughly 260 Ha of impacted subtidal habitat are in areas of low density macroalgal or sparse seagrass (14.7 Ha) which will only incur intermittent impacts associated with vessel manouvering or shading. The vast majority of the vegetative habitat within the Cape Hardy study area (2736 Ha) has been avoided.

It is expected that recovery will occur post-construction, with Posidonia spp. seagrass slowly re-colonising suitable areas and Amphibolis spp. colonising suitable areas within 3 years. Recovery will be inhibited by changes in any factor which restricts the growth of seagrass (or macro-algae), including increased sediment transport, scouring or changes in water quality. Macroalgae have generation times rapid enough to recolonise once construction has ceased provided water quality and sediment conditions remain suitable. The clearance of seagrass and sub-tidal habitat as a result of the construction of the proposed port is considered a short term impact (recoverable within 3 years) and restricted to the study area. As such, the overall impact is considered to be low.

While seagrasses are considered to be susceptible to the effects of long-term heavy shading from infrastructure or increased turbidity as a result of ship movements, most species of seagrass, and in particular *A. antarctica* and *Posidonia spp*. which are likely to exist at the site, have some tolerance for partial shading and can survive beneath jetty structures (Duarte, 1991; Dennison *et al*., 1993; Gordon *et al*., 1994; Fitzpatrick and Kirkman, 1995; Masini *et al,*. 1995; Bryars and Collins, 2008; Bryars and Rowling, 2009). Similarly, macroalgae are capable of tolerating low-light conditions, with major habitat-forming species such as *E. radiata* occurring to a maximum depth of greater than 40 m (Edgar, 2001).

A variety of factors determine the area of seabed shaded including the dimensions of the jetty / wharf, the duration of vessel mooring and the solar angle. The jetty orientation runs at 331^{o} north-north-west resulting in minimal shading by the jetty due to the approximate east-west sun path. Affected seabeds will only receive reduced light for around 1-2 hours per day. The sun is at its highest during summer at around 79^{o} with the lowest angle in winter approximately 32^{o}. Seasonal changes in the angle of the sun along with the orientation of the jetty structure means that there will be no permanent shading of the seabed beneath the jetty structure.

Shading from impact piling and temporary construction activities (i.e. jack-up barge and support vessels) is not considered likely to affect benthic habitats as the construction activities are only temporary and seagrass can tolerate heavy shading for several weeks due to their ability to draw energy from their root mass (Duarte, 1991; Westphalen *et al*., 2004).

Shading effects at the port site are expected to be restricted to the areas adjacent to and beneath the jetty and adjacent the MOF. Seagrasses identified in the footprint area include sparse coverage of the tapeweeds *Posidonia* spp. seagrasses. As a result of the jetty orientation over an area with minimal seagrass coverage, and the lack of permanent shading indicates that there will be little to no shading impacts from the jetty on seagrass. As such, shading impacts to subtidal habitats are considered to be negligible.

Hydrodynamic modelling predicts limited changes to the oceanographic conditions at the port site as a result of the proposed infrastructure (Jacobs, 2014d). The existing site hydrodynamics confine the majority of longshore sediment drift to the two embayments either side of the proposed jetty and MOF structure.

The changes to the hydrodynamic conditions at the site (as discussed in Section 5.2) are generally associated with the construction of the MOF and jetty structure. As indicated by the hydrodynamics modelling (Jacobs, 2014d), alterations to the maximum currents and bed shear across the site are not significant. The predicted increase in sedimentation rate around the MOF is less than 1% (Jacobs, 2014d); and it is anticipated that the existing seagrass beds in the area will be able to adsorb this additional sediment. As such, alterations to the hydrodynamic conditions at the port site are not considered to affect intertidal habitats within the port site, representing a negligible impact.

Tugs will be utilised for all large vessel movements in depths less than 23 m within the port site (including large vessel approaches and turning basins) to minimise propwash and subsequent sedimentation. Despite the utilisation of tugs, the repeated manoeuvring of large vessels will result in ship scour; destabilising sediments and resulting in short term turbidity. The increased turbidity will result in decreased light penetration to subtidal habitats following large ship movements. Approximately 1 cargo ship movement per day is anticipated during operation of the proposed port. As such, localised impacts to subtidal habitats within the port site as a result of sediment suspension will occur on a daily basis for the life of the port facility, and is considered to represent a medium impact.

6.3.2.2 Risks

The identification of IMS during construction and operation of the proposed port is considered likely despite the implementation of control measures. As Cape Hardy is isolated from a hydrodynamic perspective (refer Section 5.2) IMS that may colonise the area would not be readily transported by currents beyond the study area and into new regions. As such, IMS would rely on vessel movements for transportation to areas beyond the study area. To minimise the likelihood of spreading IMS in Spencer Gulf waters, measures will be developed and implemented to prevent settlement of IMS, prevent the growth of settled IMS and / or the removal and disposal of IMS if established. As such, the consequences of IMS are considered to be isolated to the Cape Hardy study area and are not considered likely to affect the marine environment at a regional level. Despite the control measures proposed to be implemented, IMS may result in the long term decrease in abundance of seagrass and marine species in the study area, considered to be a moderate consequence. As such, the overall risk associated with IMS to local flora and fauna species is considered to be high.

Construction and operation of the proposed port will result in the generation of a number of waste streams that may enter the marine environment and potentially impact sub-tidal habitats. Waste management and handling procedures developed as part of the CEMP and OEMP will control waste streams with the overarching aim of no waste products entering the marine environment. Despite the implementation of control measures, it is considered almost certain that some form of waste / debris will enter the marine environment during construction and operation of the port. As the port site is not a key habitat and does not support large areas of seagrass, the consequences of debris entering the marine environment to sub-tidal habitats are considered to be minimal; insignificant to the overall viability of species. As such, the overall risk is considered to be low.

Seagrass is also at risk from the unintended discharge of pollution in the form of site run-off, wastewater, hydrocarbons or chemicals. With any marine activity there is potential for waste or spills to enter the marine environment and affect plankton, benthic fauna and habitat forming benthic flora (e.g. seagrass), reducing habitat suitability for fish and marine fauna.

Iron ore is not known to be toxic to seagrass or macroalgal assemblages but otherrun-off or pollution from the port (as discussed in Section 5.4) has the potential to impact on water quality either stimulating algal growth through increase nutrient loading, reducing salinity as a result of increased freshwater discharge during storms, or inputs of hydrocarbons and/or other pollutants. Nutrients from run-off can stimulate algae in the water column or epiphytes that would shade benthic flora while other changes in water quality i.e. chemical contaminants such as biocides in anti-foulant paint or hydrocarbons could have direct toxic effects on benthic flora. Excess nutrients can also encourage more phytoplankton to grow in the water, reducing the amount of light getting to the seagrass, particularly in the deeper regions. Seagrass is commonly lost when nutrient levels in the water increase, these nutrients cause a large number of epiphytes to grow on the seagrass leaves, blocking light or causing the leaves to become too heavy and to break off. The implementation of design measures (refer Section 4) for the control of surface and waste water at the port site will limit hazardous pollutants from entering the marine environment in all but extreme weather events.

There remains a risk that a major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be unlikely. As previously outlined, the port site does not represent a critical habitat or support large areas of seagrass. The consequences of a major spill event are considered to be minor, as seagrass within the study area is representative of the broader Spencer Gulf. As such, seagrass loss would result in a short term decrease in the local abundance. As such, the overall risk of a major spill event affecting subtidal habitats and flora is considered to be low.

6.3.3 Conclusions

The subtidal habitats and flora identified at Cape Hardy during habitat mapping are consistent with the habitats observed in this region of the Spencer Gulf. Protected seagrass beds, which are likely to support a number of associated protected species, dominate the shallow waters to 10 m depth. No seagrass beds were present in depths greater than 19 m. Flora coverage is denser (greater than 50%) in the northern extents of the study area, whilst some areas along the shoreline to the south have a sparse cover of 5-15%. The presence and density of seagrass beds have been considered in the siting and alignment of marine infrastructure elements to avoid and minimise impacts. The total area of seagrass within the study area is around 930 Ha, of which less than 2.65 Ha (of sparse seagrass) is expected to be cleared by the port development.

6.4 Benthic Fauna

Benthic fauna can be used as an indicator of an area's environmental condition (Llansó, 2002). Most infauna (benthic fauna living within the sediments) are sedentary and respond rapidly to local environmental impacts and disturbances. Similarly, the majority of infauna and epifaunal (benthic fauna attached to the surface of substrates, rocks, vegetation or other benthic fauna) cannot easily move to avoid stressful conditions. Infauna often have short generation times and are important components of aquatic food webs, affecting transport and cycling of nutrients and toxic substances. As such, the abundance and diversity of benthic infauna can be used to indicate habitat health (Llansó, 2002; McConnaughey and Syrjala, 2008).

In general, a high density of diverse infaunal invertebrate species is an indicator of good habitat health. Conversely, low densities or a low diversity of infaunal invertebrate species indicates a lower value habitat, or one which is potentially already impacted (Ward and Hutchings, 1996). A complex and high density of epifauna can be an indicator of good habitat health, provided the species present are endemic species, while many degraded habitats are often dominated by high numbers of only a few taxa. *Zostera* and *Posidonia* beds have been shown to support distinctive epifauna and infauna assemblages (Hutchings *et al.,* 1993) therefore benthic fauna can also act as an indicator of habitat composition as well as system health.

6.4.1 Existing Environment and Key Findings

The physical isolation of the Spencer Gulf along with a lack of oceanic upwelling and low volumes of freshwater inputs has led to increased salinities and resource scarcity within the gulf. These physical conditions have contributed to high levels of endemism within the upper gulf; however the lower gulf has more in common with the southern Australian region (Poore, 1995).

Previous studies of the benthic invertebrate and infauna assemblages within the Spencer Gulf have focused on the northern and upper gulf regions (Shepherd, 1983; Ainslie *et al.,* 1989; Hutchings *et al.,* 1993; Ward and Hutchings, 1996; Gillanders *et al*., 2013). Hutchings *et al.,* (1993) investigated the infaunal community of marine sediments and seagrass beds in the upper Spencer Gulf (near Port Pirie) and showed polychaetes to be the dominant invertebrate taxa, comprising up to 76% of the infauna species in *Posidonia* seagrass beds and 48% of the infauna species in *Zostera* beds. Other infauna taxa found within Spencer Gulf include crustaceans, molluscs, ascidians and echinoderms.

The distribution of polychaete, mollusc and crustacean infauna in the upper Spencer Gulf has been connected to concentrations of trace metals in sediments (As, Cu, Mn, Pb and Zn), with areas dominated by polychaetes correlated with areas of higher trace metals (Ward and Hutchings, 1996). These studies were generally carried out in areas of high anthropogenic disturbance. Areas with a high level of disturbance can also change sediment composition i.e. distribution of grainsize can lead to differences in taxa between sites with delicate bivalves such as *Tellina* spp. preferring undisturbed coarse sand and opportunistic taxa such as polychaetes colonising areas of high disturbance in either silt or gravel.

The results of the benthic infaunal analysis are presented in Table 6-4. In summary the results indicate:

- The shallowest transect (A) had the greatest infaunal diversity, as well as the highest number of organisms per sample (Table 6-4). This transect was aligned with dense areas of seagrass habit (Figure 6-3) and sandy sediments
- Transect B had the next highest diversity of infauna, this transect had some areas of sparse to medium density seagrass habitat.
- Transect C that had predominantly sparse or no seagrass habitat with large areas of cyanobacterial mat and had the lowest diversity of infauna.
- Transect D was on average the deepest transect and was dominated by mixed small macroalgae, cyanobacterial mats and groupings of sponge and ascidians, its diversity of infauna was only slightly lower than Transect B.

Moving from north to south within the site; the trends of highest infauna diversity again aligned with areas of densest seagrass coverage at the north of the study area (0.1 infauna/cm^3 ± 0.002; density ± st. dev) and the lowest diversity of infauna was recorded at the southern extent of the study area (0.03 infauna/cm^3 ± 0.001; density ± st. dev.). The numbers of infauna recorded during survey is comparable to other recent studies of undeveloped sites in Spencer Gulf (Golder Associates, 2012; Sinclair Knight Merz, 2011) and the diversity of species indicates a good overall habitat health for the area.

Table 6-4 Richness and density of macroinvertebrate infauna collected from the marine sediment sampling locations within the Cape Hardy study area

Family	Location			
	Transect A (~10 m depth)	**Transect B (~15 m depth)**	**Transect C (~20 m depth)**	**Transect D (> 22 m depth)**
Nephtyidae	2			1
Syllidae	2			
Cheirocratidae	3	1		
Amphipoda	1			
Eusiridae	2			
Anaspidacea	3			
Asellota	2			
Isopoda	4			
Kalliapseudidae	1			
Chamidae	1			1
Limidae	1			
Littorinidae	2			
Tauraxinus sp.	1			1
Veneridae	1			
Patellidae	1			
Armandia sp.		1		
Lysianassidae		1		
Leptostraca		2		
Asteroidea		1		
Nuculana sp.		3		1
Patellidae		1		
Astralium sp.		1		
Nemertea		1		
Actiniaria			1	
Echinoidea			1	
Tellina sp.			2	2
Terebellidae				1
Stegocephalidae				2
Volutidae				1
Total # infauna spp.	27	14	4	10
Density of infauna/cm^3 ± st. dev.	0.11 ± 0.002	0.06 ± 0.002	0.02 ± 0.000	0.04 ± 0.000

Analysis of the towed video footage identified a number of epifaunal invertebrates in the study area. These are listed in Table 6-5 below. None of these species are protected under the EPBC or NPW Acts; several of the species are afforded protection in specific (aquatic reserve) areas or seasons under the SA Fisheries Management Act 2007.

Table 6-5 Benthic fauna of interest in the study area

	Scientific Name	Common Name	Legislative Protection	Commercial/ Recreational Interest
Annelida - Polychaeta	**Multiple unidentified spp.**	**Unidentified bristle worms, sandworms**	Nil	No
Porifera -	**Multiple unidentified spp.**	**Unidentified sponges. sea sponge, barrel, branching, chimney, ball**	Nil	Minimal
Urochordata - Ascidians	**Multiple unidentified spp.**	**Sea squirt**	Nil	No
Echinodermata - Asteroidea	***Coscinatsterias muricata***	**Eleven-arm seastar**	Nil	No
	Unknown spp.	**2 spp. unidentified seastars**	Nil	No
- Echinozoa	**Multiple unidentified spp.**	**Unidentified sea urchins**	Nil	Minimal
- Holothuroidea	***Stichopus ludwigi/ Holothuria hartmeyeri***	**Sea cucumbers**	Nil	Not in SA
Mollusca	*Haliotis rubra/ laevigata*	Abalone (Roe's, Black-lip and Green-lip Abalone)	At all times in intertidal reefs and aquatic reserves*	Yes
	Pinna bicolor	**Razorfish**	Catch limited	Yes
Anthropoda	***Ibacus alticrenatus, Ibacus peronii***	**Slipper lobster/bug**	When carrying external eggs*	Yes
	Jasus edwardsii	Southern rock lobster	Protected from collection May-Nov	Yes
	***Majoidea* (various)**	**Spider crab**	Nil	Minimal
	Ovalipes australiensis	**Sand crab**	When carrying external eggs*	Yes
	Portunus armatus	**Blue swimmer crab**	When carrying external eggs*	Yes
	Pseudocarcinus gigas	Giant crab	When carrying external eggs*	Yes

*Fisheries Management Act, 2007: (PIRSA, 2014). **Bold** entries represent opportunistic sightings during habitat surveys at the site.

6.4.2 Risks and Impact: Benthic fauna

Impacts could occur to the benthic fauna as a result of:

- Habitat loss or exclusion
- Build-up of contaminants, including hydrocarbons and biocides (including antifoulants, herbicides and pesticides)
- Alterations to hydrodynamic or sediment transport conditions
- Removal of habitat-forming species (i.e. seagrass)
- Changes to sediment chemistry
- Marine debris

6.4.2.1 Impacts

Disturbance to benthic fauna is expected to occur in the immediate areas involved in piling for the jetty and under the rockwall related to the MOF (see Section 6.3.2). Additional areas that may be subject to disturbance include areas underneath the jetty, ship berths and vessel manoeuvring areas, which will be subject to occasional shading. It is expected that there will be complete direct disturbance to the benthic habitat within the footprint of port structures and minor disturbance in vessel manoeuvring areas. Conservatively, 2.65 Ha of seagrass and 2.61 Ha of combined intertidal and near-shore subtidal environment will be cleared (refer Table 6-3).

Soft sediment areas directly under the MOF will be permanently lost. However, epifauna from hard substrate areas will be able to colonise the MOF and jetty surfaces, thereby creating new areas of habitat which will further increase habitat diversity as additional organisms colonise the soft/biological surfaces of the encrusting organisms.

Typically, benthic fauna will regenerate following significant disturbance such as that required to support the proposed port development. As such, impacts to benthic fauna within the study area associated with habitat clearance will be resolved in the short term (< 3 years), and are considered to represent a low impact.

Hydrodynamic modelling predicts limited changes to the oceanographic conditions at the port site as a result of the proposed infrastructure (Jacobs, 2014d). The existing site hydrodynamics confine the majority of longshore sediment drift to the two embayments either side of the proposed jetty and MOF structure. The changes to the hydrodynamic conditions at the site (as discussed in Section 5.2) are generally associated with the construction of the MOF and jetty structure. As indicated by the hydrodynamics modelling (Jacobs, 2014d), alterations to the maximum currents and bed shear across the site are not significant. The predicted increase in sedimentation rate around the MOF is less than 1%, and it is anticipated that the existing seagrass beds in the area will be able to adsorb this additional sediment. As such, alterations to the hydrodynamic conditions at the port site are not considered to significantly affect the habitat, density or diversity of benthic fauna, representing a negligible impact.

An assessment of the likelihood of occurrence and impacts to each invertebrate species potentially occurring within the study area is provided in Table 6-6 below.

Table 6-6 Invertebrate species: likelihood of occurrence and potential impacts

Invertebrate Species potentially in the area			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection. EPBC, NPW or Fisheries Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Jasus edwardsii	Southern rock lobster	Fisheries Act (SA) ICUN least concern	**Possible** for species to be present in area**.** This species is of commercial and recreational interest and occurs throughout the Spencer Gulf. To occur in high densities this species requires rocky reef habitat with a high degree of complexity (holes, cracks, overhangs or ledges). The rocky reef at Cape Hardy is granitic, which generally provides less complexity and accordingly a lower density of rock lobster (Sloan and Crosthwaite, 2007). Therefore, while it is possible that southern rock lobsters are present at Cape Hardy, the immediate area is highly unlikely to support a significant population.	Disturbance to habitat; pollution; oil spills; fisheries access/exclusion.	The species are protected from collection May-November under the Fisheries Act (SA) but are not protected under any other legislation. There will be a small area of intertidal and shallow sub-tidal reef impacted by the wharf construction. While this habitat may support some juvenile rock lobster, it is unlikely that Cape Hardy represents a significant site of lobster recruitment or habitat. It is also unlikely that the site represents a significant lobster fishing site. **No significant impact to this species will occur as a result of this development.**	N
Haliotis rubra, laevigata, roei	Abalone (Black-lip, Green-lip and Roe's abalone)	Fisheries Act (SA)	**Possible** for species to be present in area**.** This species is not listed for protection but is of commercial and recreational interest, and the collection of this species is under tight control. Abalone occur in rocky reef habitat throughout the Spencer Gulf. It is likely that suitable habitat for abalone occurs in the intertidal and shallow sub-tidal strip along the shore-line at the study area.	Disturbance to habitat; pollution; oil spills; IMS; fisheries access/exclusion	The species are protected from collection on intertidal reefs at all times under the Fisheries Act (SA). There will be a small area of intertidal and shallow sub-tidal reef impacted by the wharf construction. While this habitat may support some abalone, it is unlikely that the development will cause a permanent disturbance, or that Cape Hardy represents a significant site of abalone recruitment or habitat. It is also unlikely that the site represents a significant Abalone fishing site. **No significant impact to this species will occur as a result of this development.**	N
Portunus armatus	Blue swimmer crab	Fisheries Act (SA)	**Present.** A number of individual crabs were sighted during the video tow survey in range of substrates from bare sand to dense seagrass. Spencer Gulf Blue swimmer crabs are believed to be an isolated sub-population and rely on widespread mangrove creek and mud-flat habitats during recruitment stages. The crabs are found on a range of habitat types from algal or seagrass substrate through to bare sand or muddy substrate. Adult crabs generally migrate to deeper waters up to 50 m during the months of May to August but migrate to shallower waters in warmer months (Dixon *et al*., 2013). This species occurs at the site but it is unlikely that the	Disturbance to habitat; pollution; oil spills; fisheries access/exclusion.	Females of this species are not to be taken when carrying eggs as they are protected under the Fisheries Act (SA). The species is not listed under any other protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf, across seagrass habitat and muddy or sandy substrates There will be a small area of suitable habitat for this species impacted by the wharf construction, but it is unlikely to have an effect on the species' ability to inhabit the area. The development site does not represent habitat critical for recruitment or growth of the wider population of this species. It is also	N

Invertebrate Species potentially in the area			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection. EPBC, NPW or Fisheries Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			density of individuals is high.		unlikely that the site represents a significant Blue swimmer fishing site. **No significant impact to this species will occur as a result of this development.**	
Ovalipes australiensis	Sand crab	Fisheries Act (SA)	**Present.** This species was sighted during the video survey on areas of bare sand throughout the study area. It is of commercial and recreational interest and occurs throughout the Spencer Gulf. Sand crabs generally inhabit sandy substrates and seagrass beds. It is likely that these crabs exist in the seagrass areas as well at Cape Hardy, due to the species being known to use seagrass habitats. But it is unlikely that the site supports a large population of these crabs.	Disturbance to habitat; pollution; oil spills.	Females of this species are protected under the Fisheries Act (SA) when carrying external eggs. The species is not listed under any other protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf, across seagrass habitat and muddy or sandy substrates There will be a small area of suitable habitat for this species impacted by the wharf development, but it is unlikely to have a lasting impact on the species' ability to inhabit the area. The development site does not represent habitat critical for the recruitment or survival of this species. **No significant impact to this species will occur as a result of this development.**	N
FAMILY MAJIDAE	Spider crab	N/A	**Present.** Spider Crabs were observed on sandy or muddy bare substrate in water greater than 15m depth (generally >20 m) throughout the study area. Due to the habitat type and depth range and size of the crabs observed the species were likely *Leptomithrax gairmardii*	Disturbance to habitat; pollution; oil spills.	None of the species of Spider Crabs found in South Australia are protected or considered a commercial fisheries and as *Leptomithrax gairmardii* are generally found in waters deeper than 15m the development will impact on only a small area of suitable habitat and it is unlikely to have a lasting impact on the Spider Crabs' ability to inhabit the area. The development site does not represent habitat critical for the recruitment or survival of this species. **No significant impact to this species will occur as a result of this development.**	
Ibacus peronii, I. alticrenatus	Slipper lobsters or Slipper bugs	Fisheries Act (SA) ICUN least concern	**Present.** This species is of commercial and recreational interest and occurs throughout the Spencer Gulf. Slipper lobsters are found in a wide range of habitats including both sandy and muddy substrates. Slipper lobsters are generally taken incidentally as a part of other commercial and recreational fishing efforts (such as fishing for other crustaceans, including prawn trawling). Suitable habitat for this species exists in the area, and one was sighted on the transect video from site surveys.	Disturbance to habitat; pollution; oil spills.	There will be a small area of suitable habitat for this species impacted by the wharf development, but it is unlikely to have a lasting impact on the species' ability to inhabit the area. It is unlikely that the study area supports a high density of slipper lobsters or is a critical area for this species. It is also unlikely that the site represents a significant lobster fishing site. **No significant impact to this species will occur as a result of this development.**	N

Invertebrate Species potentially in the area			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection. EPBC, NPW or Fisheries Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Penaeus (Melicertus) latisulcatus	Western king prawn	N/A	**Possible** that species is present in area. This species is not listed for protection but is of commercial interest and occurs throughout the Spencer Gulf. Coastal mangrove and tidal flat/saltmarsh habitat is critical to population recruitment and occurs throughout Spencer Gulf, especially north of Cowell. None of this recruitment habitat occurs in the study area. Deeper waters with a generally sandy or silty substrate are the preferred habitat for adult prawns, rather than specifically seagrass or reef. It is likely that there is some suitable habitat in the outer extents of the study area. The key areas that prawns inhabit have, however, been identified and are unlikely to include the study area. For example, recently around 50% of prawns have been harvested from the Wallaroo region on the eastern side of Spencer Gulf (Dixon and Sloan, 2007).	Disturbance to habitat; pollution; oil spills.	While there may be suitable habitat for adult prawns in the deeper areas of the study area it is unlikely that the development or shipping activity will affect this habitat. It is also unlikely that the site represents a significant prawn trawling site. **No significant impact on this species or species' habitat will occur as a result of this development.**	N
Sepioteuthis australis	Southern calamary	N/A	**Possible** that species is present in area. This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. Southern calamary typically cross habitat boundaries, with larger adults preferring deeper waters while smaller individuals are typically found in shallow waters, not necessarily attracted to seagrass or rocky reef (Dixon and Sloan, 2007). As these habitats exist in the area it is possible the species will be present.	Disturbance to habitat; pollution; oil spills.	It is possible that this species occurs in the study area, but the area does not represent a large area of critical habitat for this species. The development and/or shipping operations **are not expected to have any significant impact on this species or its habitat**.	N
Sepia apama	Giant Australian cuttlefish	Reef Watch species of SA conservation concern. ICUN Near Threatened EPBC not listed, Fisheries Act (SA)	**Present.** A single cuttlefish was sighted during the video tow in an area of bare silt substrate at over 20 m. This species is of conservation concern due to its unique behaviour of aggregating annually to breed in a small area near Whyalla (upper Spencer Gulf) but is only protected in the Northern Spencer Gulf, outside of the study area. The species also holds commercial and recreational interest and occurs throughout the Spencer Gulf. This species is considered common across southern Australia, but there are a series of unknowns about the aggregation of cuttlefish including influences on recent declines in numbers (Gaylard *et al.*,	Disturbance to habitat; pollution; oil spill; underwater noise during piling	The species is only afforded protection in the northern waters of Spencer Gulf under the Fisheries Act (SA), it is not EPBC listed. It is likely that minor loss of potential habitat for this species will occur due to the construction of the wharf and MOF. It is expected that ongoing operations at the site will not cause further disturbance to this species, as the species is known to occur around jetties and piers around Southern Australia. While it is likely that cuttlefish utilise the reef and seagrass habitat at Cape Hardy, the area could not be considered of significant importance to the species. **There will be no significant impact to this species**	N

Invertebrate Species potentially in the area			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection. EPBC, NPW or Fisheries Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			2013). It is likely that *S. apama* are present across the reef and seagrass habitat at Cape Hardy in low numbers.		**as a result of this development.**	
Pectinidae spp.	scallop (various)	N/A	**Possible** that species is present in area**.** Scallops naturally occur in areas with a moderate current flow, supplying generous amounts of plankton on which to feed. Their preferred habitat ranges between	Disturbance to habitat; pollution; oil spills; IMS	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. It is possible that a small number of this species will be disturbed by the development, but it is unlikely that will represent a significant portion of the species range or population therefore it is concluded **there will be no significant impact on this species as a result of this development.**	N
Heliocidaris erythrogramma (and various similar spp.*)*	Sea urchin	N/A	**Possible** that species is present in area. This species generally inhabits subtidal rocky reefs throughout SA. It is likely that this species would be found in the reef habitat surrounding the capes at the site, though high densities are unlikely. It is unlikely that Cape Hardy represents a significant site for this species.	Disturbance to habitat; pollution; oil spills; IMS	This species is not listed for protection but is of some commercial and recreational interest and occurs throughout the Spencer Gulf. While a small amount of potential habitat for this species will be impacted by the construction of the wharf and MOF, this will not represent a significant portion of possible habitat for this species. **There will be no significant impact on this species as a result of this development.**	N
Donax deltoides	Pipi, cockle, surf clam	N/A	**Unlikely** that species is present in area. Pipis prefer to inhabit the swash zone of sandy beaches with consistently high wave energy. Cape Hardy does not have any beaches suitable to support large numbers of pipis (Ferguson, 2013).	Localised altered nearshore hydrodynamic conditions (i.e. vessel scour/propwash); disturbance to habitat; pollution; oil spills; IMS	This species is not listed for protection but is of commercial and recreational interest. However pipis are highly unlikely to occur in the study area due to insufficient suitable habitat. **There will be no significant impact to this species as a result of this development.**	N
Katelysia spp.	Vongole, clams	N/A	**Unlikely** that species is present in area. The preferred habitat for this species is generally sandy subtidal sediment across tidal flats and estuary mouths. Cape Hardy does not have habitat suitable to support high densities of Vongole,	Pollution; oil spills; IMS	This species is not listed for protection but is of commercial and recreational interest and occurs in the Spencer Gulf with less than 1 tonne of vongole commercially harvested annually across the Spencer Gulf. Vongole are unlikely to occur at Cape Hardy, as their required habitat of tidal flats or estuary mouths does not exist within the study area. **There will be no significant impact to this species as a**	N

Invertebrate Species potentially in the area			Likelihood of Occurrence	Likelihood of significant impacts		
Species Name	**Common Name**	**Legislative Protection. EPBC, NPW or Fisheries Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
					result of this development.	
Pseudocarcinus gigas	Giant crab	Fisheries Act (SA)	**Unlikely** that species is present in area**.** This species is not listed for protection but is taken by commercial fishers in the Spencer Gulf. This species prefers deeper water (>50 m) habitats and is therefore highly unlikely to utilise the habitat present at Cape Hardy.	Disturbance to habitat; pollution	Females of this species are protected under the Fisheries Act (SA) when carrying external eggs. The species is not listed under any other protection but is of commercial and recreational interest. The giant crab typically inhabits water significantly deeper than the environment at the Cape Hardy study area (>50m). Therefore it is considered unlikely that the study area plays a role in this species' growth, development or survival. **There will be no significant impact to this species as a result of this development.**	N
Pinna bicolor	Razorfish	N/A	**Present.** Observed during video tow survey. This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. Typically this species prefers lower energy environments with soft substrates, including sparse seagrass beds. This species occurs in the Cape Hardy area, but only low density beds of razorfish were identified.	Localised altered nearshore hydrodynamic conditions (i.e. vessel scour/propwash); disturbance to habitat; pollution; oil spills; IMS	Razorfish occur throughout the Spencer Gulf in higher densities than observed at Cape Hardy. Cape Hardy could not be considered a critical site for razorfish, and are unlikely to be affected by the development, including the construction of the wharf and MOF. **There will be no significant impact to this species as a result of this development.**	N
Zoila friendii ssp. thersites	Black cowry	Reef Watch species of SA conservation concern.	**Possible** to be present in port area. This species is widely distributed across southern Australia, found on reefs, in seagrass and near artificial structures such as jetty pilings. The shell of this species is popular amongst shell collectors. This species is long-lived (>12 years), and susceptible to over-exploitation. It is possible that this species occurs in the project area, as suitable habitat is present.	Loss of habitat; pollution; oil spills; IMS	This species is not listed for protection, though harvesting is controlled under the Fisheries Management Act, 2007. While a small amount of potential habitat for this species will be impacted by the construction of the wharf and MOF, this will not represent a significant portion of possible habitat for this species .The area does not represent critical habitat for this species. **This development will not cause significant impact to this species.**	N

Marine debris DEWHA (2009) Threat abatement plan for the impacts of marine debris on vertebrate marine life, May 2009. Prepared for the Department of the Environment, Water, Heritage and the Arts (DEWHA) [Threat abatement plan] available from http://www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris.html ^Fish species and family information summarised from: Baker, 2011; Gomon *et al.*, 2008; Edgar, 1997; Kuiter, 1996, unless expressed otherwise.

6.4.2.2 Risks

If large areas of seagrass loss were to occur, a reduced diversity and density of associated infauna and epifauna species would be expected in any resulting unvegetated areas (Stoner, 1980). The loss of macroalgae from reef habitat is expected to cause similar effects for benthic epifauna. The level of impact to epifauna due to loss of seagrass is difficult to predict as communities depend on a complex interaction of variables including but not limited to hydrodynamics, the seagrass species present, patch orientation, edge effects, and the area of sandy 'blowouts' (Edgar and Robertson, 1992; Tanner, 2003). The location of the marine infrastructure avoids area of dense seagrass or macroalgae thereby reducing the likelihood of affects to these habitats. As detailed in Section 6.3, nominated levels of seagrass clearance were based on conservative estimates. As such, the likelihood of further clearance of seagrass and benthic fauna habitat is considered to be unlikely. The benthic fauna and habitats within the port site are typical of those identified throughout the Spencer Gulf and are not identified as a key location supporting endangered or protected species. As such, the consequences are considered to be minor and would result in a local short term decrease in abundance of benthic fauna, but would not result in lasting effects on the local population. As such, the overall risk of unintended additional seagrass clearance on benthic fauna is considered to be low.

A major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be unlikely. The consequences of a major spill event are considered to be minor, resulting in a short term decrease in the local abundance of benthic fauna. As such, the overall risk of a major spill event affecting benthic fauna is considered to be low.

The distribution of benthic fauna can be driven by differences in sediment biogeochemistry (Reynoldson, 1987). It is considered unlikely that the emissions of iron ore dust or potential spillage of iron ore during the shipping process will lead to any measurable change in sediment chemistry, or the distribution of benthic fauna in any area other than the immediate settling area of an accidental spill (see Section 5.4.2). Iron occurs naturally in marine sediments, but is generally not soluble or bio-available (Canfield, 1989). With this in mind, it is expected that iron ore (magnetite or hematite) which reaches the sediment from dust emissions will not cause elevations in dissolved or bioavailable iron concentrations. Whilst some spillage of iron ore is considered to be almost certain, as the study area is relatively sheltered from a hydrodynamics perspective, the consequences of an ore spillage will be limited to the study area, not result in long term effects on the local population, and are considered to be minor. As such, the overall risk of iron ore spillage on benthic fauna is considered to be medium.

IMS introduction via the port operations poses a high risk to the endemic benthic fauna, as the disturbed areas created during construction along with new settlement surfaces will provide cleared areas which could be exploited by opportunistic IMS. IMS are discussed in more detail in Section 6.8.

6.4.3 Conclusions

The benthic habitats and fauna found at Cape Hardy during the habitat mapping and sediment survey are consistent with the habitats observed in this region of the Spencer Gulf. There are no significant or unique benthic habitats identified within the study area. The limited footprint of the marine infrastructure (< 17ha) will only have direct impacts on the benthic community within the footprint area of the MOF and tug harbour with a permanent loss of subtidal habitat immediately beneath the MOF (<3 Ha from Table 6-3). While there will be a fundamental change to the habitat from the loss of the soft bottom areas, this loss of habitat area is negligible in the context of the study area. It is also expected that hard substrate colonising organisms will be able to utilise the hard surfaces of the MOF and jetty, and over time the colonising organisms will encrust structures and trap particulates enabling more organisms to colonise and increase the complexity of the species utilising the site.

6.5 Marine Megafauna

In South Australia all cetaceans are protected under the State NPW Act, Fisheries Management Act 2007 and the Commonwealth EPBC Act (whether they are listed or not). The following section reviews the range of threatened marine megafauna (whales, dolphins, seals and turtles) that are potentially present within the study area and their conservation status.

6.5.1 Existing Environment and Key Findings

The database and literature reviews identified the protected species that have the potential to occur in waters around the Eyre Peninsula region in Table 6-7. Species are classed as common, uncommon, rare or vagrant based on the frequency which they are seen in the region (Caton *et al.*, 2011a). Table 6-8 summarises the output of the EPBC PMST.

Table 6-7 Protected marine megafauna potentially within study area

Common name	Scientific name	EPBC listing	NPW listing	Frequency*
	CETACEANS			
Southern Minke whale	*Balaenoptera bonaerensis*	Cetacean, Migratory	-	U
Bryde's whale	*Balaenoptera edeni*	Cetacean, Migratory	Rare	R
Blue whale	*Balaenoptera musculus*	Endangered	Endangered	U
Pygmy right whale	*Caperea marginata*	Cetacean, Migratory	Rare	U
Common dolphin	***Delphinus delphis***	**Cetacean**		**C**
Southern right whale	*Eubalaena australis*	Endangered	Vulnerable	C
Risso's dolphin	*Grampus griseus*	Cetacean	Rare	N/A
Southern bottlenose whale	*Hyperoodon planifrons*	Cetacean, Migratory	Rare	R
Dusky dolphin	*Lagenorhynchus obscurus*	Cetacean, Migratory	-	N/A
Humpback whale	*Megaptera novaeangliae*	Vulnerable	Vulnerable	C
Killer whale	*Orcinus Orca*	Cetacean, Migratory	-	C
Bottlenose dolphin	*Tursiops aduncas*	Cetacean	-	C
	PINNIPEDS			
New Zealand fur seal	*Arctocephalus forsteri*	Marine	-	C
Australian fur seal	*Arctocephalus pusillus*	Marine	Rare	V
Subantarctic fur seal	*Arctocephalus tropicalis*	Vulnerable	Endangered	V
Australian sea lion	*Neophoca cinerea*	Vulnerable	Vulnerable	C
	REPTILES			
Leatherback turtle	*Dermochelys coriacea*	Endangered	Vulnerable	R
Loggerhead turtle	*Caretta caretta*	Endangered	Endangered	R
Green turtle	*Chelonia mydas*	Vulnerable	Vulnerable	R

As reported in Caton et al. (2011a) Eyre Peninsula Coastal Action Plan (EPCAP) 2011: C = Common, U = Uncommon, R= Rare, V = Vagrant N/A = not applicable (not reported in EPCAP 2011).* ***Bold* *entries indicate opportunistic sighting during surveys. All marine mammals (and The Great White Shark) are also protected at all times under the Fisheries Management Act 2007.*

Common and bottlenose dolphins are known to occur in the Spencer Gulf region year-round (Gibbs and Kemper, 2014). Generally, bottlenose dolphins have a nearshore coastal distribution whereas common dolphins tend to be distributed more evenly across the wider gulf area in open water. A study of common dolphins in Gulf St Vincent established that the species has a preference for depths greater than 14 m (Filby,

2010). Several common dolphins were observed during the field survey (Figure 6-4), trailing the video survey vessel in around 20 m of water and captured on the towed video diving down to inspect the video sled.

Large whale species (Blue, Humpback, Southern right whales and including Killer whales) are migratory in nature and therefore are seasonal visitors to South Australian waters (Gibbs and Kemper, 2014). The Humpback Whale is listed as Vulnerable under both the EPBC Act and the NPW Act. Spencer Gulf is not located on the main Humpback whale migration routes which exist along the eastern and western Australian coasts as depicted in Figure 6-5 (Kemper, 2005; SPRAT, 2014). Humpback whales have been widely recorded in South Australian waters (BDBSA, 2013). With its distinctive humpback fin and large size the species is easily recognisable and regularly reported when it is sighted, as evidenced by the numerous sightings from Port Augusta in 2008 and 2011. However, as the gulf does not represent any known feeding or calving grounds, verified records (assessed for duplication) submitted within the Spencer Gulf are classified as uncommon (Kemper, 2005). There have been concerns raised regarding verification of 'citizen science' and data overlaps from multiple independent databases for whales in Australia (Bannister *et al*., 1996).This suggests that sightings of Humpback whales (or mother and calf) visiting Spencer Gulf have the potential to be overestimated from multiple sightings of the same vagrants in the gulf.

Blue Whales are listed as Endangered under both the EPBC Act and the NPW Act. Blue whales are migratory in nature, with a widespread oceanic distribution. Blue whale migration paths are unknown but key sighting areas have been identified within South Australia (Figure 6-6) including the Great Australian Bight, near Robe in the south-east through to the open waters of the Bonney Upwelling off western Kangaroo Island (Bannister *et al.*, 1996). Although this species has been recorded within the Spencer Gulf (ALA, 2013), they are normally found in deeper water along the 200 m contour in the Bonney Upwelling area and are unlikely to be observed closer to shore. Being the largest animal on the planet Blue Whales would be highly conspicuous in Spencer Gulf therefore it is unlikely the species frequents gulf waters more than has been reported.

Figure 6-4 Common dolphin photographed trailing video tow survey vessel in study area

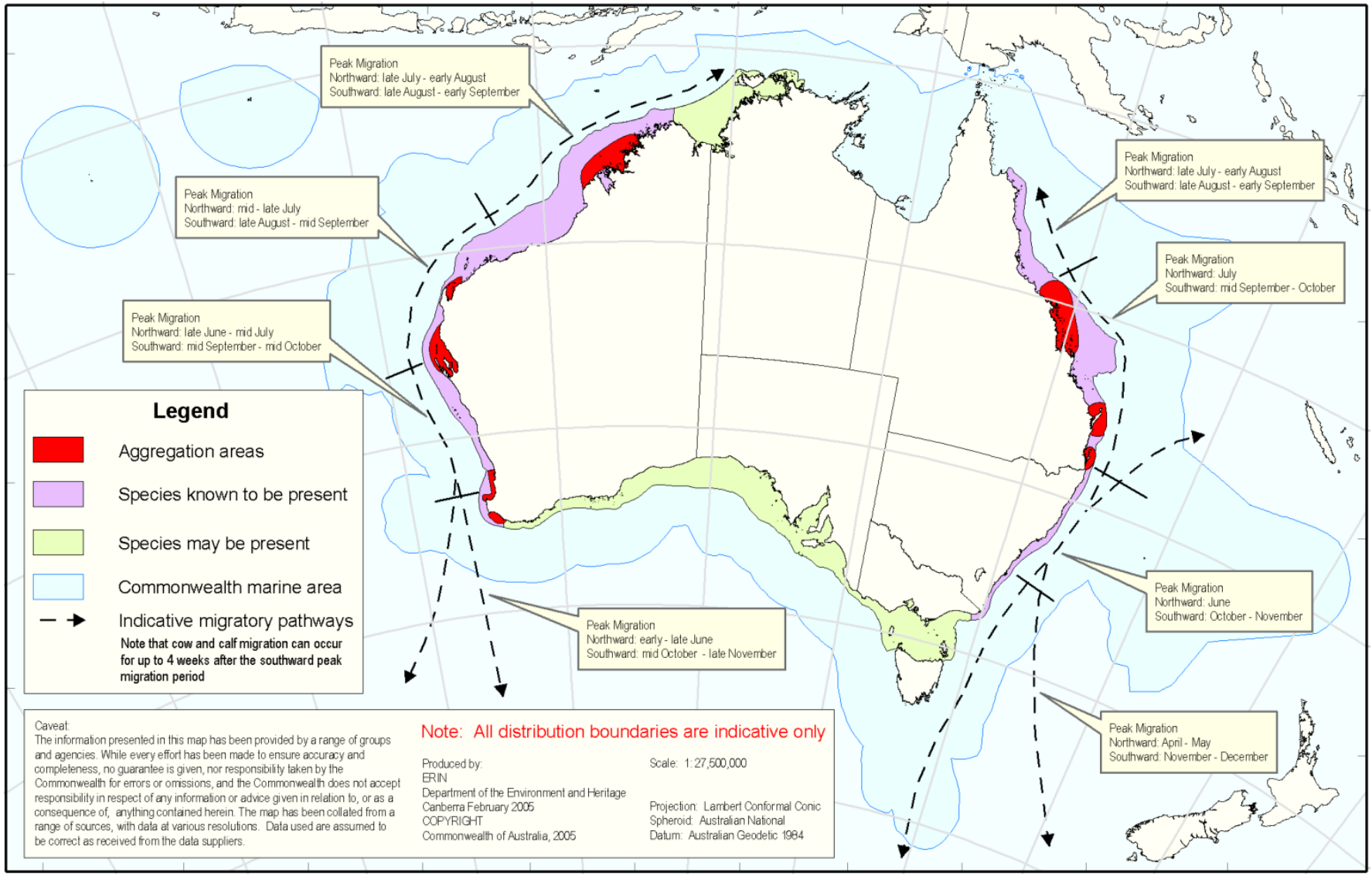


Figure 6-5 Known distribution, migration and aggregation areas of Humpback Whales (DEH, 2005a)

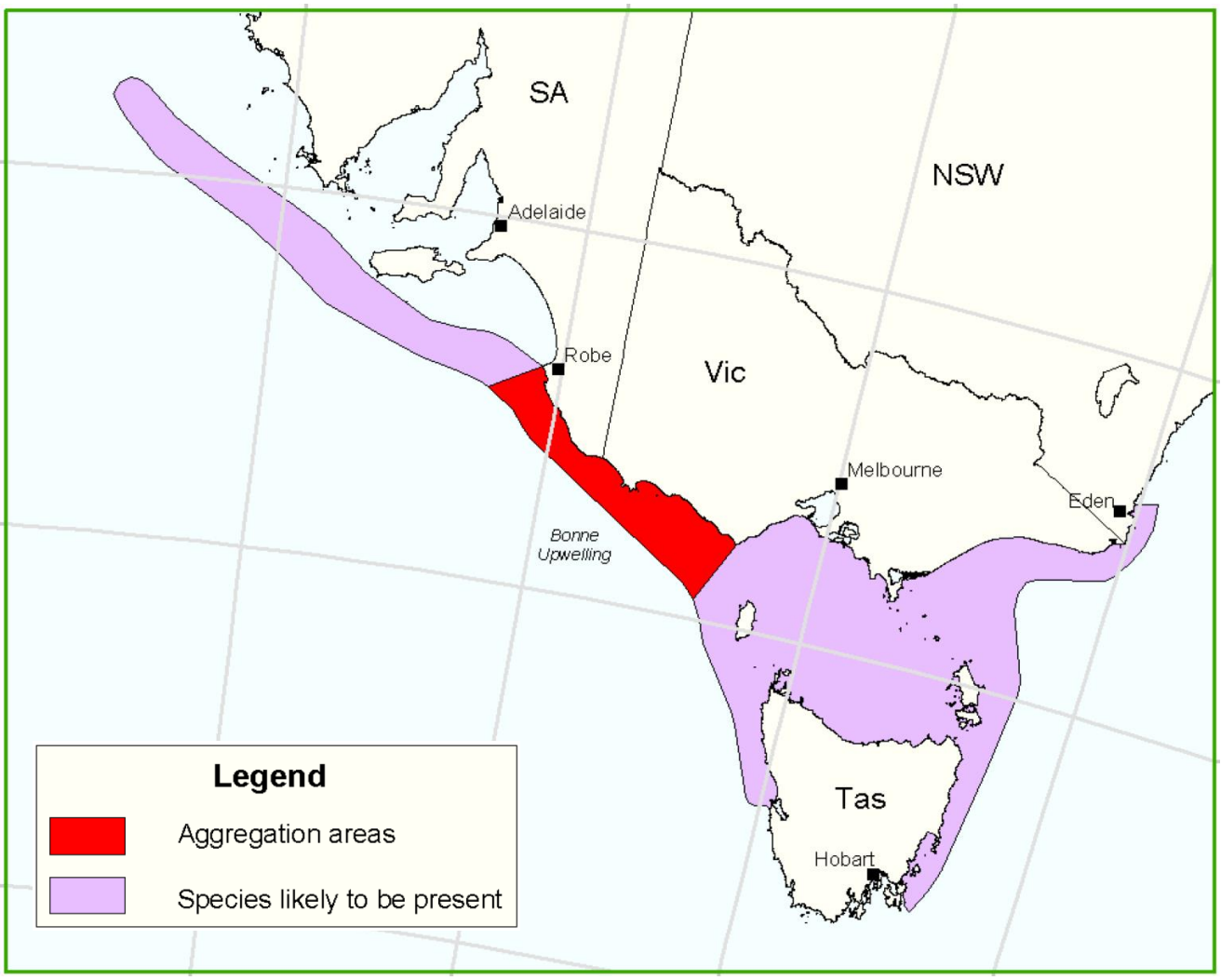


Figure 6-6 Recognised aggregation areas of Blue whales in south-east Australia (DEH, 2005b)

The Southern Right Whale (SRW) is listed as Endangered under the EPBC Act and Vulnerable under the NPW Act. The SRW was heavily impacted by the nineteenth-century whaling industry, reducing numbers from an estimated 60,000 individuals to around 300 in 1920 (Bannister, 2001; Bannister, 2007). Since the moratorium on whaling, SRW population numbers have been recovering with numbers worldwide estimated at 7000 in 2007 (NOAA, 2007), with a global population growth rate (~7%/year) approaching the biological maximum for the species (Bannister, 2007). Within Australia the population has been estimated at over 3500 and growing at close to 7% per year (Carroll *et al.*, 2014). The SRW is a circumpolar species living in the sub-Antarctic and open ocean during the summer months and non-calving years. Based on the overwintering sightings of mothers and calves in nearshore areas during nursery aggregation there are four main populations of SRW; in South Africa, Argentina, Australia and sub-Antarctic New Zealand (DSEWPaC, 2012).

Recent studies of the genetics of SRW show that mothers with calves show a high fidelity to the same aggregation areas (NOAA, 2007; Carroll et al., 2011) with the Australian population showing some limited interconnection with the sub-Antarctic New Zealand population (Bannister, 2007, Valenzuela et al., 2009; Carroll et al., 2011; DSEWPaC, 2012; Carroll et al., 2014). Within Australia there are a number of current and known historical aggregation grounds distributed from Western Australia to southern New South Wales as depicted in Figure 6-7 (DSEWPaC, 2012). These different aggregations are now known to be all from the same genetic population (Valenzuela et al., 2009). Historically, there were reported differences between the western and eastern SRW aggregation areas in Australia, likely due to historical separation of the populations during

periods of heavy whaling. Recent genetic studies indicate a relinking of these populations suggesting migration between the areas and inter-breeding (Carroll et al., 2011). Studies also indicate that the Australian distribution of SRW follows a circular, counter-clockwise seasonal migration pattern of a single undivided population (Bannister, 2001; Burnell, 2001). During the winter season whales travel westward along the southern coastline, then south towards summer feeding grounds in the sub-antarctic waters of the Southern Ocean, then eastward in the sub-polar latitudes and then finally north again to their wintering grounds with no difference in distributional movements between males and non-breeding females (Burnell, 2001).

SRW population structure suggests high juvenile and low adult mortality (Bannister *et al.,* 1996). Upon reaching maturity at around six to nine years female SRW generally calve at three-year intervals and mature females are almost never seen in Australian coastal waters in non-calving years, suggesting conception takes place elsewhere (DSEWPaC , 2012). The long interval between calving and fidelity to foraging and nursery grounds means that despite the growth in the SRW population the expansion of the species range is limited by individual animal's fecundity and their offspring's (limited) exploration of new areas.

In Western Australia the SRW population growth rate has been monitored closely and is known to be at or near the maximum population growth biologically possible for the species, however there is little knowledge of the growth rate at other nursery grounds around the country (DSEWPaC, 2012). The SRW that occur in South Australia are closely linked to the western population (Carroll *et al.*, 2011) and therefore are expected to be growing at the same rate. Given that the Australian nursery ground / aggregation populations of SRW have interlinkage (Valenzuela *et al.,* 2009; Carroll *et al.*, 2011)) it can be surmised that the Australian SRW population is growing at around the biological maximum. The population of the SRW in south Western Australia is growing at their maximum biological rate despite the presence of several major port developments in the region. This indicates that there would appear to be no apparent significant impacts from shipping or ports, despite ship strike being listed as a major threat to this species (Bannister, 2007), and that with appropriate management plans in place ports and shipping can coexist with SRW. Similarly, population recovery for SRW in South Africa is occurring despite human caused mortalities (ship strikes and entanglements in fishing gear (Best *et al.*, 2001)), indicating the species population growth rate is not severely impacted by vessel strikes. Within South Australia it has been reported that the greatest threat to SRW mortality from human interaction comes from entanglement rather than vessel strike (Kemper *et al*., 2008)

SRW are known to be present along the South Australian coast from May to November during their calving season (SPRAT, 2014) although the species tends to aggregate in predictable locations along the coast outside of the Spencer Gulf (Figure 6-7). Within South Australia there are two winter aggregation areas in the Great Australian Bight (GAB) and one aggregation area around Encounter Bay south of Fleurieu Peninsula where mothers come to calve or nurse their young (Bannister, 2007). There are no known current or historical aggregation areas within the South Australian gulfs (Kostoglou and McCarthy, 1991; DSEWPaC, 2012) indicating the gulfs are not part of the species migration path.

The SRW is easily identifiable by the general public and highly conspicuous during their nearshore mother-calve aggregations. Therefore, a single individual, or mother and calf, may be sighted on numerous occasions as they move east to west from one aggregation area to another, as evidenced by SA Whale Centre records (2013-14). The species is considered an occasional visitor to Spencer Gulf (Caton *et al.,* 2010a) with most sightings mainly during the winter months, when females use the shallow waters along Australia's southern mainland for calving (Bannister et al., 1996; Gibbs and Kemper, 2014) (Figure 6-7).

As previously discussed, genetic and isotopic studies of the species indicate that mothers and their offspring return annually to the same feeding and calving grounds (Valenzuela *et al.,* 2009; Carroll *et al.*, 2011), suggesting the species may have limited capacity to explore new feeding grounds (DSEWPaC, 2012). Despite the known sightings of SRW within Spencer Gulf, the gulf is not part of any established or historical migration path. Given the tendency of SRW to show high fidelity to aggregation areas, future high level utilisation of the

Spencer Gulf is considered highly unlikely. Individual SRW, or mother and calf pairs that visit Spencer Gulf are likely moving from one aggregation area to another (Victoria to Encounter Bay to GAB) and not using the area for foraging or nursery grounds.

Records show the SRW rarely strands in South Australia (Kemper and Ling, 1991; Kemper *et al*., 2008; Caton *et al.*, 2010), with no stranding records along the Eyre Peninsula coast. However, the calves are susceptible to direct disturbance, such as whale watching vessels and/or low flying aircraft, around calving areas. Coastal industrial activities (seismic, drilling), fishing operations (entanglement), pollution and collisions with ships can also impact SRW.

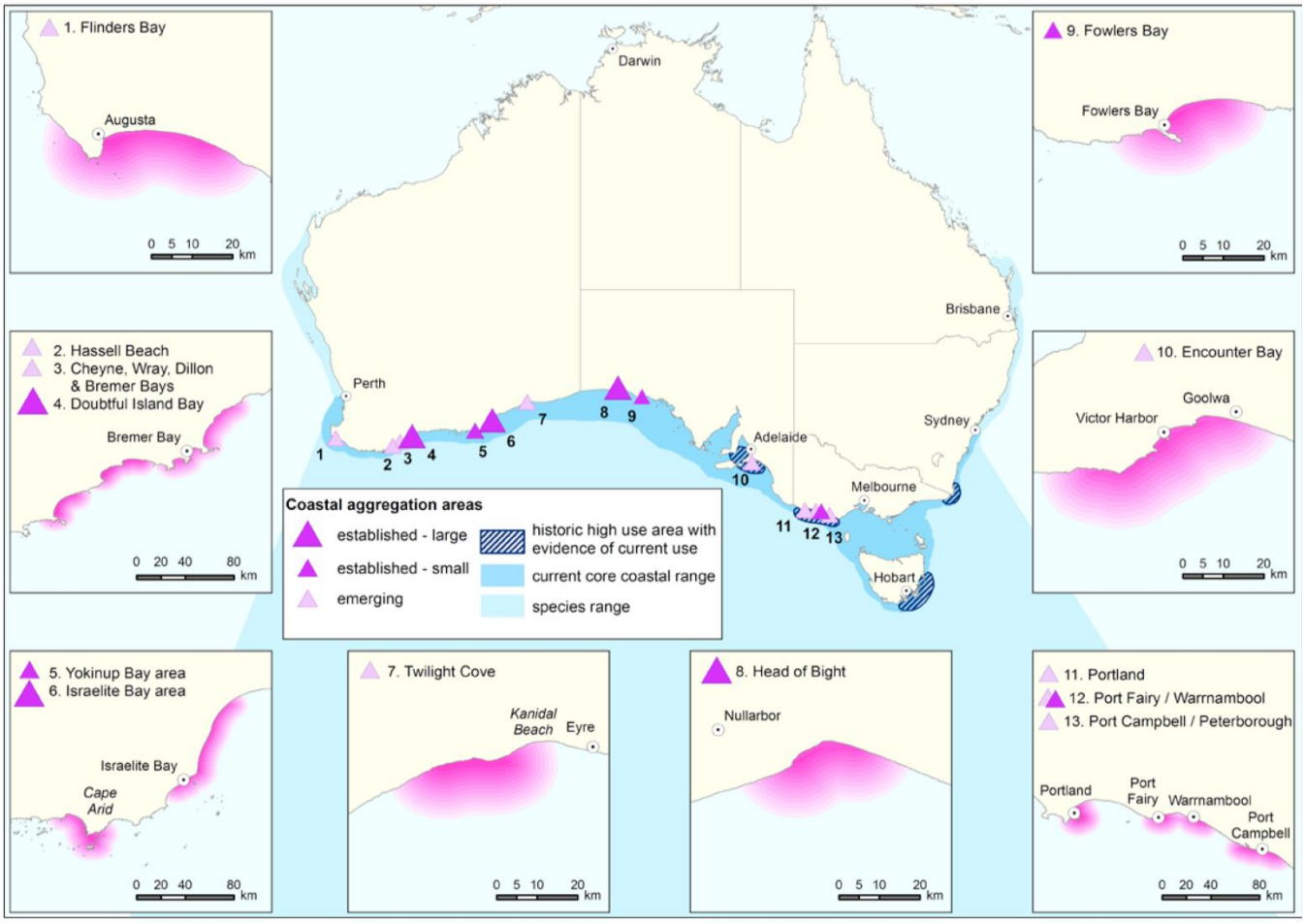
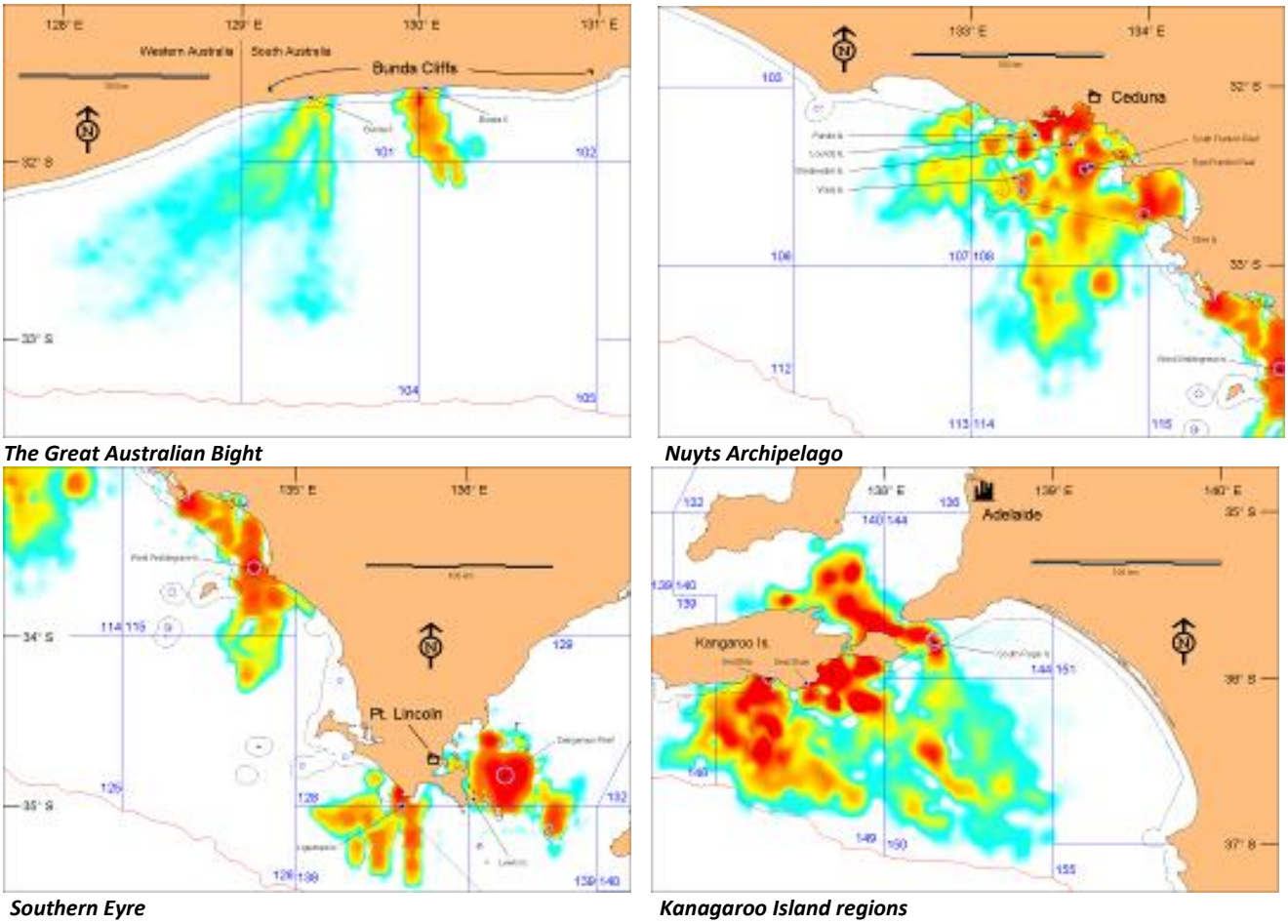


Figure 6-7 Known aggregation locations for southern right whale in South Australia (DSEWPaC, 2012)

Two seal species are considered common in the Spencer Gulf area (Caton *et al.*, 2011a), the Australian sea lion and the New Zealand fur seal. The Australia sea lion is endemic to Southern Australia and only known to occur in South Australia and Western Australia (DSEWPaC, 2013; SPRAT, 2014). The entire Spencer Gulf, including the study area, is a known foraging range for Australian sea lions (Goldsworthy *et al.*, 2007). The species range is vast covering approximately 30% of the 178,000 km^2 of potential habitat from Western Australia to Kangaroo Island, with individual Sea lions known to travel around 70 km while foraging (DSEWPaC, 2013). Aerial surveys (Shaughnessy *et al.*, 2005) indicated several pupping sites around the western and southern coast of the Eyre Peninsula. A number of pupping sites exist in the southern Spencer Gulf including English Island, Lewis Island and Dangerous Reef (PIRSA, 2008), with the closest site to the study area being in Sir Joseph Banks Conservation Park including Langton Island (Shaughnessy *et al.*, 2011) some 45 km to the south of Cape Hardy. While the species is capable of utilising all waters in South Australia they tend to aggregate in breeding colonies

where they also focus their foraging effort, (see Figure 6-8). Therefore Australian Sea lions are unlikely to be heavily reliant on the waters surrounding Cape Hardy.



The Great Australian Bight *Nuyts Archipelago*

Southern Eyre *Kanagaroo Island regions*

Figure 6-8 Geographic distribution of foraging Australian Sea lions across South Australia (high: red, medium: orange, low: blue) (DSEWPaC, 2013)

New Zealand fur seals also breed in South Australia, however all known pupping sites for the species are outside the Spencer Gulf on offshore islands either to the west or south of Eyre Peninsula and Kangaroo Island (Shaughnessy, 1999; Shaughnessy *et al.*, 2005; Goldsworthy and Page, 2009). Outside of the breeding season the South Australian colonies of New Zealand Fur Seals are known to forage from the coastline near Fowlers Bay to southern Tasmania and offshore out to 1000 km south of the continental shelf break. While adult males and juveniles are found in both gulfs adult females tend to use offshore waters (Goldsworthy and Page, 2009). Therefore although the species is likely to occur at Cape Hardy, the study area is unlikely to represent significant habitat for either breeding or foraging.

The three turtle species (leatherback, loggerhead and green) that have been recorded in Spencer Gulf are considered only occasional visitors to the area as none of the species use haul out beaches or breed within Southern Australia. They are rarely seen, with several of the records for turtles in Spencer Gulf based on dead animals washed ashore or found floating (Caton *et al.*, 2010; ALA, 2013). These species generally inhabit tropical waters in Australia from northern New South Wales, Queensland, and Northern Territory around to the Pilbara in Western Australia. All marine turtles are migratory, leading essentially pelagic lives. The males do not come ashore once hatched and tend to have large ranges that can extend into temperate waters as they forage or seek out access to new areas of females. Females are predominantly found in the tropics and only come ashore to dig nests and lay eggs. There are no known nesting sites for any marine turtle species in Southern

Australia (ICUN, 2013; IOSEA, 2013; SPRAT, 2014). Therefore the records of marine turtles in Spencer Gulf are most likely for vagrant males.

6.5.2 Impacts and Risks: Marine Megafauna

Impacts could occur to marine megafauna as a result of:

- Loss of habitat through clearance or exclusion
- Disturbance to breeding colonies or haul-out beaches
- Noise emissions during construction and operation
- Vessel interaction and increased likelihood of ship strike as a result of increased vessel traffic
- Marine debris
- Pollutant build-up or spills including oil
- Introduction of disease

6.5.2.1 Impacts

As previously outlined, the study area of the proposed port does not represent critical habitat, including haul-out or nursery beaches, foraging areas, mating area or migration path for any identified marine megafauna. As such, the loss of intertidal and subtidal habitat (as discussed in Section 6.2 and 0) is not anticipated to significantly impact marine megafauna.

The key identified impact to marine megafauna is as a result of noise emissions from the construction and operation of the proposed port. Impacts to marine fauna (including megafauna) from noise are discussed in detail in Section 6.7. In summary, the predominant source of noise is piling during construction. Vessel movements during both construction and operation also represent a key noise source. Noise emissions will alter the behavioural patterns of marine megafauna. Impacts will vary between individuals as an animal's response to construction noise is dependent on the individual animal's sensitivity and curiosity. Animals that initially display behavioural responses such as avoidance when encountering a new noise may quickly become habituated to the noise. For example bottlenose dolphins are commonly observed around the world inhabiting operating ports despite ongoing noise emissions (ADS, 2007).

Soft start piling procedures will be implemented prior to the commencement of piling operations. Soft start piling provides the opportunity for marine fauna to vacate an area and avoid the full impact of noise from piling. Noise modelling for the proposed port facility has taken into account underwater noise from vessels and predicted that there would be no noise impacts to low-frequency cetaceans beyond 10 m from the vessel propeller (Sonus, 2014). Due to the sound propagation through water it is likely that SRW or other megafauna would hear vessels long before damage could occur and move away from the source. As such, noise emissions during construction and operation of the proposed port are not anticipated to result in physical injury to marine megafauna. Behavioural patterns of megafauna are expected to change as a result of ad hoc noise emissions during construction and operation. Noise emissions will predominately occur within the study area with affects beyond this area not anticipated. As such, noise emissions from the proposed port are expected to result in a long term change to behavioural patterns of megafauna within the study area, considered to be a medium impact.

An assessment of the likelihood of occurrence and impacts to each marine megafauna potentially occurring within the study area is provided in Table 6-6 below.

Table 6-8 Marine megafauna: likelihood of occurrence and potential impacts

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
	Mammals					
Arctocephalus forsteri	New Zealand Fur seal	Marine (EPBC)	**Possible.** There are four BDBSA records for this species at Lipson Island (ALA, 2013) and one record at Port Neill, both confirmed by the SA Museum (ALA, 2013). No BDBSA records exist for this species within 10 km of the site (BDBSA, 2012). There are no known haul-out areas or breeding colonies for this species within 100 km of the development area (Shaughnessy *et al*., 2005). This species may pass in the vicinity of the development site however the size and location of the development will not significantly impact critical habitat for this species. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Oil spill; loss of habitat through clearance or exclusion; disturbance to breeding colonies or haul-out beaches; vessel impacts; noise impacts; entanglement in marine debris introduction of disease	There is no potential for the development to impact on breeding colonies or haul out beaches required by this species as there are none present in the development area. The development does not represent critical habitat or affect a large area of the gulf, therefore, no significant impacts on this species are likely from clearance or exclusion from foraging areas. Therefore **impacts on this species from the development are not expected to be significant**.	N
Arctocephalus pusillus	Australian Fur seal, Australo-African Fur seal	Marine (EPBC); Rare (NPW)	**Possible.** No live sightings of this species have been recorded within 10 km of the development area (ALA, 2013; BDBSA, 2013). There are no known haul-out areas or breeding colonies for this species within 100 km of the development area (BDBSA, 2012). There are two records for the species from the SA Museum representing preserved specimens collected at Port Neill and Tumby Bay in 2009 and 2011 respectively (ALA, 2013). This species may pass in the vicinity of the development site; however, the size and location of the port site mean it will not disrupt critical habitat for this species. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Oil spill; loss of habitat through clearance or exclusion; disturbance to breeding colonies or haul-out beaches; vessel impacts; noise impacts; entanglement in marine debris introduction of disease	There is potential for this species to pass within the vicinity of the port site. There is no potential for the development to impact on breeding colonies or haul out beaches as there are none present in the area. The development area does not represent critical habitat or a large area of the gulf; therefore no significant impacts to this species are likely from clearance or exclusion from foraging areas. Therefore **impacts on this species from the development are not expected to be significant**.	N
Balaenoptera acutorostrata	Minke whale	Whales and other Cetaceans	**Unlikely.** This species was not recorded opportunistically during Jacobs site surveys, or from recent marine surveys at Port Spencer (Golder Associates, 2011). No records for this species occur within the Spencer gulf (ALA, 2013; BDBSA, 2013). The species' range	Vessel collision; entanglement in marine debris; oil	Given the species is unlikely to frequent the area (based on historical sighting information (ALA, 2013; BDBSA 2013), has	N

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
		(EPBC); Rare (NPW)	includes coastal and offshore waters of the Pilbara, southern Australia including Tasmania and up to Cape Yorke in Queensland (SPRAT, 2014). The Common Minke Whale is found in all oceans from 65°S to 80°N (ICUN, 2013). Population estimates for Common Minke whales from the Northern hemisphere exceed 100,000 individuals while estimates for the Southern hemisphere are not available due to sighting data not distinguishing between Common and Dwarf species (ICUN, 2013). During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	spills; noise impacts – seismic, drilling, piling	a large geographic range and a total global population above any threshold for threatened species (ICUN, 2013), **impacts on this species from the development are not expected to be significant**.	
Balaenoptera edeni	Bryde's whale	Migratory, Whales and Other Cetaceans (EPBC); Rare (NPW)	**Unlikely**. This species was not recorded opportunistically from Jacobs' surveys or recent marine surveys at Port Spencer (Golder Associates, 2012). There are no records of this species within 50 km of the study area (BDBSA, 2012). Two records for this species exist in the Spencer Gulf - one stranding at Corny Point at the tip of Yorke Peninsula in 1971 from the SA Museum and one unverified and undated sighting at Port Augusta (ALA, 2013). The species' is not known to frequent Spencer Gulf and the recorded sightings of this species within South Australia are limited to stranding records (SPRAT, 2014). Historically, Bryde's Whales have been confused with other species including the Sei Whale. Bryde's Whales are likely to be found along either east or west coasts of Australia and less so along the southern coast (Bannister *et al*. 1996). Any individual or group of this species entering the gulfs would therefore be considered a vagrant visitor. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	The development site does not coincide with critical habitat for this species. Therefore, although Bryde's whales may enter the Spencer Gulf it is unlikely that the Bryde's whale travels in the vicinity of the harbour as part of its natural range. It is **unlikely for the development to have any significant impact on this species**	N
Balaenoptera musculus	Blue whale	Endangered, Migratory,, Whales and Other Cetaceans, Marine (EPBC); Endangered (NPW)	**Unlikely.** No records of this species have been submitted to the BDBSA within 50 km of the study area (BDBSA, 2012). The proposed port site is not in the vicinity of known feeding areas, migration paths or breeding grounds. This species is the largest animal to exist on the planet and therefore is highly conspicuous. Given the lack of sightings for the species in Spencer Gulf, it is highly unlikely to frequent the port site. While this species may have the potential to pass through gulf waters, the development area does not represent critical habitat for this species and therefore the presence of the species is unlikely. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	It is unlikely for this species to pass in the vicinity of the development site as the gulf is not critical habitat for this species. As the port site is not within critical habitat for the species the species is unlikely to frequent the development. Therefore **impacts on this species from the development are not expected to be significant**.	N

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Caperea marginata	Pygmy right whale	Migratory, Whales and Other Cetaceans (EPBC); Rare (NPW)	**Unlikely.** No records of this species have been recorded in the BDBSA within 50 km of the area (BDBSA, 2012). The species' range within South Australia does not include Spencer Gulf. This species has the potential to pass in the vicinity or enter the Spencer Gulf; however, the development will not interfere with critical habitat for this species. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	It is unlikely for this species to pass in the vicinity of the development site as the gulf is not critical habitat for this species. It is **unlikely for the development to have any significant impact on this species**	N
Delphinus delphis	Common dolphin, Short-beaked common dolphin	Whales and Other Cetaceans (EPBC)	**Present.** This species was sighted during the underwater video tow component of the surveys at the port site (SKM). This species is found globally in tropical, subtropical and temperate waters of the Atlantic, Pacific and Indian Oceans with a population in excess of 3 million (SPRAT, 2014). The extent or population of the Common Dolphin in Australia has not been estimated but it is known to inhabit all coastal and offshore regions of Australia with no fragmentation of the populations (SPRAT, 2014). During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	This species was observed during the marine survey at the site. As this species is highly mobile with a large global range the development area does not represent a significant area of critical habitat for this species nor would any impacts from the port pose a significant impact to the species. It is **unlikely for the development to have any significant impact on this species.**	N
Eubalaena australis	Southern right whale	Endangered, Migratory, Whales and Other Cetaceans, Marine (EPBC)	**Possible.** The port site is not considered critical habitat for this species. The known calving and feeding grounds for this species do not include Spencer Gulf. The range of this species in Australia covers southern waters from Exmouth in WA to Harvey Bay in QLD, including Tasmania. There are several calving grounds in Australia: parts of WA, the Great Australian Bight outside of the SA gulfs, Warnambool Victoria, Tasmania and NSW (SPRAT, 2014). The species only frequents Australian coastal waters during the winter months and over summers in the Southern Ocean or Sub-Antarctic waters with populations found in South Africa, New Zealand and Argentina. Kemper (SA Museum) noted that sightings of the species have been made less than 10 times within Spencer Gulf since 1948, including at the port site in 1983 and 1984 (BDBSA, 2012). This species is rather conspicuus and sightings of individual animals are often logged multiple times. Recent sightings around Lipson Island (Golder Associates, 2013) indicate the species may pass within the vicinity of the port site but the development site does not represent critical habitat for this species. The occurrence of this species at the port would be considered transient; as the gulf is not a significant migration path or critical breeding area (Bannister *et al*. 2005). During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine	Direct disturbance; vessel collision; entanglement in marine debris, oil spills; noise impacts – seismic, drilling, piling	Southern Right Whales may travel within Spencer Gulf sporadically, including in the vicinity of the port site. However, the gulf is not a significant migration path or critical breeding area. It is therefore considered unlikely the species would be present the majority of the time. As the port site does not represent critical habitat for the species the development is not expected to have a significant impact on the Southern Right Whale. It is **unlikely for the development to have any significant impact on this species.**	N

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			mammals and turtles.			
Grampus griseus	Risso's Dolphin, Grampus	Whales and Other Cetaceans (EPBC)	**Unlikely.** No records of this species have been recorded in the BDBSA within 50 km of the area (BDBSA, 2012). The species are considered to be widely distributed around the Australian mainland and are found in tropical and sub-tropical coastal and shallow offshore waters throughout the Indian Ocean, Indo-Pacific and Pacific Ocean (SPRAT, 2014). This species has the potential to pass in the vicinity or enter the Spencer Gulf; however, the development will not interfere with critical habitat for this species. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	It is likely that suitable habitat for Grampus exists near the study area, and it is possible that this species may occur as a visitor to the area. The habitat near the study area is, however, unlikely to sustain an important population of this species. Given the limited disturbance of marine habitat and the lack of sightings of Grampus in the wider area, **unlikely for the development to have any significant impact on this species.**	
Lagenorhynchus obscurus	Dusky dolphin	Migratory, Whales and Other Cetaceans, Marine (EPBC)	**Unlikely**. No records of this species have been submitted to the BDBSA within 50 km of the study area (BDBSA, 2012). The only record for this species in South Australia comes from the southern Coorong, representing a specimen collected by the SA Museum in 2003 (ALA, 2013). The species' presence in Australia is only known from 13 reports since 1828. This species has an estimated distribution from Western Australia to Tasmania (SPRAT, 2014). There are well documented populations of the species in New Zealand, South America and South Africa with its global population considered to be moderately abundant across the sub-Antarctic regions (SPRAT, 2014). Due to the paucity of records for this species in Australia, its presence at the port site is unlikely. As the species is thought to only move between Australia and other countries (SPRAT, 2014), the port site is not considered to represent critical habitat for this species. The population size of Dusky Dolphins is unknown; however, the low stranding and sighting rates suggest these dolphins are uncommon in Australian waters (Bannister *et al*. 1996). Due to the geographic range and low frequency of sightings for this species in South Australia, impacts from the development on this species are not expected to be significant. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	As the proposed development is not in the vicinity of known breeding or significant foraging areas it is considered unlikely that this species will be present at the site. It is **unlikely for the development to have any significant impact on this species.**	N
Megaptera novaeangliae	Humpback whale	Vulnerable, Migratory, Whales and Other Cetaceans	**Unlikely.** No records have been submitted to the BDBSA for this species within 50 km of the study area (BDBSA, 2012). Kemper (SA Museum) noted that there were less than 10 sightings of this species within the Spencer Gulf and there are no known calving grounds for the species off southern Australia as the species prefers tropical waters for breeding (Kemper, 2005). The Spencer Gulf does not form part of any migration path, feeding or	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic,	As the proposed development is not in the vicinity of known breeding areas, migration paths or significant foraging areas, it is considered unlikely that this species will be present. It is **unlikely for**	N

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
		Marine (EPBC); Vulnerable (NPW)	calving ground for this species (Bannister *et al*., 2005; SPRAT, 2014). Despite the potential for species to enter the gulf, the port site is not considered critical habitat for the Humpback Whale. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	drilling, piling	**the development to have any significant impact on this species.**	
Neophoca cinerea	Australian sea lion	Vulnerable, Marine (EPBC)	**Unlikely.** No BDBSA records of this species have been submitted within 10 km of the area (BDBSA, 2012). There is a record of an opportunistic sighting of a Sea lion taking a Little penguin at Lipson Island (Madden-Hallett *et al*., 2011). The most current BDBSA records of the species were a haul-out area at Point Gibbon >100 km from the Study area in 1992 (DEWNR 2013) with less than 10 individuals and no record of the species in the area since 2000. Although the development is within the known range of the species and may provide suitable habitat it is unlikely the species would frequent the beach near the development. The site is not close to any known breeding sites or existing haul-out beaches. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Loss of habitat; disturbance; vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling; introduction of disease	The proposed development is not in the vicinity of known breeding or significant foraging areas, it is considered unlikely the species would be present. It is **unlikely for the development to have any significant impact on this species.**	N
Orcinus orca	Killer whale, Orca	Migratory, Whales and Other Cetaceans, Marine (EPBC)	**Unlikely.** Orcas (Orcinus orca) are a well-known distinctive species that move freely between southern and northern hemispheres, occurring all around the world though in greater abundant in cooler waters. Orcas have been recorded in all Australian states, but not in the Northern Territory. Concentrations of an Orca population are believed to occur around Tasmania, and sightings occur in South Australia and Victoria. Orcas are not known to be migratory, and seasonal movements are thought to relate to changes in food supply. Orcas are considered a 'data deficient' species by the IUCN, reflecting the level of unknowns about the world population. There have been several records in South Australia, including one reported stranding near Tumby Bay (approximately 30 km south of the study area) in 2000 (ALA, 2013). During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	It is likely that suitable habitat for Orcas exists near the study area, and it is possible that this species may occur as a visitor to the area. The habitat near the study area is, however, unlikely to sustain an important population of this species. Given the limited disturbance of marine habitat and the lack of sightings of Orcas in the area, **unlikely for the development to have any significant impact on this species.**	N
Tursiops aduncus	Indian Ocean bottlenose dolphin, Spotted	Whales and Other Cetaceans (EPBC)	**Possible.** Two records of this species were recorded in Spencer Gulf in 1998 and 2000 by the SA Museum as identified by Kemper (ALA, 2013). The species *Tursiops aduncus* are considered to be widely distributed around the Australian mainland and are found in tropical and sub-tropical coastal and shallow offshore waters throughout the Indian	Vessel collision; entanglement in marine debris; oil spills; noise	The species is highly mobile and may pass in the vicinity of the port site however the development site is not critical habitat for this species. It is **unlikely for the**	N

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
	bottlenose dolphin		Ocean, Indo-Pacific and Pacific Ocean (SPRAT, 2014). However, recent studies of the genetics of Australian bottlenose dolphin suggest that the population in southern Australia waters described by Kemper (Kemper, 2004) may be a separate, as yet un-described taxon of dolphin (Möller *et al.*, 2008). Regardless, this species would be protected under the EPBC Act as a cetacean and under State legislation (NPW Act, 1972). As the species has been documented at Tumby Bay (ALA 2013) there is the potential for it to pass in the vicinity of the development area. However as the size and location of the port site does not represent a substantial area of habitat for this species it is not expected that the construction and operation of the port would pose a significant impact to this species. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles.	impacts – seismic, drilling, piling	**development to have any significant impact on this species.**	
Tursiops truncatus s. str.	Bottlenose dolphin	Whales and Other Cetaceans (EPBC)	**Possible**. This species occupies a broader range of habitats than any other marine mammal; it can be found in estuaries and coastal waters or open-water pelagic areas, live in large oceanic pods or small family groups, sometimes with defined territories. This species may pass in the vicinity of the development area or even use the area as a fishing ground since they have been recorded at Tumby Bay (ALA 2013). However, the size and location of the port site does not represent a large area of critical habitat for this species. The species is well adapted to human settlement with well documented pods living in operating ports such as Port Adelaide or frequenting urban waterways in WA and QLD. Given the range and adaptability of this species it is considered unlikely that the operating port would have any significant impacts on the species. During construction of the wharf and MOF a CEMP will be developed to minimise impacts to all species of marine mammals and turtles and an OEMP will be developed for the operation of the port to protect all species of marine mammals and turtles..	Vessel collision; entanglement in marine debris; oil spills; noise impacts – seismic, drilling, piling	This species is highly mobile and may pass in the vicinity of the port site. However, the development is not critical habitat for this species. It is **unlikely that the development will have any significant impact on this species.**	N
	Reptiles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory, Marine (EPBC)	**Unlikely** that this species would be present. Key breeding and foraging habitat occurs in tropical areas of Australia, far away from the study site. The development site is not a known habitat for the species. This turtle is a marine species not capable of using terrestrial area and is unlikely to frequent Cape Hardy. The Spencer Gulf is not a known habitat for this species and as such it is unlikely this species would be found in the gulf. There are no know haul out beaches in SA. No records of this species have been submitted to the BDBSA within 50 km of the area (BDBSA, 2012).No opportunistic	Entanglement in marine debris; vessel impacts; noise impacts.	The development site or gulf is not a known critical habitat for the species. It is **unlikely that this species would be present and therefore no significant impact on this species is expected from the development.**	N

Potential marine megafauna at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative Protection e.g. EPBC or NPW Status**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			sightings of this species were recorded during Jacobs surveys.			
Chelonia mydas	Green turtle	Vulnerable, Migratory, Marine (EPBC)	**Unlikely** that this species would be present. The key nesting sites for this species are in NT, WA and QLD and females rarely leave the tropics. Males (and young turtles <10 years) may travel through temperate waters however temperate oceanic waters are not critical habitat for this species. The species may pass in the vicinity of Spencer Gulf however it is unlikely to be found in the gulf. As females do not leave the tropics and males do not come ashore, Cape Hardy could not be considered a haul out beach for these turtles. No records of this species have been submitted to the BDBSA within 50 km of the area (BDBSA, 2012).No opportunistic sightings of this species were recorded during Jacobs surveys.	Entanglement in marine debris; vessel impacts; noise impacts.	As the port site is not within the vicinity of known feeding or breeding habitat it is considered **highly unlikely that there would be a significant impact to this species from the development.**	N
Dermochelys coriacea	Leatherback turtle, Leathery turtle, Luth	Endangered, Migratory, Marine (EPBC)	**Highly unlikely** to occur in the are**a.** This species has no known breeding habitat in Australia and as it is a pelagic feeder it is unlikely that the Leatherback Turtle would frequent the Cape Hardy area. Any individual found in the gulf would be a vagrant and not represent a significant number of the species. No records of this species have been submitted to the BDBSA within 50 km of the area (BDBSA, 2012).No opportunistic sightings of this species were recorded during Jacobs surveys.	Entanglement in marine debris; vessel impacts; noise impacts.	It is unlikely for this species to be found in the gulf and any individual found in the gulf would be a vagrant and not representative of the typical behaviour of the species. As the characteristics of the Spencer gulf provide neither critical habitat or breeding sites for the species it is **highly unlikely that the development would have a significant impact on the species.**	N

6.5.2.2 Risks

An increase in boat traffic and manoeuvring during the construction and operation of the proposed port poses a risk of direct contact such as vessel or propeller strike with large marine fauna including whales, pinnipeds, dolphins and turtles. Vessel speeds within the port site will be limited to 6 knots to minimise the likelihood of striking megafauna. Similarly, large cargo vessels will be manoeuvred to the jetty at low speed by tugs. Despite the implementation of vessel management procedures, it is not possible to completely negate the risk of ship strike as whales, pinnipeds, dolphins and turtles can be highly mobile and unpredictable in their movements, often remaining below the surface for substantial periods of time before surfacing.

The potential for ship strike relates to an increase in vessel numbers entering the Spencer Gulf. Currently there are six operating ports in Spencer Gulf (Port Lincoln, Wallaroo, Whyalla, Port Bonython, Port Pirie and Port Augusta) which account for over 4200 annual ship movements (Flinders Ports, 2014). The proposed port at Cape Hardy would accommodate approximately 145 vessels per year (290 vessel movements, or roughly 6 vessel movements per week). The additional 290 vessel movements a year associated with the proposed port would represent a 7% increase to vessel movements in the Spencer Gulf. This figure does not include recreational or commercial vessels based in small harbors within Spencer Gulf and therefore the overall percentage increase in vessel movements is likely far less.

It is generally accepted that the risk of boat strike increases with vessel speed (Hazel *et al.* 2007; Kite-Powell *et al.* 2007; DeAngelis *et al.* 2011) and that the most lethal or severe injuries are caused by vessels greater than 80 m when travelling over 15 knots (Laist *et al*., 2001). The slower a vessel is moving the more time is available for mobile marine fauna to recognise the danger and take action to avoid a collision (van der Hoop et al., 2008; Gende *et al*., 2011; van der Hoop et al., 2012). In addition, the force of a strike is reduced at slower speeds. If marine fauna is visible to the vessel master, then action may also be taken by the vessel master to avoid a collision, by reducing speed or changing direction. However, such action is dependent upon the size of the vessel and safety considerations. Generally, small vessels are more manoeuvrable than large vessels, and have greater capacity to be navigated to avoid collisions. Capesize vessels can take several hundred metres to reduce speed or change course, and avoidance actions are rarely practical in nearshore waters where navigation channels are relatively narrow. As vessels entering or exiting the proposed port would be restricted to less than 6 knot by the port operator, marine fauna would typically have time to avoid collision and/or be spotted by the vessel master.

Water depth also plays a role in determining the risk of boat strike. Shallow seagrass habitats used for foraging by some dolphins and pinnipeds are more likely to incur ship strike than deeper areas where there is significant clearance between the vessel hull and the seabed (Hazel *et al.* 2007). Deeper areas also allow large marine fauna to dive to avoid a collision. In this context, the risk of boat strike is likely to be higher within shipping channels surrounded by shallow seagrass habitats than in deeper habitats offshore. As the Cape Hardy site is located in area of the gulf with a width of over 50 km, water depth exceeding 20m and away from dense seagrass, marine fauna are at a reduced risk of collision compared to ports further north in the gulf.

SRW appear to be the primary species involved in vessel collisions in the southern hemisphere. This is in part due to the species use of nearshore waters during certain times of the year and the physical nature of this species in that the dead SRW have a tendency to float. It is a known attribute of the species to be neutrally buoyant and that carcasses float for several days (Kemper et al., 2008; Silber et al., 2010). Therefore numbers of recorded SRW strikes based on carcasses washed ashore, sighted at sea or even struck after they die may be biased by the very nature of these whales physiology. Nevertheless there are low numbers of recorded strikes in Australasian waters (Van Waerebeek et al, cited in SEWPaC, 2012). This observation is supported by the low number of strikes on SRW recorded by the IWC in Australian waters. Two fatal vessel collisions and three non-fatal collisions were recorded in Australian waters in the period 1950-2006 (Kemper et al, 2008). From 2007 to

2011, an additional three ship strikes on SRW, including two deaths, have been reported to the IWC (IWC, 2011). The data set from 1950-2006 shows instances of entanglement (often from fishing, aquaculture and related industries) are nearly 3 times more common than boat strikes (5 vessel collisions, 13 entanglements) (Kemper et al, 2008). Within South Australia the main areas of vessel traffic are into Port Adelaide with vessels entering or exiting Backstairs passage and Investigator Strait (Figure 6-9). Backstairs passage and Investigator Strait are part of the SRW migration route, yet there has been only one confirmed fatal strike attributable to a large vessel (vehicle and passenger ferry) which occurred at night while the vessel was travelling between Kangaroo Island and the mainland at a speed of 15 knots (Kemper et al, 2008). It should be noted that most of recorded incidents are thought to relate to smaller fast moving vessels.

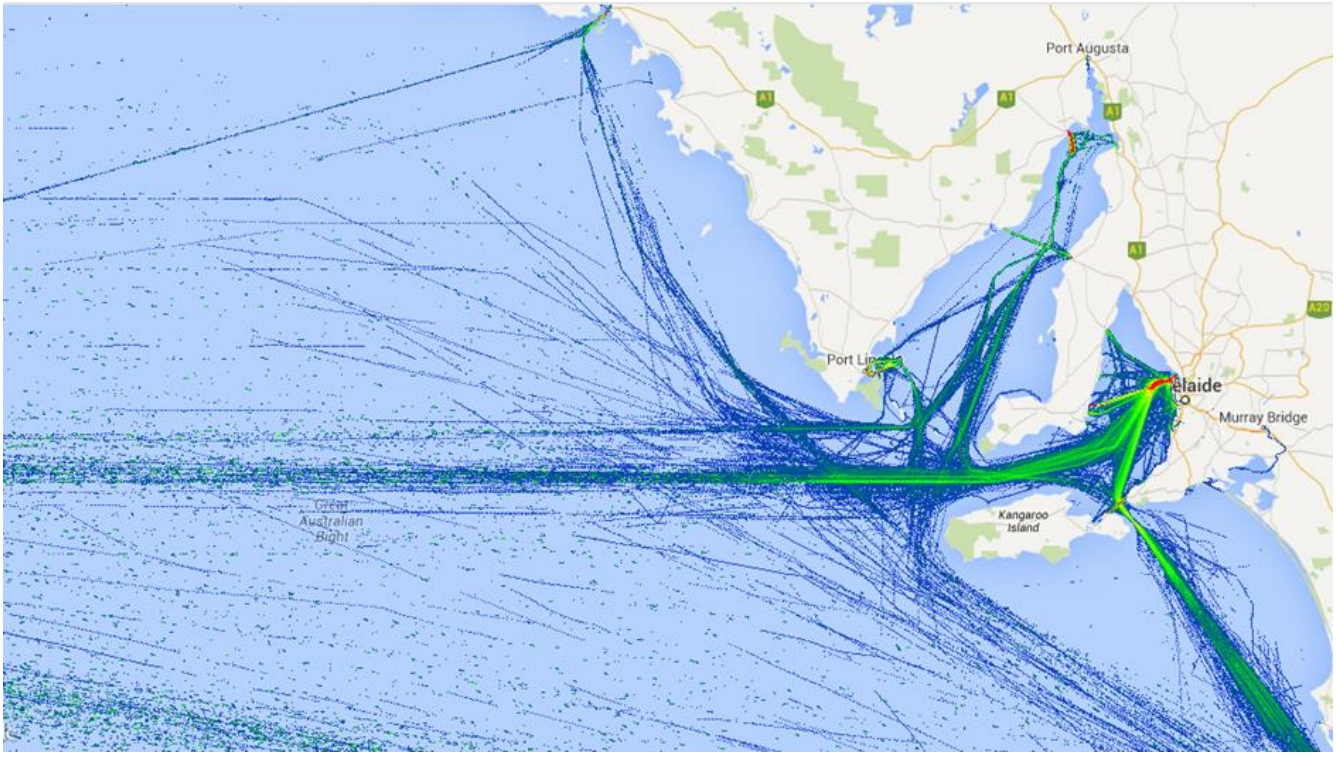


Figure 6-9 Map of shipping routes in and adjacent to Spencer Gulf, based on received Automatic Identification System data. Areas of high shipping traffic are shown in red. Map generated from http://www.marinetraffic.com/en/

The IWC recognises that many vessel strikes to whales may go unreported or undetected due the majority of collisions occurring in open (international) waters. Vessel masters are not required to report all known collisons, however the IWC maintains a register of recorded ship strikes. The Spencer Gulf is not part of any known whale migration route and has substantially less vessel traffic than Gulf St Vincent (Flinders Ports, 2014). Due to the hydrodynamic nature and prevailing winds of Spencer Gulf it is highly likely whales killed by vessel strike in or near the mouth of the gulf would be readily found within the gulf (Kemper *et al*, 2008). Therefore as the number of vessel movements within Spencer Gulf already annually exceed 4000 (Flinders Ports, 2014), the low number of recorded ship strikes on whales in South Australia it is considered that the likelihood of a vessel collision in Spencer Gulf is low.

As expected, wherever possible, most megafauna will avoid contact with moving vessels. However, dolphins, porpoises and some pinipeds often actively seek out moving vessels and swim close alongside in the bow wave which may make them vulnerable to injury from collision. Generally, the risk of collisions with marine mammals is greater for recreational craft and dolphin-watching boats, and subsequently guidelines have been developed for minimising the disturbance to dolphins and whales from these activities (DEH, 2006).

Given the implementation of vessel management procedures, the historical likelihood of ship strike in Australian waters and the location of the proposed port outside of known critical habitat, foraging areas, breeding ground or migration paths for megafauna, the likelihood of ship strike associated with construction and operation of the proposed port is considered to be possible. Should an individual be struck, the consequences are considered to be minor, given that it will not affect the overall viability of the species. As such, the overall risk of ship strike is considered to be low.

Construction and operation of the proposed port will result in the generation of a number of waste streams that may enter the marine environment. Marine debris can significantly affect megafauna as a result of pollution, injury through collision, entanglement or ingestion of non-biological products.

Waste management and handling procedures developed as part of the CEMP and OEMP will control waste streams with the overarching aim of no waste products entering the marine environment. Despite the implementation of control measures, it is considered almost certain that some form of waste / debris will enter the marine environment during construction and operation of the port. As the port site is not a key habitat or breeding area, the consequences of debris entering the marine environment are considered to be minimal; insignificant to the overall viability of megafauna. As such, the overall risk is considered to be low.

Megafauna are also at risk from the unintended discharge of pollution in the form of site run-off, wastewater, hydrocarbons or chemicals. With any marine activity there is potential for waste or spills to enter the marine environment. The implementation of design measures (refer Section 4) for the control of surface and waste water at the port site will limit the majority of hazardous pollutants from entering the marine environment. There remains a risk that a major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be unlikely. As previously outlined, the port site does not represent a critical habitat or breeding colony for megafauna, although some species (e.g. seal) may forage in the area. The consequences of a major spill event are considered to be minor, due to the low level of dependence of megafauna on the study area, resulting in a short term decrease in the local abundance of fauna. As such, the overall risk of a major spill event affecting megafauna is considered to be low.

6.5.3 Conclusions

A wide range of marine megafauna may be present in the area at different times or for limited periods; however a number of species have a higher likelihood of occurring in the waters around Cape Hardy. Australian sea lions, New Zealand fur seals, bottlenose dolphins and common dolphins are likely to be present in the area on a year-round basis. The majority of the marine megafauna potentially in the area are expected to be infrequent visitors to the site or the Spencer Gulf. One whale species, the SRW, may occur in low numbers on a seasonal basis.

Piling and underwater noise is considered to represent the greatest impact to marine megafauna, however this impact is for a limited duration and through the implementation of management procedures (such as soft start piling and observation zones) impacts are expected to be medium.

6.6 Protected Fish Species

The Spencer Gulf supports a diverse range of fish species due to the diversity of habitat niches extending from deepwater rocky reefs, to sandy beaches, seagrass beds and mangroves in the upper gulf. Many areas within the gulf provide nursery and spawning areas for protected or commercially important fisheries species. This section identifies which fish species of conservation value are present within the study area. Commercially important fish species are addressed in Section 6.9.

6.6.1 Existing Environment and Key Findings

The Spencer Gulf supports a high diversity of fish species due to its range of marine ecosystems, which provide suitable habitats for both endemic and migratory fish species. In the Cape Hardy area the predominant habitats are nearshore rocky reef, bare sediments and seagrass beds, which provide nursery and feeding area for fish, including commonly observed species of pipefish, toadfish and leatherjackets (Bryars, 2003).

During the towed video surveys several fish were observed including a leafy seadragon (protected under the Fisheries Management Act and an EPBC listed marine species) within a patch of dense *Amphibolis* and *Posidonia* seagrass meadow.

The desktop study identified 77 fish species as potentially occurring in the study area, with 29 fish species protected under either the Fisheries Act, EPBC Act, or both. Several additional fish species were also opportunistically sighted during the video-tow survey. With the exception of the leafy seadragon, none of the species observed in the area are protected under legislation. As survey transects were not designed to detail the presence, absence, abundance, density or species composition of fish in the area, this is simply a record of incidental observations.

The EPBC protected species were predominantly pipefish or seahorse species with the other species of note considered likely to occur in this region the great white shark (*Carcharodon carcharias*), shortfin mako (*Isurus oxyrinchus*) and porbeagle (*Lamna nasus*). The great white shark is protected under the EPBC Act and listed as 'Vulnerable' and the mako and porbeagle are listed as 'Migratory'. Great white sharks are also protected under the Fisheries Act. The great white shark is known to feed in the Eyre Peninsula region, especially in the vicinity of seal pupping colonies. It is also thought that great white sharks may breed in the Spencer Gulf and inshore coastal waters may be important nursery grounds (DEWHA, 2007).

6.6.2 Impacts and Risks: Protected Fish species

There is potential for a number of fish species to be present within the seagrass, reef and soft bottom areas of the site however fish species in the port area are unlikely to suffer high impacts from the ongoing operation of the port.

Impacts to protected fish could occur as a result of:

- Loss of habitat through clearance, exclusion or degradation of the environment
- Pollution from run-off, oil or chemical spills
- Marine debris
- Noise and physical impacts during construction piling
- Artificial light spill
- IMS

6.6.2.1 Impacts

As previously outlined, the study area of the proposed port does not represent critical habitat for any identified protected fish species. Loss of habitat during the construction phase has been discussed in Section 6.1, 6.2 and 0. Construction of the MOF will result in the loss of some soft bottom habitat and covering of existing reef area that may provide habitat for fish species. Recovery of lost habitat is anticipated following construction, with total clearance conservatively estimated at less than 3 Ha (Table 6-3). As such, the disturbance of intertidal and loss of subtidal habitat is considered to represent a low impact; a short term negative change to fish species that can utilise alternate habitat within the study area and areas subject to regeneration.

The key identified impact to fish species is as a result of noise emissions from the construction and operation of the proposed port. Impacts to marine fauna (including fish species) from noise are discussed in detail in Section 6.7. In summary, the predominant source of noise is piling during construction. Vessel movements during both construction and operation also represent a key noise source. Noise emissions will alter the behavioural patterns of fish species.

Soft start piling procedures will be implemented prior to the commencement of piling operations. Soft start piling provides the opportunity for fish species to vacate an area and avoid the full impact of noise from piling. Underwater noise modelling indicates that any physical damage caused by noise impacts from impact piling will be predominantly limited to fish with swim bladders and cephalopods within 30 m of the piling, while non-swim bladder fish will most likely only suffer behavioural changes (avoidance) (Sonus, 2014).

Behavioural patterns of fish species are expected to change as a result of ad hoc noise emissions during construction and operation. Noise emissions will predominately occur within the study area with affects beyond this area not anticipated. As such, noise emissions from the proposed port are expected to result in a long term change to behavioural patterns of fish species within the study area, with physical damage only caused within a few metres of impact piling and likely to be avoided through the implementation of soft start procedures, considered to be a medium impact.

The introduction of artificial light sources during construction and operation of the proposed port will be required for safe night-time operations and way finding. Artificial light sources can attract a number of fish species, thus affecting the abundance of resources for resident species. As light spill will be minimised through the use of directional lighting (i.e. oriented to a specific area) and the study area does not critical habitat for any fish species, no change to fish distribution or abundance is anticipated and the overall impact is considered to be negligible.

The likelihood of each species occurrence and potential impacts on that species are detailed in Table 6-9.

Table 6-9 Fish species: likelihood of occurrence and potential impacts

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
SHARKS						
Alopias vulpinus	Thresher shark	Reef fish of conservation concern in South Australia (Baker, 2011)	**Unlikely** for species to be present in area. This species has a very wide distribution, but is most commonly found in offshore waters. It is unlikely that this species occurs in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris	This species is not listed for protection. Given the large range of this shark species the port site development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat**	N
Carcharhinus brachyurus	Whaler shark, Bronze Whaler	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species is most abundant between Albany (WA) and Bass Straight, occasionally entering large bays and inshore areas, but spending the majority of time along continental margins. Despite a lack of records submitted to the ALA and BDBSA, it is considered likely that whaler sharks are occasional visitors in the lower Spencer Gulf. Accordingly, it is possible that this species occurs in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	This species is not listed for protection but is of conservation, commercial and recreational interest and occurs throughout the Spencer Gulf. Given the large range of this shark species the port site development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat**	N
Carcharhinus obscurus	Dusky Whaler	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species ranges from the surf zone to well offshore, to a depth of 400 m, and is found in all Australian coastal and continental shelf waters. Despite a lack of records submitted to the ALA and BDBSA, it is considered that Whaler Sharks are occasional visitors in the lower Spencer Gulf. Accordingly, it is possible that this species occurs in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	This species is not listed for protection but is of conservation, commercial and recreational interest and occurs throughout the Spencer Gulf. Given the large range of this shark species the port site development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat**	N
Carcharodon carcharias	Great White Shark	Vulnerable, Migratory, Marine (EPBC); Fisheries Act	**Possible.** No sighting records of the species have been submitted within 50 km of the area (BDBSA, 2013). The species range is large and may therefore pass in the vicinity of the wharf on route to hunt in areas north or south of Cape Hardy. The species' habits include long migrations by individuals and gatherings around seabird, seal and sea lion colonies.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; vessel impacts	The major fishing grounds for this species tend to centre on seal or sea lion colonies, which are not present within the port site. Therefore while it is possible for the species to be present at the port, given the large global range of White Sharks and the development area is not considered to represent a significant hunting area, the port **will not significantly impact this species or its preferred habitat**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Heterodontus portusjacksoni	Port Jackson shark	N/A	**Present.** Several individuals sighted during video tow survey, including one juvenile, sighted on predominantly sandy substrate. The species is well known to due to its distinctive appearance, and is common throughout South Australia	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	This species is not considered threatened or listed for protection. It occurs throughout the Spencer Gulf and southern Australia. Given the large range of this shark species the port development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat.**	N
Isurus oxyrinchus	Shortfin Mako	Migratory, Marine (EPBC) Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species ranges from close inshore in surface waters to 150 m depth, though generally restricted to waters warmer than 16 °C (Australian Museum, 2013). Fisheries catch records logged on the ALA indicate the presence of the Shortfin Mako in waters offshore of South Australia in 2001-2002 and earlier records in the 1980s from the SA Museum for inside the Spencer Gulf (ALA, 2013). It is therefore possible that this species could pass by the study area, although due to the paucity of records for the species in SA any individuals in the Cape Hardy area would be considered vagrants.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	This species is not listed for protection but is of conservation, commercial and recreational interest and occurs throughout the Spencer Gulf. Given the large range of this shark species the port development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat.**	N
Lamna nasus	Porbeagle, Mackerel Shark	Migratory, Marine (EPBC)	**Possible**. No records of the species have been submitted to the BDBSA within 50 km of the area (BDBSA, 2013). However this species has a large range and may therefore pass in the vicinity of the wharf to forage in the Cape Hardy area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	Given the large range of this shark species the port development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat.**	N
Mustelus antarcticus	Gummy shark	N/A	**Possible.** This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. It is possible that suitable habitat exists in the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	Given the large range of this shark species the port development area is not considered critical habitat and therefore is **will not significantly impact this species or its preferred habitat.**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Orectolobus halei, O. maculatus, Sutorectus tentaculatus	Wobbegong shark (various)	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species is not listed for protection but is regarded as a species of conservation concern by Reef Watch. It is possible that suitable habitat exists in the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	Given the large range of this shark species the port development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat.**	N
Urolophus orarius	Coastal Stingaree	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species is endemic to inshore areas of South Australia, usually inhabiting sandy substrates between 14-50 m depth. The range of this species is between Beachport and Ceduna, in South Australia. The majority of records for this species come from the 20 to 50 m depth range as almost all records of the species are from prawn trawl by-catch, which is restricted to depths of more than 10 m (SPRAT, 2014) The species may utilise shallower habitats as well, however there has been no sampling in shallow waters. Suitable habitat exists in the study area, and while no records have been submitted to the ALA in Spencer Gulf, it is possible that this species is present or occasionally visits the area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling	The species is classified as Endangered by the ICUN red list but was rejected for nomination of listing under the EPBC Act in 2011 (SPRAT, 2014). The species is not listed for protection but is of conservation concern. . It is likely that this species occurs in the area as suitable habitat is present. A small amount of potential habitat for this ray species will be affected by the development however given the species large range the port development area is not considered critical habitat and therefore the port **will not significantly impact this species or its preferred habitat.**	N
FINFISH						
Achoerodus gouldii	Western blue groper	Fisheries Act; Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** Individuals of this species often form residency in an area, usually preferring complex reef habitats. Juveniles of these fish are female and appear yellow-green in colour. This colour changes to a deep blue later in life after they become male. This species is iconic, growing to 1.75 m in length and often surviving for up to 70 years. It is this species' long life-span and slow growth combined with its curiosity towards humans that makes this species sensitive to fishing pressure. This species is regarded as a species of conservation concern by Reef Watch SA.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is protected at all times within Spencer Gulf under the Fisheries Act (SA) (PIRSA, 2014) as it is of conservation and recreation interest. As it occurs throughout remote areas of southern Australia it is possible that this species may occur in the wider area, but it is considered that only limited suitable reef habitat for this species occurs in the project area. Due to the small footprint of the MOF etc. no significant amount of available habitat will be impacted by this development. As the presence of the port will prevent recreational fishing in the port area the port infrastructure may overtime provide a suitable refuge area for this species that prefers complex habitats. **The development will not significantly impact this species or its preferred habitat.**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Aldrichetta forsteri	Yelloweye mullet	N/A	**Possible.** This fish species is widespread around southern Australia. This species prefers sheltered sand and seagrass habitat of < 20 m depth (. Sheltered sand and seagrass suitable for this species is widespread across the Study Site. This species is likely to occur in the area, as several sightings have been logged with the ALA near populated areas north and south of the site (ALA, 2013)^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. It is likely that this species occurs in the area as suitable habitat is present. This species is widespread. A small amount of potential habitat for this fish will be affected by the development. **The development will not significantly impact this species or its available habitat.**	N
Argyrosomus japonicus	Mulloway	N/A	**Possible.** This species' distribution includes the coasts of S.E. Asia, India, Africa, Madagascar and the southern coastline of Australia from Shark Bay (WA) to Brisbane (QLD). Fisheries targeting these fish typically operate in major estuaries in SA. It is possible that this species occurs in the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. While it is possible that this species could occur in the study area, the area does not represent critical habitat for this species. **This development will not significantly impact on this species**.	N
Arripis georgianus	Tommy ruff, Australian herring	N/A	**Likely.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom, seagrass and reefs (Bryars, 2003; Baker, 2004). This small fish species frequently schools in the open water of sheltered bays around southern Australia. It is likely that this species uses suitable habitat within the study area. This species migrates to the south-western corner of Australia to spawn in February and March^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. The study area does not represent critical habitat for this species. **This development will not significantly impact on this species**.	N
Arripis truttaceus	Australian salmon (western)	N/A	**Likely.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom, seagrass and reefs (Bryars, 2003; Baker, 2004). This large fish species is common on southern Australian coasts, often schooling in shallow water, leading to popularity amongst anglers. This species migrates westward to spawn after 5-6 years of growth. It is likely that this species passes by Cape Hardy, but the area does not represent any particular significance to this species' life cycle^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil	This species is not listed for protection but is of commercial and recreational interest and occurs throughout southern Australian waters. The study area does not represent critical habitat for this species. **This development will not significantly impact on this species**.	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				spill; pollution		
Cheliodactylus spectabilis	Banded morwong	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This fish occurs in Australia between NSW and SA, mostly on high-energy shallow coastal reefs. This species reaches a large size at maturity, and can reach 95 years of age. It is likely that their approachable behaviour leads them to be sensitive to exploitation by fishing activities. It is possible that this species occurs in the reef habitat present at the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of conservation concern, commercial and recreational interest and occurs throughout southern Australian waters. The study area does not represent critical habitat for this species. **This development will not significantly impact on this species**.	N
Dactylophora nigricans	Dusky morwong	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This large fish prefers seagrass and reef habitat in shallow waters. This species is common, sighted between NSW and WA in southern waters. It is likely that this species utilises habitat present in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of conservation concern (Baker, 2011), recreational interest and occurs throughout southern Australian waters. The study area does not represent critical habitat for this species. **This development will not significantly impact on this species**.	N
Dinolestes lewini	Long-finned Pike	N/A	**Possible.** This species is common on reefs around southern australia and is likely to occur in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of recreational interest and occurs throughout the Spencer Gulf (Baker, 2011). While it is likely that this species occurs in the study area, the habitat present is unlikely to represent a significant area for the species. **This development will not significantly impact on this species**.	N
Enoplosus armatus	Old wife	N/A	**Present.** One individual was observed over bare silt at over 23 m during the video tow survey. The species depth range is 0-100 m and commonly found as pairs or large individuals in exposed areas but as shoals of smaller fish amongst seagrass or sheltered jetties (Edgar, 1997).	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil	This species is not listed for protection but is of recreational diver interest and occurs throughout the Spencer Gulf (Baker, 2011). While this species is known to occur in the study area, the habitat present is unlikely to represent a significant area for the species and given the species ability to utilise man-made structures for shelter of smaller fish, **this species will not be significantly impacted by this development.**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				spill; pollution		
Hyporhamphus melanochir	Southern Sea garfish	N/A	**Likely.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom and seagrass (Bryars, 2003; Baker, 2004). This species is most commonly found swimming near the surface in areas of seagrass meadow. It is likely that this species occurs in the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf (Baker, 2011). The proposed development does not represent a significant portion of this species' range, and thus **this species will not be significantly impacted by this development.**	N
Hypoplectrodes nigroruber	Black-banded seaperch	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible**. This species generally inhabits reefs, but has also been recorded on artificial reefs, shipwrecks and jetties. Knowledge of this species is limited, though these fish are widely distributed between WA and NSW. It is possible that this species occurs in the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of conservation interest and occurs throughout the Spencer Gulf (Baker, 2011). The proposed development does not represent a significant portion of this species' range, and thus **this species will not be significantly impacted by this development.**	N
Kathetostoma laeve	Eastern or common stargazer	N/A	**Likely.** The species has been regularly reported along the Tumby Bay coastline in areas of sandy bottom and jetties (Baker, 2004). The species is common across southern Australia in waters 0-60 m, it is an ambush predator that prefers sandy or shelly bottoms but is also found around manmade structures. It is likely that this species is present in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of some commercial and recreational interest and occurs throughout the Spencer Gulf (Baker, 2011). As the species is already commonly sighted around jetties, the proposed development will potentially benefit this species and thus **this species will not be significantly negatively impacted by this development.**	N
Kyphosus sydneyanus	Silver drummer	N/A	**Possible.** This species is common across southern Australia, especially nearby rocky reef habitat, including reef in urbanised areas. It is likely that this species is present in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf (Baker, 2011).The proposed development does not represent a significant portion of this species' range, and thus **this species will not be significantly impacted by this development.**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				spill; pollution		
Nelusetta ayraudi	Ocean jacket	N/A	**Present.** This species was sighted on a number of occasions during the video tow survey over bare sand; it is widespread in the Southern ocean continental shelf waters between central WA and Brisbane QLD, including SA gulf waters. This species prefers deep coastal waters as adults, but juveniles utilise bays and estuaries.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of some commercial and recreational interest and occurs throughout the Spencer Gulf (Baker, 2011). While it is possible that this species could occur in the study area, the area is does not represent a large area or critical habitat for the species. **This development will not significantly impact on this species**.	N
Nemadactylus valenciennesi	Southern blue morwong/ Queen snapper	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species occurs in complex reef habitat around southern Australia^. It is likely that this species relies on shallower waters and seagrass habitat during juvenile stages. It is possible that this species occurs in the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest, and is regarded as a species of conservation concern by Reef Watch SA (Baker, 2011). The project area does not contain a significant area utilised by this species. **This development will not significantly impact on this species**.	N
Notolabrus fucicola	Purple wrasse	Reef fish of conservation concern in South Australia (Baker, 2011)	**Unlikely** This species is common in south-east Australia, but rarely sighted in the waters of Spencer Gulf, which is considered the Western-most edge of its range (Gomon *et al.*, 2008). This species prefers low rocky reefs, which have limited coverage in the study area. It is possible that this species occurs in the study area but given its rarity in Spencer Gulf its presence is considered unlikely.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is regarded as a species of conservation concern (Baker, 2011). The project area does not contain an area critical to the life cycle of this species, or likely to support a significant population. **This development will not significantly impact on this species**.	N
Notolabrus parilus	Brown/ orange -spotted wrasse	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species occurs frequently in reef habitat around southern Australia^. There is some indication that juveniles of this species utilise seagrass habitat. It is possible that this species utilises habitat within the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil	This species is not listed for protection but is of conservation concern (Baker, 2011). The project area does not contain an area crucial to the life cycle of this species, or likely to support a significant population. **The development will not significantly impact on species**.	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				spill; pollution		
Notolabrus tetricus	Blue-throated wrasse	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species occurs frequently in reef habitat around southern Australia^. There is some indication that juveniles of this species utilise seagrass habitat. It is possible that this species utilises habitat within the project area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest, and is regarded as a species of conservation concern (Baker, 2011). The project area does not contain an area critical to the life cycle of this species, or likely to support a significant population. **This development will not significantly impact on this species**.	N
Othos dentex	Harlequin fish	Reef fish of conservation concern in South Australia (Baker, 2011)	**Unlikely.** This species inhabits reef habitat around South Australia, particularly reefs with higher habitat complexity, and remote areas with lower historic fishing pressure. It is possible that this species is present in the study area, but it is unlikely that the habitat present supports a high population^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and is regarded as a species of conservation concern by Reef Watch SA, mostly due to its sensitivity to fishing pressure (Baker, 2011). The study area does not represent a significant area of suitable habitat for this species. **This development will not significantly impact on this species**.	N
Paraplesiops meleagris	Southern blue devil	Reef fish of conservation concern in South Australia (Baker, 2011)	**Possible.** This species is iconic and rare in South Australia, though distributed between the Abolhos (WA) and Port Philip Bay (VIC). These fish are territorial and highly site-attached. Individuals and pairs inhabit caves, ledges and crevices in rocky reef, between 5 and 45 m depth. It is possible that suitable habitat exists for the Blue Devil at the rocky capes in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of recreational interest and is regarded as a species of conservation concern 'in peril' by Reef Watch SA (Baker, 2011). The study area does not represent a significant area of suitable habitat for this species. **This development will not significantly impact on this species**.	N
Paristiopterus gallipavo	Brown-spotted boarfish	Reef fish of conservation concern in South Australia (Baker, 2011)	**Unlikely.** This species prefers reef habitat between 55-200 m depth^. This species occurs commonly in reef habitat around southern Australia between SA gulf waters and the central coast of WA. With water depth shallower than 30 m and no significant reef area in the study area it is considered unlikely the species would frequent the area.	Entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest, and is regarded as a species of conservation concern (Baker, 2011). The project area does not contain an area critical to the life cycle of this species, or likely to support a significant population. **This development will not significantly impact on this species**.	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Pagrus auratus / Chrysophrys auratus	Snapper	N/A	**Likely for the species to be present.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom, seagrass and reefs (Bryars, 2003; Baker, 2004). This species occurs widely across southern Australia, generally around reefs and ledges, or other distinct underwater structures such as drop-offs, artificial reefs and wrecks. Snapper can live to 35 years of age, and are a prized fish for recreational and commercial anglers. Key breeding areas for this fish have been identified, and are subject to defined closures from fishing. It is possible that Snapper are present in the study area, though the study area does not represent a key area for breeding or the life cycle of this species.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf (Baker, 2011). While it is possible that this species is present in the study area, it is not a critical area to the species. **This development will not significantly impact on this species**.	N
Pegasus lancifer	Sculptured seamoth	N/A	**Likely for the species to be present.** The species has been regularly reported along the Tumby Bay coastline in areas of sandy bottom and jetties (Baker, 2004). The species is common across southern Australia in waters 0-55m, it is bottom feeder which searches for small infauna crustaceans and polychaetes, it prefers sandy or muddy bottoms but is also found around manmade structures such as jetties and near seagrass. It is likely that this species is present in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of (limited) commercial and recreational interest and occurs throughout the Spencer Gulf (Baker, 2011). While it is possible that this species is present in the study area, it is not a critical area to the species. **This development will not significantly impact on this species**^.	N
Pentaceropsis recurvirostris	Longsnout boarfish	Reef fish of conservation concern in South Australia (Baker, 2011)	**Present.** Boarfish were sighted during the video tow survey in an area of sparse seagrass**.** This species occurs from Botany Bay (NSW) to Rottnest Island (WA), including Tasmania. The Longsnout Boarfish occurs frequently on rocky reef habitat around South Australia, to a depth of 260 m. Suitable habitat exists in the project area but it is unlikely that the habitat present supports a high population ^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of recreational interest and is regarded as a species of conservation concern 'in peril' by Reef Watch SA (Baker, 2011). The study area does not represent a significant area of suitable habitat for this species. **This development will not significantly impact on this species**.	N
Platycephalus spp.	Flathead (various)	N/A	**Likely for the species to be present.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom and seagrass (Bryars, 2003; Baker, 2004). This species prefers to inhabit sandy bottoms and shallow sandy ledges. It is likely that flathead are present at the site, though it is not likely to be an area of high significance for the species^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. Flathead species are a common target for recreational anglers in South Australia.Cape Hardy is not likely to be a key area for these species, which occurs widely throughout southern	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				impacts within 10m of piling; oil spill; pollution	Australia. **This development will not significantly impact on this species**.	
Pseudocaranx georgianus (Previously known as *P. dentex* but now distinguished from the tropical species)	Silver trevally	N/A	**Likely for species to be present in area.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom, seagrass and reefs (Bryars, 2003; Baker, 2004). This species is thought to be distributed between NSW and southern WA. Generally, this species prefers to school in shallow shelf waters. It is possible that suitable habitat occurs in the study area, and therefore that this species is present in the area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. While it is possible that this species utilises habitat in the study area, the area is not a known spawning location for this species. **This development will not significantly impact on this species**.	N
Scorpis aequipinnis	Sea sweep	N/A	**Possible.** This species is common in southern Australian waters, especially in reef habitat and shallow coastal waters to 25m (Gomon *et al*., 1994). This species often associates with artificial structures including jetties. Due to the small about of suitable habitat it is likely that this species will be present in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. It is likely that this species will be present in the study area, but considering it feeds well off the bottom almost exclusively on plankton and associates with artificial structures (Gomon *et al*., 1994), **this development will not significantly impact on this species**.	N
Seriola lalandi	Yellowtail kingfish	N/A	**Possible.** This species is circumglobal, including the coastal waters of southern Australia. This species is fast moving and pelagic, but is native to Spencer Gulf and seen in coastal areas at times. The species is farmed commercially in Spencer Gulf with aquaculture leases for both land based breeding and seacage growout. It is possible that wild fish of this species may be found in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. Due to the large range of this species, the study area does not represent critical habitat for this species. **This development will not significantly impact on this species**.	N
Sillaginodes punctatus	King George whiting	N/A	**Likely.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom, seagrass and reefs (Bryars, 2003; Baker, 2004). This species is not listed for protection but is of commercial and recreational interest and occurs	Loss of habitat through clearance or exclusion; entanglement in	Impacts to suitable habitat for this species will be restricted to the area of wharf and MOF construction, and will not greatly affect the ability for this species to inhabit the wider area. The development site does not	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			throughout the Spencer Gulf. The King George Whiting is an iconic South Australian table fish, targeted by commercial and recreational anglers. This species prefers sandy substrates, especially around seagrass beds or low profile reef habitat. Suitable habitat is present at Cape Hardy, so it is likely that King George whiting are found at the site^.	marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	represent an area critical to the recruitment or ongoing survival of this species. **This development will not significantly impact on this species**.	
Sardinops sagax, S. neopilchardus.	Pilchard, Australian sardine	N/A	**Possible.** This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. This species is known to inhabit lower Spencer Gulf, with the majority of fisheries harvest occurring in the lower Spencer Gulf area (Shanks, 2005). Generally, fishing occurs in deeper waters at the mouth of the gulf, but it is possible that schools of pilchards may enter the study area. The area is not considered a critical area for the pilchard population^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution, disturbance to recruitment; disturbance to prey species (e.g. Anchovy)	The study area is not a known fishing ground for pilchards, although it is possible that schools pass through the area, as suitable habitat exists. It is unlikely that the development site is an important area for the species. **This development will not significantly impact on this species**.	N
Sphyraena novaehollandiae	Snook	N/A	**Likely for the species to be present.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom and seagrass (Bryars, 2003; Baker, 2004). This species is widely distributed across southern Australia, including SA gulf waters and offshore to the continental shelf margin. It is likely that this species occurs in the project area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. While it is possible that this species could occur in the study area, the area is of no significance to the species. **This development will not significantly impact on this species**.	N
Sillago schomburgkii	Yellowfin whiting	N/A	**Likely.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom, seagrass and reefs (Bryars, 2003). This species occurs between central WA and the Fleurieu Peninsula in SA, including SA gulf waters. The preferred habitat for this species includes inshore sandbanks, bars, spits and estuaries. It is likely that this species utilises habitat at the study	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise	This species is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. While it is possible that this species could occur in the study area, the area is of no significance to the species. **This development will not significantly impact on this species**.	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			area^.	impacts within 10m of piling; oil spill; pollution		
Tilodon sexfasciatus	Moonlighter, six-banded coral fish, six-banded sweep, butterfish	N/A	**Likely.** The species has been regularly reported along the Tumby Bay coastline in areas of sandy bottom and jetties (Baker, 2004). The species is common across southern Australia. It is likely that this species is present in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of recreational interest and occurs throughout the Spencer Gulf. While it is likely that this species occurs in the study area, the size of the development area is not a significant portion of the species range. **This development will not significantly impact on this species**.	N
Upeneichthys vlamingii	Red mullet, blue-spotted goatfish, southern goatfish	N/A	**Likely.** The species has been regularly reported along the Tumby Bay to Port Neill coastline in areas of sandy bottom and seagrass (Bryars, 2003; Baker, 2004). The species is widespread and very common across southern Australia including Tasmania – inhabiting sheltered coastal waters, bays, estuaries usually on soft sandy or loose gravel near reefs but is also found in and around seagrass meadows. It is likely that this species is present in the study area^.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This species is not listed for protection but is of recreational and some commercial interest and occurs throughout the Spencer Gulf. While it is likely that this species occurs in the study area, the size of the development area is not a significant portion of the species range. **This development will not significantly impact on this species**.	N
Vincentia conspersa	Southern cardinalfish, gobbleguts	N/A	**Likely.** The species has been regularly reported along the Tumby Bay coastline in areas of sandy bottom and jetties (Baker, 2004). The species is common across South Australia and parts of Victoria and Tasmania, it is nocturnal carnivore which feeds on both zooplankton and benthic invertebrates, it prefers reefs hiding in caves or under overhangs by day but is also found around manmade structures such as jetties and breakwaters. It is likely that this species is present in the study area^.	Loss of habitat through clearance, shading, anchoring impacts, epiphyte blooms or smothering by ore spill; oil spills; pollution; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	The species is not protected under any current National or State legislation. They are not species targeted by fisherman but are of some interest to recreational divers. There will be a small area of benthic habitat removed due to the construction of the wharf and MOF. However given that this species distribution covers all of South Australia and its habitat preference is for reef or hard structures, the construction of the MOF and jetty will provide additional habitat for this species. **This development will not significantly impact on this species**.	N
FAMILY	Wrasse	N/A	**Likely** for the species from this Family to be present**.** "Wrasse" have	Loss of habitat	With the exception of *A. gouldii*, discussed above, this	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
Labridae	*(various)*		been regularly reported along the Tumby Bay to Port Neill coastline in areas of reef (Bryars, 2003; Baker, 2004). This family is also widespread across a variety of inshore habitats in southern waters. It is highly likely that species from this family occur in the study area^.	through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	fish family is not listed for protection but is of some commercial and recreational interest. Occurring throughout the Spencer Gulf and much of southern Australia the proposed development does not represent a significant portion of the range of this family, and thus **this family will not be significantly impacted by this development.**	
FAMILY Sparidae	Bream	Fisheries Act	**Possible.** This Family occurs between central WA and Qld, including SA gulf waters. The preferred habitat for these fish includes sheltered inshore sandbanks, bars, spits and estuaries, over seagrass to open water deep reefs (Edgar, 1997). It is therefore likely that fish in this family utilises habitat in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	This Family of fish are keenly sort by anglers both commercial and recreational. There will be a small area of seagrass and benthic habitat removed due to the construction of the wharf and MOF. Given that this family's distribution covers all of Southern Australia and parts of international waters, the small area of clearance associated with the development is not considered to represent a significant area of crucial habitat for this species. **This family will not be significantly impacted by this development.**	N
FAMILY Aracanidae	Temperate boxfish or Cowfish	N/A	**Present.** Observed on a number of occasions throughout the study area in areas of bare sand or silt or patchy to dense seagrass or amongst sponge groups.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	The Family are not protected under any current National or State legislation. They are not species targeted by fisherman but are of interest to recreational divers. There will be a small area of seagrass and benthic habitat removed due to the construction of the wharf and MOF. Given that this family's distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species **This family will not be significantly impacted by this development.**	N
FAMILY Monacanthidae	Leather- jacket *(various)*	N/A	**Present.** Several species of Leatherjacket were observed during the video tow survey, including the Mosaic leatherjacket (*Eubalichthys mosaicus*). This family is present in all major oceans globally, including tropical and temperate waters and a range of coastal	Loss of habitat through clearance or exclusion; entanglement in	This fish family is not listed for protection but is of commercial and recreational interest and occurs throughout the Spencer Gulf. The proposed development does not represent a significant portion of	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			habitat types. It is highly likely that fish species in this family utilise each of the habitat types identified in the study area. Juveniles of this family utilise seagrass beds and estuaries. Reefs of all description support this family, along with shipwrecks and artificial structures. It is likely that this family is present in the study area.	marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	the range of this family, and thus **this family will not be significantly impacted by this development.**	
FAMILY Tetraodontidae	Pufferfish and toadfish	N/A	**Possible.** This Family occurs between central WA and Qld, including SA gulf waters. The preferred habitat for these fish includes sheltered inshore sandbanks, bars, spits and estuaries, over seagrass to open water deep reefs and wrecks (Edgar, 1997). It is therefore likely that fish in this family utilises habitat in the study area.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	The Family are not protected under any current National or State legislation. They are not species targeted by fisherman as many species are highly poisonous but they are of interest to recreational divers due to the fish's highly decorative and inquisitive nature. There will be a small area of seagrass and benthic habitat removed due to the construction of the wharf and MOF. Given that this family's distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. The construction of the MOF and jetty will also provide additional habitat niches for members of this Family. **This family will not be significantly impacted by this development.**	N
SYNGNATHIDS PIPEFISHES						
Acentronura australe	Southern pygmy pipehorse	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Campichthys tryoni	Tryon's pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris;	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				underwater noise impacts within 10m of piling; oil spill; pollution	**development will not significantly impact on this species**.	
Filicampus tigris	Tiger pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species is rarely found in Spencer Gulf with less than 30 speciemens recorded. Its preferred habitat is known to be sand and mud (Inshore Fish Group, 2008), and given the amount of suitable substrate at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of sparse seagrass on sandy sediment lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Heraldia nocturna	Upside-down pipefish, eastern upside-down Pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution.	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Hippocampus breviceps	Short-head seahorse, short-snouted seahorse	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Histiogamphelus cristatus	Rhino pipefish, Macleay's, crested pipefish, ring-back, pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris;	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				underwater noise impacts within 10m of piling; oil spill; pollution	**development will not significantly impact on this species**.	
Hypselognathus rostratus	Knifesnout pipefish, knife-snouted pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance, shading, anchoring impacts, epiphyte blooms or smothering by ore spill, chemical spill or runoff impacts.	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Kaupus costatus	Deepbody pipefish, deep-bodied pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Leptoichthys fistularius	Brushtail pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Lissocampus caudalis	Australian smooth pipefish, smooth pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this**	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
				impacts within 10m of piling; oil spill; pollution	**species**.	
Lissocampus runa	Javelin pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Maroubra perserrata	Sawtooth pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Notiocampus ruber	Red pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Phycodurus eques	Leafy seadragon	Marine (EPBC); Fisheries Act	**Present.** This species was observed during the marine video tow survey amongst *Amphibolis* spp. seagrass). No records for this species have been submitted to the BDBSA (BDBSA, 2012) within 15 km of this site. This species is thought to exclusively inhabit macro-algal beds and reef habitat throughout South Australia, including suitable habitat at jetties. (Inshore Fish Group, 2008) Given that a	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise	There will be a small area of benthic vegetation lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. Furthermore the species has a preference for	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			specimen was sighted within seagrass beds during the video tow survey and there is coverage of suitable macro-algal habitat at Cape Hardy it is likely the species would be widespread across the site.	impacts within 10m of piling; oil spill; pollution	protected reef habitat including Rapid Bay Jetty where divers regularly come across these seadragons. Therefore the completed marine infrastructure for this development would potentially increase the amount of suitable habitat at the site. **This development will not significantly impact on this species**.	
Phyllopteryx taeniolatus	Common seadragon, weedy seadragon	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Pugnaso curtirostris	Pugnose pipefish, pug-nosed pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution.	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Solegnathus robustus	Robust pipehorse, robust spiny pipehorse	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Stigmatopora argus	Spotted pipefish, gulf pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the	Loss of habitat through clearance or exclusion;	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			species could inhabit the site.	entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	
Stigmatopora nigra	Widebody pipefish, wide-bodied pipefish, Black pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Stipecampus cristatus	Ringback pipefish, ring-backed pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Urocampus carinirostris	Hairy pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Vanacampus margaritifer	Mother-of-pearl pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the	Loss of habitat through clearance or exclusion;	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the	N

Fish species potentially at the port Site			Likelihood of occurrence	Likelihood of significant impacts		
Species name	**Common name**	**Legislative protection EPBC, or Fisheries Act**	**Marine environment (including MOF and wharf)**	**Potential Impacts**	**Likelihood of Impact**	**Significant Impact (Y/N)**
			species could inhabit the site.	entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution.	small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	
Vanacampus phillipi	Port Phillip pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Vanacampus poecilolaemus	Longsnout pipefish, Australian long-snout pipefish, long-snouted pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N
Vanacampus vercoi	Verco's pipefish	Marine (EPBC); Fisheries Act	**Possible.** No records for this species have been submitted to the BDBSA (BDBSA, 2012). The species in known to inhabit seagrass and given the coverage of seagrass at Cape Hardy it is possible that the species could inhabit the site.	Loss of habitat through clearance or exclusion; entanglement in marine debris; underwater noise impacts within 10m of piling; oil spill; pollution	There will be a small area of seagrass lost due to the construction of the wharf and MOF. Given that this species' distribution covers all of Southern Australia, the small area of clearance is not considered to represent a significant area of crucial habitat for this species. **This development will not significantly impact on this species**.	N

6.6.2.2 Risks

Construction and operation of the proposed port will result in the generation of a number of waste streams that may enter the marine environment. Marine debris can significantly affect fish species as a result of pollution, injury through collision, entanglement or ingestion of non-biological products.

Waste management and handling procedures developed as part of the CEMP and OEMP will control waste streams with the overarching aim of no waste products entering the marine environment. Despite the implementation of control measures, it is considered almost certain that some form of waste / debris will enter the marine environment during construction and operation of the port. Although the port site contains areas of seagrass, it is not a known key habitat or breeding area for any fish species. The consequences of debris entering the marine environment are therefore considered to be minimal; insignificant to the overall viability of fish species. As such, the overall risk is considered to be low.

Fish species are also at risk from the unintended discharge of pollution in the form of site run-off, wastewater, hydrocarbons or chemicals. With any marine activity there is potential for waste or spills to enter the marine environment and affect plankton, benthic fauna and habitat forming benthic flora (e.g. seagrass), reducing habitat suitability for fish species.

The implementation of design measures (refer Section 4) for the control of surface and waste water at the port site will limit the majority of hazardous pollutants from entering the marine environment. There remains a risk that a major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be rare. As previously outlined, the port site does not represent a critical habitat or isolated breeding grounds for fish species. The consequences of a major spill event are considered to be minor, due to the low level of dependence of fish species on the study area, resulting in a short term decrease in the local abundance of fauna. As such, the overall risk of a major spill event affecting fish species is considered to be low.

6.6.3 Conclusions

Due to the highly mobile nature of fish a wide range of species may be present in the Cape Hardy area at different times or for limited periods, however there are a number of species that have a higher likelihood of being observed in the waters around Cape Hardy. Leafy seadragon, ornate cowfish, Port Jackson shark, magpie perch, leatherjackets and toadfish were all sighted during the video survey of the study area. There is also the potential for a large number of other fish species to be present within the seagrass, reef and soft bottom areas of the site. EPBC listed Marine species are protected past the 3 nautical mile limit in Commonwealth Waters. Spencer Gulf lies completely within State waters and therefore is not subject to this protection status. Syngnathids are also protected under the Fisheries Management Act 2007 along with the great white shark as are the blue groper at all times within Spencer Gulf.

As with marine megafauna, piling and underwater noise is considered to represent the greatest impact to fish species, however these impacts are of short duration and through the implementation of management procedures (such as soft start piling and observation zones) impacts are expected to be medium.

6.7 Noise and Vibration

While it is common knowledge that cetaceans utilise sounds for navigation and communication, fish, invertebrates, and even planktonic larval stages of many marine biota also use sound for a range of important functions. Marine fauna use sounds as a part of normal behaviour when foraging, to detect prey, predators or other hazards, for navigation, communication or when locating mates. Worldwide, studies into the effects of noise on marine fauna have been undertaken since the 1950s, ranging between the effects of high-intensity and low-level noise, and a diverse range of biota from cetaceans to larvae.

Early research observed the effects of high-intensity pulsed and continuous sound from construction, explosives, sonar, shipping, and geological survey on the behaviour and physiology of marine mammals, fishes, marine turtles and other species (Richardson *et al.,* 1986; Richardson *et al.,* 1990; Richardson and Würsig 1997). High-intensity sound can cause physical trauma to sensitive species, stress responses, altered behaviour, and disorientation which has been linked to numerous stranding events (Goold and Fish, 1998; Fernandez *et al.*, 2005; Goldbogen *et al.,* 2013). Fish can also be injured by high-intensity sounds at close range, though this is dependent on the physiology of the species, sensitivity and the sound profile (Wardle *et al.*, 2001). On long time-frames however, whales have not been seen to change migratory habits or stop visiting key areas after being disturbed by noisy exploration or construction (DEWHA, 2008).

A wide range of human activities emit noise and vibration, including recreational boating, commercial shipping, coastal construction, and seismic surveys, which can be disruptive to marine biota. The impact of noise and vibration on marine biota depends on the type of noise or vibration, frequency, wavelength and duration, and the mobility and physiology of the organism. The organisms considered most sensitive to disturbance from noise and vibration are generally free-swimming, especially those with more developed auditory structures, including marine mammals and some fish (Myrberg, 1990). Fish with swim bladders are also potentially susceptible regardless of their hearing capability as high intensity sound can physically damage their swim bladder resulting in death. The following assessment of impacts and risks to marine biota from noise and vibration is undertaken based on modelling of the propagation of sound in the marine environment during the construction phase, and the proposed level of shipping activity at the port.

Noise and vibration levels will depart from normal conditions as a result of construction and operations at the port. The construction process will involve pile driving, which poses a risk of injury or disturbance to marine mammals and fish in the immediate area. The elevated ambient or background noise and vibration during standard shipping operations at the site poses a risk of masking the sounds required for normal behaviour of large marine fauna including marine mammals or other smaller marine biota including fish and invertebrates (Slabbekoorn *et al.*, 2010). The full effects of masking sounds is not understood as most studies of hearing loss or masking are based on small sample sizes or individual animals under experimental conditions, and do not account for variations in hearing range between individuals or reflect animals natural stress responses (Southall, 2005).

Habituation of marine animals to areas of high vessel traffic and noise has been shown to occur readily around the globe. Several resident populations of marine mammals, birds and fish species are observed at existing large ports in Australia e.g. Port Adelaide Port River (SA) dolphins and bird rookeries; Port Phillip Bay (VIC) dolphin and seabird populations; Swan River (WA) bottlenose dolphins. Therefore, while marine animals are known to be highly sensitive to underwater noise impacts and display either behavioural or physiological changes due to these disturbances, impacts from commercial vessel and port operations are not as clearly understood, with cohabitation of the marine environment a demonstrated outcome.

6.7.1 Existing Environment and Key Findings

Ambient underwater noise measurements within the marine study area were not taken as part of the investigations for the proposed port. Ambient noise levels differ based on sea conditions, water depths, and natural and main made noise sources. As previously outlined, the marine study area is a shallow, moderate energy coastal environment meaning that ocean noise (wind and wave noise) will be higher than in deep water.

No significant man made noise sources were identified in the vicinity of the proposed port. The coastal townships of Port Neill and Tumby Bay are respectively located north and south of the port. Low levels of recreational and commercial vessels utilise these townships and would generate low levels of ambient noise. East of the port site is the shipping channel to support the movement of larger commercial vessels to Whyalla and Port Augusta. Ship movements within the channel would also contribute to low levels of ambient noise.

When considering the impact that noise has on the marine fauna, consideration is given to a range of factors such as the sensitivity of the species to noise, the distance between the noise source and fauna, and the duration of exposure to the noise.

A number of peer reviewed studies have assessed the impact of noise on marine mammals. The most contemporary information is provided in the recommendations for marine mammals of the United States National Oceanic and Atmospheric Administration (NOAA), *Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals* (NOAA, 2013).

There is limited information regarding the effects of noise on fish. The studies that have been conducted to date only consider a tiny fraction of the species in existence and in environments which typically do not represent wild fish in their natural habitats (Popper and Hastings 2009). Fish are able to detect sounds, with the majority of species regarded as “hearing generalists” that have a narrow hearing bandwidth. A small number of fish species are classified as “hearing specialists” and have a greater hearing bandwidth and sensitivity due to a coupling between gas filled organs (such as the swim bladder) and inner ear (Hastings and Popper 2005). The hearing range for the different types of fish is provided below. Fish sensitivity to noise also depends on the mass of the fish. It has been found that tissue damage from noise will increase as the mass of the fish decreases (Carlson *et al.*, 2007).

Information regarding the known effects of underwater noise on turtles is limited. Independent studies by Ridgway and Bartol (cited in Bartol, 2008) confirm that turtles can hear and that the hearing range of turtles is approximately between 200Hz and 1000Hz. There are no recommended noise criteria for turtles, however based on behavioural response studies by O'Hara and Wilcox (cited in Bartol, 2008) and Moein (cited in Bartol, 2008), and the hearing range of turles, the low frequency Cetaceans noise criteria is considered appropriate.

There is very limited information known about the effects of underwater noise on penguins (penguins may utilise the port site for foraging purposes). Studies indicate that the hearing range of penguins is best between 2000Hz and 5000Hz in air and is likely to reduce to frequencies below 4000Hz in water (Dooling and Therrien, 2012). Based on the hearing range, and the lack of specific objective criteria, the low-frequency Cetaceans noise criteria have also been applied to penguins.

There is very limited information known about the effects of underwater noise on Cephalopods (cuttlefish). Studies indicate that Cephalopods can perceive low-frequencies. It is not known if Cephalopods can “hear” or if they are sensitive to particle velocity (Mooney *et al.,* 2012). Notwithstanding, it has been shown that they can perceive sounds with frequencies of up to 1.5kHz, but as they do not have any gas filled bladders there is no possibility for sound amplification and therefore have a hearing capacity comparable to fish without swim bladders (Hu *et al.,* 2009). Based on the above, the noise criteria for fish have been conservatively applied to Cephalopods for the assessment of impacts presented here.

The level of noise resulting in auditory injury changes for different species and types of noise is provided in Table 6-10 below, with the threshold level being reached if either the peak level or SEL_{cum} (cumulative sound exposure level), is exceeded (NOAA, 2013).

Table 6-10 Summary of relevant noise limits

Species	Hearing Range	Impulsive Noise criteria	Non-impulsive noise criteria (includes continuous noise)
Low-frequency Cetaceans (Baleen whales)	Between 7 Hz and 30 kHz	Peak level: 230 dB_{peak} SEL_{cum}: 187 dB	Peak level: 230 dB_{peak} SEL_{cum}: 198 dB
Mid-frequency Cetaceans (Dolphins)	Between 150 Hz and 160 kHz	Peak level: 230 dB_{peak} SEL_{cum}: 187 dB	Peak level: 230 dB_{peak} SEL_{cum}: 198 dB
High-frequency Cetaceans (Porpoise)	Between 200 Hz and 180 kHz	Peak level: 201 dB_{peak} SEL_{cum}: 161 dB	Peak level: 201 dB_{peak} SEL_{cum}: 180 dB
Phocid Pinnipeds (Earless Seals)	Between 75 Hz and 100 kHz	Peak level: 235 dB_{peak} SEL_{cum}: 192 dB	Peak level: 235 dB_{peak} SEL_{cum}: 197 dB
Otariid Pinnipeds (eared sea lions and fur seals)	Between 100 Hz and 40 kHz	Peak level: 235 dB_{peak} SEL_{cum}: 215 dB	Peak level: 235 dB_{peak} SEL_{cum}: 220 dB
Fish (hearing generalist)	Between 50 Hz and 500-1500 Hz	Peak level: 206 dB_{peak} SEL_{cum}: 187 dB	Peak level: 206 dB_{peak} SEL_{cum}: 187 dB
Fish (hearing specialist)	Between 50 Hz and 3-100 kHz	Peak level: 206 dB_{peak} SEL_{cum}: 187 dB	Peak level: 206 dB_{peak} SEL_{cum}: 187 dB
Turtles	Between 200 Hz and 1000 Hz	Peak level: 230 dB_{peak} SEL_{cum}: 187 dB	Peak level: 230 dB_{peak} SEL_{cum}: 198 dB
Penguins	Between 2000 Hz and 4000 Hz (in water)	Peak level: 230 dB_{peak} SEL_{cum}: 187 dB	Peak level: 230 dB_{peak} SEL_{cum}: 198 dB
Cephalopods (cuttlefish)	Unknown	Peak level: 206 dB_{peak} SEL_{cum}: 187 dB	Peak level: 206 dB_{peak} SEL_{cum}: 187 dB

The underwater noise assessment for the proposed port development at Cape Hardy (Sonus, 2014) indicates that separation distances between some noise sources (i.e. piling) and specific marine fauna during construction will be required to minimise noise impacts. The impact criteria for single strike sound exposure level (SEL_{ss}) were taken from the DPTI Underwater Piling Noise Guidelines, and the criterion for all species is 150 dB (DPTI 2012). The full results of the underwater noise modelling are presented in Sonus (2014). The minimum separation distance between different species and noise sources required to achieve noise criteria (refer Table 6-10) is provided in Table 6-11.

Table 6-11 Separation distance required to meet requirements of noise criteria

	Separation distance required to achieve noise criteria (m)										
	Low-frequency Cetaceans			Mid-frequency Cetaceans			Otariid Pinnipeds			Fish	
Noise Source	SELcum (NOAA 2013)	SELss (DPTI 2012)	Peak level	SELcum (NOAA 2013)	SELss (DPTI 2012)	Peak level	SELcum (NOAA 2013)	SELss (DPTI 2012)	Peak level	SELcum	Peak level
Impact Piling	240	470	0	<10	30	0	<10	470	0	450	30
Drilling	0	-	-	0	-	-	0	-	-	10	-
Vessels	10	-	-	0	-	-	0	-	-	80	-

6.7.2 Impacts and Risks: Noise and Vibration

Noise and vibration associated with the proposed development could cause impacts to the marine environment from:

- Construction activities (e.g. piling and drilling)
- Vessel movement
- Operations activities (e.g. ship loader and conveyor)

6.7.2.1 Impacts

The construction phase of the proposed port will result in the highest level of noise emissions that may impact marine biota, due to the extent of piling works required. The underwater noise modelling concluded that the effects of other noise sources, such as vessels or equipment, will not increase cumulative noise levels above the peak levels produced through impact piling, as sound waves are not additive (Sonus, 2014).

The Sonus (2014) report identifies that a minimum separation distance of 470 m from piling to marine biota will avoid physical impacts to all species (based on DPTI / NOAA criteria). Physical trauma is anticipated to affect marine biota where:

- Baleen whales and seals are within 470 m
- Cephalopods are within 450 m
- Fish are within 30 m

The most sensitive fishes will be those with swim bladders, while fishes without swim bladders and cephalopods will most likely only suffer behavioural changes (avoidance of the piling site). Through the implementation of soft start procedures, safety observation zones to monitor movement of marine biota and shut down procedures where marine mammals are identified within 500 m of piling activities, it is not anticipated that any marine biota will be significantly affected by underwater noise emissions. Marine biota that may be affected are highly mobile and will likely vacate the study area during soft start procedures. As such, widespread physical trauma to marine biota is not anticipated.

Construction of the port will occur over an approximate 18 month period. Underwater noise emissions during this time will result in behavioural changes to marine fauna, with avoidance of the study area likely as a result of noise emissions. Following construction, marine fauna are expected to return to the study area. These altered arrangements represent a short term alteration to existing behavioural patterns of marine fauna within the study area, and are considered to be a low impact.

There will be some operational noise from the ore conveyor, ship loaders and equipment located on the jetty and wharf. As these noise sources do not have any direct connection to the water there will be limited noise propagation into the water from these sources. Some structure-borne vibration energy will travel through the jetty/wharf and into the water column. However, Sonus (2014) predict the structure borne propagation would only comprise low levels of sound that would be quickly attenuated to levels below the ambient underwater noise level due to the bathymetry of the site and will not impact marine fauna.

Propeller cavitation and flow noise around the hull are the primary causes of vessel noise and will occur throughout operation of the proposed port. While not causing direct physical harm, an increase in anthropogenic noise from sources such as industry and shipping can mask the sounds required for normal behaviour in marine biota (Codarin *et al.*, 2009). At low ship speeds, machinery noise dominates and is primarily low-frequency, although main gearboxes and gas turbines may produce higher-frequency sound. The predicted underwater noise at the port during operation will be dominated by the low frequencies as vessel speeds will be restricted in the port with cargo ships being manoeuvred into position by tugs. Due to the bathymetry of the site, modelling predicts sound propagation in the port area will be restricted (Sonus 2014).

There are no particularly sensitive receptors in the study area (i.e. no marine mammal breeding colonies or bird rookeries), and operational noise will result in negligible impacts to the behaviour and physical wellbeing of marine fauna with an insignificant increase in background noise levels within the study area.

Outside of the study area, increasing vessel numbers in the gulf associated with the port operations will increase the ambient noise levels in the marine environment, as low-frequency sound can travel great distances in the open water environment. This noise can mask communication and navigational sound used by many marine species. The proposed port will result in approximately one additional ship movement per day through the Spencer Gulf (an overall increase in vessel traffic of approximately 7% based on 290 additional vessel movements or 145 vessels per year). Sonus (2014) predicts that separation distances of 80 m for fish and 10 m from whales would be required to prevent physical damage from low-frequency vessel noise. In deeper water low-frequency sound propagates further than high frequency sound enabling most fish and larger marine fauna to avoid any physical damage caused by noise impacts by moving away from high–intensity, low-frequency sounds before physical damage occurs. As such, the affect to ambient noise levels within the gulf as a result of additional ship movements is considered to be insignificant and result in negligible impacts to marine fauna.

6.7.2.2 Risks

A risk associated with underwater noise and vibration in the study area is incorrect assumptions regarding the presence or absence of marine fauna in the area. If additional fauna are present within the area than identified by the review undertaken here, potential impacts to marine fauna from noise and vibration could be greater than predicted. Given the modelling has included all marine fauna types, and exclusion zones calculated from the modelling are conservative, the application of management measures such as soft starts and observation zones for larger fauna should mitigate additional impact. As such, the consequence of additional fauna being present in the area is considered to be minor. The likelihood of additional fauna than those identified here being present is considered to be possible. As such, the risk to marine fauna as a result of additional species being present than identified here is considered to be low.

In the event that the underwater noise and vibration modelling is incorrect, and sound propagates further and at higher amplitudes through the marine environment than predicted, impacts to marine fauna could be more widespread and severe. As above, the exclusion zones proposed which dictate management strategies for shut downs are conservative and already well exceed the predicted impact area based on the modelling, meaning additional impacts are considered unlikely. Consequences of greater than modelled impacts are considered to be minor and therefore overall risk as a result of underestimation of modelled impacts is considered to be low.

6.7.3 Conclusions

Combining the knowledge gained from the underwater noise modelling, publically available reports and legislative guidelines, it is considered that the noise impacts at the Cape Hardy site during piling will represent the largest impact to marine fauna (which is short term), while operational noise from the proposed facility is considered to have no detrimental impacts to the marine environment.

Through the implementation of management procedures (such as soft start piling and observation zones) all impacts associated with noise to marine fauna have been reduced to low or negligible.

6.8 Invasive Marine Species

IMS are marine organisms that are not native to an area but have been introduced by human activities such as shipping. Australia has over 250 introduced marine species. Most of these have little impact. Some however, have the potential to establish large populations and spread geographically to the detriment of native species and/or human uses. IMS are globally recognised as a significant threat to the marine environment (GISD, 2014). Several crabs, mussels, seastars and macroalgae have become aggressive pests in a number of locations. Once

established, IMS can either directly prey upon, displace or outcompete indigenous species. IMS also have the potential to carry diseases which can eliminate native species.

Potential methods of IMS introduction at ports include organisms being attached to cargo imported to sites, within ships' ballast water as cysts, larvae or juveniles, or on the hulls of vessels or vessel infrastructure as biofouling (encrusting organisms) that can break off and reattach from asexual growth or release spawn.

6.8.1 Existing Environment and Key Findings

No IMS were identified as known to exist within the study area during the course of the desktop investigations (Ditmann *et al*., 2010; Wiltshire *et al.*,2010; NIMPIS, 2014), video surveys or site visits. Within South Australia and specifically Spencer Gulf several IMS have been detected or established themselves and are discussed below. Species such as *Salmo salar* (Atlantic salmon), *Crassostrea gigas* (Pacific oyster) and *Ostrea edulis* (European flat oyster) are not considered to be IMS as they are not on the National or State list of declared pests (NIMPIS, 2014) and in the case of Atlantic salmon are an unlikely species to be transported via port operations.

Caulerpa taxifolia is an invasive marine alga that is widely used as a decorative plant in aquaria. Once in a suitable marine environment it is extremely invasive and smothers other algal species, seagrasses and sessile invertebrate communities forming dense monocultures that exclude much marine life. It does this by either out-competing species for nutrients and light or due to a toxic compound it produces (caulerpenyne; that has almost no known grazers). The primary effects on humans are mostly related to the reduction of catches for commercial fishermen due to the elimination of fish habitat by *C. taxifolia*. This IMS can also foul nets, ropes and moorings. In South Australia it is only known to have established itself within Port Adelaide and its presence is thought to be related to the nutrient loading and warmer waters of that estuary (Wiltshire, 2010).

The Asian paddle crab or lady crab, *Charybdis japonica*, has only been identified in South Australia from one male specimen. It can vary in colour from red / purple / orange to pale green and off-white; it is similar in appearance to the native blue swimmer crab. No other specimens have been found since its initial discovery and it is not currently considered to be present in Australia. It is an aggressive crab that can out-compete native species for food and habitat. It is also known to carry the white spot syndrome, a virus that can impact native and farmed prawns, crabs and lobsters (NIMPIS, 2014).

Codium fragile ssp. tomentosoides is an alga that has been introduced around the globe through shellfish aquaculture, recreational boating, and transport on ship hulls. This IMS exhibits various modes of reproduction, which is a common trait of many IMS. It can reproduce sexually, parthenogentically, and vegetatively which makes eradication difficult. It can propagate from small pieces of the parent plant that can be broken off by propeller wash or hull cleaning (from recreational vessels) and then carried by water currents over long distances, introducing it to new locations. This IMS is also tolerant of a variety of salinity and water temperature levels and thrives in sheltered habitats. This IMS can cause a nuisance to humans when it accumulates on beaches and rots, producing a foul odour. Its main threats to the marine environment come from its tendency to overgrow and smother shellfish beds, often attaching to the shells of oysters, mussels, scallops, and clams. The attached algae can hinder the movement and feeding of the shellfish. There are several direct and indirect effects of this attachment including: smothering shellfish by preventing opening of the valves, clogging aquaculture nets, fouling moorings, interfering with the collection of shellfish and where the attached alga is relatively large and wave exposure is high, the shellfish can be swept away with the alga. This species has been reported as occurring in the Spencer Gulf and is listed as a threat to aquaculture in the area by the global invasive species database (GISD, 2014).

The Asian date or bag mussel, *Musculista senhousia*, is a small, short-lived mussel native to East Asia. This IMS has been identified within Port Adelaide (Wiltshire and Deveney, 2011) and more recently near Lipson Cove during a benthic habitat survey (Golder Associates, 2012). This IMS can grow rapidly and is capable of marked

habitat alteration through reaching high densities (>2000 individuals/m^2) on the surface of soft sediments. It can form continuous byssal carpets that smother most other benthic habitat-forming organisms (GISD, 2014). As with many IMS it is an opportunistic species capable of fouling wharf pilings and artificial structures and can be found from intertidal to subtidal soft bottom habitats (to a depth of 20 m). The species is a filter-feeder and due to its high densities can have dramatic impacts on plankton abundance and reduce the densities of native bivalves. High densities of this IMS can dramatically alter the natural benthic habitat, changing both the local physical environment, and the resident macroinvertebrate assemblage and the growth of nearby seagrass (GISD, 2014).

Polysiphonia brodiei (red macroalgae) is a branched filamentous red alga that has become one of the most globally widespread IMS. It has been introduced via ships to Australia, New Zealand and Japan. It has been confirmed around Robe and American River, but not within the Spencer Gulf. It is a hull-fouling organism on slow-moving vessels such as barges, and also fouls ropes, buoys and harbour structures such as pylons and boat ramps. Apart from biofouling there are currently no other known impacts from this IMS (GISD, 2014).

Sabella spallanzanii (the European fan worm), is a filter-feeding tube worm which has the potential to alter native marine ecosystems and compete with native organisms for food and space. It may also inflict economic damage by competing with mussels and oysters in aquaculture farms. These IMS readily settle on shellfish grow-out lines and may reduce shellfish growth by altering water flow around the lines and competing with the shellfish for suspended food. Some species of seagrass can be impacted by the settlement of worms on their fronds (CSIRO, 2001). The European fan worm is considered a major threat to benthic assemblages in both hard and soft bottom habitats and potentially affects nutrient cycling processes in soft sediments (O'Brien *et al.*, 2006). It has been estimated that *S. spallanzanii* can filter around 12 $m^3/d/m^2$ of habitat (Stabilia *et al*. 2006). This rate of filter-feeding can drastically impact plankton abundance including larval fish, and therefore the impacts of this species go beyond smothering and biofouling. The species has been identified in South Australia in Port Augusta and upper Spencer Gulf (BHP Billiton, 2009), Port Lincoln and Port Adelaide (including Westlakes waterways where it has established itself (Conservation Council SA 2011). The species can be transported by cargo vessels (either on the hull, in ballast water or attached to cargo), fisheries and aquaculture (by vessels, accidental translocation through aquaculture farm activities and movements), recreational vessels (hulls and moorings) or through natural dispersal once it has established in an area. As the species is already established in Spencer Gulf it is likely that this IMS will reach the port site and most areas of the Gulf over time.

Watersipora spp. are encrusting bryozoans. The risk from these IMS are their tolerance to copper-based antifouling coatings on ships' hulls which can then facilitate the fouling and spread of other IMS. This IMS is considered widely invasive in temperate ports (GISD, 2014). They are tolerant of copper-based antifoulants and can provide a non-toxic surface for other fouling species to settle. In addition to assisting in the spread of other IMS, *Watersipora* can also compete with native bryozoans and other encrusting organisms and once established are often the most common intertidal bryozoan. In Australia *W. arcuata* is declared a medium priority pest and is widespread in South Australia, including the southern Spencer Gulf (NIMPIS, 2014; GISD, 2014).

The European or green shore crab (*Carcinus maenas*) is a voracious predator that feeds on many types of organisms including shellfish and other crabs. This IMS has great potential to impact aquaculture when present in high densities as it is able to crush mussels, and can threaten mussel farms. In invaded regions, this species has been considered responsible for significant impacts on epibenthic and infaunal species, such as bivalves, other molluscs, and crustaceans, through predation, competition, and burrowing (GISD, 2014). This species is a potential facilitator of another IMS, *Styela*, which is an invasive club tunicate in some areas (GISD, 2014). The crabs could facilitate *Styela* invasions by preying on tunicate predators, enabling *Styela* to establish. The European shore crab is known to consume prey from at least 158 genera and has been widely documented to decrease the diversity and biomass of estuarine communities. The species has been previously identified in

Port Adelaide; however recent surveys have failed to detect this crab in South Australia (Wiltshire and Deveney, 2011).

Alexandrium minutum is a toxic, planktonic dinoflagellate (single-celled alga) responsible for toxic algal blooms in warm, temperate, coastal and estuarine waters. It has been reported over a wide geographical range and in a wide range of coastal hydrographic regimes (Hallegraeff *et al*., 1988; Yoshida *et al*., 2000; Usup *et al*., 2002). This IMS produces compounds which are toxic to some zooplankton and fish. The toxins can also bioaccumulate in zooplankton and shellfish. The consumption of contaminated shellfish can lead to paralytic shellfish poisoning in humans and other mammals. The toxins responsible for this disease are neurotoxins, which in humans can cause muscular paralysis, neurological symptoms and, in extreme cases, death (Hallegraeff, 1993). Due to the potential for disease outbreaks the occurrence of algal blooms near shellfish farms usually results in their closure. This IMS is classed as a high priority species for temperate water ports (NIMPIS, 2014)

Alexandrium minutum is restricted to coastal, nutrient-enriched sites, particularly harbours, estuaries and lagoons (GISD, 2014). Blooms are often associated with low salinities and nutrient-rich freshwater inputs (Vila *et al*., 2005). The growth rate of *A. minutum* increases with increasing temperature and light (Lim *et al*., 2006); nevertheless it can reach relatively high growth rates (up to 0.5 divisions/day) at 12 ºC (Cannon, 1996). The algae produce cysts in bloom areas, which can accumulate in fine estuarine and coastal sediments, and persist for years (Garcés *et al*., 2004; Bravo *et al*., 2006). Given that the environmental conditions linked to outbreaks of this IMS are not dominant in the Cape Hardy area its introduction at Cape Hardy is considered unlikely. The coastline is not enclosed nor are there regular inputs on nutrient-rich freshwater required to support this IMS.

6.8.2 Impacts and Risks: Invasive Marine Species

IMS are opportunistic species that use either marine operations as vectors to transfer between areas, or disturbances to the marine environment or changes in the local environment along with artificial surfaces to colonise new areas. As a port area is likely to provide all three of those scenarios during both construction and the ongoing operation of the port, introduction of IMS has the potential to significantly affect the marine environment at Cape Hardy.

6.8.2.1 Impacts

The introduction of IMS to the study area as a result of the construction and operation of the proposed port is not planned. As such, IMS are considered to be a risk to the project rather than a known impact and are discussed below.

6.8.2.2 Risks

IMS could be transported to the study area as biofouling on vessel hulls, jack-up barge legs, anchors, anchor chains, mooring lines, internal boat compartments, sediment transported in or on vessels, or in any seawater onboard vessels/barges including ballast water, in bilge, inside pipes or pumps. IMS are not selective and will take advantage of any vessel regardless of size. Therefore the jack-up equipment or support vessels used during construction, as well as cargo ships during operation all have the potential to transport IMS to the study area.

IMS can exist in low numbers or persist as cysts in an area and can rapidly increase in numbers after a disturbance to the environment or removal of competitive indigenous species. Therefore construction activities have the potential to either release cysts or propagules of IMS as well as provide cleared surfaces for IMS to colonise. Due to the opportunistic traits of IMS the disturbed areas and new hard surfaces of the MOF, tug harbour and jetty will create suitable areas for IMS to colonise.

All vessels utilising the port site will be required to comply with the national guidelines relevant to biofouling and ballast water. However, the identification of IMS during construction and operation of the proposed port is considered likely despite the implementation of control measures. As Cape Hardy is relatively isolated from a hydrodynamic perspective, IMS that may colonise the area would not be readily transported by currents beyond the study area and into new regions. As such, most IMS would rely on vessel movements for transportation to areas beyond the study area. Therefore, of the effects of water bourne IMS are considered to be isolated to the Cape Hardy study area and are not considered likely to affect the marine environment at a regional level, considered to be of moderate consequence. As such, the overall risk associated with IMS to local flora and fauna species is considered to be high.

Although the introduction of IMS is a possibility, the likelihood of introducing an algal IMS species that effects water quality is considered unlikely due to the Commonwealth requirements for vessels to discharge ballast water in open waters and the requirement for operators to adhere to a CEMP and OEMP for the port. The consequences of introducing an algal IMS species would be considered minor (localised to the marine study area and algal blooms are typically short term in duration). As such, the risk to water quality from IMS algae is considered to be low.

Some IMS such as mussels have the potential to build up biological reefs consequently changing the bathymetry and therefore ultimately the hydrodynamics of an area. Seagrass has also been shown to influence the hydrodynamics of coastal areas by physically slowing currents. Therefore if a reef-building seagrass pest or smothering IMS such as *Caulerpa taxifolia* were introduced to the site it could cause seagrass loss, which could in turn lead to alterations in hydrodynamics and sediment dynamics. The consequences of such an introduction will be limited to the local study area and will likely be present for a long term, and are therefore considered moderate. As with any operating port the introduction of IMS is a possibility, however the likelihood of introducing a specific reef building or seagrass smothering IMS is considered unlikely. Therefore, the risk of IMS to hydrodynamics and bathymetry is considered medium.

6.8.3 Conclusions

Due to the ability of IMS to utilise multiple modes of transport within the marine environment (i.e. any vessel big or small, from small fishing boats to commercial ships to aquaculture operations) and the interconnected nature of marine environments the risks from IMS are already present within the Spencer Gulf and South Australia.

No IMS were identified within the Cape Hardy area during the course of the investigation. IMS have, however, been detected in several locations around South Australia and the presence of a port will provide both suitable substrate for IMS to colonise and to establish as well as vectors for IMS to spread in Spencer Gulf waters. As such, risks associated with the establishment of IMS at the study area to local flora and fauna species are considered to be high. IMS can also affect bathymetry and therefore ultimately the hydrodynamics of an area, however this is considered unlikely to occur, with an overall risk of IMS to hydrodynamics and bathymetry considered medium.

6.9 Fisheries and Aquaculture

Spencer Gulf is an important fisheries and aquaculture area, with a number of commercial fisheries throughout the gulf and designated Aquaculture Zones. Commercial fishery species in the gulf include Abalone, Blue swimmer crab, Garfish, Western King Prawn, King George Whiting, Australian Salmon, Sardines, Snapper and Calamari. In recent years there have been a number of restrictions on fisheries including suspension of trawling and the introduction of Marine Park Sanctuary Zones that prohibit fishing. Aquaculture in the gulf is a growing industry, with farmed marine species including Pacific Oysters, Kingfish, Mulloway, Mussels and Bluefin Tuna. Currently 670 ha of aquaculture is permitted within restricted locations of the Spencer Gulf. Aquaculture has been excluded from certain areas for water quality, navigation, conservation, historic, recreation or commercial fishing reasons.

6.9.1 Existing Environment and Key Findings

Fishing and aquaculture have a significant commercial role in the Spencer Gulf region. Other than agriculture, these industries provide the bulk of income and employment in the region. Port Lincoln (~100 km south of Cape Hardy) is the major centre of fisheries and aquaculture production in South Australia. Arno Bay (~50 km north of Cape Hardy) is another centre of fisheries and aquaculture.

The proposed port site lies within the Port Neill Aquaculture Exclusion zone as delineated by the Land Not Within a Council Area (Coastal Waters) Development Plan. There were two exemptions within the Port Neill Aquaculture Exclusion Zone for registered finfish aquaculture leases numbered LA00071 and LA00072 (Aquaculture Zones, 2008), however these were surrendered to PIRSA in 2013 (personal comms. E. Kaese, PIRSA, 2013). As these leases have been surrendered, no aquaculture activity is permitted within the Port Neill Aquaculture Exclusion Zone.

Currently the closest active aquaculture leases lie 30 km to the south of the study area off Cape Euler where there is a land based lease for abalone, calamari, greenback flounder, blue and pen mussels, native and pacific oysters, scallops, sea urchin, cockles, razorfish, pot-bellied seahorse and leafy seadragon. These commercially reared species are all held in onshore tanks. There is also an offshore lease in the historic Tumby Offshore Aquaculture Zone, with offshore seacages for three abalone species. Thirty three km to the north of the study area in the Arno Aquaculture Zone are several leases with the majority of the licenses for finfish sea cages of bluefin tuna, yellowtail kingfish, mulloway, snapper and black bream. There are also land based operations with license for King George whiting, knifefish, calamari, abalone and pacific oyster at Arno Bay.

It should be noted that while the Port Neill Aquaculture Exclusion Zone provides a buffer from potential aquaculture activities, the Port Neill Aquaculture zone extends to within 2 km of the proposed port location at Cape Hardy (see Figure 6-10). There are currently no active leases within that area however it is possible that at some point in the future the area will be utilised by some form of aquaculture.

During the towed video surveys several commercial fish and invertebrate species were observed. Numerous blue swimmer and sand crabs were sighted throughout the survey area along with several slipper lobsters near seagrass beds and one giant cuttlefish. The Australian Giant Cuttlefish and all cephalopods are protected by the Fisheries Act in the upper Spencer Gulf by the temporary cuttlefish closure area until (at least) February 2015. The protected area extends from the top of the gulf down to Arno Bay and Wallaroo; approximately 35 km north of Cape Hardy.

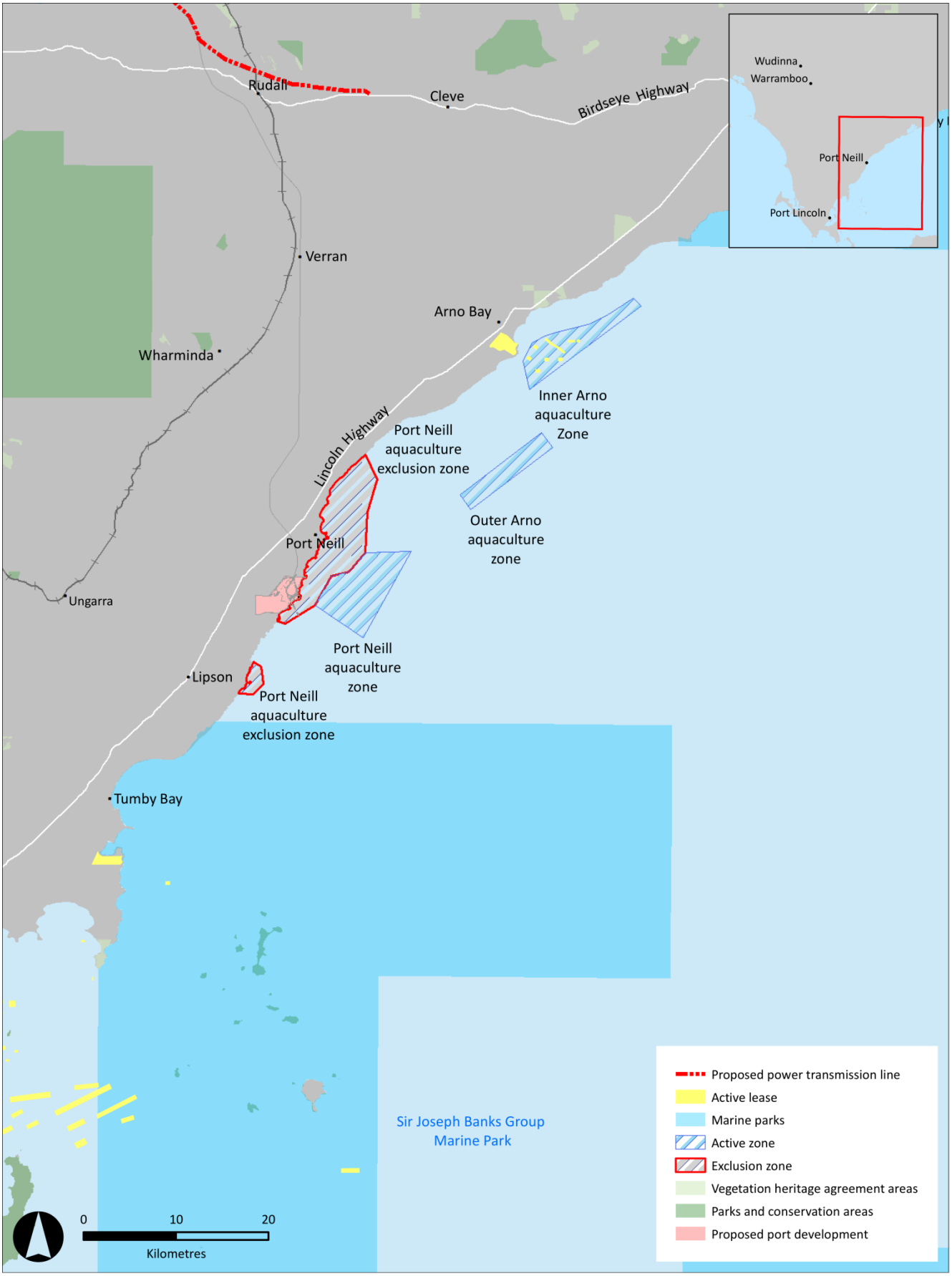


Figure 6-10 Port Neill aquaculture exclusion zones and Port Neill aquaculture zone

Spencer Gulf is also an important area for a number of commercial fisheries, including those targeting (western) king prawn, blue swimmer crab, abalone, rock lobster, sardines and marine finfish such as snapper and King George whiting (Knight and Tsolos, 2012).

The northern end of the gulf is an important spawning and nursery area for king prawns and supports an economically valuable fishery. The Spencer Gulf has been subdivided into management areas for the prawn fishery and the Cape Hardy area falls within the Cowell zone which encompasses Cowell to the north down to Tumby Bay in the south. The mean Catch per Unit Effort (CPUE) for the Cowell zone from 2005-11 was approximately 80 kg/h (Dixon *et al.*, 2012). Generally, within the gulf higher CPUEs are observed to the north and west. The annual catch for the Cowell zone was 80 and 17 tonnes in 2009 and 2010 respectively (Dixon *et al.*, 2012), while, annual catches for the upper gulf have been as high as 150 tonnes. Prawn fishing in the Spencer Gulf is restricted to between the months of November to June and generally during nighttime hours, in waters over 10 m in depth (Dixon *et al.*, 2012). Cape Hardy falls within the prawn fishing block 107. An independent survey of block-specific data for this fishery shows there has been no historic trawling effort in block 107 (Currie *et al*., 2009) however there may be some interaction with the fishery by the vessels accessing the port within the deeper water of the gulf. Currie et al. (2009) show that the heaviest trawling effort is in shipping channel areas of the upper gulf, indicating that the prawn fishery can coexist with large cargo vessel movements. The proposed vessel approach vectors (Figure 3-3) and the port itself, represents only a small portion of the overall fishery and it is not anticipated that the construction or operation of the port will restrict access to the deeper water areas trawled for this species.

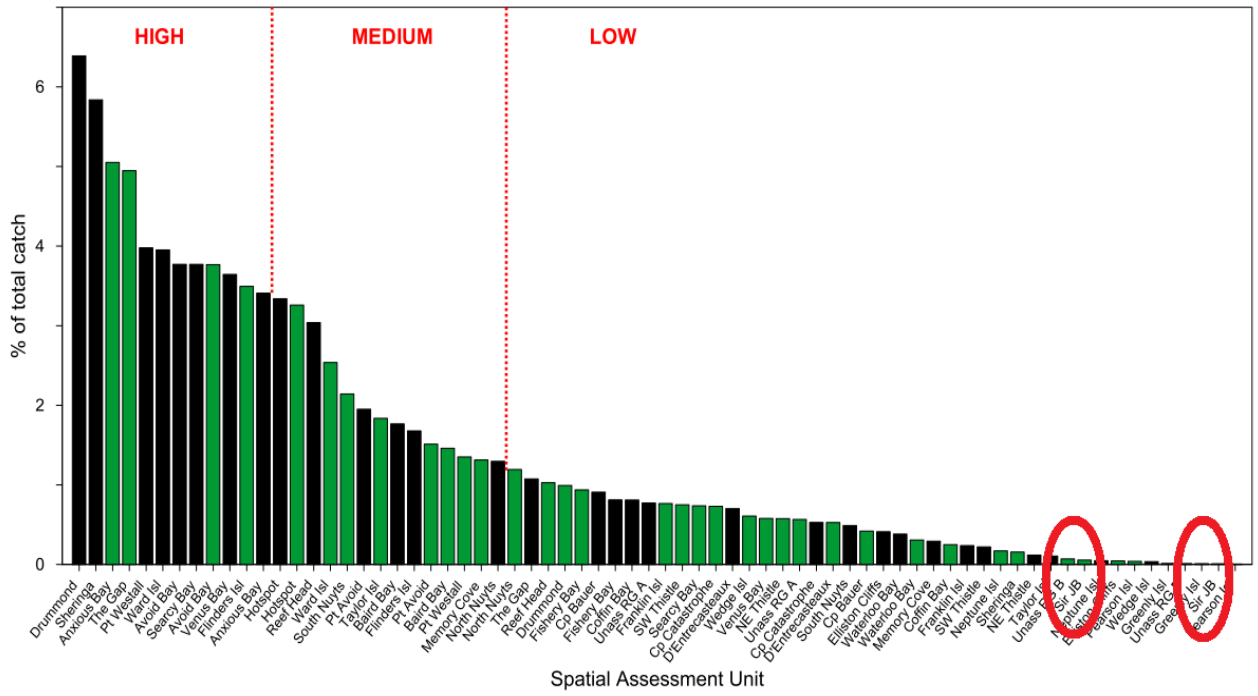
A blue swimmer crab (*Portunus armatus*) fishery operates in the Spencer Gulf and is managed under the Fisheries Management (Blue Crab Regulations, 1998) which closes the fishery from 21 December to 19 February. Cape Hardy falls within the fishing block 59 of the Spencer Gulf Blue Crab fishery which includes all waters north of Tumby Bay. No block-specific data is available for the block 59 blue crab fishery. The dominant fishery for this species is greater than 100 km from Cape Hardy in the upper Spencer Gulf fishery north of Cowell (Dixon *et al*., 2013).

The blue swimmer crab is distributed throughout coastal waters of tropical regions of the western Indian Ocean through to the southern temperate waters of Australia and into the eastern Pacific Ocean. In South Australian waters the species has altered its life cycle to have increased growth and reproduction during the warmer months of the year when water temperatures increase to those similar to tropical regions. The species' habitat range is also large with the crabs found on algal and seagrass habitats on both sandy and muddy substrates from intertidal to at least 50 m depth. Within South Australia there is a seasonal movement of adult crabs from deeper waters into inshore shallow waters during the warmer months of September to April during the breeding season and into deeper water offshore during the colder months of May to August. Observations made during the video survey in November 2011 recorded the species as widely distributed in areas of both sandy bottom and seagrass beds. It is therefore likely the species utilises the Cape Hardy area. However due to the large range of this species, the location of the study area 100 km south of the dominant fishery for this species and the size of the port footprint, the benthic habitat at Cape Hardy is not expected to be on critical habitat for this species or its fishery.

The Northern Zone rock lobster fishery operates in Spencer Gulf between November and May. Cape Hardy falls within Marine Fishing Area (MFA) 29 for this fishery. The species distribution is typically around offshore islands and rocky reefs. In 2011 the total catch estimates for the species indicated that 19% of the catch came from the southern Spencer Gulf (SSG) with the majority of the catch coming from the far west coast of South Australia and Kangaroo Island (80% combined) (Linnane *et al*., 2012). The catch for this species across South Australia have been declining since 2000 despite increased effort; attributed to low juvenile recruitment. The species has a four-year settlement and recruitment cycle and in 2007-2012 there was low settlement (Linnane *et al*., 2012). This indicates that recruitment from 2011-2016 may be low and catch numbers may be reduced for several

years for this species in the SSG. The historical catch from MFA 29 represents only 0.02% of the total Northern Zone catch between 1993 and 2009 (Ward and Burch, 2012), indicating the area around Cape Hardy is not a key area for this fishery. Given the low percent catch attributable to MFA 29 and the limited subtidal reef areas present within the Cape Hardy study area the interaction with rock lobster fishing is expected to be minimal.

Green-lip and Black-lip Abalone are also fished in the Spencer Gulf with permits restricted to a number of licensed divers. Cape Hardy Falls within Abalone fishing block 20c. There is no detailed fishing activity or catch data available for 20c, however the relative catch numbers for the State indicate 20c is not a significant fishery area for the species (Figure 6-11). It is anticipated that the bulk of the limited catch from 20c has historically come from near the offshore islands of the Sir Joseph Banks group. Abalone is typically found on rocky substrate and subtidal low reef areas which are not extensive within the study area. Based on the known environment surrounding Cape Hardy and the relative catch data for this fishery, it is not anticipated that the proposed port area is heavily utilised by Abalone divers.



Relative importance (% of catch) of each blacklip (black bars) and greenlip (green bars) SAU. Note each SAU is ranked twice, once for blacklip and once for greenlip. Red text and dotted lines indicate SAU importance and division. Note abbreviations for cape (Cp), island (Isl), Joseph Banks (JB) and Unass RG A or Unass RG B (unassigned Region A or Region B, respectively).

Figure 6-11 Relative catch percentage of Abalone for Western Zone Region A, taken in 2010/11.
Note: red ovals indicate relative total catch from the Sir Joseph Banks SAU which includes the study area (Adapted from Stobart *et al.*, 2012)

There are also three main finfish fisheries that operate in the Spencer Gulf; the Sardine, King George whiting and Snapper. Cape Hardy lies within the SSG fishery and the Marine (finfish) Fishery Area (MFA) 29 which is over 4250 km^2.

The SSG is an important area for the Sardine fishery providing the largest catch for the past 15 years (Ward *et a*l., 2012). The bulk of the catch is from deep water areas of MFAs 39, 30 and 29 (Knight and Tsolos, 2012). Sardines are a small pelagic schooling fish and are generally fished in South Australia using purse seines.

The commercial catch for King George whiting in the SSG has predominantly used hand lines since net closures in 2005. Recorded commercial catches for the SSG are approximately 73 tonnes in 2008, 82 tonnes in 2009 and 80 tonnes in 2010. Only the far west coast of Eyre Peninsula recorded higher catches within South Australia during this period (Fowler *et al.*, 2011). There is no commercial fishery data available for MFA 29 as data from all the MFA (29, 30, 31, 32 and 33) in SSG have been pooled together (Fowler *et al.*, 2011). While the SSG is a substantial fishery for the King George whiting, the fishery is widespread throughout South Australia waters, and the Cape Hardy area does not represent any key nursery grounds therefore little interaction with this fishery is expected.

There is no dedicated giant crab fishery in South Australia as most of the crabs are taken as bycatch in the lobster fisheries (within depths shallower than 120 m; Levings *et al.,* 2001; Currie, 2011; Stobart, 2014). The giant crab is endemic to southern Australia and found between southern Western Australia and central New South Wales (Kailola *et al.,* 1993) inhabiting waters between 18 and 400 m in depth and in temperatures between 10 and 18 ^{o} C. The highest population densities occur at the shelf break, where the continental shelf and slope meet (~200 m in depth). Size distribution is stratified by depth (Levings *et al.,* 2001). Circumstantial evidence (based on catch records) suggests that females move onto soft muddy substrate when they moult while males are captured across a broader depth range than females (Levings *et al.,* 2001). As this species' preferred depth range and habitat generally falls outside of the footprint of the study area, direct effects on commercial fishing of this species from the development are unlikely.

Commercial fishing of Garfish in the SSG falls into the MFA 29 and had an average catch of less than 0.5 tonnes for 2010/11, with previous years 2004-2010 between 0.5 -3.0 tonnes (Steer *et al.*, 2012). Recreational fishing for Garfish fell from 5 tonnes in 2001 to less than 0.5 tonnes in 2008. The reduction in catch for both recreational and commercial tonnage has been attributed to area closures for haul netting and a shift to dab netting in the SSG. It is unlikely that Garfish would be present in large numbers within the Cape Hardy study area. The species diet is composed significantly of *Zostera muelleri* (commonly called Garweed) and *Heterozostera nigricaulis* (Steer *et al.*, 2012). There are no large stands of these seagrass species identified in the study area. The nearshore areas of the study area were not surveyed with video tow and may contain patches of *Zostera muelleri* or *Heterozostera nigricaulis*, however the aerial imagery indicates little coverage of seagrass in the nearshore. Therefore the total geographic area of either *Zostera muelleri* or *Heterozostera nigricaulis* distribution in the study area would not be significant. As such, any impacts on the seagrass areas within the study area due to the construction and operation of the port are unlikely to impact on the distribution of Garfish.

There are also a number other fisheries that operate within the wider Spencer Gulf, these species along with species that may be taken recreationally or as bycatch are included in Table 5-5 and Table 6-9 which assess their likelihood of occurrence within the study area as well as the likelihood of potential impacts from the development.

6.9.2 Impacts and Risks: Fisheries and Aquaculture

Impacts to fisheries and aquaculture could occur as a result of:

- Loss of habitat through clearance, exclusion or degradation of the environment
- Exclusion from fishing grounds
- Pollution from run-off, oil or chemical spills
- Marine debris
- Noise and physical impacts during construction piling
- Safety and navigation
- IMS

6.9.2.1 Impacts

Construction and operation of the proposed port will restrict commercial fisheries from operating within the marine study area. As previously discussed, noise emissions during construction and operation of the proposed port may result in the temporary displacement of fish species from the study area. The entire marine study area comprises approximately 1% of MFA 29 and does not contain any habitat identified as critical for commercially fished species. As such, restricting commercial fisheries from operating within the study area will not significantly impact commercial fishing operations and is considered to represent a negligible impact.

6.9.2.2 Risks

As fisheries are dependent on availability of fish the risks to fisheries are in general the same as those to fish species and are discussed in Section 6.6.

As previously outlined, the introduction of IMS is considered likely and may result in the long term decrease in abundance of seagrass and marine species, and subsequently affect the the distribution of fish species. As detailed in Section 6.8, IMS is considered to represent a high risk to fish species. Although IMS may affect the distribution of fish species, the marine study area does not contain any nursery grounds or other habitat identified as critical for commercially fished species. As such, the introduction of IMS is considered to be of minimal consequence to fisheries and aquaculture, representing a low risk.

Additional risks to commercial fisheries could occur as a result of the release of waste products into the marine environment. Construction and operation of the proposed port will result in the generation of a number of waste streams that may enter the marine environment. Marine debris can significantly affect fish species as a result of pollution, injury through collision, entanglement or ingestion of non-biological products.

Waste management and handling procedures developed as part of the CEMP and OEMP will control waste streams with the overarching aim of no waste products entering the marine environment. Despite the implementation of control measures, it is considered almost certain that some form of waste / debris will enter the marine environment during construction and operation of the port. As the port site is not a key habitat or breeding area, the consequences of debris entering the marine environment are considered to be minimal; insignificant to the overall viability of fish species. As such, the overall risk is considered to be low.

Fish species are also at risk from the unintended discharge of pollution in the form of site run-off, wastewater, hydrocarbons or chemicals. With any marine activity there is potential for waste or spills to enter the marine environment and affect plankton, benthic fauna and habitat forming benthic flora (e.g. seagrass), reducing habitat suitability for fish species.

The implementation of design measures (refer Section 4) for the control of surface and waste water at the port site will limit the majority of hazardous pollutants from entering the marine environment. There remains a risk that a major spill of oil or other chemicals may occur as a result of vessel failure or accident. Based on the experiences of other operating ports, the likelihood of this event occurring is considered to be unlikely. As previously outlined, the port site does not represent a critical habitat or breeding colony for fish species. The consequences of a major spill event are considered to be minor, due to the low level of dependence of fish species on the study area, resulting in a short term decrease in the local abundance of fauna. As such, the overall risk of a major spill event affecting fish species is considered to be low.

6.9.3 Conclusions

The port is located within the Port Neill Aquaculture Exclusion zone, with the Port Neill Aquaculture zone located 2 km from the nearest point of the jetty. There are currently no aquaculture leases or licenses located within the Port Neill Aquaculture zone (PIRSA, 2014). Aquaculture leases with licenses for yellowtail kingfish

that were previously approved within the Port Neill Aquaculture Exclusion zone, have been withdrawn or surrendered and are no longer permitted in the Exclusion zone.

Cape Hardy lies within a number of areas designated for specific shellfish and finfish fisheries. It is anticipated that no interactions are likely in regard to the Prawn, Rock lobster and Abalone fisheries. It is anticipated that due to depth requirements for fishing methods the utilisation of the port site infrastructure areas by commercial finfish fisheries would be limited.The deep-water offshore areas of southern Spencer Gulf which have historically provided high catches of snapper, King George whiting and sardines are considered to be outside of the proposed port site and only the vessel approaches and anchorage areas would potentially interact with these fisheries during only limited times.

Although the introduction of IMS is considered a high risk to the distribution of fish species, the marine study area does not contain any habitat identified as critical for commercially fished species. As such, the introduction of IMS is considered to be on minimal consequence to fisheries and aquaculture, representing a low risk. Similarly, the unintended discharge of waste or pollution would not affect critical commercial fishery habitat or aquaculture areas and are considered to represent a low risk.

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Appendix A Bathymetry Survey Reports

AUSTRALIAN HYDROGRAPHIC SERVICE

SURVEY SUMMARY

INSTRUCTIONS FOR RENDERING

This Survey Summary form should be completed for all data rendered to the Australian Hydrographic Office which is not accompanied by a full written report, Method Statement, Plans or other reports which would normally include details such as those in this form.

This will provide the minimum information required to manage data within Australia's area of charting interest.

The preferred format of bathymetric data is:

- **Processed,**
- **Ungridded for singlebeam and multibeam, shoal biased, true position,**
- **Provided as either GSF, ascii .xyz, .dxf, .dgn, or Hydrographic Transfer Format (.htf, available from the AHS website http://www.hydro.gov.au). If these formats are not available, full source data will be accepted.**

Any ancillary data such as tides, benchmarks, linework and final levelling heights etc. is also of assistance. If supplying such data, please include positional data of deployed equipment.

Please forward survey data with the completed Survey Summary to:

Hydrographer of Australia
C/- Manager Digital Information
Australian Hydrographic Office
Locked Bag 8801
Wollongong NSW 2500

Guidance on Confidence Levels and Error Ellipse scaling is contained in ICSM Publication Number 1 (SP-1), uncertainties from IHO publication S-44 or by contacting the Validation and Assessment Section at the Australian Hydrographic Office on 02 4223 6500.

SURVEY SUMMARY

General

Survey Title and ID	**Locality**
Cape Hardy Soundings	Spencer Gulf, South Australia
Survey Authority	**Survey Sponsor/Custodian**
HydroSurvey Australia	Flinders Ports South Australia Pty Ltd
Surveyor in Charge and Qualification	**Date this Survey Summary was completed**
Peter Woolfall (Level 1)	23rd March 2012
Start Date of Survey	**End Date of Survey**
18th February 2012	23rd February 2012
Survey Platform/Vessel Name	**Scale (if applicable)**
S.V. Pathfinder	5000
Purpose of the Survey	
Cape Hardy Marine Investigation Project	
List of Data Provided	
2 x csv files, 3 x dwg file	

Do you require the media returned and to which address?	No	

Horizontal Control

Soundings are on the following datum (WGS 84 preferred by not essential).			
Datum	GDA94	**Spheroid**	GRS80
Projection	MGA94	**Zone**	53 South

Was the positioning system validated?	Yes	**Were laybacks applied?**	No

Estimated horizontal accuracy of soundings at 2σ (95%) confidence level **(Calculations can be included as an attachment)**	+/- 1 metres

Vertical Control

Tides applied	Soundings corrected using Observed Tides	**Sounding Datum**	Indian Springs Low Water

Tide Station Details	Tumby Bay (34°22’39”S 136°06’21'E) Cape Hardy (34°11’56”S 136°18’00'E)
Benchmark (BM) used and height difference between BM and Datum	CD(approx ISLW) is 3.885m below benchmark PSMP 6129/1003. BM PSMP = EL 2.658m AHD
Geoid details if using GPS tides	n/a

Were soundings corrected for draught?	Yes
Estimated vertical accuracy of soundings at 1.96σ (95%) confidence level **(Calculations can be included as an attachment)**	+/- 0.39 metres

Details of Survey Execution

The following positioning systems were used	
Positioning System 1	Trimble DSM232 DGPS

Positioning System 2	POS MV Wavemaster V4	
Base Station	OmniStar ITRF to GDA94 corrections (2012.5 epoch)	
The following sounding systems were used		
	Model / System Details	**Frequency**
Echosounder 1	GeoSwath Plus MBES	250 kHz
Echosounder 2	Odom Echotrac Mk2	200 / 24 kHz
Motion Reference Unit	POS MV Wavemaster V4 RM IP68	
Towed Side Scan Sonar	n/a	kHz
Hull Mounted Side Scan Sonar	n/a	kHz
	Model / System Details	**Spot density**
LIDAR	n/a	X by X metres
Sweep System	n/a	

Logging and Processing Systems used		**Version**
Logging	GeoSwath Plus / HydroPro	3.50r / 2.40
Processing	GeoSwath Plus / HydroPro / Terramodel	3.50r / 2.40 / 10.61
Was the survey systematically controlled with planned survey lines or methods?		Yes
Were soundings corrected for sound velocity?		Yes
Was full feature detection achieved as defined in IHO publication S-44?		Yes
Were all shoal depths systematically investigated and their least depths determined?		Yes
Has the data been thinned from that collected?		Yes
If thinned, what thinning method and bin size was used?	2m bin out of GS+, thinned to 45m circle of influence in Terramodel (shoal bias) for plotting purposes (1 to 5000)	
If thinned, have least depths and their positions been retained?		Yes

Remarks (If applicable):

Shoals and Dangers

This section seeks comment on any features that may be dangerous to surface navigation.
Small Yellow Buoy located at 34°11’22.9”S 136°19’55.4'E

Appendix B Sediment Analysis Results

B1. Particle Size Distribution Lab Results

University of South Australia

Laser Diffraction particle sizing of 15 Marine Sediment Samples

Project Number	2012/005
Prepared for	Sinclair Knight Merz L5, 33 King William St Adelaide SA 5000
Attention	Dr Greg Barbara
Prepared by	Dr Scott Abbott
Date of issue	18 January 2012
Distribution	Sinclair Knight Merz Ian Wark Research Institute: Scientific Services

Ian Wark Research Institute
ARC Special Research Centre

Minerals and Materials Science – Nanotechnology – Interfaces

Director
Professor John Ralston AO *FAA FTSE*

Deputy Director
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www.unisa.edu.au/iwri

Australian Research Council
Special Research Centre for
Particle and Material Interfaces

CRICOS Provider Number 00121B

Important Notice

This report applies only to the subject of the project.

This report is confidential and was prepared exclusively for the client named above. It is not intended for, nor does the University of South Australia accept any responsibility for its use by any third party. This report consists of one cover page and thirty four (total 35) pages of text and figures plus an attached spreadsheet of data.

Introduction

15 marine sediment samples were received at the Ian Wark Research Institute (commonly referred to as The Wark™) on Friday 13th January 2012 for laser particle size distribution (PSD) analysis. A purchase order complete with number was received on the same day. The supplied samples were labelled as shown in Table 1.

Experimental

Before analysis, the samples were wet sieved using a 2,000µm mesh sieve. Significant observations made during the sieving process are also summarised in Table 1. Particle size distribution of the -2,000µm fraction was then measured using a Malvern Mastersizer 2000 Static Light Scattering/Laser diffraction instrument covering the measurement range of 0.02 to 2,000µm. Three measurements of each sample were conducted for 20 seconds and these 3 results for each sample were averaged. The exception was sample C6. The majority of the particulate in sample C6 was very coarse (>1mm) and as such tended to 'drop-out' and settle in the Mastersizer feed tube. As such, only one measurement could be recorded before this settling was observed.

Results

Samples consisted of a variety of forms from medium sand through to coarse shell fragments, with a wide range of larger material, including some small rocks.

The measured volume % PSD plots (Figure 1 and Figure 2) are overlaid on pages 4 and 5 of this report for ease of comparison purposes. You will note that the overlays presented in Figures 1 and 2 are different. Also attached to this report are the individual insize and undersize Mastersizer result analysis reports for your perusal.

Sample	Significant Observations
A1	Sediment was not too coarse. Packed well in the vial as was difficult to remove for analysis.
B1	As above
C1	As above
D1	As above
A4	Sediment was coarser than those above and as such was removed from the supplied vial much easier.
B4	Appeared of similar consistency to A—D1, maybe slightly coarser.
C4	As for B4
D4	As for B4. Very large stones removed from this sample on the sieve. Stones up to 4cm in size (4 of them).
A5	Large shell and stones again removed from this sample on the sieve.
B5	-
C5	-
D5	-
B6	The majority of this sample was >2mm in size and as such most of the sample remained on the sieve.
C6	<2mm sediment was difficult to size due to the sample being coarse and 'dropping out' in the Mastersizer feed tuning. Only one measurement made. No averaging performed here.
D6	-

Table 1: Supplied marine sediment samples and observations made during the sizing analysis.

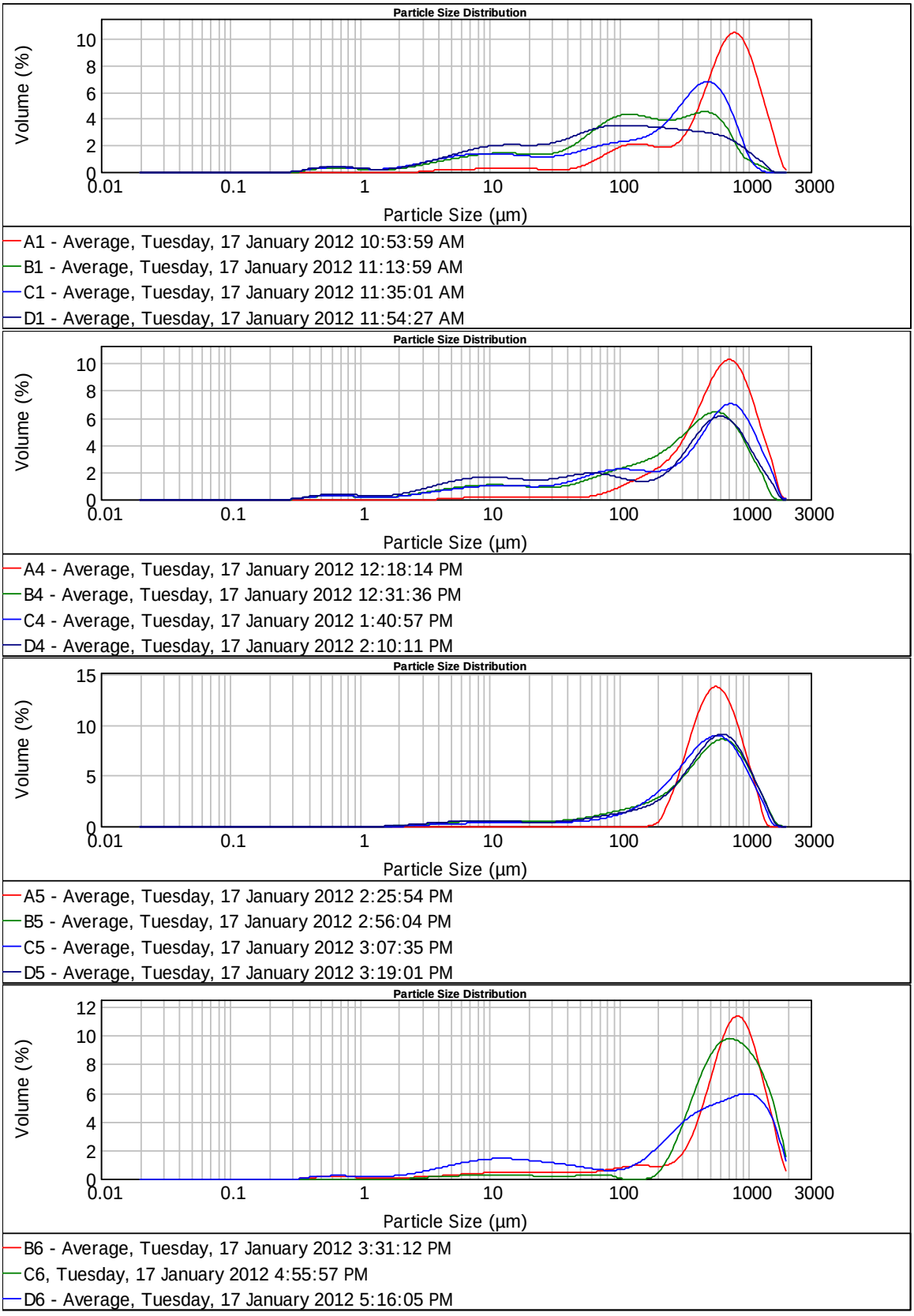


Figure 1: Overlay of the measured PSD plots for ease of comparison purposes.

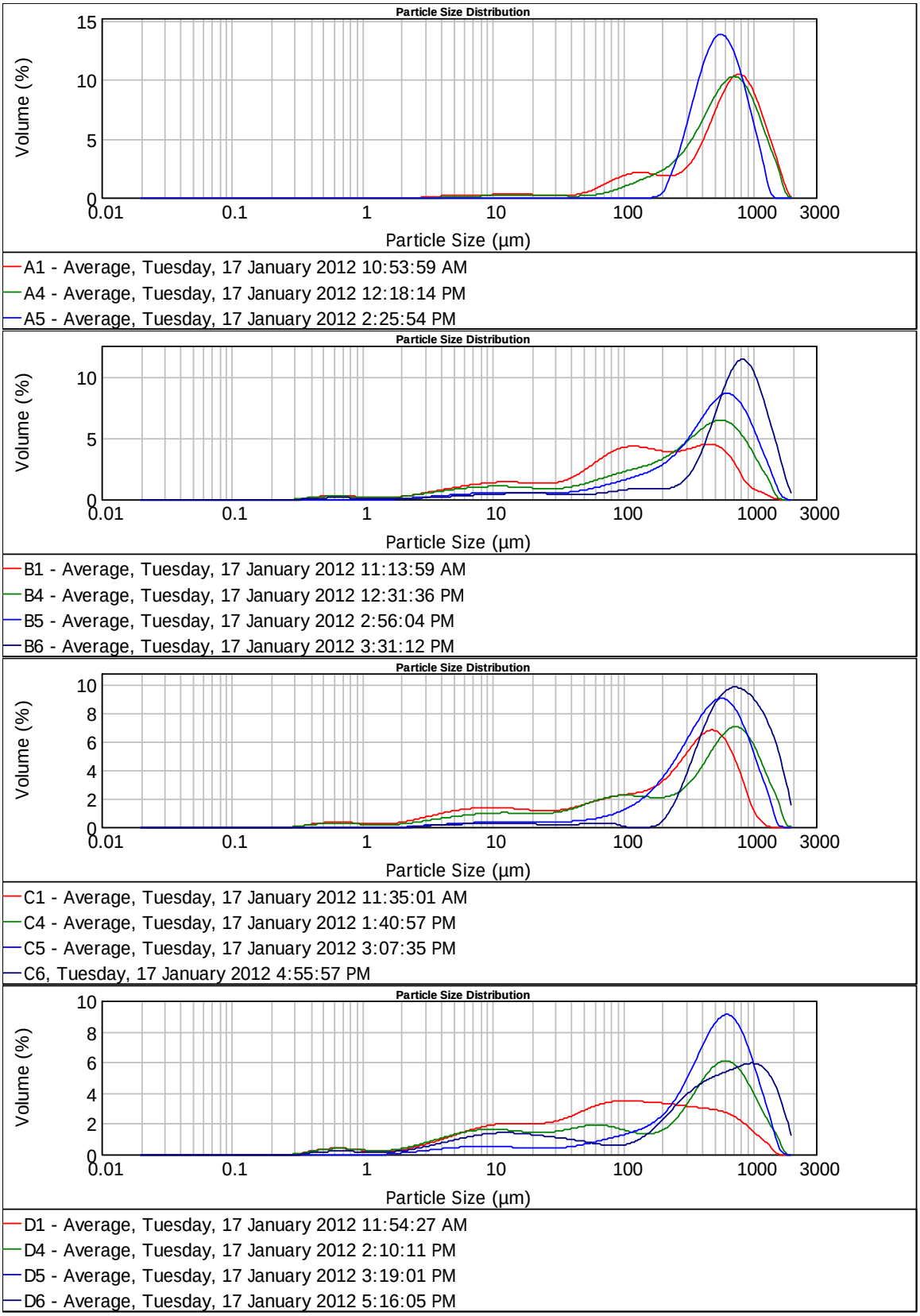


Figure 2: Overlay of the measured PSD plots for ease of comparison purposes.

MASTERSIZER 2000

Result Analysis Report

Sample Name:
A1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 10:53:59 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 10:54:01 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
13.88 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
5.323 %

Result Emulation:
Off

Concentration:
0.3346 %Vol

Span :
1.729

Uniformity:
0.52

Result units:
Volume

Specific Surface Area:
0.037 m²/g

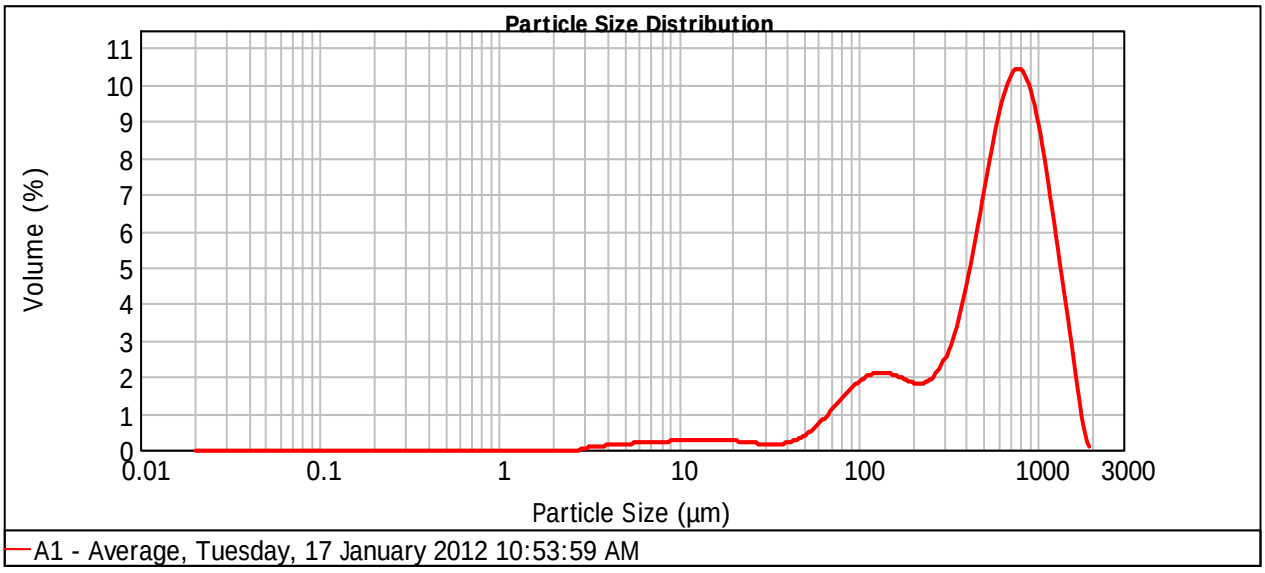
Surface Weighted Mean D[3,2]:
162.231 um

Vol. Weighted Mean D[4,3]:
647.587 um

---

d(0.1): 111.734 um **d(0.5):** 627.177 um **d(0.9):** 1196.139 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.00
0.417	0.00
0.479	0.00
0.550	0.00
0.631	0.00
0.724	0.00
0.832	0.00
0.955	0.00
1.096	0.00

Size (µm)	Volume In %
1.096	0.00
1.259	0.00
1.445	0.00
1.660	0.00
1.905	0.00
2.188	0.00
2.512	0.00
2.884	0.05
3.311	0.09
3.802	0.11
4.365	0.13
5.012	0.15
5.754	0.17
6.607	0.18
7.586	0.20
8.710	0.21
10.000	0.22
11.482	

Size (µm)	Volume In %
11.482	0.24
13.183	0.24
15.136	0.24
17.378	0.23
19.953	0.21
22.909	0.18
26.303	0.15
30.200	0.13
34.674	0.15
39.811	0.21
45.709	0.33
52.481	0.52
60.256	0.77
69.183	1.06
79.433	1.36
91.201	1.62
104.713	1.81
120.226	

Size (µm)	Volume In %
120.226	1.90
138.038	1.89
158.489	1.80
181.970	1.69
208.930	1.64
239.883	1.75
275.423	2.11
316.228	2.82
363.078	3.86
416.869	5.21
478.630	6.68
549.541	8.05
630.957	9.05
724.436	9.43
831.764	9.05
954.993	7.93
1096.478	6.29
1258.925	

Size (µm)	Volume In %
1258.925	4.46
1445.440	2.65
1659.587	0.77
1905.461	0.00
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 11:13:59 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 11:14:01 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
15.33 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.416 %

Result Emulation:
Off

Concentration:
0.0505 %Vol

Span :
4.300

Uniformity:
1.32

Result units:
Volume

Specific Surface Area:
0.37 m²/g

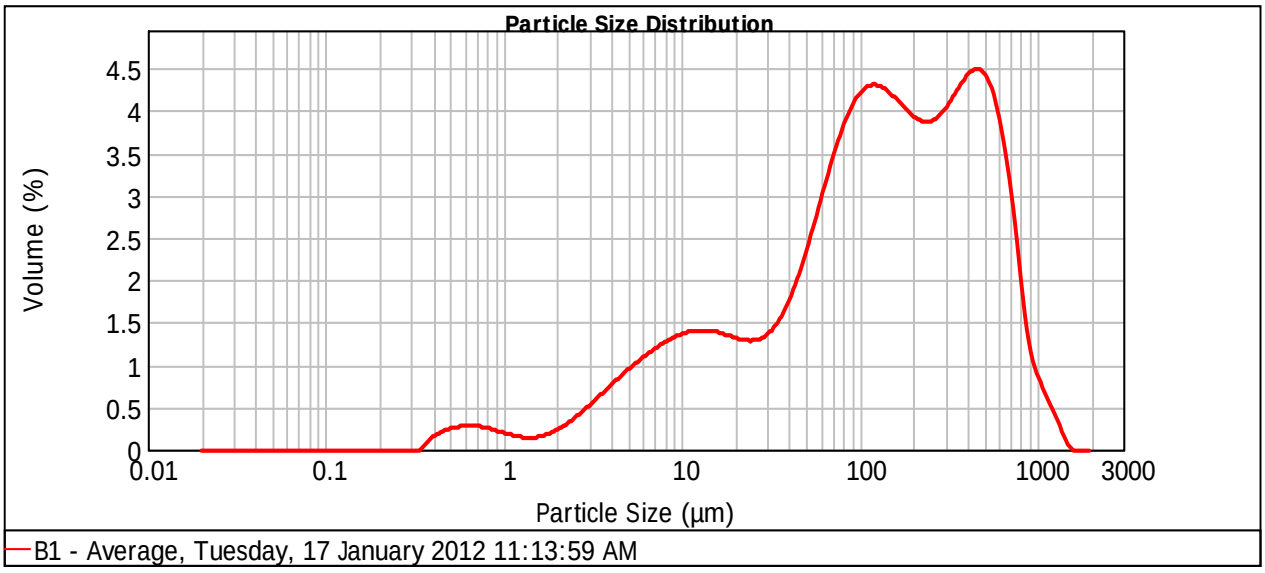
Surface Weighted Mean D[3,2]:
16.237 um

Vol. Weighted Mean D[4,3]:
225.161 um

---

d(0.1): 8.772 um **d(0.5):** 132.553 um **d(0.9):** 578.695 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.14	11.482	1.27	120.226	3.88	1258.925	0.24
0.011	0.00	0.120	0.00	1.259	0.13	13.183	1.27	138.038	3.80	1445.440	0.01
0.013	0.00	0.138	0.00	1.445	0.14	15.136	1.24	158.489	3.68	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.17	17.378	1.21	181.970	3.57	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.23	19.953	1.17	208.930	3.50	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.30	22.909	1.16	239.883	3.51	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.39	26.303	1.19	275.423	3.61	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.50	30.200	1.29	316.228	3.78	3311.311	0.00
0.030	0.00	0.316	0.01	3.311	0.60	34.674	1.46	363.078	3.96	3801.894	0.00
0.035	0.00	0.363	0.13	3.802	0.71	39.811	1.73	416.869	4.06	4365.158	0.00
0.040	0.00	0.417	0.19	4.365	0.81	45.709	2.07	478.630	3.99	5011.872	0.00
0.046	0.00	0.479	0.23	5.012	0.91	52.481	2.46	549.541	3.65	5754.399	0.00
0.052	0.00	0.550	0.25	5.754	1.00	60.256	2.87	630.957	3.03	6606.934	0.00
0.060	0.00	0.631	0.25	6.607	1.08	69.183	3.25	724.436	2.11	7585.776	0.00
0.069	0.00	0.724	0.24	7.586	1.16	79.433	3.56	831.764	1.15	8709.636	0.00
0.079	0.00	0.832	0.21	8.710	1.21	91.201	3.78	954.993	0.75	10000.000	0.00
0.091	0.00	0.955	0.17	10.000	1.25	104.713	3.88	1096.478	0.49		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 11:35:01 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 11:35:03 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
19.99 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.804 %

Result Emulation:
Off

Concentration:
0.0595 %Vol

Span :
2.871

Uniformity:
0.946

Result units:
Volume

Specific Surface Area:
0.439 m²/g

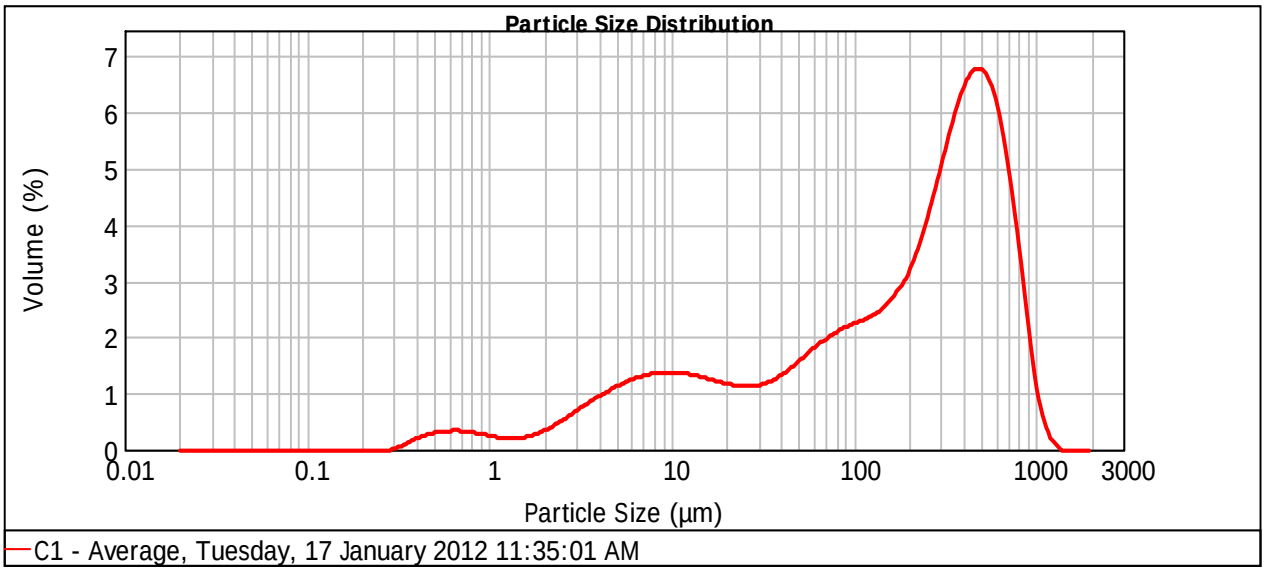
Surface Weighted Mean D[3,2]:
13.679 um

Vol. Weighted Mean D[4,3]:
284.412 um

---

d(0.1): 6.900 um **d(0.5):** 228.844 um **d(0.9):** 663.849 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.19	11.482	1.21	120.226	2.16	1258.925	0.00
0.011	0.00	0.120	0.00	1.259	0.18	13.183	1.18	138.038	2.29	1445.440	0.00
0.013	0.00	0.138	0.00	1.445	0.20	15.136	1.13	158.489	2.49	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.25	17.378	1.08	181.970	2.81	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.32	19.953	1.04	208.930	3.25	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.41	22.909	1.02	239.883	3.81	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.52	26.303	1.03	275.423	4.46	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.64	30.200	1.07	316.228	5.13	3311.311	0.00
0.030	0.00	0.316	0.08	3.311	0.76	34.674	1.14	363.078	5.70	3801.894	0.00
0.035	0.00	0.363	0.16	3.802	0.87	39.811	1.26	416.869	6.06	4365.158	0.00
0.040	0.00	0.417	0.23	4.365	0.97	45.709	1.40	478.630	6.09	5011.872	0.00
0.046	0.00	0.479	0.27	5.012	1.06	52.481	1.55	549.541	5.68	5754.399	0.00
0.052	0.00	0.550	0.30	5.754	1.13	60.256	1.70	630.957	4.84	6606.934	0.00
0.060	0.00	0.631	0.30	6.607	1.19	69.183	1.83	724.436	3.64	7585.776	0.00
0.069	0.00	0.724	0.29	7.586	1.22	79.433	1.93	831.764	2.22	8709.636	0.00
0.079	0.00	0.832	0.25	8.710	1.24	91.201	2.01	954.993	0.92	10000.000	
0.091	0.00	0.955	0.22	10.000	1.23	104.713	2.08	1096.478	0.29		
0.105		1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 11:54:27 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 11:54:29 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
17.49 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.059 %

Result Emulation:
Off

Concentration:
0.0440 %Vol

Span :
6.518

Uniformity:
1.93

Result units:
Volume

Specific Surface Area:
0.502 m²/g

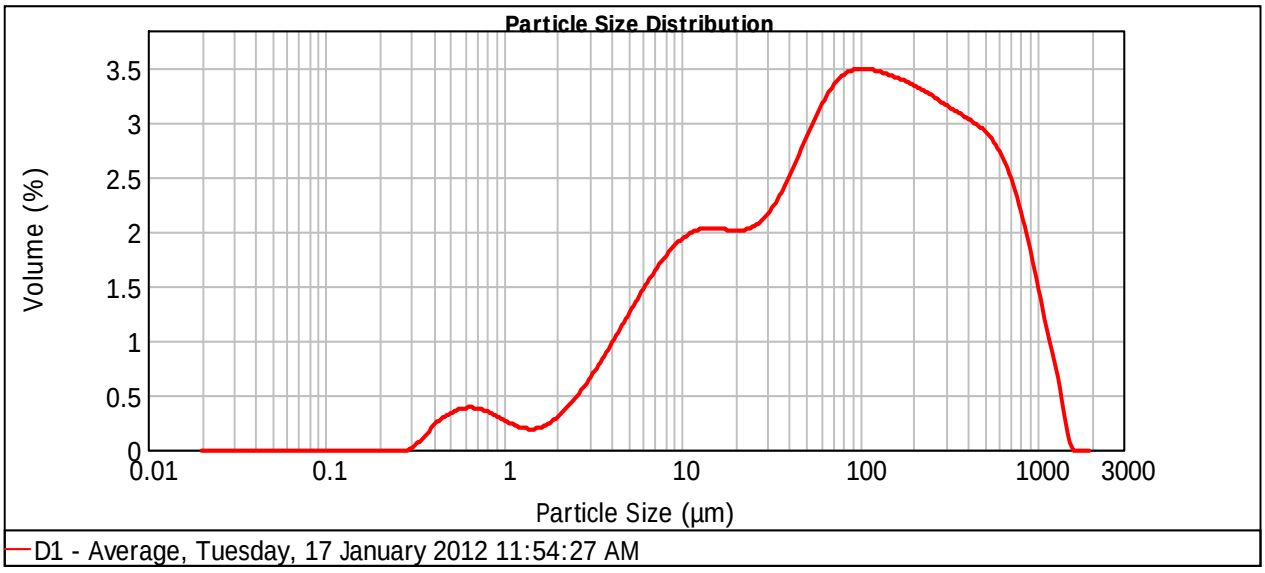
Surface Weighted Mean D[3,2]:
11.943 um

Vol. Weighted Mean D[4,3]:
202.146 um

---

d(0.1): 6.517 um **d(0.5):** 89.308 um **d(0.9):** 588.636 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.01
0.316	0.08
0.363	0.18
0.417	0.26
0.479	0.31
0.550	0.34
0.631	0.35
0.724	0.32
0.832	0.28
0.955	0.23
1.096	

Size (µm)	Volume In %
1.096	0.19
1.259	0.17
1.445	0.18
1.660	0.22
1.905	0.28
2.188	0.38
2.512	0.49
2.884	0.61
3.311	0.75
3.802	0.90
4.365	1.05
5.012	1.20
5.754	1.35
6.607	1.49
7.586	1.61
8.710	1.71
10.000	1.78
11.482	

Size (µm)	Volume In %
11.482	1.82
13.183	1.83
15.136	1.83
17.378	1.82
19.953	1.81
22.909	1.84
26.303	1.90
30.200	2.01
34.674	2.16
39.811	2.35
45.709	2.55
52.481	2.75
60.256	2.92
69.183	3.04
79.433	3.12
91.201	3.15
104.713	3.15
120.226	

Size (µm)	Volume In %
120.226	3.13
138.038	3.10
158.489	3.06
181.970	3.03
208.930	2.98
239.883	2.92
275.423	2.87
316.228	2.81
363.078	2.75
416.869	2.70
478.630	2.62
549.541	2.51
630.957	2.32
724.436	2.06
831.764	1.71
954.993	1.29
1096.478	0.88
1258.925	

Size (µm)	Volume In %
1258.925	0.48
1445.440	0.02
1659.587	0.00
1905.461	0.00
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
A4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 12:18:14 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 12:18:16 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
12.04 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
4.757 %

Result Emulation:
Off

Concentration:
0.4640 %Vol

Span :
1.623

Uniformity:
0.495

Result units:
Volume

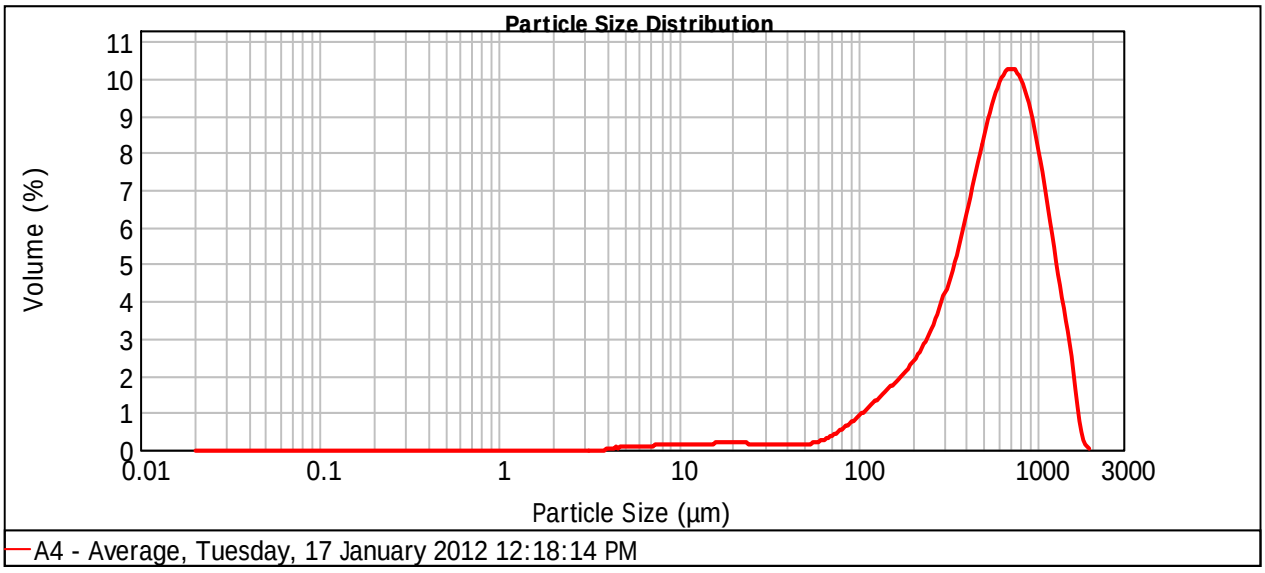
Specific Surface Area:
0.0239 m²/g

Surface Weighted Mean D[3,2]:
250.903 um

Vol. Weighted Mean D[4,3]:
636.603 um

---

d(0.1): 185.391 um **d(0.5):** 593.174 um **d(0.9):** 1148.302 um



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.14	120.226	1.23	1258.925	3.86
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.15	138.038	1.48	1445.440	2.30
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.15	158.489	1.73	1659.587	0.33
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.16	181.970	2.02	1905.461	0.01
0.017	0.00	0.182	0.00	1.905	0.00	19.953	0.16	208.930	2.40	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.00	22.909	0.15	239.883	2.91	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.00	26.303	0.14	275.423	3.59	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.00	30.200	0.12	316.228	4.48	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.00	34.674	0.11	363.078	5.55	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.02	39.811	0.10	416.869	6.72	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.05	45.709	0.12	478.630	7.84	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.06	52.481	0.17	549.541	8.74	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.09	60.256	0.25	630.957	9.22	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.10	69.183	0.38	724.436	9.14	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.11	79.433	0.56	831.764	8.43	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.12	91.201	0.76	954.993	7.17	10000.000	
0.091	0.00	0.955	0.00	10.000	0.13	104.713	1.00	1096.478	5.55		
0.105	0.00	1.096	0.00	11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 12:31:36 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 12:31:37 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
19.63 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.114 %

Result Emulation:
Off

Concentration:
0.0778 %Vol

Span :
2.844

Uniformity:
0.901

Result units:
Volume

Specific Surface Area:
0.328 m²/g

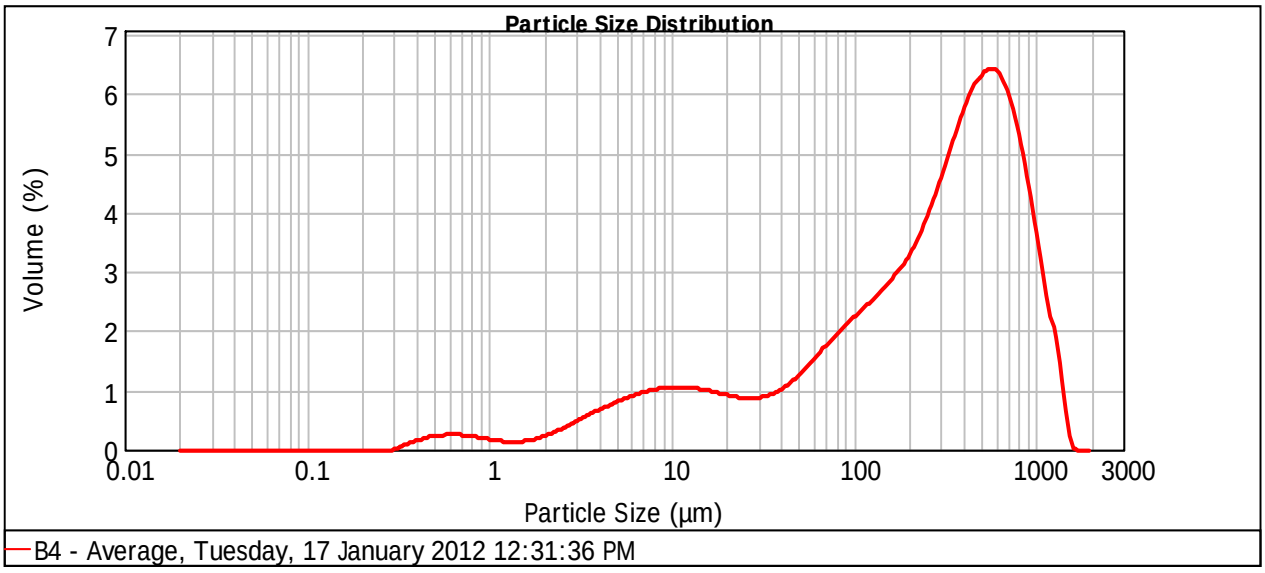
Surface Weighted Mean D[3,2]:
18.298 um

Vol. Weighted Mean D[4,3]:
370.929 um

---

d(0.1): 10.615 um **d(0.5):** 297.105 um **d(0.9):** 855.563 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.07
0.363	0.13
0.417	0.17
0.479	0.21
0.550	0.23
0.631	0.23
0.724	0.21
0.832	0.18
0.955	0.15
1.096	

Size (µm)	Volume In %
1.096	0.13
1.259	0.12
1.445	0.13
1.660	0.16
1.905	0.21
2.188	0.28
2.512	0.36
2.884	0.44
3.311	0.53
3.802	0.61
4.365	0.69
5.012	0.77
5.754	0.83
6.607	0.88
7.586	0.92
8.710	0.94
10.000	0.95
11.482	

Size (µm)	Volume In %
11.482	0.95
13.183	0.93
15.136	0.89
17.378	0.85
19.953	0.82
22.909	0.79
26.303	0.78
30.200	0.81
34.674	0.87
39.811	0.97
45.709	1.11
52.481	1.28
60.256	1.46
69.183	1.65
79.433	1.83
91.201	1.99
104.713	2.15
120.226	

Size (µm)	Volume In %
120.226	2.30
138.038	2.46
158.489	2.66
181.970	2.91
208.930	3.22
239.883	3.61
275.423	4.07
316.228	4.57
363.078	5.06
416.869	5.48
478.630	5.75
549.541	5.79
630.957	5.54
724.436	4.99
831.764	4.19
954.993	3.21
1096.478	2.20
1258.925	

Size (µm)	Volume In %
1258.925	1.24
1445.440	0.09
1659.587	0.00
1905.461	0.00
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 1:40:57 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 1:40:58 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
22.36 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.813 %

Result Emulation:
Off

Concentration:
0.0926 %Vol

Span :
2.725

Uniformity:
0.898

Result units:
Volume

Specific Surface Area:
0.327 m²/g

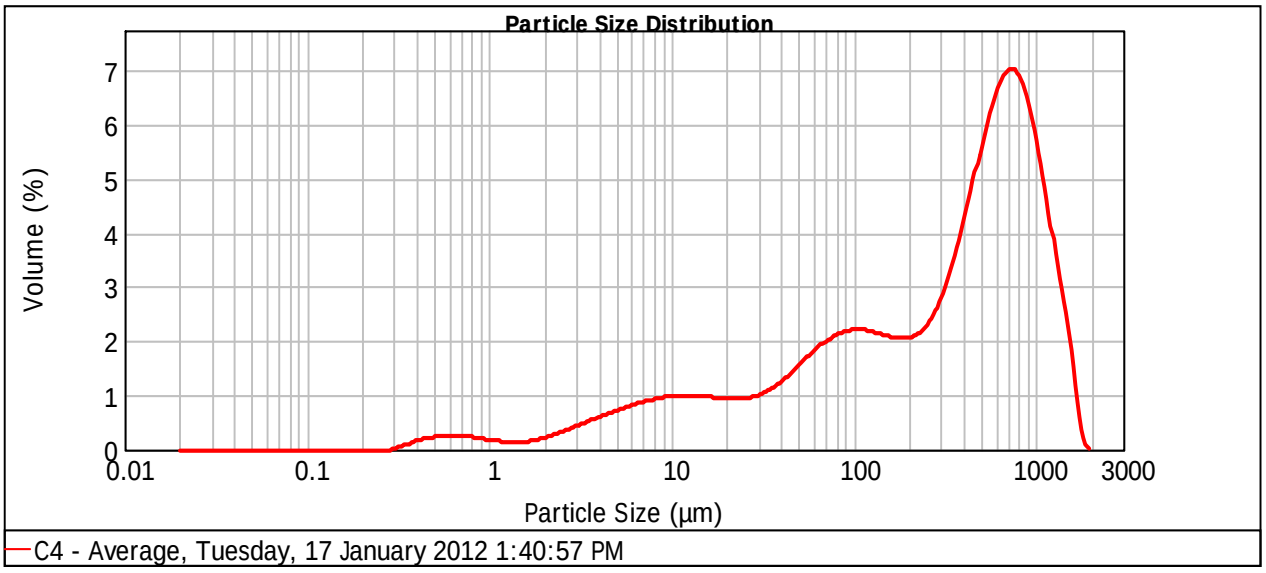
Surface Weighted Mean D[3,2]:
18.372 um

Vol. Weighted Mean D[4,3]:
457.101 um

---

d(0.1): 11.695 um **d(0.5):** 382.678 um **d(0.9):** 1054.336 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.14	11.482	0.90	120.226	1.96	1258.925	2.77
0.011	0.00	0.120	0.00	1.259	0.12	13.183	0.89	138.038	1.91	1445.440	1.68
0.013	0.00	0.138	0.00	1.445	0.13	15.136	0.88	158.489	1.87	1659.587	0.25
0.015	0.00	0.158	0.00	1.660	0.16	17.378	0.86	181.970	1.86	1905.461	0.01
0.017	0.00	0.182	0.00	1.905	0.20	19.953	0.85	208.930	1.93	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.26	22.909	0.85	239.883	2.12	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.33	26.303	0.89	275.423	2.45	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.40	30.200	0.95	316.228	2.96	3311.311	0.00
0.030	0.00	0.316	0.07	3.311	0.48	34.674	1.06	363.078	3.63	3801.894	0.00
0.035	0.00	0.363	0.13	3.802	0.55	39.811	1.21	416.869	4.41	4365.158	0.00
0.040	0.00	0.417	0.18	4.365	0.62	45.709	1.37	478.630	5.20	5011.872	0.00
0.046	0.00	0.479	0.21	5.012	0.69	52.481	1.55	549.541	5.87	5754.399	0.00
0.052	0.00	0.550	0.23	5.754	0.75	60.256	1.72	630.957	6.28	6606.934	0.00
0.060	0.00	0.631	0.23	6.607	0.80	69.183	1.85	724.436	6.30	7585.776	0.00
0.069	0.00	0.724	0.22	7.586	0.84	79.433	1.95	831.764	5.88	8709.636	0.00
0.079	0.00	0.832	0.19	8.710	0.87	91.201	1.99	954.993	5.06	10000.000	
0.091	0.00	0.955	0.16	10.000	0.89	104.713	1.99	1096.478	3.96		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 2:10:11 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 2:10:13 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
16.69 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.435 %

Result Emulation:
Off

Concentration:
0.0526 %Vol

Span :
3.413

Uniformity:
1.16

Result units:
Volume

Specific Surface Area:
0.487 m²/g

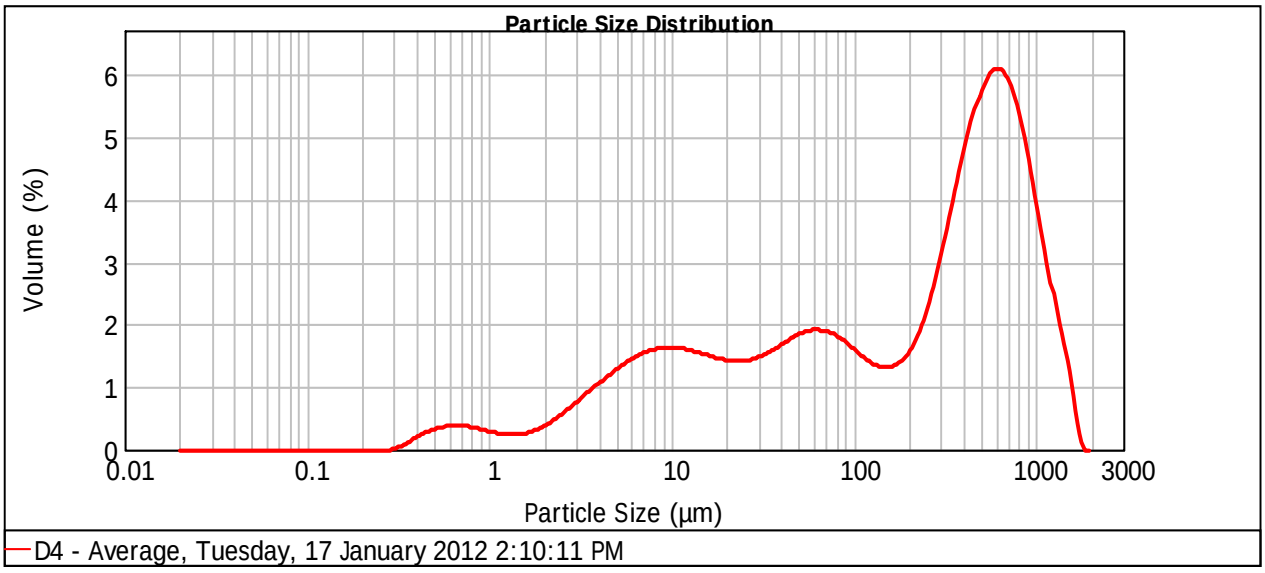
Surface Weighted Mean D[3,2]:
12.323 um

Vol. Weighted Mean D[4,3]:
367.026 um

---

d(0.1): 6.026 um **d(0.5):** 267.250 um **d(0.9):** 918.145 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.23	11.482	1.44	120.226	1.24	1258.925	1.75
0.011	0.00	0.120	0.00	1.259	0.22	13.183	1.40	138.038	1.19	1445.440	0.99
0.013	0.00	0.138	0.00	1.445	0.23	15.136	1.35	158.489	1.23	1659.587	0.07
0.015	0.00	0.158	0.00	1.660	0.28	17.378	1.31	181.970	1.38	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.36	19.953	1.29	208.930	1.66	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.46	22.909	1.29	239.883	2.12	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.58	26.303	1.32	275.423	2.72	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.71	30.200	1.38	316.228	3.42	3311.311	0.00
0.030	0.00	0.316	0.07	3.311	0.84	34.674	1.47	363.078	4.14	3801.894	0.00
0.035	0.00	0.363	0.16	3.802	0.98	39.811	1.56	416.869	4.80	4365.158	0.00
0.040	0.00	0.417	0.24	4.365	1.11	45.709	1.65	478.630	5.27	5011.872	0.00
0.046	0.00	0.479	0.30	5.012	1.23	52.481	1.71	549.541	5.50	5754.399	0.00
0.052	0.00	0.550	0.34	5.754	1.32	60.256	1.73	630.957	5.42	6606.934	0.00
0.060	0.00	0.631	0.35	6.607	1.40	69.183	1.69	724.436	5.03	7585.776	0.00
0.069	0.00	0.724	0.33	7.586	1.45	79.433	1.60	831.764	4.35	8709.636	0.00
0.079	0.00	0.832	0.30	8.710	1.47	91.201	1.47	954.993	3.46	10000.000	
0.091	0.00	0.955	0.26	10.000	1.47	104.713	1.34	1096.478	2.58		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
A5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 2:25:54 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 2:25:56 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
13.48 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
5.186 %

Result Emulation:
Off

Concentration:
1.0423 %Vol

Span :
1.103

Uniformity:
0.336

Result units:
Volume

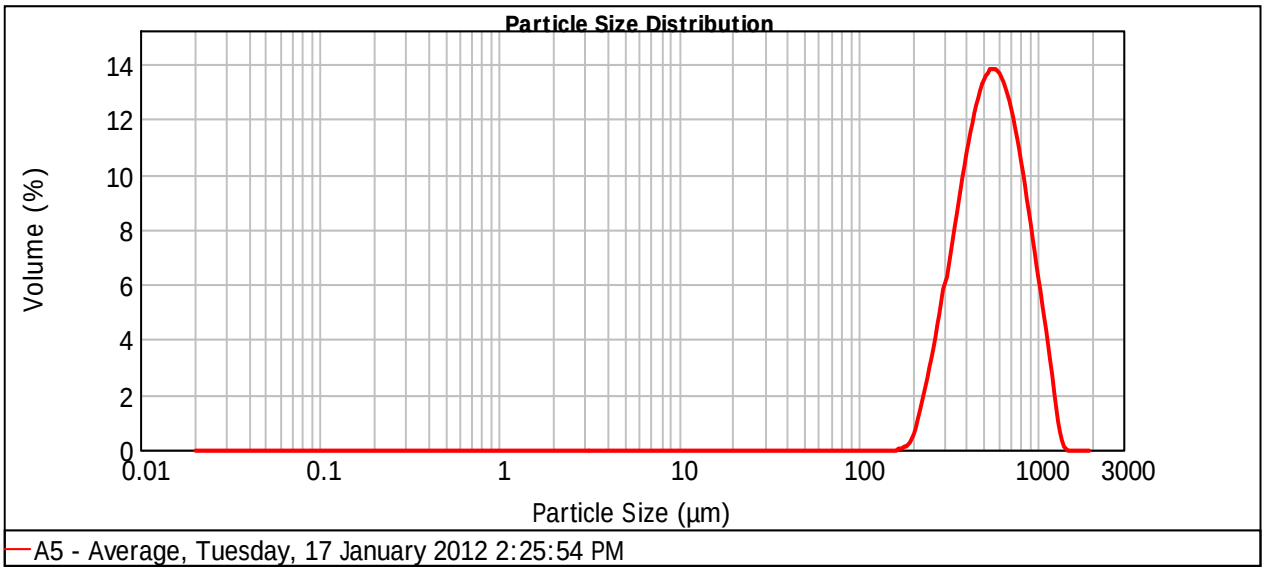
Specific Surface Area:
0.0118 m²/g

Surface Weighted Mean D[3,2]:
506.982 um

Vol. Weighted Mean D[4,3]:
593.948 um

---

d(0.1): 320.863 um **d(0.5):** 553.821 um **d(0.9):** 931.814 um



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.00
0.417	0.00
0.479	0.00
0.550	0.00
0.631	0.00
0.724	0.00
0.832	0.00
0.955	0.00
1.096	0.00

Size (µm)	Volume In %
1.096	0.00
1.259	0.00
1.445	0.00
1.660	0.00
1.905	0.00
2.188	0.00
2.512	0.00
2.884	0.00
3.311	0.00
3.802	0.00
4.365	0.00
5.012	0.00
5.754	0.00
6.607	0.00
7.586	0.00
8.710	0.00
10.000	0.00
11.482	

Size (µm)	Volume In %
11.482	0.00
13.183	0.00
15.136	0.00
17.378	0.00
19.953	0.00
22.909	0.00
26.303	0.00
30.200	0.00
34.674	0.00
39.811	0.00
45.709	0.00
52.481	0.00
60.256	0.00
69.183	0.00
79.433	0.00
91.201	0.00
104.713	0.00
120.226	

Size (µm)	Volume In %
120.226	0.00
138.038	0.00
158.489	0.02
181.970	0.23
208.930	1.32
239.883	2.89
275.423	4.89
316.228	7.17
363.078	9.36
416.869	11.17
478.630	12.26
549.541	12.43
630.957	11.65
724.436	10.02
831.764	7.81
954.993	5.39
1096.478	2.98
1258.925	

Size (µm)	Volume In %
1258.925	0.42
1445.440	0.00
1659.587	0.00
1905.461	0.00
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 2:56:04 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 2:56:06 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
15.04 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
3.362 %

Result Emulation:
Off

Concentration:
0.1782 %Vol

Span :
2.039

Uniformity:
0.622

Result units:
Volume

Specific Surface Area:
0.0748 m²/g

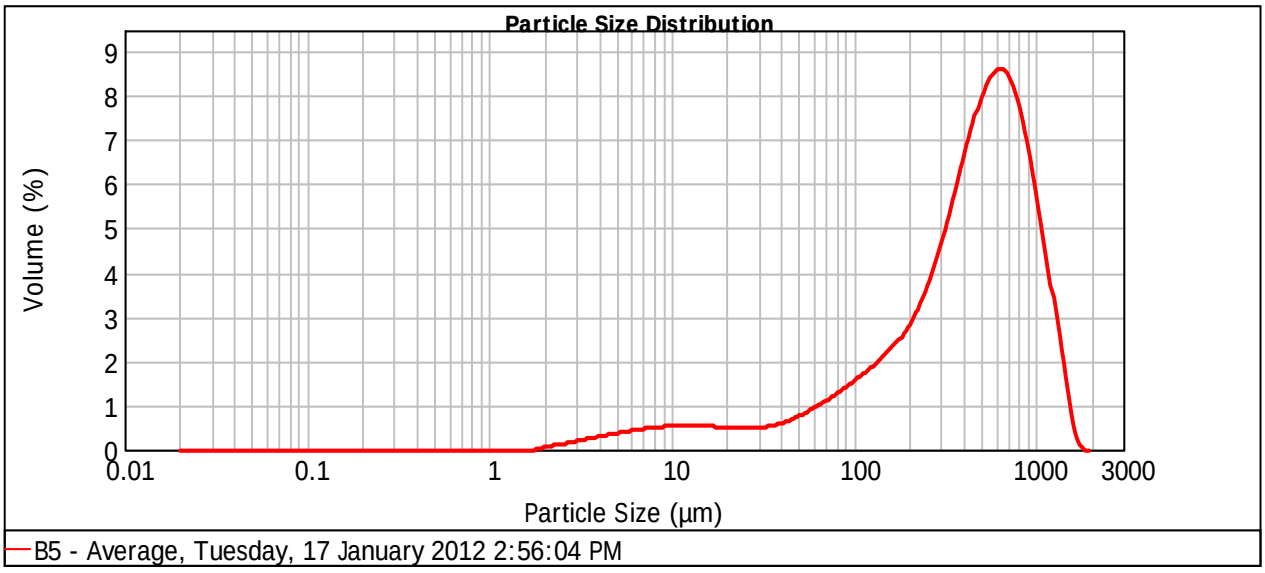
Surface Weighted Mean D[3,2]:
80.228 um

Vol. Weighted Mean D[4,3]:
500.129 um

---

d(0.1): 59.017 um **d(0.5):** 458.886 um **d(0.9):** 994.662 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.49	120.226	1.72	1258.925	2.22
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.48	138.038	1.92	1445.440	0.74
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.48	158.489	2.16	1659.587	0.03
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.46	181.970	2.47	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.07	19.953	0.45	208.930	2.88	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.10	22.909	0.44	239.883	3.41	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.13	26.303	0.45	275.423	4.08	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.18	30.200	0.47	316.228	4.88	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.23	34.674	0.51	363.078	5.75	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.27	39.811	0.57	416.869	6.60	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.32	45.709	0.66	478.630	7.30	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.36	52.481	0.78	549.541	7.72	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.40	60.256	0.91	630.957	7.72	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.43	69.183	1.06	724.436	7.24	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.45	79.433	1.21	831.764	6.30	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.47	91.201	1.37	954.993	5.03	10000.000	
0.091	0.00	0.955	0.00	10.000	0.48	104.713	1.54	1096.478	3.61		
0.105	0.00	1.096	0.00	11.482	0.48	120.226	1.54	1258.925	3.61		

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 3:07:35 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 3:07:36 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
14.77 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
3.315 %

Result Emulation:
Off

Concentration:
0.2673 %Vol

Span :
1.859

Uniformity:
0.568

Result units:
Volume

Specific Surface Area:
0.0508 m²/g

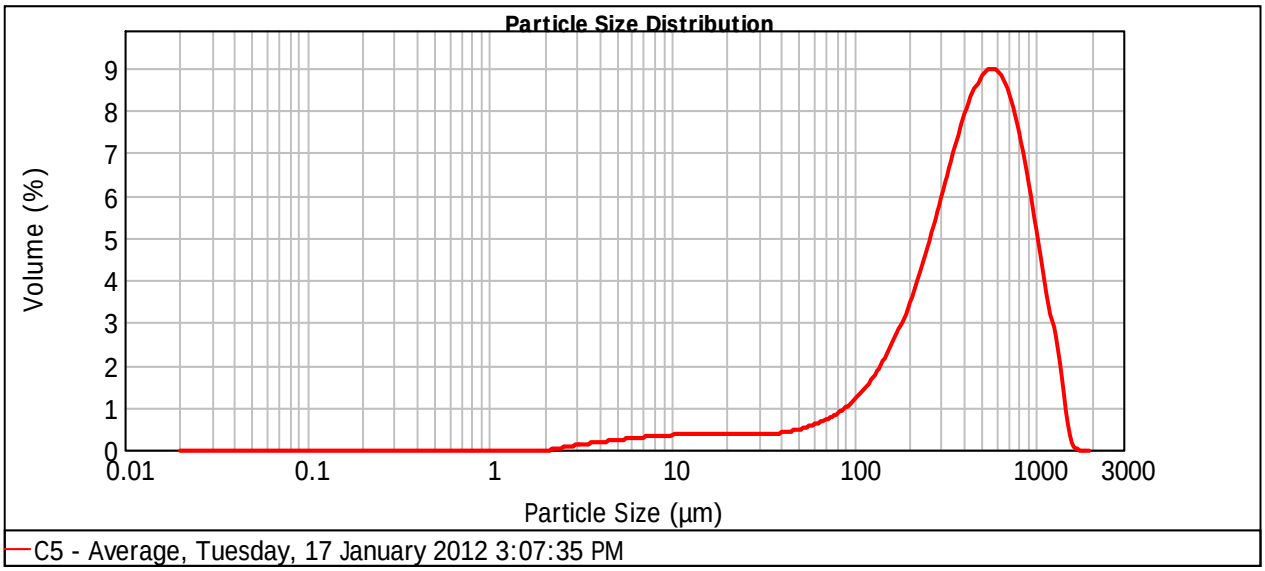
Surface Weighted Mean D[3,2]:
118.227 um

Vol. Weighted Mean D[4,3]:
493.829 um

---

d(0.1): 109.265 um **d(0.5):** 448.521 um **d(0.9):** 943.215 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.00
0.417	0.00
0.479	0.00
0.550	0.00
0.631	0.00
0.724	0.00
0.832	0.00
0.955	0.00
1.096	0.00

Size (µm)	Volume In %
1.096	0.00
1.259	0.00
1.445	0.00
1.660	0.00
1.905	0.00
2.188	0.02
2.512	0.07
2.884	0.10
3.311	0.13
3.802	0.16
4.365	0.19
5.012	0.22
5.754	0.24
6.607	0.27
7.586	0.29
8.710	0.30
10.000	0.32
11.482	

Size (µm)	Volume In %
11.482	0.33
13.183	0.33
15.136	0.33
17.378	0.33
19.953	0.32
22.909	0.32
26.303	0.32
30.200	0.33
34.674	0.34
39.811	0.37
45.709	0.42
52.481	0.48
60.256	0.57
69.183	0.68
79.433	0.83
91.201	1.02
104.713	1.26
120.226	

Size (µm)	Volume In %
120.226	1.56
138.038	1.94
158.489	2.41
181.970	2.98
208.930	3.65
239.883	4.41
275.423	5.23
316.228	6.09
363.078	6.89
416.869	7.57
478.630	8.01
549.541	8.10
630.957	7.79
724.436	7.04
831.764	5.91
954.993	4.53
1096.478	3.10
1258.925	

Size (µm)	Volume In %
1258.925	1.74
1445.440	0.15
1659.587	0.00
1905.461	0.00
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 3:19:01 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 3:19:03 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
12.49 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
3.547 %

Result Emulation:
Off

Concentration:
0.1342 %Vol

Span :
1.944

Uniformity:
0.582

Result units:
Volume

Specific Surface Area:
0.0813 m²/g

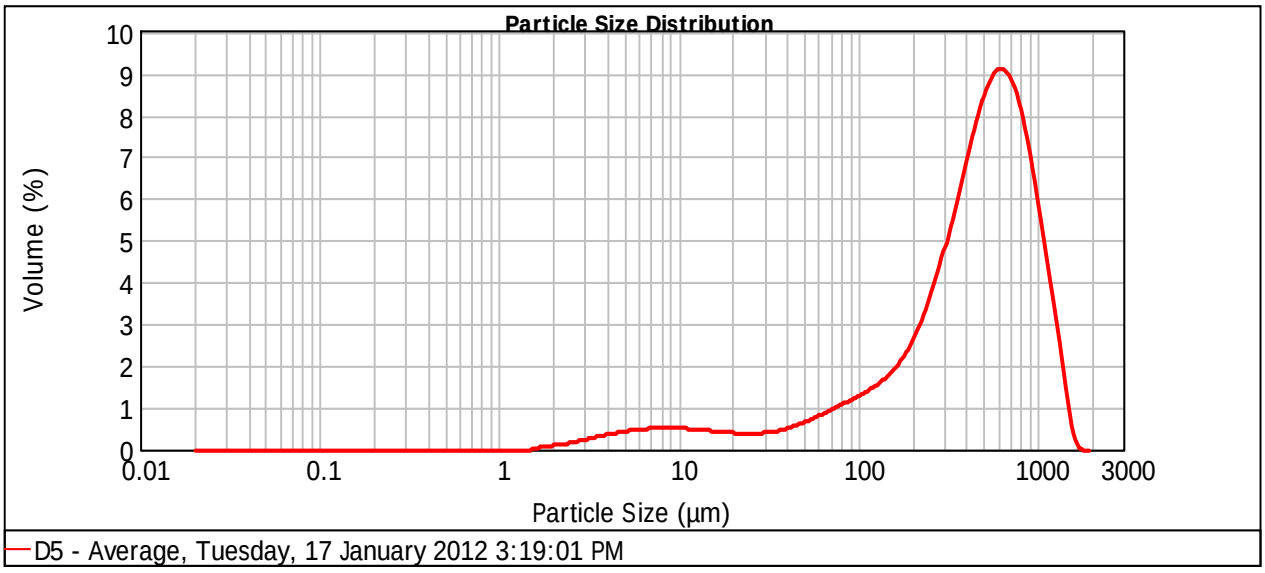
Surface Weighted Mean D[3,2]:
73.819 um

Vol. Weighted Mean D[4,3]:
511.165 um

---

d(0.1): 64.419 um **d(0.5):** 476.553 um **d(0.9):** 990.660 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.44	120.226	1.41	1258.925	2.16
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.42	138.038	1.60	1445.440	0.54
0.013	0.00	0.138	0.00	1.445	0.01	15.136	0.40	158.489	1.86	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.06	17.378	0.37	181.970	2.22	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.09	19.953	0.36	208.930	2.71	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.13	22.909	0.35	239.883	3.36	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.18	26.303	0.36	275.423	4.15	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.23	30.200	0.38	316.228	5.09	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.28	34.674	0.43	363.078	6.08	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.33	39.811	0.49	416.869	7.02	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.38	45.709	0.58	478.630	7.77	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.41	52.481	0.67	549.541	8.19	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.44	60.256	0.78	630.957	8.15	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.46	69.183	0.90	724.436	7.59	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.47	79.433	1.02	831.764	6.55	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.47	91.201	1.13	954.993	5.16	10000.000	
0.091	0.00	0.955	0.00	10.000	0.46	104.713	1.26	1096.478	3.65		
0.105	0.00	1.096	0.00	11.482	0.46	120.226	1.26	1258.925	3.65		

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B6 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 3:31:12 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 3:31:14 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
11.59 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
6.876 %

Result Emulation:
Off

Concentration:
0.2626 %Vol

Span :
1.699

Uniformity:
0.483

Result units:
Volume

Specific Surface Area:
0.139 m²/g

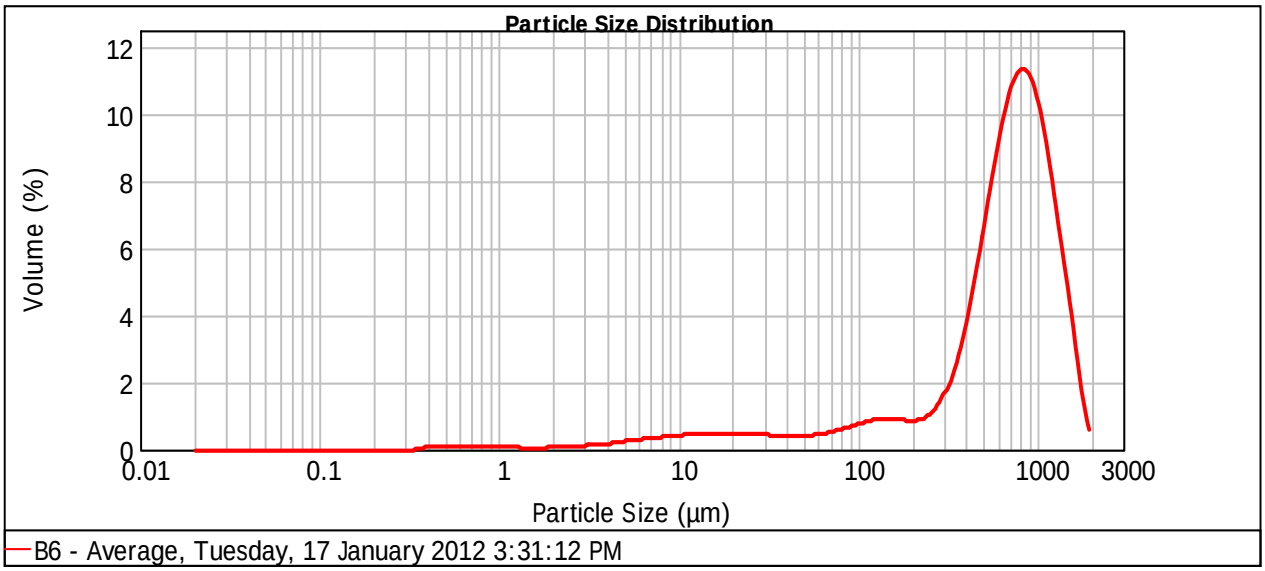
Surface Weighted Mean D[3,2]:
43.246 um

Vol. Weighted Mean D[4,3]:
718.950 um

---

d(0.1): 87.251 um **d(0.5):** 705.996 um **d(0.9):** 1286.731 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.07
0.417	0.09
0.479	0.10
0.550	0.11
0.631	0.11
0.724	0.11
0.832	0.09
0.955	0.08
1.096	

Size (µm)	Volume In %
1.096	0.06
1.259	0.05
1.445	0.05
1.660	0.05
1.905	0.06
2.188	0.08
2.512	0.10
2.884	0.12
3.311	0.14
3.802	0.17
4.365	0.20
5.012	0.25
5.754	0.28
6.607	0.31
7.586	0.34
8.710	0.37
10.000	0.39
11.482	

Size (µm)	Volume In %
11.482	0.42
13.183	0.43
15.136	0.44
17.378	0.44
19.953	0.44
22.909	0.42
26.303	0.41
30.200	0.39
34.674	0.38
39.811	0.37
45.709	0.37
52.481	0.39
60.256	0.43
69.183	0.50
79.433	0.58
91.201	0.67
104.713	0.76
120.226	

Size (µm)	Volume In %
120.226	0.81
138.038	0.82
158.489	0.81
181.970	0.78
208.930	0.81
239.883	0.97
275.423	1.37
316.228	2.11
363.078	3.22
416.869	4.69
478.630	6.36
549.541	8.04
630.957	9.41
724.436	10.17
831.764	10.13
954.993	9.22
1096.478	7.62
1258.925	

Size (µm)	Volume In %
1258.925	5.64
1445.440	3.66
1659.587	1.51
1905.461	0.22
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C6

SOP Name:

Measured:
Tuesday, 17 January 2012 4:55:57 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 4:55:59 PM

Sample bulk lot ref:

Result Source:
Measurement

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
5.58 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
6.472 %

Result Emulation:
Off

Concentration:
0.1396 %Vol

Span :
1.563

Uniformity:
0.49

Result units:
Volume

Specific Surface Area:
0.0337 m²/g

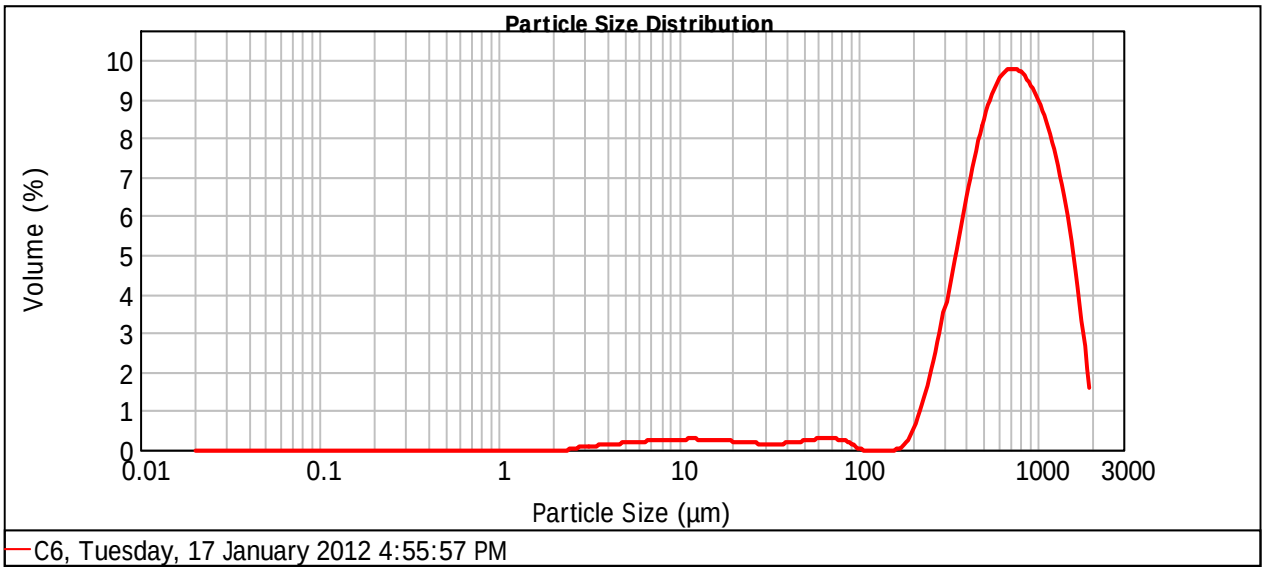
Surface Weighted Mean D[3,2]:
177.992 um

Vol. Weighted Mean D[4,3]:
770.974 um

---

d(0.1): 306.801 um **d(0.5):** 695.114 um **d(0.9):** 1393.505 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.00
0.417	0.00
0.479	0.00
0.550	0.00
0.631	0.00
0.724	0.00
0.832	0.00
0.955	0.00
1.096	0.00

Size (µm)	Volume In %
1.096	0.00
1.259	0.00
1.445	0.00
1.660	0.00
1.905	0.00
2.188	0.00
2.512	0.05
2.884	0.08
3.311	0.10
3.802	0.12
4.365	0.14
5.012	0.17
5.754	0.19
6.607	0.20
7.586	0.22
8.710	0.23
10.000	0.24
11.482	

Size (µm)	Volume In %
11.482	0.24
13.183	0.24
15.136	0.23
17.378	0.21
19.953	0.18
22.909	0.16
26.303	0.14
30.200	0.13
34.674	0.14
39.811	0.16
45.709	0.20
52.481	0.23
60.256	0.26
69.183	0.25
79.433	0.21
91.201	0.05
104.713	0.00
120.226	

Size (µm)	Volume In %
120.226	0.00
138.038	0.00
158.489	0.01
181.970	0.29
208.930	0.90
239.883	1.81
275.423	2.96
316.228	4.29
363.078	5.63
416.869	6.86
478.630	7.83
549.541	8.48
630.957	8.79
724.436	8.79
831.764	8.52
954.993	8.03
1096.478	7.30
1258.925	

Size (µm)	Volume In %
1258.925	6.27
1445.440	4.89
1659.587	2.87
1905.461	0.70
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D6 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 5:16:05 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 5:16:07 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
12.39 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.998 %

Result Emulation:
Off

Concentration:
0.0688 %Vol

Span :
3.000

Uniformity:
0.938

Result units:
Volume

Specific Surface Area:
0.297 m²/g

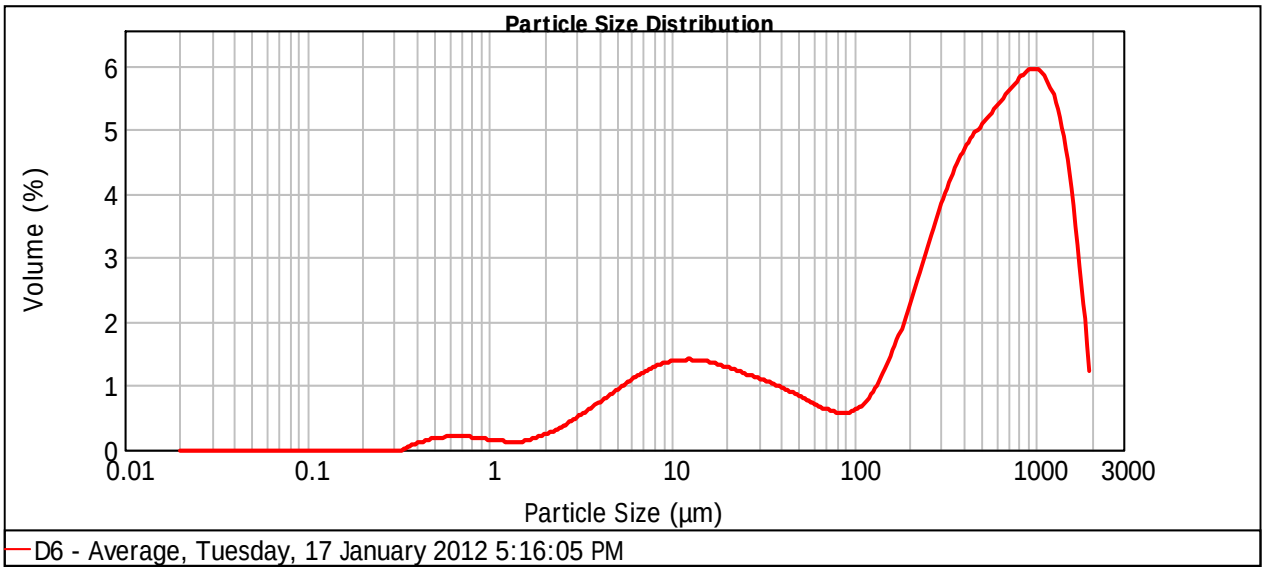
Surface Weighted Mean D[3,2]:
20.195 um

Vol. Weighted Mean D[4,3]:
545.749 um

---

d(0.1): 9.451 um **d(0.5):** 429.527 um **d(0.9):** 1298.067 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.01
0.363	0.08
0.417	0.13
0.479	0.16
0.550	0.18
0.631	0.19
0.724	0.18
0.832	0.16
0.955	0.14
1.096	

Size (µm)	Volume In %
1.096	0.12
1.259	0.11
1.445	0.12
1.660	0.17
1.905	0.22
2.188	0.28
2.512	0.37
2.884	0.46
3.311	0.57
3.802	0.68
4.365	0.79
5.012	0.90
5.754	1.00
6.607	1.09
7.586	1.17
8.710	1.22
10.000	1.26
11.482	

Size (µm)	Volume In %
11.482	1.27
13.183	1.26
15.136	1.23
17.378	1.19
19.953	1.14
22.909	1.09
26.303	1.03
30.200	0.97
34.674	0.91
39.811	0.84
45.709	0.77
52.481	0.69
60.256	0.61
69.183	0.55
79.433	0.52
91.201	0.54
104.713	0.64
120.226	

Size (µm)	Volume In %
120.226	0.83
138.038	1.11
158.489	1.48
181.970	1.93
208.930	2.42
239.883	2.92
275.423	3.39
316.228	3.80
363.078	4.14
416.869	4.40
478.630	4.62
549.541	4.80
630.957	4.99
724.436	5.18
831.764	5.33
954.993	5.36
1096.478	5.17
1258.925	

Size (µm)	Volume In %
1258.925	4.63
1445.440	3.71
1659.587	2.21
1905.461	0.54
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
A1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 10:53:59 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 10:54:01 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
13.88 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
5.323 %

Result Emulation:
Off

Concentration:
0.3346 %Vol

Span :
1.729

Uniformity:
0.52

Result units:
Volume

Specific Surface Area:
0.037 m²/g

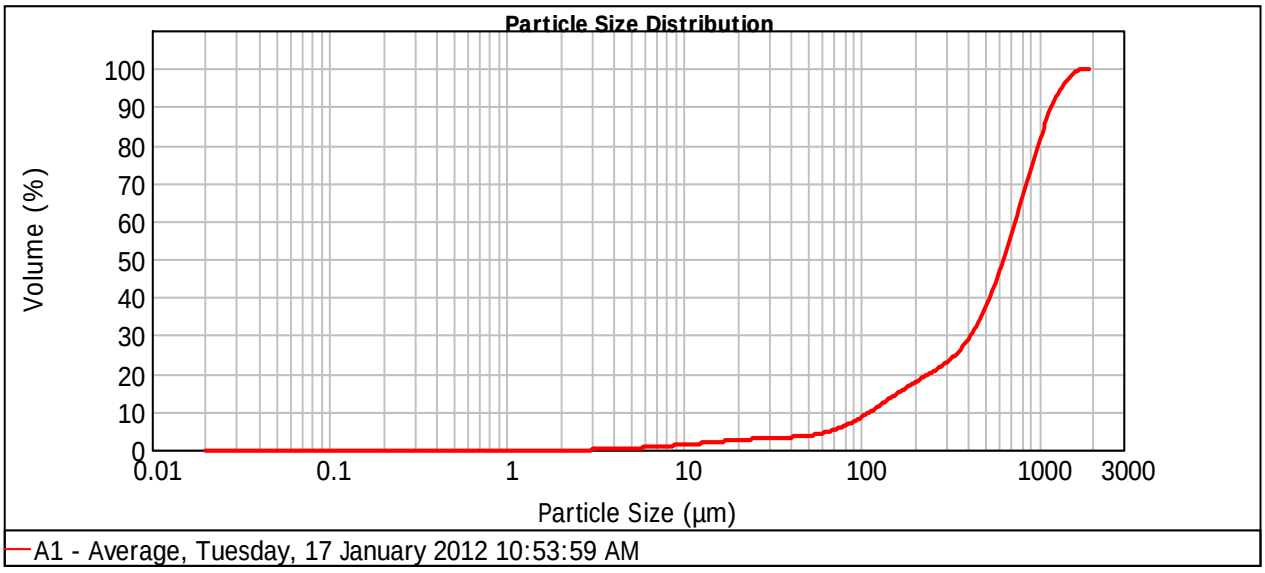
Surface Weighted Mean D[3,2]:
162.231 um

Vol. Weighted Mean D[4,3]:
647.587 um

---

d(0.1): 111.734 um **d(0.5):** 627.177 um **d(0.9):** 1196.139 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.24	120.226	1.90	1258.925	4.46
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.24	138.038	1.89	1445.440	2.65
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.24	158.489	1.80	1659.587	0.77
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.23	181.970	1.69	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.00	19.953	0.21	208.930	1.64	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.00	22.909	0.18	239.883	1.75	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.00	26.303	0.15	275.423	2.11	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.05	30.200	0.13	316.228	2.82	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.09	34.674	0.15	363.078	3.86	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.11	39.811	0.21	416.869	5.21	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.13	45.709	0.33	478.630	6.68	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.15	52.481	0.52	549.541	8.05	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.17	60.256	0.77	630.957	9.05	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.18	69.183	1.06	724.436	9.43	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.20	79.433	1.36	831.764	9.05	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.21	91.201	1.62	954.993	7.93	10000.000	
0.091	0.00	0.955	0.00	10.000	0.22	104.713	1.81	1096.478	6.29		
0.105	0.00	1.096	0.00	11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 11:13:59 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 11:14:01 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
15.33 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.416 %

Result Emulation:
Off

Concentration:
0.0505 %Vol

Span :
4.300

Uniformity:
1.32

Result units:
Volume

Specific Surface Area:
0.37 m²/g

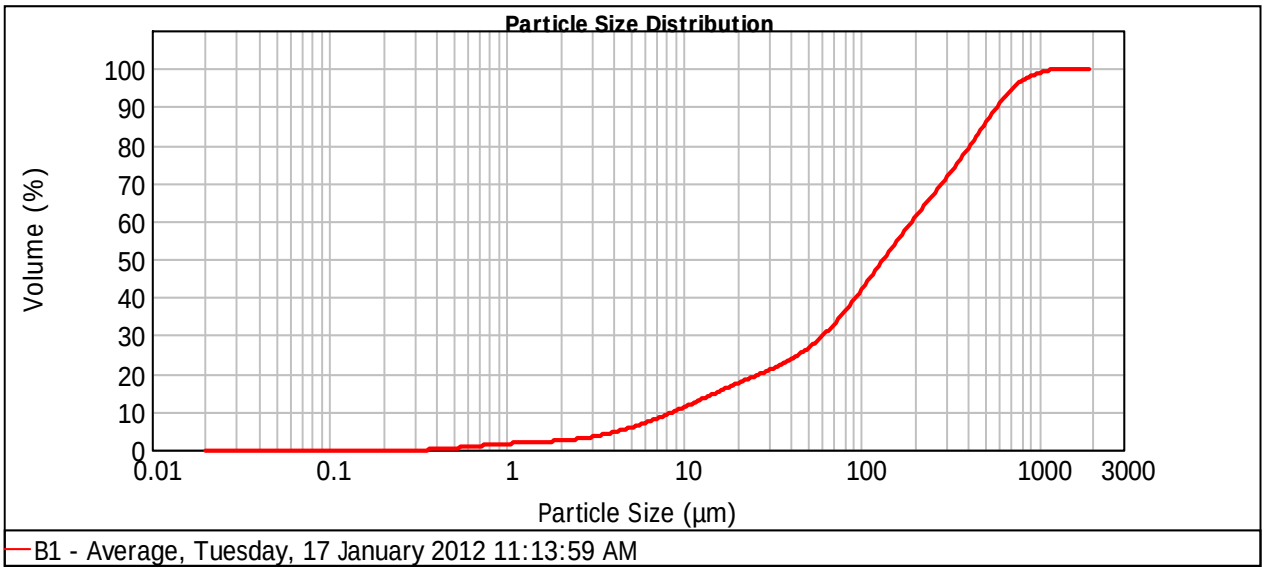
Surface Weighted Mean D[3,2]:
16.237 um

Vol. Weighted Mean D[4,3]:
225.161 um

---

d(0.1): 8.772 um **d(0.5):** 132.553 um **d(0.9):** 578.695 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.14	11.482	1.27	120.226	3.88	1258.925	0.24
0.011	0.00	0.120	0.00	1.259	0.13	13.183	1.27	138.038	3.80	1445.440	0.01
0.013	0.00	0.138	0.00	1.445	0.14	15.136	1.24	158.489	3.68	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.17	17.378	1.21	181.970	3.57	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.23	19.953	1.17	208.930	3.50	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.30	22.909	1.16	239.883	3.51	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.39	26.303	1.19	275.423	3.61	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.50	30.200	1.29	316.228	3.78	3311.311	0.00
0.030	0.00	0.316	0.01	3.311	0.60	34.674	1.46	363.078	3.96	3801.894	0.00
0.035	0.00	0.363	0.13	3.802	0.71	39.811	1.73	416.869	4.06	4365.158	0.00
0.040	0.00	0.417	0.19	4.365	0.81	45.709	2.07	478.630	3.99	5011.872	0.00
0.046	0.00	0.479	0.23	5.012	0.91	52.481	2.46	549.541	3.65	5754.399	0.00
0.052	0.00	0.550	0.25	5.754	1.00	60.256	2.87	630.957	3.03	6606.934	0.00
0.060	0.00	0.631	0.25	6.607	1.08	69.183	3.25	724.436	2.11	7585.776	0.00
0.069	0.00	0.724	0.24	7.586	1.16	79.433	3.56	831.764	1.15	8709.636	0.00
0.079	0.00	0.832	0.21	8.710	1.21	91.201	3.78	954.993	0.75	10000.000	
0.091	0.00	0.955	0.17	10.000	1.25	104.713	3.88	1096.478	0.49		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 11:35:01 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 11:35:03 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
19.99 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.804 %

Result Emulation:
Off

Concentration:
0.0595 %Vol

Span :
2.871

Uniformity:
0.946

Result units:
Volume

Specific Surface Area:
0.439 m²/g

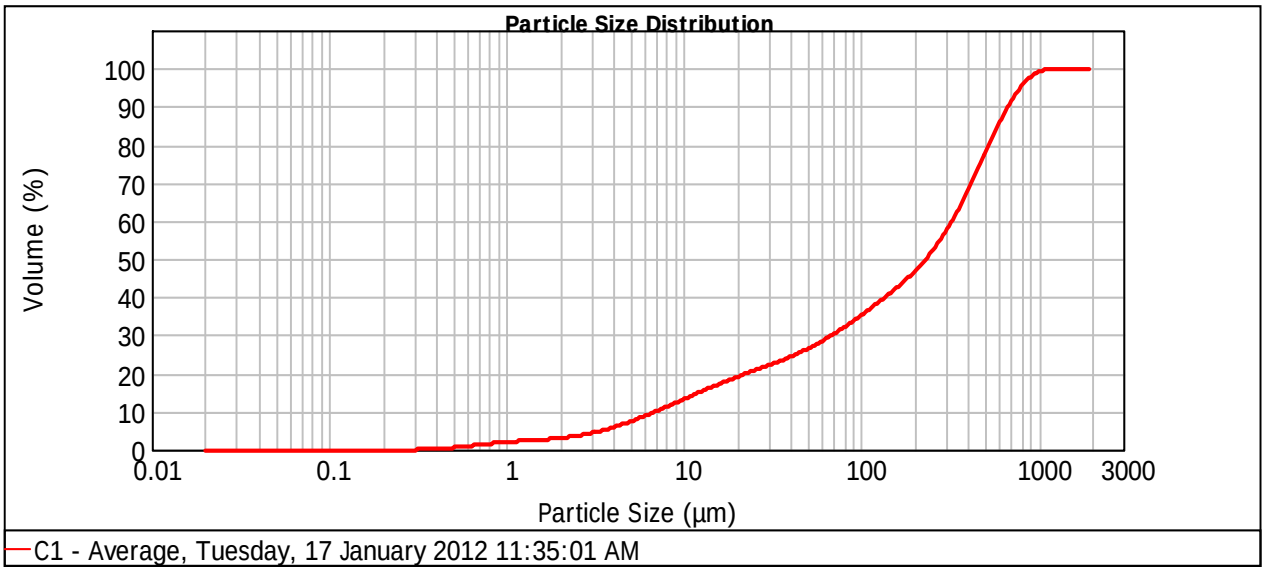
Surface Weighted Mean D[3,2]:
13.679 um

Vol. Weighted Mean D[4,3]:
284.412 um

---

d(0.1): 6.900 um **d(0.5):** 228.844 um **d(0.9):** 663.849 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.19	11.482	1.21	120.226	2.16	1258.925	0.00
0.011	0.00	0.120	0.00	1.259	0.18	13.183	1.18	138.038	2.29	1445.440	0.00
0.013	0.00	0.138	0.00	1.445	0.20	15.136	1.13	158.489	2.49	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.25	17.378	1.08	181.970	2.81	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.32	19.953	1.04	208.930	3.25	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.41	22.909	1.02	239.883	3.81	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.52	26.303	1.03	275.423	4.46	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.64	30.200	1.07	316.228	5.13	3311.311	0.00
0.030	0.00	0.316	0.08	3.311	0.76	34.674	1.14	363.078	5.70	3801.894	0.00
0.035	0.00	0.363	0.16	3.802	0.87	39.811	1.26	416.869	6.06	4365.158	0.00
0.040	0.00	0.417	0.23	4.365	0.97	45.709	1.40	478.630	6.09	5011.872	0.00
0.046	0.00	0.479	0.27	5.012	1.06	52.481	1.55	549.541	5.68	5754.399	0.00
0.052	0.00	0.550	0.30	5.754	1.13	60.256	1.70	630.957	4.84	6606.934	0.00
0.060	0.00	0.631	0.30	6.607	1.19	69.183	1.83	724.436	3.64	7585.776	0.00
0.069	0.00	0.724	0.29	7.586	1.22	79.433	1.93	831.764	2.22	8709.636	0.00
0.079	0.00	0.832	0.25	8.710	1.24	91.201	2.01	954.993	0.92	10000.000	
0.091	0.00	0.955	0.22	10.000	1.23	104.713	2.08	1096.478	0.29		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D1 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 11:54:27 AM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 11:54:29 AM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
17.49 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.059 %

Result Emulation:
Off

Concentration:
0.0440 %Vol

Span :
6.518

Uniformity:
1.93

Result units:
Volume

Specific Surface Area:
0.502 m²/g

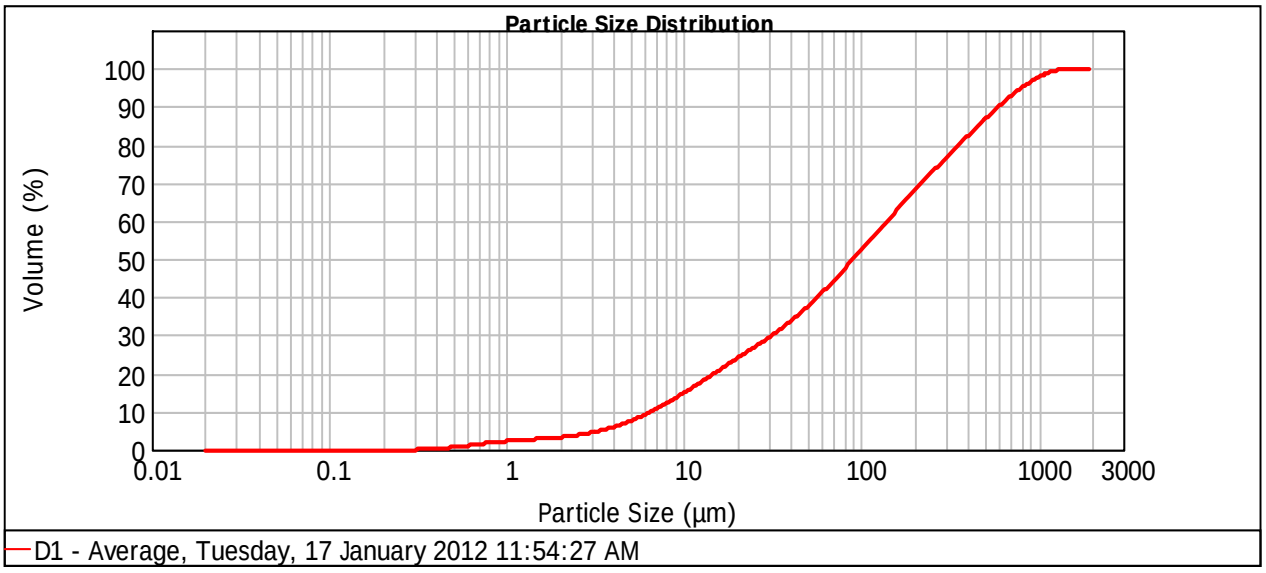
Surface Weighted Mean D[3,2]:
11.943 um

Vol. Weighted Mean D[4,3]:
202.146 um

---

d(0.1): 6.517 um **d(0.5):** 89.308 um **d(0.9):** 588.636 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.19	11.482	1.82	120.226	3.13	1258.925	0.48
0.011	0.00	0.120	0.00	1.259	0.17	13.183	1.83	138.038	3.10	1445.440	0.02
0.013	0.00	0.138	0.00	1.445	0.18	15.136	1.83	158.489	3.06	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.22	17.378	1.82	181.970	3.03	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.28	19.953	1.81	208.930	2.98	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.38	22.909	1.84	239.883	2.92	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.49	26.303	1.90	275.423	2.87	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.61	30.200	2.01	316.228	2.81	3311.311	0.00
0.030	0.00	0.316	0.08	3.311	0.75	34.674	2.16	363.078	2.75	3801.894	0.00
0.035	0.00	0.363	0.18	3.802	0.90	39.811	2.35	416.869	2.70	4365.158	0.00
0.040	0.00	0.417	0.26	4.365	1.05	45.709	2.55	478.630	2.62	5011.872	0.00
0.046	0.00	0.479	0.31	5.012	1.20	52.481	2.75	549.541	2.51	5754.399	0.00
0.052	0.00	0.550	0.34	5.754	1.35	60.256	2.92	630.957	2.32	6606.934	0.00
0.060	0.00	0.631	0.35	6.607	1.49	69.183	3.04	724.436	2.06	7585.776	0.00
0.069	0.00	0.724	0.32	7.586	1.61	79.433	3.12	831.764	1.71	8709.636	0.00
0.079	0.00	0.832	0.28	8.710	1.71	91.201	3.15	954.993	1.29	10000.000	
0.091	0.00	0.955	0.23	10.000	1.78	104.713	3.15	1096.478	0.88		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
A4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 12:18:14 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 12:18:16 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
12.04 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
4.757 %

Result Emulation:
Off

Concentration:
0.4640 %Vol

Span :
1.623

Uniformity:
0.495

Result units:
Volume

Specific Surface Area:
0.0239 m²/g

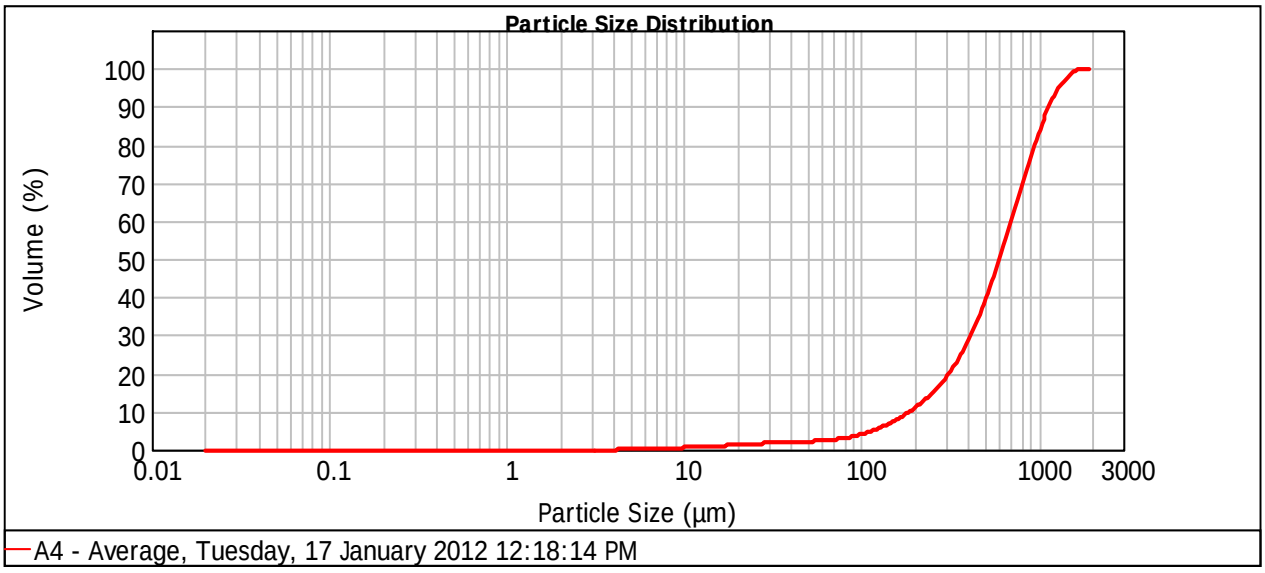
Surface Weighted Mean D[3,2]:
250.903 um

Vol. Weighted Mean D[4,3]:
636.603 um

---

d(0.1): 185.391 um **d(0.5):** 593.174 um **d(0.9):** 1148.302 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.14	120.226	1.23	1258.925	3.86
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.15	138.038	1.48	1445.440	2.30
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.15	158.489	1.73	1659.587	0.33
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.16	181.970	2.02	1905.461	0.01
0.017	0.00	0.182	0.00	1.905	0.00	19.953	0.16	208.930	2.40	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.00	22.909	0.15	239.883	2.91	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.00	26.303	0.14	275.423	3.59	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.00	30.200	0.12	316.228	4.48	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.00	34.674	0.11	363.078	5.55	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.02	39.811	0.10	416.869	6.72	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.05	45.709	0.12	478.630	7.84	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.06	52.481	0.17	549.541	8.74	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.09	60.256	0.25	630.957	9.22	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.10	69.183	0.38	724.436	9.14	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.11	79.433	0.56	831.764	8.43	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.12	91.201	0.76	954.993	7.17	10000.000	
0.091	0.00	0.955	0.00	10.000	0.13	104.713	1.00	1096.478	5.55		
0.105	0.00	1.096	0.00	11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 12:31:36 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 12:31:37 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
19.63 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.114 %

Result Emulation:
Off

Concentration:
0.0778 %Vol

Span :
2.844

Uniformity:
0.901

Result units:
Volume

Specific Surface Area:
0.328 m²/g

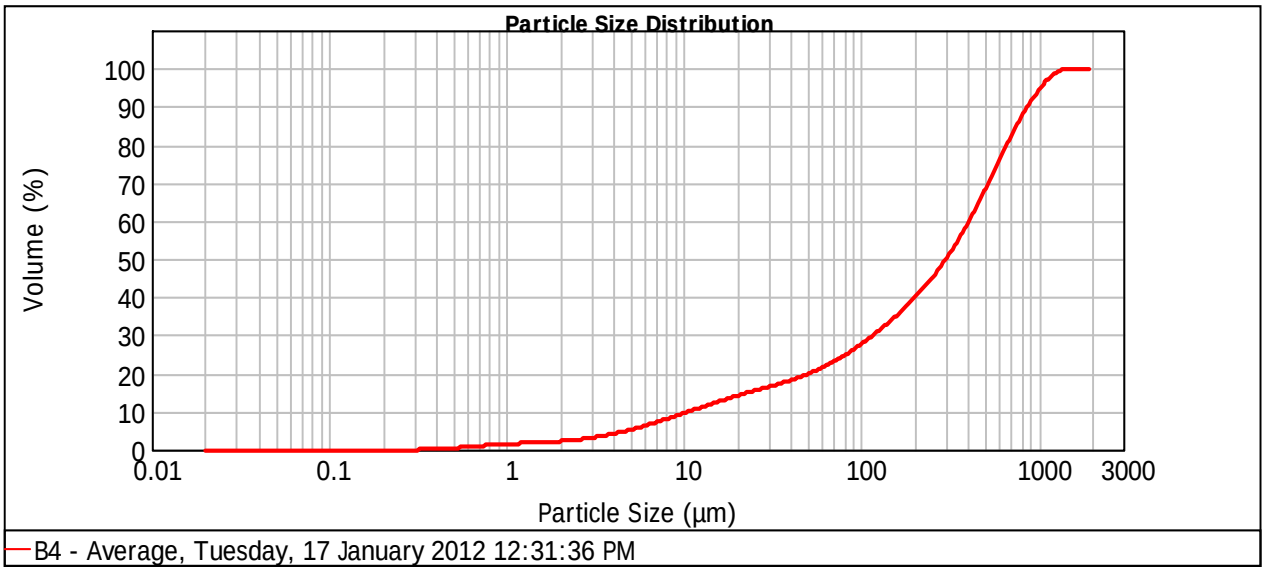
Surface Weighted Mean D[3,2]:
18.298 um

Vol. Weighted Mean D[4,3]:
370.929 um

---

d(0.1): 10.615 um **d(0.5):** 297.105 um **d(0.9):** 855.563 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.13	11.482	0.95	120.226	2.30	1258.925	1.24
0.011	0.00	0.120	0.00	1.259	0.12	13.183	0.93	138.038	2.46	1445.440	0.09
0.013	0.00	0.138	0.00	1.445	0.13	15.136	0.89	158.489	2.66	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.16	17.378	0.85	181.970	2.91	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.21	19.953	0.82	208.930	3.22	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.28	22.909	0.79	239.883	3.61	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.36	26.303	0.78	275.423	4.07	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.44	30.200	0.81	316.228	4.57	3311.311	0.00
0.030	0.00	0.316	0.07	3.311	0.53	34.674	0.87	363.078	5.06	3801.894	0.00
0.035	0.00	0.363	0.13	3.802	0.61	39.811	0.97	416.869	5.48	4365.158	0.00
0.040	0.00	0.417	0.17	4.365	0.69	45.709	1.11	478.630	5.75	5011.872	0.00
0.046	0.00	0.479	0.21	5.012	0.77	52.481	1.28	549.541	5.79	5754.399	0.00
0.052	0.00	0.550	0.23	5.754	0.83	60.256	1.46	630.957	5.54	6606.934	0.00
0.060	0.00	0.631	0.23	6.607	0.88	69.183	1.65	724.436	4.99	7585.776	0.00
0.069	0.00	0.724	0.21	7.586	0.92	79.433	1.83	831.764	4.19	8709.636	0.00
0.079	0.00	0.832	0.18	8.710	0.94	91.201	1.99	954.993	3.21	10000.000	
0.091	0.00	0.955	0.15	10.000	0.95	104.713	2.15	1096.478	2.20		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 1:40:57 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 1:40:58 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
22.36 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.813 %

Result Emulation:
Off

Concentration:
0.0926 %Vol

Span :
2.725

Uniformity:
0.898

Result units:
Volume

Specific Surface Area:
0.327 m²/g

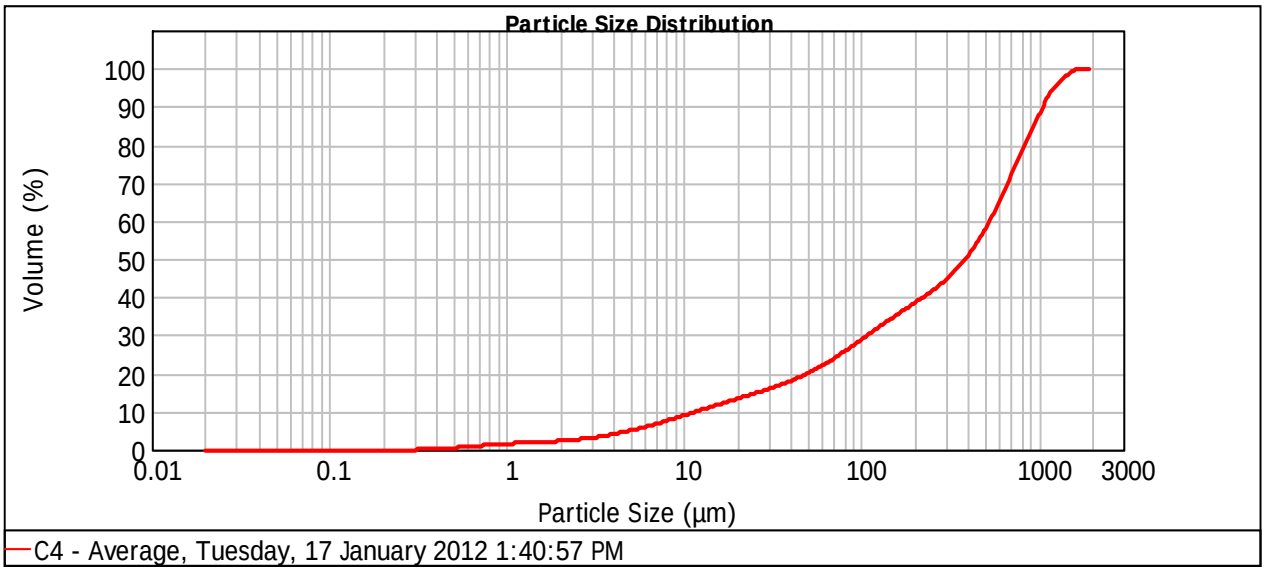
Surface Weighted Mean D[3,2]:
18.372 um

Vol. Weighted Mean D[4,3]:
457.101 um

---

d(0.1): 11.695 um **d(0.5):** 382.678 um **d(0.9):** 1054.336 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.14	11.482	0.90	120.226	1.96	1258.925	2.77
0.011	0.00	0.120	0.00	1.259	0.12	13.183	0.89	138.038	1.91	1445.440	1.68
0.013	0.00	0.138	0.00	1.445	0.13	15.136	0.88	158.489	1.87	1659.587	0.25
0.015	0.00	0.158	0.00	1.660	0.16	17.378	0.86	181.970	1.86	1905.461	0.01
0.017	0.00	0.182	0.00	1.905	0.20	19.953	0.85	208.930	1.93	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.26	22.909	0.85	239.883	2.12	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.33	26.303	0.89	275.423	2.45	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.40	30.200	0.95	316.228	2.96	3311.311	0.00
0.030	0.00	0.316	0.07	3.311	0.48	34.674	1.06	363.078	3.63	3801.894	0.00
0.035	0.00	0.363	0.13	3.802	0.55	39.811	1.21	416.869	4.41	4365.158	0.00
0.040	0.00	0.417	0.18	4.365	0.62	45.709	1.37	478.630	5.20	5011.872	0.00
0.046	0.00	0.479	0.21	5.012	0.69	52.481	1.55	549.541	5.87	5754.399	0.00
0.052	0.00	0.550	0.23	5.754	0.75	60.256	1.72	630.957	6.28	6606.934	0.00
0.060	0.00	0.631	0.23	6.607	0.80	69.183	1.85	724.436	6.30	7585.776	0.00
0.069	0.00	0.724	0.22	7.586	0.84	79.433	1.95	831.764	5.88	8709.636	0.00
0.079	0.00	0.832	0.19	8.710	0.87	91.201	1.99	954.993	5.06	10000.000	
0.091	0.00	0.955	0.16	10.000	0.89	104.713	1.99	1096.478	3.96		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D4 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 2:10:11 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 2:10:13 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
16.69 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.435 %

Result Emulation:
Off

Concentration:
0.0526 %Vol

Span :
3.413

Uniformity:
1.16

Result units:
Volume

Specific Surface Area:
0.487 m²/g

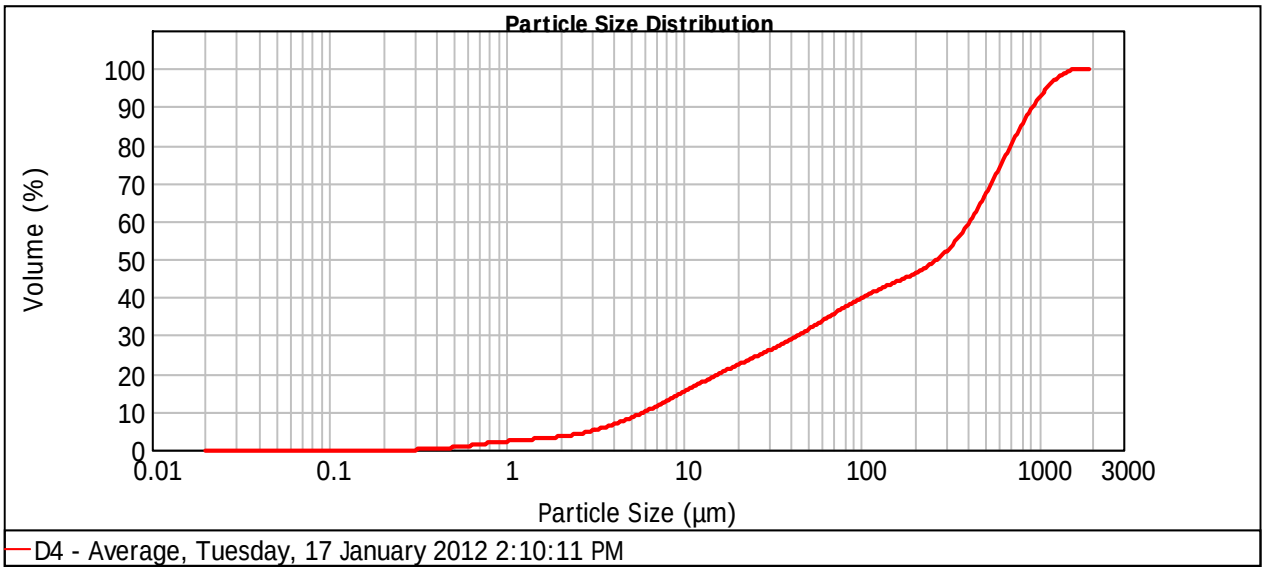
Surface Weighted Mean D[3,2]:
12.323 um

Vol. Weighted Mean D[4,3]:
367.026 um

---

d(0.1): 6.026 um **d(0.5):** 267.250 um **d(0.9):** 918.145 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.23	11.482	1.44	120.226	1.24	1258.925	1.75
0.011	0.00	0.120	0.00	1.259	0.22	13.183	1.40	138.038	1.19	1445.440	0.99
0.013	0.00	0.138	0.00	1.445	0.23	15.136	1.35	158.489	1.23	1659.587	0.07
0.015	0.00	0.158	0.00	1.660	0.28	17.378	1.31	181.970	1.38	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.36	19.953	1.29	208.930	1.66	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.46	22.909	1.29	239.883	2.12	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.58	26.303	1.32	275.423	2.72	2884.032	0.00
0.026	0.00	0.275	0.01	2.884	0.71	30.200	1.38	316.228	3.42	3311.311	0.00
0.030	0.00	0.316	0.07	3.311	0.84	34.674	1.47	363.078	4.14	3801.894	0.00
0.035	0.00	0.363	0.16	3.802	0.98	39.811	1.56	416.869	4.80	4365.158	0.00
0.040	0.00	0.417	0.24	4.365	1.11	45.709	1.65	478.630	5.27	5011.872	0.00
0.046	0.00	0.479	0.30	5.012	1.23	52.481	1.71	549.541	5.50	5754.399	0.00
0.052	0.00	0.550	0.34	5.754	1.32	60.256	1.73	630.957	5.42	6606.934	0.00
0.060	0.00	0.631	0.35	6.607	1.40	69.183	1.69	724.436	5.03	7585.776	0.00
0.069	0.00	0.724	0.33	7.586	1.45	79.433	1.60	831.764	4.35	8709.636	0.00
0.079	0.00	0.832	0.30	8.710	1.47	91.201	1.47	954.993	3.46	10000.000	
0.091	0.00	0.955	0.26	10.000	1.47	104.713	1.34	1096.478	2.58		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
A5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 2:25:54 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 2:25:56 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
13.48 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
5.186 %

Result Emulation:
Off

Concentration:
1.0423 %Vol

Span :
1.103

Uniformity:
0.336

Result units:
Volume

Specific Surface Area:
0.0118 m²/g

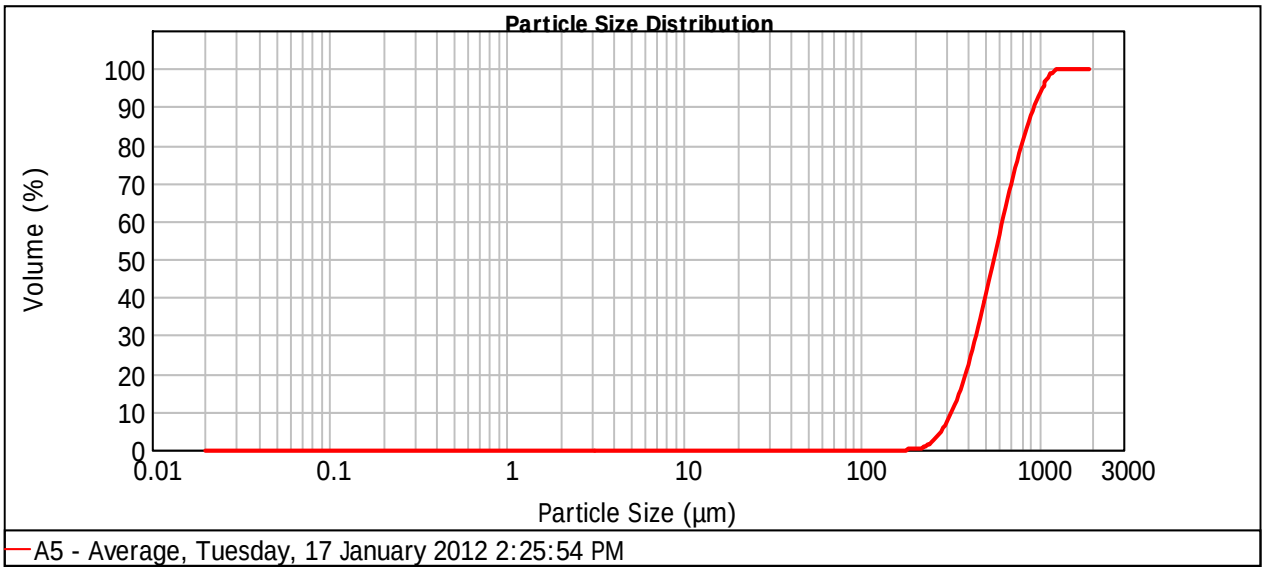
Surface Weighted Mean D[3,2]:
506.982 um

Vol. Weighted Mean D[4,3]:
593.948 um

---

d(0.1): 320.863 um **d(0.5):** 553.821 um **d(0.9):** 931.814 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.00	120.226	0.00	1258.925	0.42
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.00	138.038	0.00	1445.440	0.00
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.00	158.489	0.02	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.00	181.970	0.23	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.00	19.953	0.00	208.930	1.32	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.00	22.909	0.00	239.883	2.89	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.00	26.303	0.00	275.423	4.89	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.00	30.200	0.00	316.228	7.17	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.00	34.674	0.00	363.078	9.36	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.00	39.811	0.00	416.869	11.17	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.00	45.709	0.00	478.630	12.26	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.00	52.481	0.00	549.541	12.43	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.00	60.256	0.00	630.957	11.65	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.00	69.183	0.00	724.436	10.02	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.00	79.433	0.00	831.764	7.81	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.00	91.201	0.00	954.993	5.39	10000.000	
0.091	0.00	0.955	0.00	10.000	0.00	104.713	0.00	1096.478	2.98		
0.105	0.00	1.096	0.00	11.482	0.00	120.226	0.00	1258.925	2.98		

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 2:56:04 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 2:56:06 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
15.04 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
3.362 %

Result Emulation:
Off

Concentration:
0.1782 %Vol

Span :
2.039

Uniformity:
0.622

Result units:
Volume

Specific Surface Area:
0.0748 m²/g

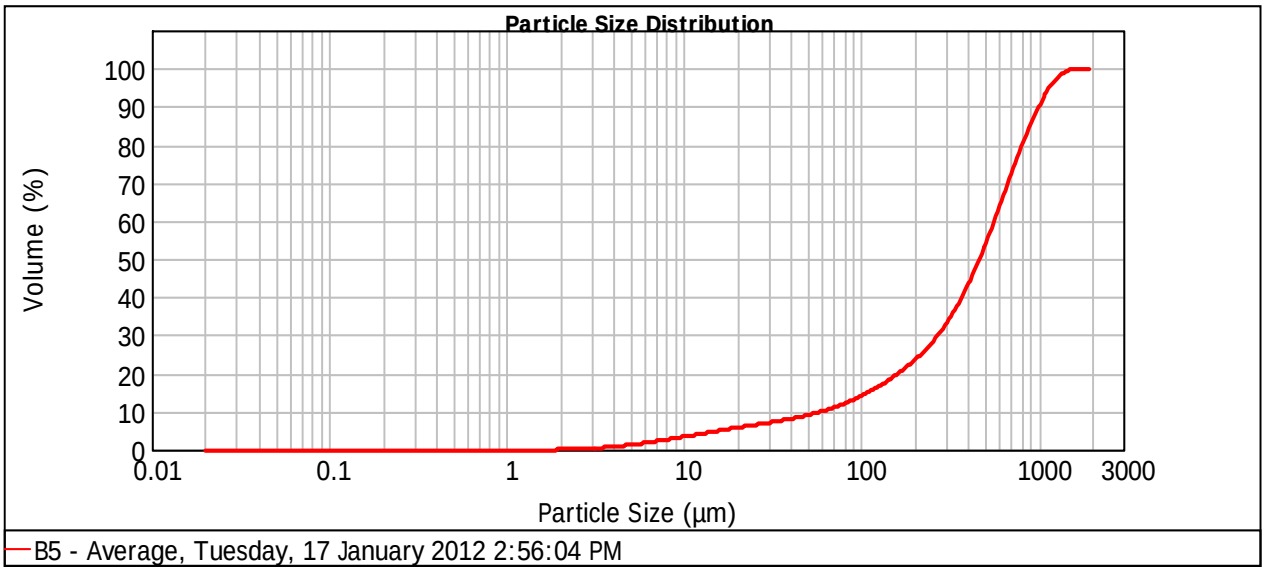
Surface Weighted Mean D[3,2]:
80.228 um

Vol. Weighted Mean D[4,3]:
500.129 um

---

d(0.1): 59.017 um **d(0.5):** 458.886 um **d(0.9):** 994.662 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.49	120.226	1.72	1258.925	2.22
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.48	138.038	1.92	1445.440	0.74
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.48	158.489	2.16	1659.587	0.03
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.46	181.970	2.47	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.07	19.953	0.45	208.930	2.88	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.10	22.909	0.44	239.883	3.41	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.13	26.303	0.45	275.423	4.08	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.18	30.200	0.47	316.228	4.88	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.23	34.674	0.51	363.078	5.75	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.27	39.811	0.57	416.869	6.60	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.32	45.709	0.66	478.630	7.30	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.36	52.481	0.78	549.541	7.72	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.40	60.256	0.91	630.957	7.72	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.43	69.183	1.06	724.436	7.24	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.45	79.433	1.21	831.764	6.30	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.47	91.201	1.37	954.993	5.03	10000.000	
0.091	0.00	0.955	0.00	10.000	0.48	104.713	1.54	1096.478	3.61		
0.105	0.00	1.096	0.00	11.482	0.48	120.226	1.54	1258.925	3.61		

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 3:07:35 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 3:07:36 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
14.77 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
3.315 %

Result Emulation:
Off

Concentration:
0.2673 %Vol

Span :
1.859

Uniformity:
0.568

Result units:
Volume

Specific Surface Area:
0.0508 m²/g

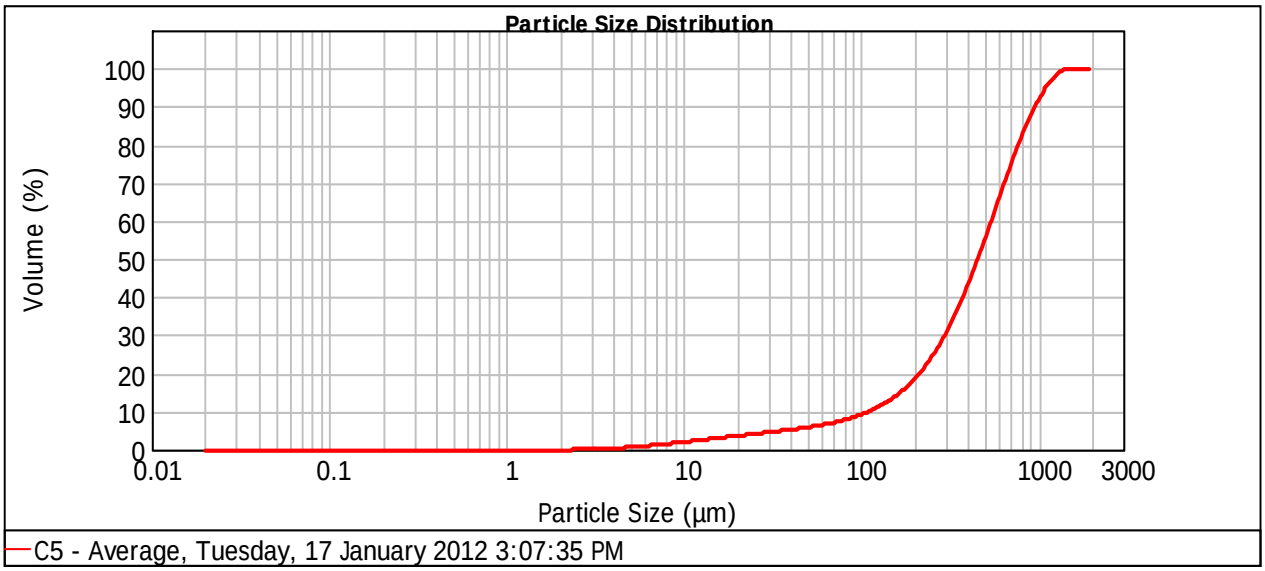
Surface Weighted Mean D[3,2]:
118.227 um

Vol. Weighted Mean D[4,3]:
493.829 um

---

d(0.1): 109.265 um **d(0.5):** 448.521 um **d(0.9):** 943.215 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.33	120.226	1.56	1258.925	1.74
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.33	138.038	1.94	1445.440	0.15
0.013	0.00	0.138	0.00	1.445	0.00	15.136	0.33	158.489	2.41	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.00	17.378	0.33	181.970	2.98	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.00	19.953	0.32	208.930	3.65	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.02	22.909	0.32	239.883	4.41	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.07	26.303	0.32	275.423	5.23	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.10	30.200	0.33	316.228	6.09	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.13	34.674	0.34	363.078	6.89	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.16	39.811	0.37	416.869	7.57	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.19	45.709	0.42	478.630	8.01	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.22	52.481	0.48	549.541	8.10	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.24	60.256	0.57	630.957	7.79	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.27	69.183	0.68	724.436	7.04	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.29	79.433	0.83	831.764	5.91	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.30	91.201	1.02	954.993	4.53	10000.000	
0.091	0.00	0.955	0.00	10.000	0.32	104.713	1.26	1096.478	3.10		
0.105	0.00	1.096	0.00	11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D5 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 3:19:01 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 3:19:03 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
12.49 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
3.547 %

Result Emulation:
Off

Concentration:
0.1342 %Vol

Span :
1.944

Uniformity:
0.582

Result units:
Volume

Specific Surface Area:
0.0813 m²/g

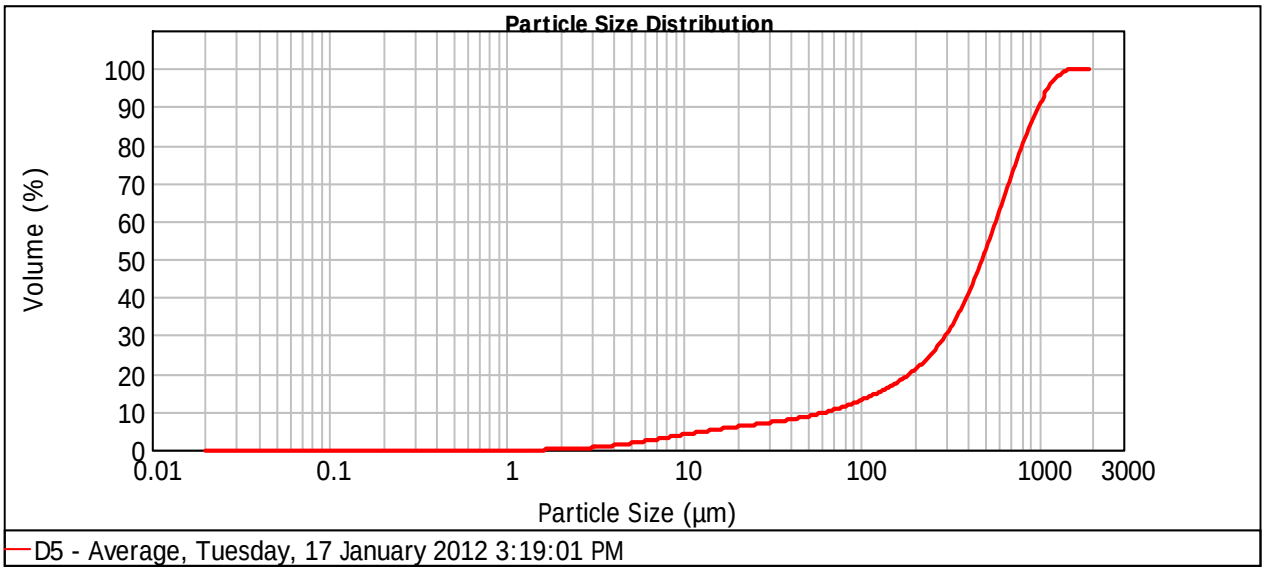
Surface Weighted Mean D[3,2]:
73.819 um

Vol. Weighted Mean D[4,3]:
511.165 um

---

d(0.1): 64.419 um **d(0.5):** 476.553 um **d(0.9):** 990.660 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.44	120.226	1.41	1258.925	2.16
0.011	0.00	0.120	0.00	1.259	0.00	13.183	0.42	138.038	1.60	1445.440	0.54
0.013	0.00	0.138	0.00	1.445	0.01	15.136	0.40	158.489	1.86	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.06	17.378	0.37	181.970	2.22	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.09	19.953	0.36	208.930	2.71	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.13	22.909	0.35	239.883	3.36	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.18	26.303	0.36	275.423	4.15	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.23	30.200	0.38	316.228	5.09	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.28	34.674	0.43	363.078	6.08	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.33	39.811	0.49	416.869	7.02	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.38	45.709	0.58	478.630	7.77	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.41	52.481	0.67	549.541	8.19	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.44	60.256	0.78	630.957	8.15	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.46	69.183	0.90	724.436	7.59	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.47	79.433	1.02	831.764	6.55	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.47	91.201	1.13	954.993	5.16	10000.000	
0.091	0.00	0.955	0.00	10.000	0.46	104.713	1.26	1096.478	3.65		
0.105	0.00	1.096	0.00	11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
B6 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 3:31:12 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 3:31:14 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
11.59 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
6.876 %

Result Emulation:
Off

Concentration:
0.2626 %Vol

Span :
1.699

Uniformity:
0.483

Result units:
Volume

Specific Surface Area:
0.139 m²/g

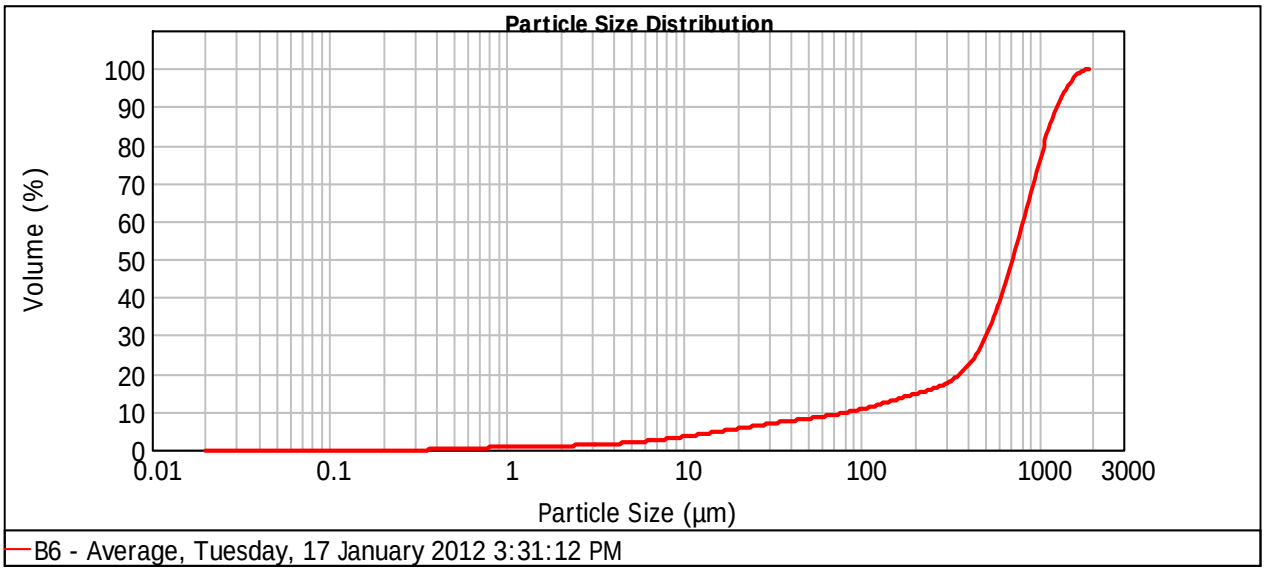
Surface Weighted Mean D[3,2]:
43.246 um

Vol. Weighted Mean D[4,3]:
718.950 um

---

d(0.1): 87.251 um **d(0.5):** 705.996 um **d(0.9):** 1286.731 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.06	11.482	0.42	120.226	0.81	1258.925	5.64
0.011	0.00	0.120	0.00	1.259	0.05	13.183	0.43	138.038	0.82	1445.440	3.66
0.013	0.00	0.138	0.00	1.445	0.05	15.136	0.44	158.489	0.81	1659.587	1.51
0.015	0.00	0.158	0.00	1.660	0.05	17.378	0.44	181.970	0.78	1905.461	0.22
0.017	0.00	0.182	0.00	1.905	0.06	19.953	0.44	208.930	0.81	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.08	22.909	0.42	239.883	0.97	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.10	26.303	0.41	275.423	1.37	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.12	30.200	0.39	316.228	2.11	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.14	34.674	0.38	363.078	3.22	3801.894	0.00
0.035	0.00	0.363	0.07	3.802	0.17	39.811	0.37	416.869	4.69	4365.158	0.00
0.040	0.00	0.417	0.09	4.365	0.20	45.709	0.37	478.630	6.36	5011.872	0.00
0.046	0.00	0.479	0.10	5.012	0.25	52.481	0.39	549.541	8.04	5754.399	0.00
0.052	0.00	0.550	0.11	5.754	0.28	60.256	0.43	630.957	9.41	6606.934	0.00
0.060	0.00	0.631	0.11	6.607	0.31	69.183	0.50	724.436	10.17	7585.776	0.00
0.069	0.00	0.724	0.11	7.586	0.34	79.433	0.58	831.764	10.13	8709.636	0.00
0.079	0.00	0.832	0.09	8.710	0.37	91.201	0.67	954.993	9.22	10000.000	
0.091	0.00	0.955	0.08	10.000	0.39	104.713	0.76	1096.478	7.62		
0.105	0.00	1.096		11.482		120.226		1258.925			

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
C6

SOP Name:

Measured:
Tuesday, 17 January 2012 4:55:57 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 4:55:59 PM

Sample bulk lot ref:

Result Source:
Measurement

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
5.58 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
6.472 %

Result Emulation:
Off

Concentration:
0.1396 %Vol

Span :
1.563

Uniformity:
0.49

Result units:
Volume

Specific Surface Area:
0.0337 m²/g

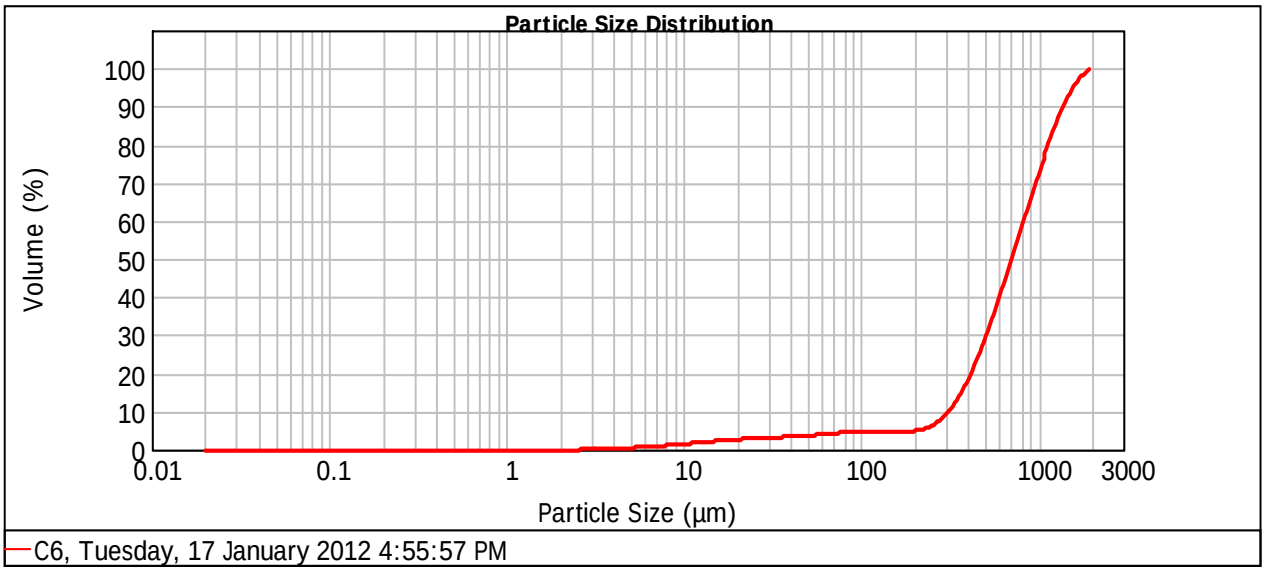
Surface Weighted Mean D[3,2]:
177.992 um

Vol. Weighted Mean D[4,3]:
770.974 um

---

d(0.1): 306.801 um **d(0.5):** 695.114 um **d(0.9):** 1393.505 um

---



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.00
0.417	0.00
0.479	0.00
0.550	0.00
0.631	0.00
0.724	0.00
0.832	0.00
0.955	0.00
1.096	0.00

Size (µm)	Volume In %
1.096	0.00
1.259	0.00
1.445	0.00
1.660	0.00
1.905	0.00
2.188	0.00
2.512	0.05
2.884	0.08
3.311	0.10
3.802	0.12
4.365	0.14
5.012	0.17
5.754	0.19
6.607	0.20
7.586	0.22
8.710	0.23
10.000	0.24
11.482	

Size (µm)	Volume In %
11.482	0.24
13.183	0.24
15.136	0.23
17.378	0.21
19.953	0.18
22.909	0.16
26.303	0.14
30.200	0.13
34.674	0.14
39.811	0.16
45.709	0.20
52.481	0.23
60.256	0.26
69.183	0.25
79.433	0.21
91.201	0.05
104.713	0.00
120.226	

Size (µm)	Volume In %
120.226	0.00
138.038	0.00
158.489	0.01
181.970	0.29
208.930	0.90
239.883	1.81
275.423	2.96
316.228	4.29
363.078	5.63
416.869	6.86
478.630	7.83
549.541	8.48
630.957	8.79
724.436	8.79
831.764	8.52
954.993	8.03
1096.478	7.30
1258.925	

Size (µm)	Volume In %
1258.925	6.27
1445.440	4.89
1659.587	2.87
1905.461	0.70
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

Operator notes:

MASTERSIZER 2000

Result Analysis Report

Sample Name:
D6 - Average

SOP Name:

Measured:
Tuesday, 17 January 2012 5:16:05 PM

Sample Source & type:

Measured by:
abbottsj

Analysed:
Tuesday, 17 January 2012 5:16:07 PM

Sample bulk lot ref:

Result Source:
Averaged

Particle Name:
Silica 1.45

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.450

Absorption:
0.1

Size range:
0.020 to 2000.000 um

Obscuration:
12.39 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.998 %

Result Emulation:
Off

Concentration:
0.0688 %Vol

Span :
3.000

Uniformity:
0.938

Result units:
Volume

Specific Surface Area:
0.297 m²/g

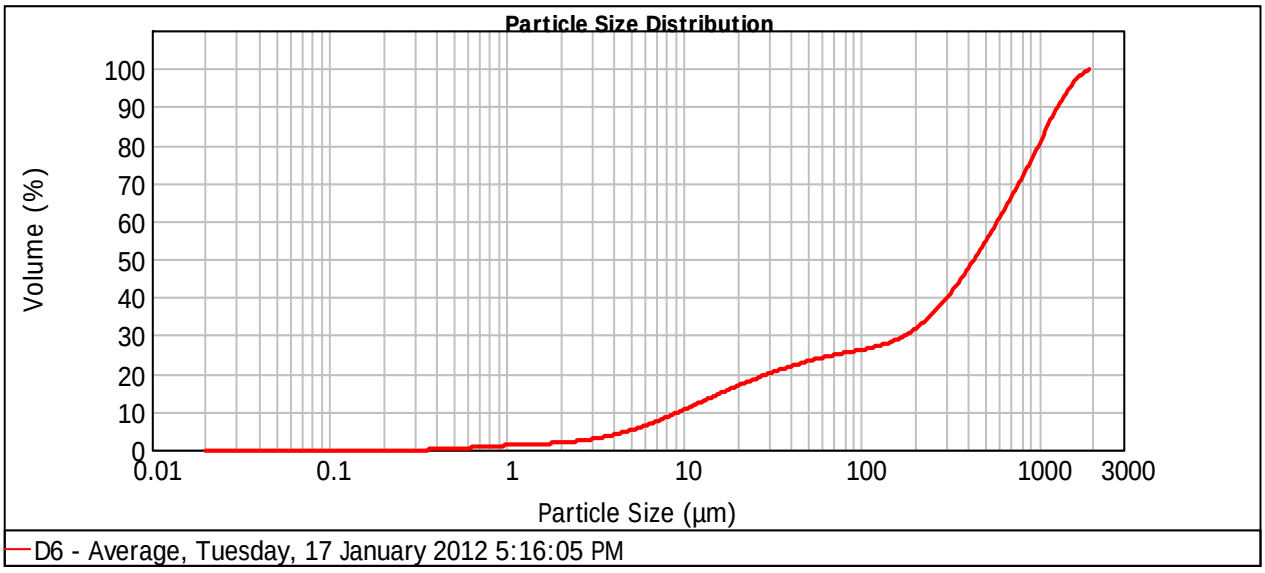
Surface Weighted Mean D[3,2]:
20.195 um

Vol. Weighted Mean D[4,3]:
545.749 um

---

d(0.1): 9.451 um **d(0.5):** 429.527 um **d(0.9):** 1298.067 um

---



Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.12	11.482	1.27	120.226	0.83	1258.925	4.63
0.011	0.00	0.120	0.00	1.259	0.11	13.183	1.26	138.038	1.11	1445.440	3.71
0.013	0.00	0.138	0.00	1.445	0.12	15.136	1.23	158.489	1.48	1659.587	2.21
0.015	0.00	0.158	0.00	1.660	0.17	17.378	1.19	181.970	1.93	1905.461	0.54
0.017	0.00	0.182	0.00	1.905	0.22	19.953	1.14	208.930	2.42	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.28	22.909	1.09	239.883	2.92	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.37	26.303	1.03	275.423	3.39	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.46	30.200	0.97	316.228	3.80	3311.311	0.00
0.030	0.00	0.316	0.01	3.311	0.57	34.674	0.91	363.078	4.14	3801.894	0.00
0.035	0.00	0.363	0.08	3.802	0.68	39.811	0.84	416.869	4.40	4365.158	0.00
0.040	0.00	0.417	0.13	4.365	0.79	45.709	0.77	478.630	4.62	5011.872	0.00
0.046	0.00	0.479	0.16	5.012	0.90	52.481	0.69	549.541	4.80	5754.399	0.00
0.052	0.00	0.550	0.18	5.754	1.00	60.256	0.61	630.957	4.99	6606.934	0.00
0.060	0.00	0.631	0.19	6.607	1.09	69.183	0.55	724.436	5.18	7585.776	0.00
0.069	0.00	0.724	0.18	7.586	1.17	79.433	0.52	831.764	5.33	8709.636	0.00
0.079	0.00	0.832	0.16	8.710	1.22	91.201	0.54	954.993	5.36	10000.000	
0.091	0.00	0.955	0.14	10.000	1.26	104.713	0.64	1096.478	5.17		
0.105		1.096		11.482		120.226		1258.925			

Operator notes:

B2. Chemical Analysis of Sediments Laboratory Results

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EM1114568**	Page	: 1 of 8
Amendment	: **1**		
Client	: SINCLAIR KNIGHT MERZ	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@globalskm.com	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 28-FEB-2012
Order number	: ----		
		No. of samples received	: 14
Quote number	: EN/003/10	No. of samples analysed	: 14

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA055: Moisture Content							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**----**	----	----	**31-DEC-2011**	02-JAN-2012	✓
EG005T: Total Metals by ICP-AES							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**05-JAN-2012**	16-JUN-2012	✓	**06-JAN-2012**	16-JUN-2012	✓
EG020-SD: Total Metals in Sediments by ICPMS							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**05-JAN-2012**	16-JUN-2012	✓	**05-JAN-2012**	16-JUN-2012	✓
EG035T: Total Recoverable Mercury by FIMS							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**05-JAN-2012**	16-JAN-2012	✓	**05-JAN-2012**	16-JAN-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP068A: Organochlorine Pesticides (OC)							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**30-DEC-2011**	07-FEB-2012	✓
EP068B: Organophosphorus Pesticides (OP)							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**30-DEC-2011**	07-FEB-2012	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**31-DEC-2011**	07-FEB-2012	✓
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**30-DEC-2011**	02-JAN-2012	✓
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**31-DEC-2011**	07-FEB-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**30-DEC-2011**	02-JAN-2012	✓
EP080-SD: BTEXN							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**29-DEC-2011**	02-JAN-2012	✓	**30-DEC-2011**	02-JAN-2012	✓
EP090: Organotin Compounds							
Soil Glass Jar - Unpreserved							
A1, B1, C1, D1, A4, B4, C4, D4, A5, C5, D5, B6, C6, D6	**19-DEC-2011**	**28-DEC-2011**	02-JAN-2012	✓	**03-JAN-2012**	06-FEB-2012	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Moisture Content	EA055-103	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organotin Analysis	EP090	2	9	**22.2**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	2	17	**11.8**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS (Low Level)	EG035T-LL	2	14	**14.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	14	**14.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals in Sediments by ICPMS	EG020-SD	2	14	**14.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071-SD	2	14	**14.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX in Sediments	EP080-SD	2	14	**14.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Organotin Analysis	EP090	1	9	**11.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	17	**5.9**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS (Low Level)	EG035T-LL	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals in Sediments by ICPMS	EG020-SD	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071-SD	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX in Sediments	EP080-SD	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Organotin Analysis	EP090	1	9	**11.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	17	**5.9**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS (Low Level)	EG035T-LL	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals in Sediments by ICPMS	EG020-SD	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071-SD	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX in Sediments	EP080-SD	1	14	**7.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Organotin Analysis	EP090	1	9	**11.1**	**5.0**	✓	ALS QCS3 requirement
Pesticides by GCMS	EP068	1	17	**5.9**	**5.0**	✓	ALS QCS3 requirement
Total Mercury by FIMS (Low Level)	EG035T-LL	1	14	**7.1**	**5.0**	✓	ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	14	**7.1**	**5.0**	✓	ALS QCS3 requirement
Total Metals in Sediments by ICPMS	EG020-SD	1	14	**7.1**	**5.0**	✓	ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071-SD	1	14	**7.1**	**5.0**	✓	ALS QCS3 requirement
TPH Volatiles/BTEX in Sediments	EP080-SD	1	14	**7.1**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Moisture Content	EA055-103	SOIL	A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2010 Draft) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Total Metals by ICP-AES	EG005T	SOIL	(APHA 21st ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)
Total Metals in Sediments by ICPMS	EG020-SD	SOIL	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector. Analyte list and LORs per NODG.
Total Mercury by FIMS (Low Level)	EG035T-LL	SOIL	AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3)
Pesticides by GCMS	EP068	SOIL	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (1999) Schedule B(3) (Method 504,505)
TPH - Semivolatile Fraction	EP071-SD	SOIL	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504)
TPH Volatiles/BTEX in Sediments	EP080-SD	SOIL	(USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 501)
Organotin Analysis	EP090	SOIL	(USEPA SW 846 - 8270D) Prepared sample extracts are analysed by GC/MS coupled with high volume injection, and quanitified against an established calibration curve.

Preparation Methods	Method	Matrix	Method Descriptions
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)
Methanolic Extraction of Soils for Purge and Trap	* ORG16	SOIL	(USEPA SW 846 - 5030A) 5g of solid is shaken with surrogate and 10mL methanol prior to analysis by Purge and Trap - GC/MS.
Tumbler Extraction of Solids (Option A - Concentrating)	ORG17A	SOIL	In-house, Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.
Tumbler Extraction of Solids for LVI (Non-concentrating)	ORG17D	SOIL	In house: 10g of sample, Na2SO4 and surrogate are extracted with 50mL 1:1 DCM/Acetone by end over end tumbling. An aliquot is concentrated by nitrogen blowdown to a reduced volume for analysis if required.

Preparation Methods	Method	Matrix	Method Descriptions
Organotin Sample Preparation	ORG35	SOIL	In house. 20g sample is spiked with surrogate and leached in a methanol:acetic acid:UHP water mix and vacuum filtered. Reagents and solvents are added to the sample and the mixture tumbled. The butyltin compounds are simultaneously derivatised and extracted. The extract is further extracted with petroleum ether. The resultant extracts are combined and concentrated for analysis.

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	2492376-002	----	**Prothiofos**	34643-46-4	112 %	65.4-111%	**Recovery greater than upper control limit**
Matrix Spike (MS) Recoveries							
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons	EM1114568-001	A1	**C6 - C9 Fraction**	----	130 %	70-130%	**Recovery greater than upper data quality objective**

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**

Regular Sample Surrogates

Sub-Matrix: **SEDIMENT**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP090S: Organotin Surrogate	EM1114568-013	C6	**Tripropyltin**	----	146 %	35-130 %	**Recovery greater than upper data quality objective**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- **No Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EM1114568**	Page	: 1 of 11
Amendment	: **1**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@globalskm.com	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 28-FEB-2012
Order number	: ----		
		No. of samples received	: 14
Quote number	: EN/003/10	No. of samples analysed	: 14

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Di-An Dao		Sydney Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Phalak Inthaksone	Laboratory Manager - Organics	Sydney Organics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA055: Moisture Content (QC Lot: 2111940)									
EM1114568-003	C1	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	35.6	35.6	0.0	0% - 20%
EM1114568-014	D6	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	31.3	31.8	1.7	0% - 20%
EG005T: Total Metals by ICP-AES (QC Lot: 2115272)									
EM1114568-001	A1	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	<10	<10	0.0	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	2460	2520	2.4	0% - 20%
EM1114568-011	D5	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	<10	<10	0.0	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	6540	6630	1.3	0% - 20%
EG020-SD: Total Metals in Sediments by ICPMS (QC Lot: 2115274)									
EM1114568-001	A1	EG020-SD: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG020-SD: Cobalt	7440-48-4	0.5	mg/kg	<0.5	0.5	0.0	No Limit
		EG020-SD: Chromium	7440-47-3	1.0	mg/kg	5.5	6.8	21.4	No Limit
		EG020-SD: Copper	7440-50-8	1.0	mg/kg	1.3	1.3	0.0	No Limit
		EG020-SD: Lead	7439-92-1	1.0	mg/kg	1.1	1.3	16.2	No Limit
		EG020-SD: Nickel	7440-02-0	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EG020-SD: Zinc	7440-66-6	1.0	mg/kg	1.4	1.6	10.4	No Limit
		EG020-SD: Arsenic	7440-38-2	1.00	mg/kg	2.54	2.25	11.9	No Limit
		EG020-SD: Manganese	7439-96-5	10	mg/kg	10	11	0.0	No Limit
		EG020-SD: Vanadium	7440-62-2	2.0	mg/kg	<2.0	<2.0	0.0	No Limit
EM1114568-011	D5	EG020-SD: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
		EG020-SD: Cobalt	7440-48-4	0.5	mg/kg	0.5	<0.5	0.0	No Limit
		EG020-SD: Chromium	7440-47-3	1.0	mg/kg	13.5	12.4	8.6	0% - 50%
		EG020-SD: Copper	7440-50-8	1.0	mg/kg	<1.0	<1.0	0.0	No Limit
		EG020-SD: Lead	7439-92-1	1.0	mg/kg	1.8	1.7	9.1	No Limit
		EG020-SD: Nickel	7440-02-0	1.0	mg/kg	1.3	1.1	18.0	No Limit
		EG020-SD: Zinc	7440-66-6	1.0	mg/kg	2.1	1.9	12.7	No Limit
		EG020-SD: Arsenic	7440-38-2	1.00	mg/kg	8.99	8.31	7.9	No Limit
		EG020-SD: Manganese	7439-96-5	10	mg/kg	14	12	13.0	No Limit
		EG020-SD: Vanadium	7440-62-2	2.0	mg/kg	19.1	17.6	8.3	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115273)									
EM1114568-001	A1	EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EM1114568-011	D5	EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	0.0	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 2106215)									
EM1114568-001	A1	EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068A: Organochlorine Pesticides (OC) (QC Lot: 2106215) - continued									
EM1114568-001	A1	EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EM1114568-011	D5	EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068A: Organochlorine Pesticides (OC) (QC Lot: 2106215) - continued									
EM1114568-011	D5	EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 2106215)									
EM1114568-001	A1	EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP068: Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EM1114568-011	D5	EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP068: Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 2106215) - continued									
EM1114568-011	D5	EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 2106035)									
EM1114568-002	B1	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	22	22	0.0	No Limit
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	9	9	0.0	No Limit
EM1114568-012	B6	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	31	30	0.0	0% - 50%
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	12	9	24.3	No Limit
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 2109665)									
EM1114568-001	A1	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
EM1114568-011	D5	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.0	No Limit
EP080-SD: BTEXN (QC Lot: 2109665)									
EM1114568-001	A1	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EM1114568-011	D5	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP090: Organotin Compounds (QC Lot: 2105989)									
EM1114568-001	A1	EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	0.0	No Limit
EM1114568-010	C5	EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2115272)								
EG005T: Barium	7440-39-3	10	mg/kg	<10	137.41 mg/kg	95.0	70	130
EG005T: Beryllium	7440-41-7	1	mg/kg	<1	5.51 mg/kg	94.5	70	130
EG005T: Iron	7439-89-6	50	mg/kg	<50	----	----	----	----
EG020-SD: Total Metals in Sediments by ICPMS (QCLot: 2115274)								
EG020-SD: Arsenic	7440-38-2	1.0	mg/kg	<1.00	13.1 mg/kg	107	70	130
EG020-SD: Cadmium	7440-43-9	0.1	mg/kg	<0.1	2.76 mg/kg	98.1	70	130
EG020-SD: Chromium	7440-47-3	1.0	mg/kg	<1.0	60.9 mg/kg	102	70	130
EG020-SD: Copper	7440-50-8	1.0	mg/kg	<1.0	54.7 mg/kg	103	70	130
EG020-SD: Cobalt	7440-48-4	10	mg/kg	<10.0	24.5 mg/kg	106	70	130
EG020-SD: Lead	7439-92-1	1.0	mg/kg	<1.0	54.8 mg/kg	108	70	130
EG020-SD: Manganese	7439-96-5	10	mg/kg	<10	136 mg/kg	101	70	130
EG020-SD: Nickel	7440-02-0	1.0	mg/kg	<1.0	55.2 mg/kg	108	70	130
EG020-SD: Vanadium	7440-62-2	2	mg/kg	<2.0	34 mg/kg	90.5	70	130
EG020-SD: Zinc	7440-66-6	1.0	mg/kg	<1.0	104 mg/kg	99.7	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115273)								
EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	0.11 mg/kg	84.7	74.2	126
EP068A: Organochlorine Pesticides (OC) (QCLot: 2106215)								
EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	0.5 mg/kg	100	60.8	116
EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	0.5 mg/kg	90.0	59.4	115
EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	0.5 mg/kg	95.0	59.8	117
EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	0.5 mg/kg	94.8	59.8	118
EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	0.5 mg/kg	82.5	65.8	114
EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	0.5 mg/kg	88.2	65.6	115
EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	0.5 mg/kg	110	67	113
EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	0.5 mg/kg	91.6	65.6	113
EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	0.5 mg/kg	113	60.7	113
EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	0.5 mg/kg	110	65.8	116
EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	0.5 mg/kg	74.6	57.3	120
EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	0.5 mg/kg	104	67.4	116
EP068: 4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	0.5 mg/kg	104	67.5	114
EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	0.5 mg/kg	94.3	63	121
EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	0.5 mg/kg	104	66.1	117
EP068: 4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	0.5 mg/kg	110	65.3	116
EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	0.5 mg/kg	85.0	57.3	115

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 2106215) - continued								
EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	0.5 mg/kg	108	63.6	119
EP068: 4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	0.5 mg/kg	112	58.4	127
EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	0.5 mg/kg	104	63.6	117
EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	0.5 mg/kg	98.8	50.4	132
EP068B: Organophosphorus Pesticides (OP) (QCLot: 2106215)								
EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	0.5 mg/kg	103	25.5	124
EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	0.5 mg/kg	103	10.1	159
EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	0.5 mg/kg	77.0	2.88	149
EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	0.5 mg/kg	91.8	48.6	126
EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	0.5 mg/kg	96.8	64.9	111
EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	0.5 mg/kg	110	65.1	111
EP068: Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	0.5 mg/kg	97.4	61.4	113
EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	0.5 mg/kg	83.4	60.4	127
EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	0.5 mg/kg	102	64.7	110
EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	0.5 mg/kg	104	64.2	111
EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	0.5 mg/kg	96.1	60	116
EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	0.5 mg/kg	91.8	64.8	111
EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	0.5 mg/kg	89.9	61.4	123
EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	0.5 mg/kg	81.7	64.3	114
EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	0.5 mg/kg	109	45.5	128
EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	0.5 mg/kg	# 112	65.4	111
EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	0.5 mg/kg	112	62	116
EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	0.5 mg/kg	112	59.5	119
EP068: Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	0.5 mg/kg	78.3	29.8	137
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2106035)								
EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	5 mg/kg	87.0	75.2	116
EP071-SD: C15 - C28 Fraction	----	3	mg/kg	<3	6.75 mg/kg	99.2	75.3	113
EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	5 mg/kg	79.0	72.6	117
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2109665)								
EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	26 mg/kg	114	61	133
EP080-SD: BTEXN (QCLot: 2109665)								
EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	1 mg/kg	113	66	122
EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	1 mg/kg	112	69	122
EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	1 mg/kg	113	66	126
EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	2.5 mg/kg	91.5	59	129
EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	1 mg/kg	109	66	126
EP090: Organotin Compounds (QCLot: 2105989)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP090: Organotin Compounds (QCLot: 2105989) - continued								
EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	1.25 µgSn/kg	46.4	19.5	129

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020-SD: Total Metals in Sediments by ICPMS (QCLot: 2115274)							
EM1114568-001	A1	EG020-SD: Arsenic	7440-38-2	50 mg/kg	105	70	130
		EG020-SD: Cadmium	7440-43-9	50 mg/kg	108	70	130
		EG020-SD: Chromium	7440-47-3	50 mg/kg	104	70	130
		EG020-SD: Copper	7440-50-8	250 mg/kg	98.2	70	130
		EG020-SD: Lead	7439-92-1	250 mg/kg	107	70	130
		EG020-SD: Nickel	7440-02-0	50 mg/kg	104	70	130
		EG020-SD: Zinc	7440-66-6	250 mg/kg	88.9	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115273)							
EM1114568-001	A1	EG035T-LL: Mercury	7439-97-6	0.50 mg/kg	75.8	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 2106215)							
EM1114568-001	A1	EP068: gamma-BHC	58-89-9	0.5 mg/kg	101	70	130
		EP068: Heptachlor	76-44-8	0.5 mg/kg	92.0	70	130
		EP068: Aldrin	309-00-2	0.5 mg/kg	80.6	70	130
		EP068: Dieldrin	60-57-1	0.5 mg/kg	95.6	70	130
		EP068: Endrin	72-20-8	2 mg/kg	102	70	130
		EP068: 4.4`-DDT	50-29-3	2 mg/kg	76.9	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 2106215)							
EM1114568-001	A1	EP068: Diazinon	333-41-5	0.5 mg/kg	109	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5 mg/kg	104	70	130
		EP068: Pirimphos-ethyl	23505-41-1	0.5 mg/kg	104	70	130
		EP068: Bromophos-ethyl	4824-78-6	0.5 mg/kg	80.1	70	130
		EP068: Prothiofos	34643-46-4	0.5 mg/kg	72.0	70	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2106035)							
EM1114568-002	B1	EP071-SD: C10 - C14 Fraction	----	19.75 mg/kg	76.7	70	130
		EP071-SD: C15 - C28 Fraction	----	87.25 mg/kg	92.9	70	130
		EP071-SD: C29 - C36 Fraction	----	60 mg/kg	95.6	70	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2109665)							
EM1114568-001	A1	EP080-SD: C6 - C9 Fraction	----	25 mg/kg	# 130	70	130
EP080-SD: BTEXN (QCLot: 2109665)							
EM1114568-001	A1	EP080-SD: Benzene	71-43-2	2.5 mg/kg	117	70	130
		EP080-SD: Toluene	108-88-3	2.5 mg/kg	110	70	130
		EP080-SD: Ethylbenzene	100-41-4	2.5 mg/kg	107	70	130
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	2.5 mg/kg	109	70	130

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EP080-SD: BTEXN (QCLot: 2109665) - continued							
EM1114568-001	A1	EP080-SD: ortho-Xylene	95-47-6	2.5 mg/kg	109	70	130
EP090: Organotin Compounds (QCLot: 2105989)							
EM1114568-002	B1	EP090: Tributyltin	56573-85-4	1.25 µgSn/kg	52.5	20	130

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EM1114568**	Page	: 1 of 12
Amendment	: **1**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@globalskm.com	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 28-FEB-2012
Site	: ----		
		No. of samples received	: 14
Quote number	: EN/003/10	No. of samples analysed	: 14

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Di-An Dao		Sydney Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Phalak Inthaksone	Laboratory Manager - Organics	Sydney Organics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **27/2/12 - This report has been amended and re-released to allow the reporting of additional analytical data.**
- **All analysis with the exception of TBT conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.**
- **EG020: LCS recoveries for particular element(s) fall outside ALS Dynamic control limit, however, they are within the acceptance criteria based on ALS DQO. No further action is required.**
- **TBT conducted by ALS Brisbane, NATA Site No. 818.**
- **Tributyltin: Sample C6 shows poor surrogate recovery due to matrix interference. Confirmed by re-extraction and re-analysis.**

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: A1	B1	C1	D1	A4
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114568-001	EM1114568-002	EM1114568-003	EM1114568-004	EM1114568-005
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**29.0**	**34.5**	**35.6**	**42.5**	**29.8**
EG005T: Total Metals by ICP-AES								
Barium	7440-39-3	10	mg/kg	<10	<10	<10	<10	<10
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Iron	7439-89-6	50	mg/kg	**2460**	**3520**	**4070**	**5020**	**3210**
EG020-SD: Total Metals in Sediments by ICPMS								
Arsenic	7440-38-2	1.00	mg/kg	**2.54**	**2.08**	**3.76**	**2.88**	**4.64**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	1.0	mg/kg	**5.5**	**10.6**	**10.4**	**16.1**	**6.7**
Copper	7440-50-8	1.0	mg/kg	**1.3**	**2.1**	**1.5**	**2.2**	<1.0
Cobalt	7440-48-4	0.5	mg/kg	<0.5	**0.6**	**0.6**	**0.8**	<0.5
Lead	7439-92-1	1.0	mg/kg	**1.1**	**2.1**	**2.0**	**2.9**	**1.4**
Manganese	7439-96-5	10	mg/kg	**10**	**12**	**11**	**14**	**11**
Nickel	7440-02-0	1.0	mg/kg	<1.0	**2.0**	**1.9**	**3.2**	**1.1**
Vanadium	7440-62-2	2.0	mg/kg	<2.0	<2.0	**3.7**	**8.0**	**5.2**
Zinc	7440-66-6	1.0	mg/kg	**1.4**	**2.7**	**3.2**	**3.6**	**1.9**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: A1	B1	C1	D1	A4
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114568-001	EM1114568-002	EM1114568-003	EM1114568-004	EM1114568-005
EP068A: Organochlorine Pesticides (OC) - Continued								
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**30**	**32**	**26**	**56**	**27**
>C34 - C40 Fraction	----	5	mg/kg	<5	**8**	<5	**12**	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	**23**	**22**	**19**	**39**	**20**
C29 - C36 Fraction	----	5	mg/kg	**5**	**9**	**6**	**14**	<5
^ **C10 - C36 Fraction (sum)**	----	3	mg/kg	**28**	**31**	**25**	**53**	**20**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: A1	B1	C1	D1	A4
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114568-001	EM1114568-002	EM1114568-003	EM1114568-004	EM1114568-005
EP080-SD: BTEXN - Continued								
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.1	%	**94.5**	**85.5**	**84.6**	**91.0**	**72.0**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	**93.0**	**82.8**	**81.7**	**90.1**	**63.8**
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**114**	**126**	**107**	**119**	**107**
Toluene-D8	2037-26-5	0.1	%	**104**	**108**	**98.4**	**103**	**99.7**
4-Bromofluorobenzene	460-00-4	0.1	%	**88.4**	**94.4**	**87.8**	**91.1**	**86.4**
EP090S: Organotin Surrogate								
Tripropyltin	----	0.1	%	**46.4**	**92.8**	**66.5**	**108**	**121**

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: B4	C4	D4	A5	C5
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114568-006	EM1114568-007	EM1114568-008	EM1114568-009	EM1114568-010
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**32.3**	**34.6**	**37.3**	**20.2**	**29.6**
EG005T: Total Metals by ICP-AES								
Barium	7440-39-3	10	mg/kg	<10	<10	<10	<10	<10
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Iron	7439-89-6	50	mg/kg	**3940**	**5830**	**5400**	**3000**	**5060**
EG020-SD: Total Metals in Sediments by ICPMS								
Arsenic	7440-38-2	1.00	mg/kg	**3.74**	**7.36**	**5.06**	**6.71**	**7.38**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	1.0	mg/kg	**9.9**	**13.5**	**13.7**	**5.8**	**8.4**
Copper	7440-50-8	1.0	mg/kg	**1.2**	**1.6**	**2.0**	<1.0	<1.0
Cobalt	7440-48-4	0.5	mg/kg	**0.6**	**0.6**	**0.6**	<0.5	<0.5
Lead	7439-92-1	1.0	mg/kg	**1.9**	**2.3**	**2.6**	<1.0	**1.6**
Manganese	7439-96-5	10	mg/kg	**12**	**14**	**12**	<10	<10
Nickel	7440-02-0	1.0	mg/kg	**1.7**	**1.9**	**2.1**	<1.0	<1.0
Vanadium	7440-62-2	2.0	mg/kg	**5.5**	**12.3**	**14.2**	**10.1**	**10.9**
Zinc	7440-66-6	1.0	mg/kg	**2.6**	**2.9**	**3.1**	**1.7**	**1.4**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: B4	C4	D4	A5	C5
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114568-006	EM1114568-007	EM1114568-008	EM1114568-009	EM1114568-010
EP068A: Organochlorine Pesticides (OC) - Continued								
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	**53**	**31**	**30**	**21**	**28**
>C34 - C40 Fraction	----	5	mg/kg	**11**	<5	**7**	<5	**5**
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	**37**	**22**	**20**	**16**	**20**
C29 - C36 Fraction	----	5	mg/kg	**14**	**7**	**9**	<5	**7**
^ **C10 - C36 Fraction (sum)**	----	3	mg/kg	**51**	**29**	**29**	**16**	**27**
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: B4	C4	D4	A5	C5
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114568-006	EM1114568-007	EM1114568-008	EM1114568-009	EM1114568-010
EP080-SD: BTEXN - Continued								
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	1330-20-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.1	%	**90.3**	**85.8**	**96.1**	**93.9**	**95.9**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	**86.4**	**81.1**	**81.4**	**90.4**	**94.8**
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**105**	**109**	**123**	**121**	**115**
Toluene-D8	2037-26-5	0.1	%	**96.1**	**102**	**118**	**111**	**106**
4-Bromofluorobenzene	460-00-4	0.1	%	**82.2**	**87.0**	**100**	**96.2**	**90.3**
EP090S: Organotin Surrogate								
Tripropyltin	----	0.1	%	**106**	**106**	**87.5**	**111**	**109**

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: D5	B6	C6	D6	----
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	----
				EM1114568-011	EM1114568-012	EM1114568-013	EM1114568-014	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**25.7**	**32.9**	**38.8**	**31.3**	----
EG005T: Total Metals by ICP-AES								
Barium	7440-39-3	10	mg/kg	<10	<10	<10	<10	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	----
Iron	7439-89-6	50	mg/kg	**6540**	**3480**	**14000**	**13500**	----
EG020-SD: Total Metals in Sediments by ICPMS								
Arsenic	7440-38-2	1.00	mg/kg	**8.99**	**10.3**	**51.1**	**29.6**	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Chromium	7440-47-3	1.0	mg/kg	**13.5**	**8.4**	**23.2**	**24.0**	----
Copper	7440-50-8	1.0	mg/kg	<1.0	**2.4**	<1.0	<1.0	----
Cobalt	7440-48-4	0.5	mg/kg	**0.5**	<0.5	<0.5	<0.5	----
Lead	7439-92-1	1.0	mg/kg	**1.8**	**1.1**	**2.1**	**1.8**	----
Manganese	7439-96-5	10	mg/kg	**14**	<10	**10**	<10	----
Nickel	7440-02-0	1.0	mg/kg	**1.3**	<1.0	<1.0	<1.0	----
Vanadium	7440-62-2	2.0	mg/kg	**19.1**	**13.6**	**57.4**	**50.7**	----
Zinc	7440-66-6	1.0	mg/kg	**2.1**	**2.0**	**1.2**	**1.4**	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----

Analytical Results

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	LOR	Unit	Client sample ID: D5	B6	C6	D6	----
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	----
				EM1114568-011	EM1114568-012	EM1114568-013	EM1114568-014	----
EP068A: Organochlorine Pesticides (OC) - Continued								
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
>C16 - C34 Fraction	----	3	mg/kg	**24**	**36**	**35**	**35**	----
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	**5**	<5	----
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C15 - C28 Fraction	----	3	mg/kg	**17**	**31**	**26**	**26**	----
C29 - C36 Fraction	----	5	mg/kg	**6**	**12**	**6**	**6**	----
^ **C10 - C36 Fraction (sum)**	----	3	mg/kg	**23**	**43**	**32**	**32**	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----

Analytical Results

Sub-Matrix: SEDIMENT				Client sample ID	D5	B6	C6	D6	----
				Client sampling date / time	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	----
Compound	CAS Number	LOR	Unit		EM1114568-011	EM1114568-012	EM1114568-013	EM1114568-014	----
EP080-SD: BTEXN - Continued									
Toluene	108-88-3	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
Ethylbenzene	100-41-4	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
ortho-Xylene	95-47-6	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
^ **Total Xylenes**	1330-20-7	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
Naphthalene	91-20-3	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
EP090: Organotin Compounds									
Tributyltin	56573-85-4	0.5	µgSn/kg		<0.5	<0.5	<0.5	<0.5	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.1	%		**90.1**	**94.4**	**97.1**	**83.9**	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		**87.6**	**100**	**90.6**	**75.4**	----
EP080-SD: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**121**	**111**	**119**	**130**	----
Toluene-D8	2037-26-5	0.1	%		**103**	**105**	**110**	**117**	----
4-Bromofluorobenzene	460-00-4	0.1	%		**89.0**	**87.8**	**95.1**	**102**	----
EP090S: Organotin Surrogate									
Tripropyltin	----	0.1	%		**110**	**104**	**146**	**110**	----

Surrogate Control Limits

Sub-Matrix: **SEDIMENT**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	19.5	167.0
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	22.7	163.5
EP080-SD: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	67	137
Toluene-D8	2037-26-5	74	134
4-Bromofluorobenzene	460-00-4	73	137
EP090S: Organotin Surrogate			
Tripropyltin	----	35	130

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EM1114567**	Page	: 1 of 13
Amendment	: **1**		
Client	: SINCLAIR KNIGHT MERZ	Laboratory	: Environmental Division Melbourne
Contact	: GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
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Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 28-FEB-2012
Order number	: ----		
		No. of samples received	: 60
Quote number	: ADBQ/037/11	No. of samples analysed	: 60

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Suspended Solids							
Clear Plastic Bottle - Natural							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B, C3B, D3B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	**----**	----	----	**23-DEC-2011**	26-DEC-2011	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Unfiltered; Lab-acidified								
A1S,	B1S,	**19-DEC-2011**	**23-DEC-2011**	16-JUN-2012	✓	**30-DEC-2011**	16-JUN-2012	✓
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B							
Clear Plastic Bottle - Unfiltered; Lab-acidified								
C3B,	D3B,	**19-DEC-2011**	**28-DEC-2011**	16-JUN-2012	✓	**30-DEC-2011**	16-JUN-2012	✓
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified								
A1S,	B1S,	**19-DEC-2011**	**----**	----	----	**05-JAN-2012**	16-JAN-2012	✓
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid								
A1S,	B1S,	**19-DEC-2011**	**---**	16-JAN-2012	----	**06-JAN-2012**	16-JAN-2012	✓
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural								
A1S,	B1S,	**19-DEC-2011**	**---**	21-DEC-2011	----	**22-DEC-2011**	21-DEC-2011	×
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, A4S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B, C3B, D3B, A4B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	---	16-JAN-2012	----	**05-JAN-2012**	16-JAN-2012	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid							
C3B, D3B, A4B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	**03-JAN-2012**	16-JAN-2012	✓	**03-JAN-2012**	16-JAN-2012	✓
Clear Plastic Bottle - Sulfuric Acid							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, A4S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B	**19-DEC-2011**	**30-DEC-2011**	16-JAN-2012	✓	**30-DEC-2011**	16-JAN-2012	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid							
C3B, D3B, A4B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	**03-JAN-2012**	16-JAN-2012	✓	**03-JAN-2012**	16-JAN-2012	✓
Clear Plastic Bottle - Sulfuric Acid							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, A4S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B	**19-DEC-2011**	**30-DEC-2011**	16-JAN-2012	✓	**30-DEC-2011**	16-JAN-2012	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	8	69	**11.6**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	4	69	**5.8**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	4	69	**5.8**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids (High Level)	EA025H	WATER	APHA 21st ed., 2540D A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Ammonia as N by Discrete analyser	EK055G	WATER	APHA 21st ed., 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite as N by Discrete Analyser	EK057G	WATER	APHA 21st ed., 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrate as N by Discrete Analyser	EK058G	WATER	APHA 21st ed., 4500-NO3- F. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	APHA 21st ed., 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Cadmium Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	APHA 21st ed., 4500-Norg D. 25mL water samples are digested using a traditional Kjeldahl digestion followed by determination by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	APHA 21st ed., 4500-Norg / 4500-NO3-. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	APHA 21st ed., 4500-P B&F This procedure involves sulphuric acid digestion of a 100mL sample to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 21st ed., 4500 Norg - D; APHA 21st ed., 4500 P - H. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	**Days overdue**	Date analysed	Due for analysis	**Days overdue**
EA025: Suspended Solids						
Clear Plastic Bottle - Natural						
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S	----	----	----	28-DEC-2011	26-DEC-2011	**2**
EK057G: Nitrite as N by Discrete Analyser						

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser - Analysis Holding Time Compliance							
Clear Plastic Bottle - Natural							
A1S,	B1S,	----	----	----	22-DEC-2011	21-DEC-2011	**1**
C1S,	D1S,						
A2S,	B2S,						
C2S,	D2S,						
A3S,	B3S,						
C3S,	D3S,						
A4S,	B4S,						
C4S,	D4S,						
X4S,	Y4S,						
AaS,	BbS,						
CcS,	DdS,						
A5S,	B5S,						
C5S,	D5S,						
A6S,	B6S,						
C6S,	D6S,						
A1B,	B1B,						
C1B,	D1B,						
A2B,	B2B,						
C2B,	D2B,						
A3B,	B3B,						
C3B,	D3B,						
A4B,	B4B,						
C4B,	D4B,						
X4B,	Y4B,						
AaB,	BbB,						
CcB,	DdB,						
A5B,	B5B,						
C5B,	D5B,						
A6B,	B6B,						
C6B,	D6B						

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EM1114567**	Page	: 1 of 12
Amendment	: **1**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@skm.com.au	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 28-FEB-2012
Order number	: ----		
		No. of samples received	: 60
Quote number	: ADBQ/037/11	No. of samples analysed	: 60

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Eric Chau	Metals Team Leader	Melbourne Inorganics
Herman Lin	Laboratory Coordinator	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA025: Suspended Solids (QC Lot: 2105373)									
EM1114567-027	A6S	EA025H: Suspended Solids (SS)	----	5	mg/L	223	240	7.3	0% - 20%
EM1114567-036	B2B	EA025H: Suspended Solids (SS)	----	5	mg/L	129	130	0.8	0% - 20%
EA025: Suspended Solids (QC Lot: 2105374)									
EM1114567-048	Y4B	EA025H: Suspended Solids (SS)	----	5	mg/L	128	128	0.0	0% - 20%
EM1114567-057	A6B	EA025H: Suspended Solids (SS)	----	5	mg/L	111	114	2.7	0% - 20%
EA025: Suspended Solids (QC Lot: 2107718)									
EM1114567-001	A1S	EA025H: Suspended Solids (SS)	----	5	mg/L	50	69	31.9	0% - 50%
EM1114567-010	B3S	EA025H: Suspended Solids (SS)	----	5	mg/L	60	63	4.9	0% - 50%
EA025: Suspended Solids (QC Lot: 2107719)									
EM1114567-022	DdS	EA025H: Suspended Solids (SS)	----	5	mg/L	62	66	6.2	0% - 50%
EM1114604-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	835	865	3.5	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 2105258)									
EM1114567-001	A1S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.008	0.009	21.7	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.006	0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EM1114567-010	B3S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.009	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.003	0.001	64.5	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 2105258) - continued									
EM1114567-010	B3S	EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2105259)									
EM1114567-021	CcS	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EM1114567-030	D6S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2107796)									
EM1114566-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.013	0.014	11.3	0% - 50%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.058	0.061	5.0	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.017	0.017	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.015	0.016	7.4	0% - 50%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 2107796) - continued									
EM1114566-001	Anonymous	EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.082	0.087	5.1	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.016	0.017	0.0	0% - 50%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.163	0.187	13.7	0% - 20%
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	0.06	0.06	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	1.67	1.71	2.4	0% - 20%
EM1114567-050	BbB	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.005	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.006	0.009	32.8	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.06	0.10	42.2	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115265)									
EM1114567-001	A1S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EM1114567-010	B3S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0007	151	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115266)									
EM1114567-021	CcS	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EM1114567-030	D6S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115267)									
EM1114567-041	C3B	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EM1114567-050	BbB	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2115294)									
EM1114567-001	A1S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.10	0.10	0.0	0% - 50%
EM1114567-010	B3S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.12	0.11	10.1	0% - 50%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2115297)									
EM1114567-021	CcS	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.11	0.10	0.0	0% - 50%
EM1114567-030	D6S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.10	0.09	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2115299)									
EM1114567-041	C3B	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.12	0.15	16.8	0% - 50%
EM1114567-050	BbB	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.11	0.13	16.8	0% - 50%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2105293)									
EM1114567-001	A1S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-010	B3S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2105294)									
EM1114567-021	CcS	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-030	D6S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2105295)									
EM1114567-041	C3B	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-050	BbB	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115293)									
EM1114567-001	A1S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-010	B3S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115296)									
EM1114567-021	CcS	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-030	D6S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115298)									
EM1114567-041	C3B	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-050	BbB	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2109542)									
EM1114567-001	A1S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.3	0.0	No Limit
EM1114567-010	B3S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.2	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2109544)									
EM1114567-021	CcS	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.1	0.0	No Limit
EM1114567-030	D6S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.2	52.8	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2110810)									
EM1114567-041	C3B	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	0.2	0.0	No Limit
EM1114567-050	BbB	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2109543)									
EM1114567-001	A1S	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-010	B3S	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.01	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2109545)									
EM1114567-021	CcS	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-030	D6S	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.05	0.04	29.9	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2110811)									
EM1114567-041	C3B	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.01	0.0	No Limit
EM1114567-050	BbB	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Suspended Solids (QCLot: 2105373)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	101	96	112
EA025: Suspended Solids (QCLot: 2105374)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	101	96	112
EA025: Suspended Solids (QCLot: 2107718)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	101	96	112
EA025: Suspended Solids (QCLot: 2107719)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	105	96	112
EG020T: Total Metals by ICP-MS (QCLot: 2105258)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	106	86	110
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	104	68	128
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	104	87	115
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	87	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	103	87	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	101	88	114
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	104	88	110
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	90	114
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	104	87	113
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	107	89	113
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	103	86	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	104	82	116
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	81	125
EG020T: Total Metals by ICP-MS (QCLot: 2105259)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	102	86	110
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	124	68	128
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	101	87	115
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.9	87	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	87	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	88	114
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	102	88	110
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	99.2	90	114
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	100	87	113
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	105	89	113
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	108	86	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	101	82	116

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2105259) - continued								
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	112	81	125
EG020T: Total Metals by ICP-MS (QCLot: 2107796)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	110	86	110
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	105	68	128
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	110	87	115
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	103	87	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	87	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	107	88	114
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	108	88	110
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	107	90	114
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	108	87	113
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	109	89	113
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	103	86	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	110	82	116
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	108	81	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115265)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	89.2	69	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115266)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	85.6	69	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115267)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	80.5	69	125
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115294)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	113	76	122
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115297)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	114	76	122
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115299)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	110	76	122
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105293)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	100	84	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105294)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.1	84	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105295)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.7	84	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115293)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	95.0	73	127
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115296)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	104	73	127

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115298)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	73	127
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109542)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	104	63	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109544)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	106	63	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2110810)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.1	63	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109543)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	99.5	73	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109545)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	89.7	73	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2110811)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	98.0	73	117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2105258)							
EM1114567-001	A1S	EG020A-T: Arsenic	7440-38-2	1 mg/L	110	72	146
		EG020A-T: Beryllium	7440-41-7	1 mg/L	85.8	61	139
		EG020A-T: Barium	7440-39-3	1 mg/L	98.8	78	126
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	83.3	73	131
		EG020A-T: Chromium	7440-47-3	1 mg/L	85.1	65	131
		EG020A-T: Cobalt	7440-48-4	1 mg/L	101	68	132
		EG020A-T: Copper	7440-50-8	1 mg/L	84.6	71	125
		EG020A-T: Lead	7439-92-1	1 mg/L	95.5	68	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	88.8	63	129
		EG020A-T: Nickel	7440-02-0	1 mg/L	89.5	72	128
		EG020A-T: Vanadium	7440-62-2	1 mg/L	95.6	66	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	79.4	67	129
EG020T: Total Metals by ICP-MS (QCLot: 2105259)							
EM1114567-021	CcS	EG020A-T: Arsenic	7440-38-2	1 mg/L	104	72	146
		EG020A-T: Beryllium	7440-41-7	1 mg/L	94.9	61	139
		EG020A-T: Barium	7440-39-3	1 mg/L	109	78	126
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	93.9	73	131
		EG020A-T: Chromium	7440-47-3	1 mg/L	105	65	131
		EG020A-T: Cobalt	7440-48-4	1 mg/L	111	68	132
		EG020A-T: Copper	7440-50-8	1 mg/L	93.9	71	125
		EG020A-T: Lead	7439-92-1	1 mg/L	105	68	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	99.6	63	129
		EG020A-T: Nickel	7440-02-0	1 mg/L	101	72	128
		EG020A-T: Vanadium	7440-62-2	1 mg/L	110	66	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	88.4	67	129
EG020T: Total Metals by ICP-MS (QCLot: 2107796)							
EM1114567-041	C3B	EG020A-T: Arsenic	7440-38-2	1 mg/L	117	72	146
		EG020A-T: Beryllium	7440-41-7	1 mg/L	94.9	61	139
		EG020A-T: Barium	7440-39-3	1 mg/L	120	78	126
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	104	73	131
		EG020A-T: Chromium	7440-47-3	1 mg/L	112	65	131
		EG020A-T: Cobalt	7440-48-4	1 mg/L	125	68	132
		EG020A-T: Copper	7440-50-8	1 mg/L	101	71	125
		EG020A-T: Lead	7439-92-1	1 mg/L	112	68	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	108	63	129

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
				Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2107796) - continued							
EM1114567-041	C3B	EG020A-T: Nickel	7440-02-0	1 mg/L	110	72	128
		EG020A-T: Vanadium	7440-62-2	1 mg/L	118	66	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	99.9	67	129
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115265)							
EM1114567-002	B1S	EG035T: Mercury	7439-97-6	0.0100 mg/L	84.8	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115266)							
EM1114567-022	DdS	EG035T: Mercury	7439-97-6	0.0100 mg/L	84.9	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115267)							
EM1114567-042	D3B	EG035T: Mercury	7439-97-6	0.0100 mg/L	82.0	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115294)							
EM1114567-002	B1S	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	94.4	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115297)							
EM1114567-022	DdS	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	98.3	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115299)							
EM1114567-042	D3B	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	90.3	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105293)							
EM1114567-002	B1S	EK057G: Nitrite as N	----	0.5 mg/L	118	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105294)							
EM1114567-022	DdS	EK057G: Nitrite as N	----	0.5 mg/L	118	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105295)							
EM1114567-042	D3B	EK057G: Nitrite as N	----	0.5 mg/L	115	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115293)							
EM1114567-002	B1S	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	119	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115296)							
EM1114567-022	DdS	EK059G: Nitrite + Nitrate as N	----	0.6 mg/L	110	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115298)							
EM1114567-042	D3B	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	117	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109542)							
EM1114567-002	B1S	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	107	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109544)							
EM1114567-022	DdS	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	76.7	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2110810)							
EM1114567-042	D3B	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	102	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109543)							
EM1114567-002	B1S	EK067G: Total Phosphorus as P	----	5 mg/L	79.7	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	Matrix Spike (MS) Report: Spike Recovery (%) MS	Matrix Spike (MS) Report: Recovery Limits (%) Low	Matrix Spike (MS) Report: Recovery Limits (%) High
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109545)							
EM1114567-022	DdS	EK067G: Total Phosphorus as P	----	5 mg/L	88.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2110811)							
EM1114567-042	D3B	EK067G: Total Phosphorus as P	----	5 mg/L	95.2	70	130

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EM1114567**	Page	: 1 of 14
Amendment	: **1**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@skm.com.au	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 28-FEB-2012
Site	: ----		
		No. of samples received	: 60
Quote number	: ADBQ/037/11	No. of samples analysed	: 60

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Eric Chau	Metals Team Leader	Melbourne Inorganics
Herman Lin	Laboratory Coordinator	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **27/2/12 - This report has been amended and re-released to allow the reporting of additional analytical data.**
- **EA025: Total Suspended Solids has been conducted outside of holding times due to laboratory constraints. Results should be scrutinised accordingly.**
- **It is recognised that Total Kjeldahl Nitrogen is less than Ammonia for sample EM1114567. However, the difference is within experimental variation of the methods.**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: A1S Client sampling date / time: 19-DEC-2011 15:00 EM1114567-001	B1S 19-DEC-2011 15:00 EM1114567-002	C1S 19-DEC-2011 15:00 EM1114567-003	D1S 19-DEC-2011 15:00 EM1114567-004	A2S 19-DEC-2011 15:00 EM1114567-005
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**50**	**85**	**69**	**31**	**52**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	**0.0001**	**0.0001**	<0.0001	**0.0001**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.008**	**0.020**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	**0.003**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.022**	<0.005	<0.005	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.11**	**0.10**	**0.09**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.3**	**0.3**	**0.4**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.2**	**0.3**	**0.3**	**0.4**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	**0.03**	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: B2S	C2S	D2S	A3S	B3S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-006	EM1114567-007	EM1114567-008	EM1114567-009	EM1114567-010
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**26**	**30**	**44**	**60**	**60**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.007**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	**0.003**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.005**	**0.006**	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.11**	**0.10**	**0.10**	**0.11**	**0.12**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	**0.01**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	**0.01**	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**0.3**	**0.2**	**0.2**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.4**	**0.3**	**0.2**	**0.2**	**0.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: C3S	D3S	A4S	B4S	C4S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-011	EM1114567-012	EM1114567-013	EM1114567-014	EM1114567-015
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**28**	**42**	----	**50**	**40**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.007**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	**0.0006**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.014**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.007**	<0.005	<0.005	<0.005	**0.028**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.12**	**0.09**	**0.10**	**0.10**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.01**	<0.01	**0.01**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	<0.01	**0.01**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.6**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.6**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.05**	**0.03**	**0.03**	**0.04**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D4S	X4S	Y4S	AaS	BbS
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-016	EM1114567-017	EM1114567-018	EM1114567-019	EM1114567-020
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**51**	**36**	**45**	**47**	**63**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.011**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.131**	<0.005	**0.010**	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.09**	**0.08**	**0.10**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.01**	**0.04**	**0.02**	**0.02**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: CcS	DdS	A5S	B5S	C5S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-021	EM1114567-022	EM1114567-023	EM1114567-024	EM1114567-025
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**47**	**62**	**60**	**47**	**48**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.002**	**0.004**	**0.003**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.11**	**0.09**	**0.11**	**0.08**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.04**	**0.05**	**0.09**	**0.03**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D5S	A6S	B6S	C6S	D6S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-026	EM1114567-027	EM1114567-028	EM1114567-029	EM1114567-030
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**67**	----	----	----	----
Suspended Solids (SS)	----	5	mg/L	----	**223**	**114**	**128**	**154**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.006**	**0.006**	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.10**	**0.11**	**0.11**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.1**	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.1**	**0.3**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.02**	**0.02**	<0.01	**0.05**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: A1B	B1B	C1B	D1B	A2B
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-031	EM1114567-032	EM1114567-033	EM1114567-034	EM1114567-035
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**177**	**216**	**143**	**147**	**146**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.013**	**0.009**	<0.005	<0.005	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.12**	**0.11**	**0.09**	**0.12**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.01**	**0.02**	<0.01	**0.04**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: B2B	C2B	D2B	A3B	B3B
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-036	EM1114567-037	EM1114567-038	EM1114567-039	EM1114567-040
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	129	183	99	129	161
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.006	0.006	0.006
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0001	<0.0001	<0.0001	0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.011	0.010	0.010
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.002	0.003	0.003	0.004	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	0.006	<0.005	0.006	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.13	0.10	0.09	0.12	0.09
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	0.2	0.1	0.1	0.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	0.2	0.1	0.1	0.2
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.02	0.01	0.06	0.02	0.04

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: C3B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-041	D3B 19-DEC-2011 15:00 EM1114567-042	A4B 19-DEC-2011 15:00 EM1114567-043	B4B 19-DEC-2011 15:00 EM1114567-044	C4B 19-DEC-2011 15:00 EM1114567-045
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**114**	**188**	----	**158**	**94**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.005**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.009**	**0.009**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.004**	**0.004**	**0.005**	**0.005**	**0.005**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.007**	**0.008**	**0.007**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.08**	<0.05	**0.06**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.12**	**0.13**	**0.12**	**0.10**	**0.09**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D4B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-046	Client sample ID: X4B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-047	Client sample ID: Y4B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-048	Client sample ID: AaB Client sampling date / time: 19-DEC-2011 15:00 EM1114567-049	Client sample ID: BbB Client sampling date / time: 19-DEC-2011 15:00 EM1114567-050
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**163**	**141**	**128**	**116**	**137**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.005**	**0.007**	**0.006**	**0.005**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	<0.0001	<0.0001	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.011**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.005**	**0.005**	**0.004**	**0.004**	**0.005**
Lead	7439-92-1	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.010**	**0.006**	**0.008**	**0.007**	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	**0.06**	**0.06**	**0.10**	**0.06**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.08**	**0.16**	**0.11**	**0.12**	**0.11**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.04**	<0.01	<0.01	**0.01**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	<0.01	<0.01	**0.01**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.02**	<0.01	**0.03**	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: CcB	DdB	A5B	B5B	C5B
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-051	EM1114567-052	EM1114567-053	EM1114567-054	EM1114567-055
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**166**	**104**	**174**	**187**	**155**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.007**	**0.005**	**0.005**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0001**	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.011**	**0.010**	**0.011**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.005**	**0.005**	**0.005**	**0.005**	**0.004**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	<0.005	**0.011**	**0.006**	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	**0.09**	**0.17**	**0.14**	**0.12**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.13**	**0.08**	**0.12**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**0.1**	<0.1	**0.2**	**1.0**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	**0.1**	<0.1	**0.2**	**1.0**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.14**	**0.02**	**0.05**	**0.05**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D5B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-056	A6B 19-DEC-2011 15:00 EM1114567-057	B6B 19-DEC-2011 15:00 EM1114567-058	C6B 19-DEC-2011 15:00 EM1114567-059	D6B 19-DEC-2011 15:00 EM1114567-060
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**99**	**111**	**156**	**19**	**43**
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.007**	**0.005**	**0.006**	**0.005**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0001**	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.012**	**0.011**	**0.010**	**0.012**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.006**	**0.005**	**0.005**	**0.005**	**0.006**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Vanadium	7440-62-2	0.01	mg/L	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.025**	**0.008**	**0.009**	**0.014**
Iron	7439-89-6	0.05	mg/L	**0.10**	**0.16**	**0.17**	**0.16**	**0.14**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.09**	**0.08**	**0.08**	**0.11**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	**0.1**	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	**0.1**	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.02**	**0.04**	**0.04**	**0.02**

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Appendix C Geochemistry of Metal Scavenging: Technical Note

To	Iron Road Ltd.	Date	26 June 2014
From	Land Quality and Sediment Chemistry, Jacobs	Project No	VE23730
Subject	**Controls On Trace Metal and Metalloid Geochemistry**		

Introduction

There are a number of process which control the geochemistry of metals and metalloids at the seawater/sediment interface. These controls are related to redox and, as a consequence the changes from anoxic to oxic geochemical environment. The relatively straight forward geochemistry can be complicated by the trace metal interaction with inorganic and organic ligands arising under anoxic conditions. Common inorganic complexes forming in anoxic pore waters include phosphate, carbonate, bicarbonate, bisulphite, sulphur and chloride. In addition marine organism can accumulate metals and metalloids (Langston, 1984) with the bioaccumulation within species of alga (Luoma *et al*., 1982) and marine invertebrates such as polycheates (Waring and Maher, 2005). While anaerobic microorganisms may play an important part in actively scavenging trace metals from the water column and surrounding sediments in anoxic sediments (Gaillard and Webb, 1998). Vanadium (V) has also been identified as an important element in the blood chemistry of sea squirts of the ascidian family (Michibata and Sakurai, 1990) and numerous studies have shown these marine filter feeders concentrate vanadium in their bodies to a level one million times higher than the concentration of vanadium in seawater. Finally organic ligands such as those which form colloidal complexes can increase solubility by a factor of ten beyond the theoretical inorganic solubility (Kersten, 1998). All of these interactions can either together or on their own create conditions for a trace metal "sink" which actively draws metals and metalloids, such as arsenic (As) and V into the sediment.

The data from the Jacobs survey at Cape Hardy suggest that the south to north transects appear to show evidence of a more increased redox in the south with the most anoxic sediment in the northern reaches (Jacobs, 2014). The concentrations of V, chromium (Cr) and, in particular iron (Fe) and As, increase in the sediment as they become more anoxic.

To understand the elevated concentrations of metals identified in sediments across the study area it is important to understand that the chemical or valence state of these elements drives their accumulation. Across the study area the highest concentration of As and Fe are noted to occur in the sediment with the lowest redox potential. Conversely, Zn concentrations are noted to decrease in the sediment with decreasing redox. These accumulation behaviours would appear counter intuitive to the anticipated elemental geochemistry, which would dictate that all these three elements should display similar positive ion speciation's. The behaviour of these metals and metalloids and the controls of their valence state and physical state within the water column and surficial sediments are discussed below.

Arsenic

Arsenic (As) concentrations were identified in elevated concentrations in sediments from several samples in the north eastern extent of the study area. As is a metalloid which can display a high mobility in anoxic sediment-water systems. The valence state of As is important as arsenite (As^{3+}) is more toxic for biological species and more mobile than arsenate (As^{5+}). The arsenate-arsenite interconversion in response to redox (Eh) reduction across oxic-anoxic interfaces can change the speciation from valence As^{3+} to As^{5+}. Kersten (1988) described the following reaction:

$HAsO_4^{2-} + 2H^+ + 2e^- = HAsO_3^{2-} + H_2O$

Arsenate Arsenite

At pH 7.3 (which is typical of anoxic sediments) and no significant complexation by As oxyanions, the ration can be expressed as a function of redox:

$$\text{Log}\left(\frac{As^{3+}}{As^{5+}}\right) = \left(\frac{-Eh(mV)}{29.6}\right) - 6.46$$

Whilst an assessment of the redox conditions of the sediments was not undertaken during sampling, a strong sulphurous odour was reported. Typically the onset of sulfate reduction occurs from redox -0.1V and can still be occurring at 0.5V. So assuming a redox 0.1V and a mid point redox of 0.25V, will impact the ratio and the more toxic form of As (i.e. As^{3+}) will dominate in decreasing redox. Studies have shown that under these conditions As will precipitate in the presence of sulfide and adsorption on Fe (Peterson and Carpenter, 1986).

Arsenic may substitute for sulfide in pyrite (FeS_2) and thus the presence of As in reduced (i.e. anoxic) sediments is likely to be represented by arseno-pyrite (Appelo and Postma, 2005). The oxidation of pyrite and subsequent release of arsenic can be one of the major causes of arsenic in groundwater or sediment pore water (Smedley and Kinniburgh, 2002). A separate process associated with accumulation of As in sediments is the sorption of arsenic to iron oxide particles during deposition (Ravenscroft *et al*., 2001). These theorems when considered with the high concentrations of Fe recorded from sediment samples collected in the northeastern corner of the study area, may help to explain the elevated measurements of As in the same samples.

Anaerobic sediments elevated in As that become aerobic through re-suspending sediment will impact the arsenic speciation and has the potential to increase arsenic levels in the overlying water column. However due to the high concentrations of Fe in the sediment within the study area the arsenic would be readily reabsorbed back into the sediment.

Vanadium and Chromium

The increased concentration of V and Cr in anoxic sediment, as identified across the study area is consistent with the geochemistry and thermodynamics of these trace elements. Calvert and Peterson (1986) have shown that a change in valency means V and Cr compounds are precipitated under anoxic conditions. Hence, the enrichment of trace elements indicates that the host sediments accumulated the metals under anoxic conditions. This is supported by the Eh-pH diagrams for V and Cr presented below in Figure 1. . With increased redox V favours a solid species and tends to precipitate, and with a change of redox such as that associated with resuspension of sediment in the water column, V is more likely to be present as a dissolved species. The same relationship is evident the Eh-pH diagram for chromium examined in Figure 2:

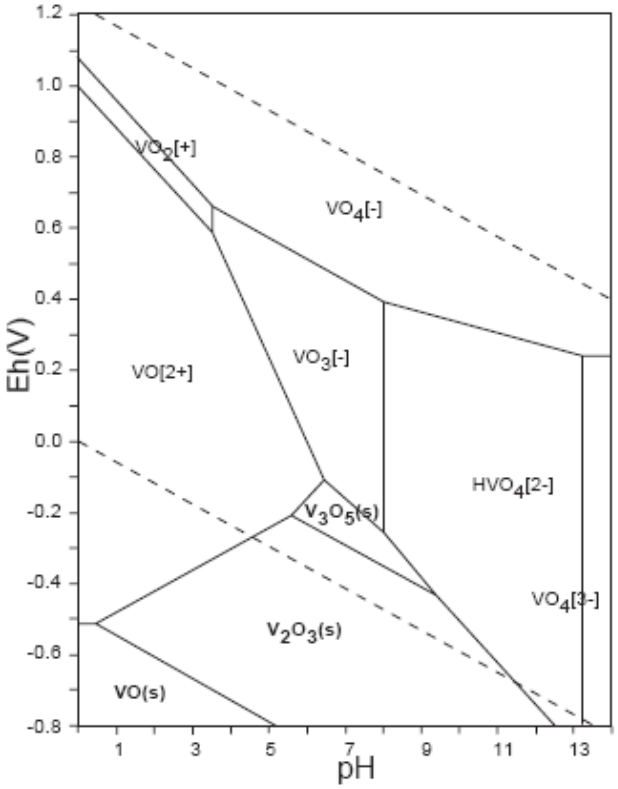

Figure 1 Vanadium redox state at varying pH (Takeno (2005)

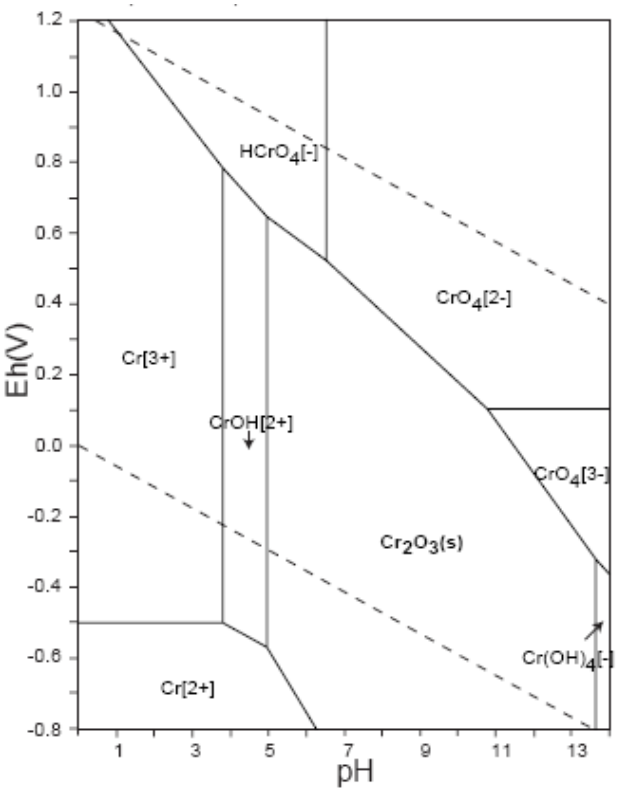

Figure 2 Chromium redox state at varying pH (Takeno, 2005)

Zinc

In accordance with the above noted elemental geochemistry it would be expected that with increased redox that Zn would also be present as an insoluble sulphide precipitate in the sediment. It is noted however that Zn concentrations were observed to decrease with decreasing sediment redox across the study area.

A possible explanation for this observation is that colloidal chemistry is rendering Zn more 'soluble' resulting in it being present in the abundant organic matter (algal) or detritus. For this to be a viable consideration the Zn would need to be present in a Zn-acetate complex and acetate would need to be approximately four orders of magnitude more abundant than bisulfide (Gammons and Frandsen, 2001). Notwithstanding, it is considered likely that Zn is bound as sulfide phase in the sediments and will therefore maintain its bioavailability because of the continued cycling between pore waters and surface sediments due to physical mixing and bioturbation (Atkinson *et al.,* 2007).

Conclusions

As noted during the video tow survey of the study area the regions of anoxic sediment showed signs of seasquirts (known to accumulate V) and bioturbation indicating the presence of polychaete worms, several species of which are known to bioaccumulate As (Waring and Maher, 2005). Therefore it is considered possible the elevated levels of As and V identified in the sediments across the northern region of the study area are a result of the naturally prevailing chemical properties of the sediment (high iron levels and low redox) acting together with bioaccumulation by invertebrates. While low concentrations of Zn reported in the sediment are potentially the result of these same bioturbation and biological processes. Aerobic conditions would be created by the localised resuspension of sediment creating allowing the release of Zn (As and V) back into the water column while seasquirt and polychaetes then scavenge back the As and V into the sediment. This type of selective scavenging could account for the differences in trace metal concentrations across the study area.

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Appendix D Water Quality Laboratory Results

CHAIN OF CUSTODY FORM

ALS

SKM

From : SKM Pty Ltd
ABN: 37 001 024 095
Level 5, 33 King William St, Adelaide, SA 5000
ph: (08) 8424 3800 fax: (08) 8424 3810

LAB USE ONLY
QUOTE NUMBER

Project No: ~~VE23610.207~~ VE23610.609

Job Code:
Due Date:
Custody seal intact?
Sample cold?
Received for Laboratory by:
Date:
Time:

Project Manager: Dr. Greg Barbara
Sampler(s): Greg Barbara
Checked:
Date: 23/11/2011

Lab Id	Date	Matrix	Sample Identification	Comments	Container Identification: Size / Type / Preserv / Analytes	500ml Green Label none Suspended Solids EA025	250 ml purple Nutrients NT-8	60 ml red none Total Metals EG020F (Metals As, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Pb, V, Zn, Hg)		
						Tick required analytes				
1	19/12/2011	Water	A1S	Surface sample		✓	✓	✓		
2	19/12/2011	Water	B1S	Surface sample		✓	✓	✓		
3	19/12/2011	Water	C1S	Surface sample		✓	✓	✓		
4	19/12/2011	Water	D1S	Surface sample		✓	✓	✓		
5	19/12/2011	Water	A2S	Surface sample		✓	✓	✓		
6	19/12/2011	Water	B2S	Surface sample		✓	✓	✓		
7	19/12/2011	Water	C2S	Surface sample		✓	✓	✓		
8	19/12/2011	Water	D2S	Surface sample		✓	✓	✓		
9	19/12/2011	Water	A3S	Surface sample		✓	✓	✓		
10	19/12/2011	Water	B3S	Surface sample		✓	✓	✓		
11	19/12/2011	Water	C3S	Surface sample		✓	✓	✓		
12	19/12/2011	Water	D3S	Surface sample		✓	✓	✓		
13	19/12/2011	Water	A4	Surface sample		✓	✓	✓	P	
14	19/12/2011	Water	B4	Surface sample		✓	✓	✓		
15	19/12/2011	Water	C4	Surface sample		✓	✓	✓		
16	19/12/2011	Water	D4	Surface sample		✓	✓	✓		
17	19/12/2011	Water	X4	Surface sample		✓	✓	✓		
18	19/12/2011	Water	Y4	Surface sample		✓	✓	✓		
19	19/12/2011	Water	Aa	Surface sample		✓	✓	✓		
20	19/12/2011	Water	Bb	Surface sample		✓	✓	✓		
21	19/12/2011	Water	Cc	Surface sample		✓	✓	✓		
22	19/12/2011	Water	Dd	Surface sample		✓	✓	✓		
23	19/12/2011	Water	A5	Surface sample		✓	✓	✓		
24	19/12/2011	Water	B5	Surface sample		✓	✓	✓		
25	19/12/2011	Water	C5	Surface sample		✓	✓	✓		
26	19/12/2011	Water	D5	Surface sample		✓	✓	✓		
27	19/12/2011	Water	A6	Surface sample		✓	✓	✓		
28	19/12/2011	Water	B6	Surface sample		✓	✓	✓		
29	19/12/2011	Water	C6	Surface sample		✓	✓	✓		
30	19/12/2011	Water	D6	Surface sample		✓	✓	✓		
31	19/12/2011	Water	A1B	Bottom Sample		✓	✓	✓		
32	19/12/2011	Water	B1B	Bottom Sample		✓	✓	✓		
33	19/12/2011	Water	C1B	Bottom Sample		✓	✓	✓		
34	19/12/2011	Water	D1B	Bottom Sample		✓	✓	✓		
35	19/12/2011	Water	A2B	Bottom Sample		✓	✓	✓		
36	19/12/2011	Water	B2B	Bottom Sample		✓	✓	✓		
37	19/12/2011	Water	C2B	Bottom Sample		✓	✓	✓		
38	19/12/2011	Water	D2B	Bottom Sample		✓	✓	✓		
39	19/12/2011	Water	A3B	Bottom Sample		✓	✓	✓		
40	19/12/2011	Water	B3B	Bottom Sample		✓	✓	✓		
41	19/12/2011	Water	C3B	Bottom Sample		✓	✓	✓		
42	19/12/2011	Water	D3B	Bottom Sample		✓	✓	✓		
43	19/12/2011	Water	A4	Bottom Sample		✓	✓	✓	P	
44	19/12/2011	Water	B4	Bottom Sample		✓	✓	✓		
45	19/12/2011	Water	C4	Bottom Sample		✓	✓	✓		
46	19/12/2011	Water	D4	Bottom Sample		✓	✓	✓		
47	19/12/2011	Water	X4	Bottom Sample		✓	✓	✓		
48	19/12/2011	Water	Y4	Bottom Sample		✓	✓	✓		
49	19/12/2011	Water	Aa	Bottom Sample		✓	✓	✓		
50	19/12/2011	Water	Bb	Bottom Sample		✓	✓	✓		
51	19/12/2011	Water	Cc	Bottom Sample		✓	✓	✓		
52	19/12/2011	Water	Dd	Bottom Sample		✓	✓	✓		
53	19/12/2011	Water	A5	Bottom Sample		✓	✓	✓		
54	19/12/2011	Water	B5	Bottom Sample		✓	✓	✓		
55	19/12/2011	Water	C5	Bottom Sample		✓	✓	✓		
56	19/12/2011	Water	D5	Bottom Sample		✓	✓	✓		
57	19/12/2011	Water	A6	Bottom Sample		✓	✓	✓		
58	19/12/2011	Water	B6	Bottom Sample		✓	✓	✓		
59	19/12/2011	Water	C6	Bottom Sample		✓	✓	✓		
60	19/12/2011	Water	D6	Bottom Sample		✓	✓	✓		
				TOTAL		60	60	60		

A4S & A4B Green bottles have less than 50 ml. Spoke to Greg and need to do Nitrate only please.

Notes:

Samples have not been filtered/sieved - collected from seabed using a Petite Ponar and transferred into sample containers using a stainless steel sampling spoon.

Email results to gbarbara@globalskm.com for queries with samples call Greg Barbara on 0459826420

Sheet

COC-RevA

Environmental Division
Melbourne
Work Order
EM1114567

Telephone : +61-3-8549 9600

Alex Haines

From: Barbara, Greg (SKM) [GBarbara@globalskm.com]
Sent: Thursday, 22 December 2011 3:15 PM
To: Alex Haines
Subject: RE: VE23610.609 (EM1114567)

Please report as per the sample bottle eg. A6B etc.

Thank you
Greg

Please consider the environment before printing this e-mail

Dr Greg Barbara
Marine Scientist - SKM (VESA)
BSc (Marine Biology) (Hon) PhD (Marine Biology)

SINCLAIR KNIGHT MERZ (SKM)
L5, 33 King William St, Adelaide SA 5000
P: +61 8 8424 6508 |**F**: +61 8 8424 3810 |**M**: 0459 826420 |**E**: GBarbara@globalskm.com

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For further information, visit our website www.globalskm.com

From: Alex Haines [mailto:Alex.Haines@alsglobal.com]
Sent: Thursday, 22 December 2011 2:43 PM
To: Barbara, Greg (SKM)
Cc: Carol Walsh
Subject: VE23610.609 (EM1114567)

Hi Greg

I am logging this work order for you and have a question concerning the IDs on some of the samples. All surface water samples are written with an S following the code on the samples themselves but the COC is missing this S for numerous samples eg A4 on the CoC is written as A4S on the sample, this is also true for bottom water samples. Which IDs would you like us to report, the ones on the samples or the ones on the CoC?
Thank you

Regards,

Alex Haines
WORK ORDER CREATION/LOGIN OFFICER

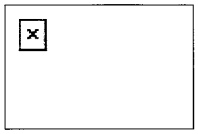
ALS | Environmental (General Environmental Group)

Address

4 Westall Road
Springvale VIC 3171

PHONE +61 3 8549 9600
FAX +61 3 8549 9601

Winner of the inaugural CARE Award 2011 – Sustainable Technology & Innovation:
Reduction in Sample Volumes – Improving quality, safety, efficiency and sustainability in environmental practices



www.alsglobal.com

P Please consider the environment before printing this email.

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EM1114567**		
Amendment	: 2		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@globalskm.com	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	Page	: 1 of 5
Order number	: ----		
C-O-C number	: ----	Quote number	: EA2011SINKNI0361 (ADBQ/037/11)
Site	: ----		
Sampler	: GB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 22-DEC-2011	Issue Date	: 30-MAR-2012
Client Requested Due Date	: 28-FEB-2012	Scheduled Reporting Date	: **28-FEB-2012**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 16-22 - Ice bricks present
No. of coolers/boxes	: 3	No. of samples received	: 60
Security Seal	: Intact.	No. of samples analysed	: 60

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **Please direct any queries related to sample condition / numbering / breakages to Peter Ravlic.**
- **Analytical work for this work order will be conducted at ALS Melbourne.**
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - NT-08 Total Nitrogen + NO2 + NO3 + NH3 + Total P	WATER - W-03T 13 Metals (Total) (NEPM)
EM1114567-001	19-DEC-2011 15:00	A1S	✓	✓
EM1114567-002	19-DEC-2011 15:00	B1S	✓	✓
EM1114567-003	19-DEC-2011 15:00	C1S	✓	✓
EM1114567-004	19-DEC-2011 15:00	D1S	✓	✓
EM1114567-005	19-DEC-2011 15:00	A2S	✓	✓
EM1114567-006	19-DEC-2011 15:00	B2S	✓	✓
EM1114567-007	19-DEC-2011 15:00	C2S	✓	✓
EM1114567-008	19-DEC-2011 15:00	D2S	✓	✓
EM1114567-009	19-DEC-2011 15:00	A3S	✓	✓
EM1114567-010	19-DEC-2011 15:00	B3S	✓	✓
EM1114567-011	19-DEC-2011 15:00	C3S	✓	✓
EM1114567-012	19-DEC-2011 15:00	D3S	✓	✓
EM1114567-013	19-DEC-2011 15:00	A4S	✓	✓
EM1114567-014	19-DEC-2011 15:00	B4S	✓	✓
EM1114567-015	19-DEC-2011 15:00	C4S	✓	✓
EM1114567-016	19-DEC-2011 15:00	D4S	✓	✓
EM1114567-017	19-DEC-2011 15:00	X4S	✓	✓
EM1114567-018	19-DEC-2011 15:00	Y4S	✓	✓
EM1114567-019	19-DEC-2011 15:00	AaS	✓	✓
EM1114567-020	19-DEC-2011 15:00	BbS	✓	✓
EM1114567-021	19-DEC-2011 15:00	CcS	✓	✓
EM1114567-022	19-DEC-2011 15:00	DdS	✓	✓
EM1114567-023	19-DEC-2011 15:00	A5S	✓	✓
EM1114567-024	19-DEC-2011 15:00	B5S	✓	✓
EM1114567-025	19-DEC-2011 15:00	C5S	✓	✓
EM1114567-026	19-DEC-2011 15:00	D5S	✓	✓
EM1114567-027	19-DEC-2011 15:00	A6S	✓	✓
EM1114567-028	19-DEC-2011 15:00	B6S	✓	✓
EM1114567-029	19-DEC-2011 15:00	C6S	✓	✓
EM1114567-030	19-DEC-2011 15:00	D6S	✓	✓
EM1114567-031	19-DEC-2011 15:00	A1B	✓	✓
EM1114567-032	19-DEC-2011 15:00	B1B	✓	✓
EM1114567-033	19-DEC-2011 15:00	C1B	✓	✓
EM1114567-034	19-DEC-2011 15:00	D1B	✓	✓
EM1114567-035	19-DEC-2011 15:00	A2B	✓	✓

			WATER - NT-08 Total Nitrogen + NO2 + NO3 + NH3 + Total P	WATER - W-03T 13 Metals (Total) (NEPM)
EM1114567-036	19-DEC-2011 15:00	B2B	✓	✓
EM1114567-037	19-DEC-2011 15:00	C2B	✓	✓
EM1114567-038	19-DEC-2011 15:00	D2B	✓	✓
EM1114567-039	19-DEC-2011 15:00	A3B	✓	✓
EM1114567-040	19-DEC-2011 15:00	B3B	✓	✓
EM1114567-041	19-DEC-2011 15:00	C3B	✓	✓
EM1114567-042	19-DEC-2011 15:00	D3B	✓	✓
EM1114567-043	19-DEC-2011 15:00	A4B	✓	✓
EM1114567-044	19-DEC-2011 15:00	B4B	✓	✓
EM1114567-045	19-DEC-2011 15:00	C4B	✓	✓
EM1114567-046	19-DEC-2011 15:00	D4B	✓	✓
EM1114567-047	19-DEC-2011 15:00	X4B	✓	✓
EM1114567-048	19-DEC-2011 15:00	Y4B	✓	✓
EM1114567-049	19-DEC-2011 15:00	AaB	✓	✓
EM1114567-050	19-DEC-2011 15:00	BbB	✓	✓
EM1114567-051	19-DEC-2011 15:00	CcB	✓	✓
EM1114567-052	19-DEC-2011 15:00	DdB	✓	✓
EM1114567-053	19-DEC-2011 15:00	A5B	✓	✓
EM1114567-054	19-DEC-2011 15:00	B5B	✓	✓
EM1114567-055	19-DEC-2011 15:00	C5B	✓	✓
EM1114567-056	19-DEC-2011 15:00	D5B	✓	✓
EM1114567-057	19-DEC-2011 15:00	A6B	✓	✓
EM1114567-058	19-DEC-2011 15:00	B6B	✓	✓
EM1114567-059	19-DEC-2011 15:00	C6B	✓	✓
EM1114567-060	19-DEC-2011 15:00	D6B	✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method		Due for extraction	Due for analysis	Samples Received		Instructions Received	
Client Sample ID(s)	Container			Date	Evaluation	Date	Evaluation
EK057G: Nitrite as N by Discrete Analyser							
A1B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A1S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A2B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A2S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A3B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A3S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A4B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A4S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A5B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A5S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A6B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
A6S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
AaB	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
AaS	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B1B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B1S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B2B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B2S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B3B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B3S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B4B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B4S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B5B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B5S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B6B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
B6S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
BbB	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
BbS	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C1B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C1S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C2B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C2S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C3B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C3S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C4B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C4S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C5B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C5S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C6B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
C6S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
CcB	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
CcS	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D1B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D1S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D2B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D2S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D3B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D3S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D4B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D4S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D5B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D5S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D6B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
D6S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
DdB	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
DdS	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----
X4B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	×	----	----

X4S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	✘	----	----
Y4B	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	✘	----	----
Y4S	Clear Plastic Bottle - Natural	21-DEC-2011	----	22-DEC-2011	✘	----	----

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	CLM-Adelaide@skm.com.au

ALL REPORTS

- *AU Certificate of Analysis - NATA	Email	CLM-Adelaide@globalskm.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep)	Email	CLM-Adelaide@globalskm.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA	Email	CLM-Adelaide@globalskm.com.au
- A4 - AU Sample Receipt Notification - Environmental HT	Email	CLM-Adelaide@globalskm.com.au
- A4 - AU Tax Invoice	Email	CLM-Adelaide@globalskm.com.au
- Chain of Custody (CoC)	Email	CLM-Adelaide@globalskm.com.au
- EDI Format - ENMRG	Email	CLM-Adelaide@globalskm.com.au
- EDI Format - ESDAT	Email	CLM-Adelaide@globalskm.com.au
- EDI Format - XTab	Email	CLM-Adelaide@globalskm.com.au

DR GREG BARBARA

- *AU Certificate of Analysis - NATA	Email	gbarbara@globalskm.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep)	Email	gbarbara@globalskm.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA	Email	gbarbara@globalskm.com
- A4 - AU Sample Receipt Notification - Environmental HT	Email	gbarbara@globalskm.com
- A4 - AU Tax Invoice	Email	gbarbara@globalskm.com
- Chain of Custody (CoC)	Email	gbarbara@globalskm.com
- EDI Format - ENMRG	Email	gbarbara@globalskm.com
- EDI Format - ESDAT	Email	gbarbara@globalskm.com
- EDI Format - XTab	Email	gbarbara@globalskm.com

GREG BARBARA

- *AU Certificate of Analysis - NATA (COA)	Email	gbarbara@skm.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	gbarbara@skm.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	gbarbara@skm.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	gbarbara@skm.com.au
- A4 - AU Tax Invoice (INV)	Email	gbarbara@skm.com.au
- Chain of Custody (CoC) (COC)	Email	gbarbara@skm.com.au
- EDI Format - ENMRG (ENMRG)	Email	gbarbara@skm.com.au
- EDI Format - ESDAT (ESDAT)	Email	gbarbara@skm.com.au
- EDI Format - XTab (XTAB)	Email	gbarbara@skm.com.au

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EM1114567**	Page	: 1 of 12
Amendment	: **2**		
Client	: SINCLAIR KNIGHT MERZ	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@globalskm.com	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
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Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 30-MAR-2012
Order number	: ----		
		No. of samples received	: 60
Quote number	: ADBQ/037/11	No. of samples analysed	: 60

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Unfiltered; Lab-acidified							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, A4S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B	**19-DEC-2011**	**23-DEC-2011**	16-JUN-2012	✓	**30-DEC-2011**	16-JUN-2012	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified							
C3B, D3B, A4B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	**28-DEC-2011**	16-JUN-2012	✓	**30-DEC-2011**	16-JUN-2012	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified								
A1S,	B1S,	**19-DEC-2011**	**----**	----	----	**05-JAN-2012**	16-JAN-2012	✓
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid								
A1S,	B1S,	**19-DEC-2011**	**---**	16-JAN-2012	----	**06-JAN-2012**	16-JAN-2012	✓
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural								
A1S,	B1S,	**19-DEC-2011**	**---**	21-DEC-2011	----	**22-DEC-2011**	21-DEC-2011	×
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid								
A1S,	B1S,	**19-DEC-2011**	**---**	16-JAN-2012	----	**05-JAN-2012**	16-JAN-2012	✓
C1S,	D1S,							
A2S,	B2S,							
C2S,	D2S,							
A3S,	B3S,							
C3S,	D3S,							
A4S,	B4S,							
C4S,	D4S,							
X4S,	Y4S,							
AaS,	BbS,							
CcS,	DdS,							
A5S,	B5S,							
C5S,	D5S,							
A6S,	B6S,							
C6S,	D6S,							
A1B,	B1B,							
C1B,	D1B,							
A2B,	B2B,							
C2B,	D2B,							
A3B,	B3B,							
C3B,	D3B,							
A4B,	B4B,							
C4B,	D4B,							
X4B,	Y4B,							
AaB,	BbB,							
CcB,	DdB,							
A5B,	B5B,							
C5B,	D5B,							
A6B,	B6B,							
C6B,	D6B							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid							
C3B, D3B, A4B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	**03-JAN-2012**	16-JAN-2012	✓	**03-JAN-2012**	16-JAN-2012	✓
Clear Plastic Bottle - Sulfuric Acid							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, A4S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B	**19-DEC-2011**	**30-DEC-2011**	16-JAN-2012	✓	**30-DEC-2011**	16-JAN-2012	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid							
C3B, D3B, A4B, B4B, C4B, D4B, X4B, Y4B, AaB, BbB, CcB, DdB, A5B, B5B, C5B, D5B, A6B, B6B, C6B, D6B	**19-DEC-2011**	**03-JAN-2012**	16-JAN-2012	✓	**03-JAN-2012**	16-JAN-2012	✓
Clear Plastic Bottle - Sulfuric Acid							
A1S, B1S, C1S, D1S, A2S, B2S, C2S, D2S, A3S, B3S, C3S, D3S, A4S, B4S, C4S, D4S, X4S, Y4S, AaS, BbS, CcS, DdS, A5S, B5S, C5S, D5S, A6S, B6S, C6S, D6S, A1B, B1B, C1B, D1B, A2B, B2B, C2B, D2B, A3B, B3B	**19-DEC-2011**	**30-DEC-2011**	16-JAN-2012	✓	**30-DEC-2011**	16-JAN-2012	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	2	11	**18.2**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	6	60	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	1	11	**9.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	1	11	**9.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	3	60	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Mercury by FIMS	EG035T	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	3	60	**5.0**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids (High Level)	EA025H	WATER	APHA 21st ed., 2540D A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Ammonia as N by Discrete analyser	EK055G	WATER	APHA 21st ed., 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite as N by Discrete Analyser	EK057G	WATER	APHA 21st ed., 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrate as N by Discrete Analyser	EK058G	WATER	APHA 21st ed., 4500-NO3- F. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	APHA 21st ed., 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Cadmium Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	APHA 21st ed., 4500-Norg D. 25mL water samples are digested using a traditional Kjeldahl digestion followed by determination by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	APHA 21st ed., 4500-Norg / 4500-NO3-. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	APHA 21st ed., 4500-P B&F This procedure involves sulphuric acid digestion of a 100mL sample to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 21st ed., 4500 Norg - D; APHA 21st ed., 4500 P - H. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	**Days overdue**	Date analysed	Due for analysis	**Days overdue**
EK057G: Nitrite as N by Discrete Analyser						

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser - Analysis Holding Time Compliance						
Clear Plastic Bottle - Natural						
A1S, B1S,	----	----	----	22-DEC-2011	21-DEC-2011	**1**
C1S, D1S,						
A2S, B2S,						
C2S, D2S,						
A3S, B3S,						
C3S, D3S,						
A4S, B4S,						
C4S, D4S,						
X4S, Y4S,						
AaS, BbS,						
CcS, DdS,						
A5S, B5S,						
C5S, D5S,						
A6S, B6S,						
C6S, D6S,						
A1B, B1B,						
C1B, D1B,						
A2B, B2B,						
C2B, D2B,						
A3B, B3B,						
C3B, D3B,						
A4B, B4B,						
C4B, D4B,						
X4B, Y4B,						
AaB, BbB,						
CcB, DdB,						
A5B, B5B,						
C5B, D5B,						
A6B, B6B,						
C6B, D6B						

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EM1114567**	Page	: 1 of 12
Amendment	: **2**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
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Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 30-MAR-2012
Order number	: ----		
		No. of samples received	: 60
Quote number	: ADBQ/037/11	No. of samples analysed	: 60

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Eric Chau	Metals Team Leader	Melbourne Inorganics
Herman Lin	Laboratory Coordinator	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2105258)									
EM1114567-001	A1S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.008	0.009	21.7	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.006	0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EM1114567-010	B3S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.009	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.003	0.001	64.5	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2105259)									
EM1114567-021	CcS	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 2105259) - continued									
EM1114567-021	CcS	EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EM1114567-030	D6S	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.006	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2107796)									
EM1114566-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.013	0.014	11.3	0% - 50%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.058	0.061	5.0	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.017	0.017	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.015	0.016	7.4	0% - 50%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.082	0.087	5.1	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.016	0.017	0.0	0% - 50%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.163	0.187	13.7	0% - 20%
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	0.06	0.06	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	1.67	1.71	2.4	0% - 20%
EM1114567-050	BbB	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.005	0.006	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.010	0.010	0.0	0% - 50%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 2107796) - continued									
EM1114567-050	BbB	EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.006	0.009	32.8	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.06	0.10	42.2	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115265)									
EM1114567-001	A1S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EM1114567-010	B3S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0007	151	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115266)									
EM1114567-021	CcS	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EM1114567-030	D6S	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2115267)									
EM1114567-041	C3B	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EM1114567-050	BbB	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2115294)									
EM1114567-001	A1S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.10	0.10	0.0	0% - 50%
EM1114567-010	B3S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.12	0.11	10.1	0% - 50%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2115297)									
EM1114567-021	CcS	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.11	0.10	0.0	0% - 50%
EM1114567-030	D6S	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.10	0.09	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2115299)									
EM1114567-041	C3B	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.12	0.15	16.8	0% - 50%
EM1114567-050	BbB	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.11	0.13	16.8	0% - 50%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2105293)									
EM1114567-001	A1S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-010	B3S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2105294)									
EM1114567-021	CcS	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-030	D6S	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2105295)									
EM1114567-041	C3B	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-050	BbB	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115293)									
EM1114567-001	A1S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-010	B3S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115296)									
EM1114567-021	CcS	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115296) - continued									
EM1114567-030	D6S	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2115298)									
EM1114567-041	C3B	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-050	BbB	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2109542)									
EM1114567-001	A1S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.3	0.0	No Limit
EM1114567-010	B3S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.2	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2109544)									
EM1114567-021	CcS	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.1	0.0	No Limit
EM1114567-030	D6S	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.2	52.8	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2110810)									
EM1114567-041	C3B	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	0.2	0.0	No Limit
EM1114567-050	BbB	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2109543)									
EM1114567-001	A1S	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-010	B3S	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.01	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2109545)									
EM1114567-021	CcS	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM1114567-030	D6S	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.05	0.04	29.9	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2110811)									
EM1114567-041	C3B	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.01	0.0	No Limit
EM1114567-050	BbB	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2105258)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	106	86	110
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	104	68	128
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	104	87	115
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	87	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	103	87	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	101	88	114
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	104	88	110
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	90	114
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	104	87	113
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	107	89	113
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	103	86	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	104	82	116
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	81	125
EG020T: Total Metals by ICP-MS (QCLot: 2105259)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	102	86	110
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	124	68	128
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	101	87	115
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.9	87	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	87	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	88	114
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	102	88	110
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	99.2	90	114
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	100	87	113
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	105	89	113
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	108	86	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	101	82	116
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	112	81	125
EG020T: Total Metals by ICP-MS (QCLot: 2107796)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	110	86	110
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	105	68	128
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	110	87	115
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	103	87	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	87	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	107	88	114

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2107796) - continued								
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	108	88	110
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	107	90	114
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	108	87	113
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	109	89	113
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	103	86	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	110	82	116
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	108	81	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115265)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	89.2	69	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115266)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	85.6	69	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115267)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	80.5	69	125
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115294)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	113	76	122
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115297)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	114	76	122
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115299)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	110	76	122
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105293)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	100	84	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105294)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.1	84	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105295)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.7	84	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115293)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	95.0	73	127
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115296)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	104	73	127
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115298)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	73	127
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109542)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	104	63	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109544)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	106	63	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2110810)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2110810) - continued								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.1	63	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109543)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	99.5	73	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109545)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	89.7	73	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2110811)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	98.0	73	117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2105258)							
EM1114567-001	A1S	EG020A-T: Arsenic	7440-38-2	1 mg/L	110	72	146
		EG020A-T: Beryllium	7440-41-7	1 mg/L	85.8	61	139
		EG020A-T: Barium	7440-39-3	1 mg/L	98.8	78	126
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	83.3	73	131
		EG020A-T: Chromium	7440-47-3	1 mg/L	85.1	65	131
		EG020A-T: Cobalt	7440-48-4	1 mg/L	101	68	132
		EG020A-T: Copper	7440-50-8	1 mg/L	84.6	71	125
		EG020A-T: Lead	7439-92-1	1 mg/L	95.5	68	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	88.8	63	129
		EG020A-T: Nickel	7440-02-0	1 mg/L	89.5	72	128
		EG020A-T: Vanadium	7440-62-2	1 mg/L	95.6	66	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	79.4	67	129
EG020T: Total Metals by ICP-MS (QCLot: 2105259)							
EM1114567-021	CcS	EG020A-T: Arsenic	7440-38-2	1 mg/L	104	72	146
		EG020A-T: Beryllium	7440-41-7	1 mg/L	94.9	61	139
		EG020A-T: Barium	7440-39-3	1 mg/L	109	78	126
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	93.9	73	131
		EG020A-T: Chromium	7440-47-3	1 mg/L	105	65	131
		EG020A-T: Cobalt	7440-48-4	1 mg/L	111	68	132
		EG020A-T: Copper	7440-50-8	1 mg/L	93.9	71	125
		EG020A-T: Lead	7439-92-1	1 mg/L	105	68	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	99.6	63	129
		EG020A-T: Nickel	7440-02-0	1 mg/L	101	72	128
		EG020A-T: Vanadium	7440-62-2	1 mg/L	110	66	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	88.4	67	129
EG020T: Total Metals by ICP-MS (QCLot: 2107796)							
EM1114567-041	C3B	EG020A-T: Arsenic	7440-38-2	1 mg/L	117	72	146
		EG020A-T: Beryllium	7440-41-7	1 mg/L	94.9	61	139
		EG020A-T: Barium	7440-39-3	1 mg/L	120	78	126
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	104	73	131
		EG020A-T: Chromium	7440-47-3	1 mg/L	112	65	131
		EG020A-T: Cobalt	7440-48-4	1 mg/L	125	68	132
		EG020A-T: Copper	7440-50-8	1 mg/L	101	71	125
		EG020A-T: Lead	7439-92-1	1 mg/L	112	68	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	108	63	129

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2107796) - continued							
EM1114567-041	C3B	EG020A-T: Nickel	7440-02-0	1 mg/L	110	72	128
		EG020A-T: Vanadium	7440-62-2	1 mg/L	118	66	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	99.9	67	129
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115265)							
EM1114567-002	B1S	EG035T: Mercury	7439-97-6	0.0100 mg/L	84.8	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115266)							
EM1114567-022	DdS	EG035T: Mercury	7439-97-6	0.0100 mg/L	84.9	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2115267)							
EM1114567-042	D3B	EG035T: Mercury	7439-97-6	0.0100 mg/L	82.0	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115294)							
EM1114567-002	B1S	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	94.4	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115297)							
EM1114567-022	DdS	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	98.3	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2115299)							
EM1114567-042	D3B	EK055G: Ammonia as N	7664-41-7	0.5 mg/L	90.3	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105293)							
EM1114567-002	B1S	EK057G: Nitrite as N	----	0.5 mg/L	118	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105294)							
EM1114567-022	DdS	EK057G: Nitrite as N	----	0.5 mg/L	118	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2105295)							
EM1114567-042	D3B	EK057G: Nitrite as N	----	0.5 mg/L	115	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115293)							
EM1114567-002	B1S	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	119	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115296)							
EM1114567-022	DdS	EK059G: Nitrite + Nitrate as N	----	0.6 mg/L	110	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2115298)							
EM1114567-042	D3B	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	117	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109542)							
EM1114567-002	B1S	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	107	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2109544)							
EM1114567-022	DdS	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	76.7	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2110810)							
EM1114567-042	D3B	EK061G: Total Kjeldahl Nitrogen as N	----	25 mg/L	102	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109543)							
EM1114567-002	B1S	EK067G: Total Phosphorus as P	----	5 mg/L	79.7	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
				Concentration	MS	Low	High
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2109545)							
EM1114567-022	DdS	EK067G: Total Phosphorus as P	----	5 mg/L	88.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2110811)							
EM1114567-042	D3B	EK067G: Total Phosphorus as P	----	5 mg/L	95.2	70	130

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EM1114567**	Page	: 1 of 14
Amendment	: **2**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Melbourne
Contact	: DR GREG BARBARA	Contact	: Carol Walsh
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: gbarbara@globalskm.com	E-mail	: carol.walsh@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61-3-8549 9608
Facsimile	: +61 08 8424 3810	Facsimile	: +61-3-8549 9601
Project	: VE23610 609	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 22-DEC-2011
Sampler	: GB	Issue Date	: 30-MAR-2012
Site	: ----		
		No. of samples received	: 60
Quote number	: ADBQ/037/11	No. of samples analysed	: 60

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Eric Chau	Metals Team Leader	Melbourne Inorganics
Herman Lin	Laboratory Coordinator	Melbourne Inorganics
Varsha Ho Wing	Non-Metals Team Leader	Melbourne Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **27/2/12 - This report has been amended and re-released to allow the reporting of additional analytical data.**
- **30/3/12 - This report has been amended following the request to issue the report without Suspended Solids results.**
- **EA025: Total Suspended Solids has been conducted outside of holding times due to laboratory constraints. Results should be scrutinised accordingly.**
- **It is recognised that Total Kjeldahl Nitrogen is less than Ammonia for sample EM1114567. However, the difference is within experimental variation of the methods.**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: A1S Client sampling date / time: 19-DEC-2011 15:00 EM1114567-001	B1S 19-DEC-2011 15:00 EM1114567-002	C1S 19-DEC-2011 15:00 EM1114567-003	D1S 19-DEC-2011 15:00 EM1114567-004	A2S 19-DEC-2011 15:00 EM1114567-005
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	**0.0001**	**0.0001**	<0.0001	**0.0001**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.008**	**0.020**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	**0.003**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.022**	<0.005	<0.005	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.11**	**0.10**	**0.09**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.3**	**0.3**	**0.4**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.2**	**0.3**	**0.3**	**0.4**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	**0.03**	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: B2S	C2S	D2S	A3S	B3S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-006	EM1114567-007	EM1114567-008	EM1114567-009	EM1114567-010
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.007**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	**0.003**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.005**	**0.006**	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.11**	**0.10**	**0.10**	**0.11**	**0.12**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	**0.01**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	**0.01**	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**0.3**	**0.2**	**0.2**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.4**	**0.3**	**0.2**	**0.2**	**0.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: C3S	D3S	A4S	B4S	C4S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-011	EM1114567-012	EM1114567-013	EM1114567-014	EM1114567-015
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.007**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	**0.0006**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.014**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.007**	<0.005	<0.005	<0.005	**0.028**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.12**	**0.09**	**0.10**	**0.10**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.01**	<0.01	**0.01**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	<0.01	**0.01**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.6**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.6**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.05**	**0.03**	**0.03**	**0.04**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D4S Client sampling date / time: 19-DEC-2011 15:00 EM1114567-016	X4S 19-DEC-2011 15:00 EM1114567-017	Y4S 19-DEC-2011 15:00 EM1114567-018	AaS 19-DEC-2011 15:00 EM1114567-019	BbS 19-DEC-2011 15:00 EM1114567-020
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.011**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.131**	<0.005	**0.010**	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.09**	**0.08**	**0.10**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.01**	**0.04**	**0.02**	**0.02**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: CcS	DdS	A5S	B5S	C5S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-021	EM1114567-022	EM1114567-023	EM1114567-024	EM1114567-025
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.002**	**0.004**	**0.003**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.11**	**0.09**	**0.11**	**0.08**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.04**	**0.05**	**0.09**	**0.03**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D5S	A6S	B6S	C6S	D6S
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-026	EM1114567-027	EM1114567-028	EM1114567-029	EM1114567-030
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.006**	**0.006**	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.10**	**0.11**	**0.11**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.1**	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.1**	**0.3**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.02**	**0.02**	<0.01	**0.05**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: A1B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-031	B1B 19-DEC-2011 15:00 EM1114567-032	C1B 19-DEC-2011 15:00 EM1114567-033	D1B 19-DEC-2011 15:00 EM1114567-034	A2B 19-DEC-2011 15:00 EM1114567-035
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.002**	**0.002**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.013**	**0.009**	<0.005	<0.005	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.12**	**0.11**	**0.09**	**0.12**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.01**	**0.02**	<0.01	**0.04**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: B2B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-036	C2B 19-DEC-2011 15:00 EM1114567-037	D2B 19-DEC-2011 15:00 EM1114567-038	A3B 19-DEC-2011 15:00 EM1114567-039	B3B 19-DEC-2011 15:00 EM1114567-040
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	<0.0001	<0.0001	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.010**	**0.011**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.003**	**0.003**	**0.004**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	<0.005	**0.006**	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.13**	**0.10**	**0.09**	**0.12**	**0.09**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**0.2**	**0.1**	**0.1**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	**0.2**	**0.1**	**0.1**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.01**	**0.06**	**0.02**	**0.04**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: C3B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-041	D3B 19-DEC-2011 15:00 EM1114567-042	A4B 19-DEC-2011 15:00 EM1114567-043	B4B 19-DEC-2011 15:00 EM1114567-044	C4B 19-DEC-2011 15:00 EM1114567-045
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.005**	**0.006**	**0.006**	**0.006**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.009**	**0.009**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.004**	**0.004**	**0.005**	**0.005**	**0.005**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.007**	**0.008**	**0.007**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.08**	<0.05	**0.06**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.12**	**0.13**	**0.12**	**0.10**	**0.09**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D4B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-046	X4B 19-DEC-2011 15:00 EM1114567-047	Y4B 19-DEC-2011 15:00 EM1114567-048	AaB 19-DEC-2011 15:00 EM1114567-049	BbB 19-DEC-2011 15:00 EM1114567-050
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.005**	**0.007**	**0.006**	**0.005**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	<0.0001	<0.0001	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.011**	**0.010**	**0.010**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.005**	**0.005**	**0.004**	**0.004**	**0.005**
Lead	7439-92-1	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.010**	**0.006**	**0.008**	**0.007**	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	**0.06**	**0.06**	**0.10**	**0.06**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.08**	**0.16**	**0.11**	**0.12**	**0.11**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.04**	<0.01	<0.01	**0.01**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	<0.01	<0.01	**0.01**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	<0.1	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.02**	<0.01	**0.03**	<0.01

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: CcB	DdB	A5B	B5B	C5B
				Client sampling date / time: 19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00	19-DEC-2011 15:00
				EM1114567-051	EM1114567-052	EM1114567-053	EM1114567-054	EM1114567-055
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.006**	**0.007**	**0.005**	**0.005**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0001**	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.011**	**0.010**	**0.011**	**0.010**
Manganese	7439-96-5	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.005**	**0.005**	**0.005**	**0.005**	**0.004**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	<0.005	**0.011**	**0.006**	**0.006**
Iron	7439-89-6	0.05	mg/L	<0.05	**0.09**	**0.17**	**0.14**	**0.12**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	**0.13**	**0.08**	**0.12**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**0.1**	<0.1	**0.2**	**1.0**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	**0.1**	<0.1	**0.2**	**1.0**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.14**	**0.02**	**0.05**	**0.05**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: D5B Client sampling date / time: 19-DEC-2011 15:00 EM1114567-056	A6B 19-DEC-2011 15:00 EM1114567-057	B6B 19-DEC-2011 15:00 EM1114567-058	C6B 19-DEC-2011 15:00 EM1114567-059	D6B 19-DEC-2011 15:00 EM1114567-060
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.007**	**0.005**	**0.006**	**0.005**	**0.006**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0001**	**0.0001**	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.010**	**0.012**	**0.011**	**0.010**	**0.012**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.006**	**0.005**	**0.005**	**0.005**	**0.006**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Vanadium	7440-62-2	0.01	mg/L	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.025**	**0.008**	**0.009**	**0.014**
Iron	7439-89-6	0.05	mg/L	**0.10**	**0.16**	**0.17**	**0.16**	**0.14**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.09**	**0.08**	**0.08**	**0.11**	**0.10**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	**0.1**	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	**0.1**	**0.1**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.02**	**0.04**	**0.04**	**0.02**

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Appendix E Infauna Sampling Results

benthic australia Pty Ltd

Client	SKM - Adelaide
Contact	Greg Barbara
Location	Unknown
Collection Date	19/12/2011
Taonomist	Shona Hocknull
Id Date	05/02/2012

Phylum	Class/order	Family	Species	A1	A4	A5	A6	B1	B1	B4	B5	B6	C1	C4	C5	C6	D5	D6	DI
Annelida	Polychaeta	Nephtyidae		1		1		1											
Annelida	Polychaeta	Opheliidae	*Armandia* sp.1									1							
Annelida	Polychaeta	Syllidae			1		1												
Annelida	Polychaeta	Terebellidae																	1
Arthropoda/ Crustacea	Amphipoda	Cheirocratidae			1	1	1					3							
Arthropoda/ Crustacea	Amphipoda	Damaged				1													
Arthropoda/ Crustacea	Amphipoda	Eusiridae					2												
Arthropoda/ Crustacea	Amphipoda	Lysianassidae										1							
Arthropoda/ Crustacea	Amphipoda	Stegocephalidae						1											1
Arthropoda/ Crustacea	Anaspidacea				3														
Arthropoda/ Crustacea	Asellota						2												
Arthropoda/ Crustacea	Isopoda					1	3												
Arthropoda/ Crustacea	Leptostraca											2							
Arthropoda/ Crustacea	Tanaidacea	Kalliapseudidae			1														
Cnideria	Actiniaria													1					
Echinodermata	Asteroidea	Asteroidea										1							
Echinodermata	Echinoidea	Echinoidea													1				
Mollusca	Bivalvia	Chamidae		1													1		
Mollusca	Bivalvia	Limidae		1															
Mollusca	Bivalvia	Littorinidae					2												
Mollusca	Bivalvia	Nuculanidae	*Nuculana* sp.1						2		1								1
Mollusca	Bivalvia	Tellinidae	*Tellina* sp.1					2					1		1				
Mollusca	Bivalvia	Thyasiridae	*Tauraxinus* sp.1				1	1											
Mollusca	Bivalvia	Veneridae					1												
Mollusca	Gastropoda	Patellidae					1					1							
Mollusca	Gastropoda	Turbinidae	*Astralium* sp.1									1							
Mollusca	Gastropoda	Volutidae						1											
Nemertea	Nemertea	Nemertea										1							

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Appendix F EPBC Search Result

Australian Government

Department of the Environment

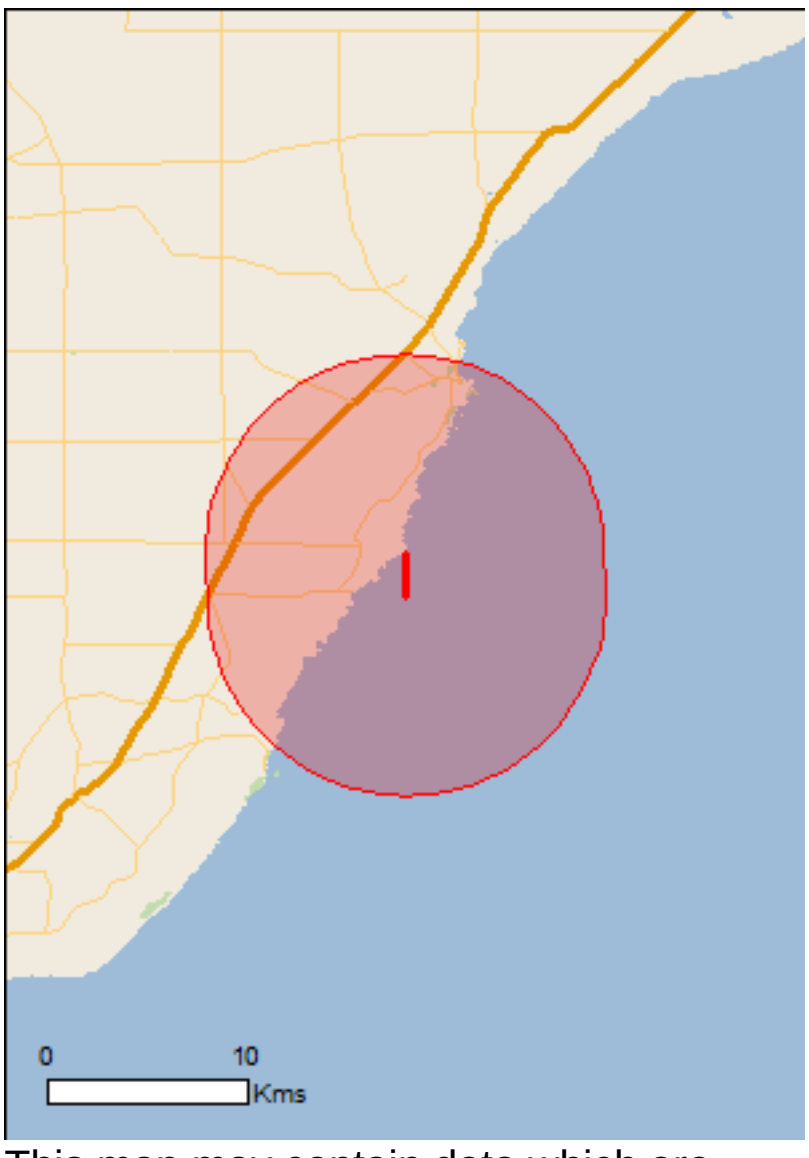
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

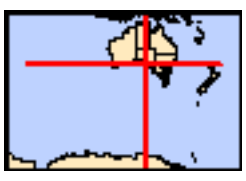
Report created: 13/11/13 18:26:01



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	34
Listed Migratory Species:	33

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	62
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	1
State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	17
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Acanthiza iredalei iredalei		
Slender-billed Thornbill (western) [25967]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora epomophora		
Southern Royal Albatross [25996]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora sanfordi		
Northern Royal Albatross [82331]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans antipodensis		
Antipodean Albatross [82269]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans exulans		
Tristan Albatross [82337]	Endangered	Species or species habitat may occur within area
Diomedea exulans (sensu lato)		
Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea		
Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Macronectes giganteus		
Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Psophodes nigrogularis leucogaster Western Whipbird (eastern) [64448]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris impavida Campbell Albatross [82449]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion [22]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Sminthopsis psammophila Sandhill Dunnart [291]	Endangered	Species or species habitat likely to occur within area
Plants		
Acacia enterocarpa Jumping-jack Wattle [17615]	Endangered	Species or species habitat likely to occur within area
Acacia pinguifolia Fat-leaved Wattle [5319]	Endangered	Species or species habitat may occur within area
Caladenia tensa Greencomb Spider-orchid, Rigid Spider-orchid [24390]	Endangered	Species or species habitat likely to occur within area
Frankenia plicata [4225]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
[Prostanthera calycina](#)		
West Coast Mintbush, Limestone Mintbush, Red Mintbush [9470]	Vulnerable	Species or species habitat likely to occur within area
[Ptilotus beckerianus](#)		
Ironstone Mulla Mulla [3787]	Vulnerable	Species or species habitat may occur within area
[Pultenaea trichophylla](#)		
Tufted Bush-pea [12715]	Endangered	Species or species habitat may occur within area
Reptiles		
[Caretta caretta](#)		
Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
[Chelonia mydas](#)		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Dermochelys coriacea](#)		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Sharks		
[Carcharodon carcharias](#)		
Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#)		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Diomedea antipodensis](#)		
Antipodean Albatross [64458]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
[Diomedea dabbenena](#)		
Tristan Albatross [66471]	Endangered*	Species or species habitat may occur within area
[Diomedea epomophora (sensu stricto)](#)		
Southern Royal Albatross [1072]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
[Diomedea exulans (sensu lato)](#)		
Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Diomedea sanfordi](#)		
Northern Royal Albatross [64456]	Endangered*	Foraging, feeding or related behaviour likely to occur within area
[Macronectes giganteus](#)		
Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
[Macronectes halli](#)		
Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
[Puffinus carneipes](#)		
Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
[Thalassarche cauta (sensu stricto)](#)		
Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross [64459]	Vulnerable*	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat likely to occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat likely to occur within area
Catharacta skua		
Great Skua [59472]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena		
Tristan Albatross [66471]	Endangered*	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto)		
Southern Royal Albatross [1072]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato)		
Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered*	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross [64459]	Vulnerable*	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour likely to occur within area
[Thinornis rubricollis rubricollis](#) Hooded Plover (eastern) [66726]		Species or species habitat known to occur within area
Fish		
[Acentronura australe](#) Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
[Campichthys tryoni](#) Tryon's Pipefish [66193]		Species or species habitat may occur within area
[Filicampus tigris](#) Tiger Pipefish [66217]		Species or species habitat may occur within area
[Heraldia nocturna](#) Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
[Hippocampus breviceps](#) Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
[Histiogamphelus cristatus](#) Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
[Hypselognathus rostratus](#) Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
[Kaupus costatus](#) Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
[Leptoichthys fistularius](#) Brushtail Pipefish [66248]		Species or species habitat may occur within area
[Lissocampus caudalis](#) Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
[Lissocampus runa](#) Javelin Pipefish [66251]		Species or species habitat may occur within area
[Maroubra perserrata](#) Sawtooth Pipefish [66252]		Species or species habitat may occur within area
[Notiocampus ruber](#) Red Pipefish [66265]		Species or species habitat may occur within area
[Phycodurus eques](#) Leafy Seadragon [66267]		Species or species habitat may occur within area
[Phyllopteryx taeniolatus](#) Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
[Pugnaso curtirostris](#) Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
[Solegnathus robustus](#) Robust Pipehorse, Robust Spiny Pipehorse		Species or species

Name	Threatened	Type of Presence
[66274]		habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Vanacampus vercoi Verco's Pipefish [66286]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion [22]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Lipson Island Conservation Park	SA	Registered

State and Territory Reserves [Resource Information]

Name	State
Lipson Island	SA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Alauda arvensis Skylark [656]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Coordinates

-34.18179 136.323,-34.19738 136.32383

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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