Ashburton Salt Project, EPA Referral Supporting Document

K plus S Salt Australia Pty Ltd

K04 – J04

7 October 2016

DISCLAIMER, CONFIDENTIALITY AND COPYRIGHT STATEMENT

REPORT DETAILS

Project Number:
Report Name:Ashburton Salt Project, EPA Referral Supporting Document

AUTHORISATION FOR ISSUE

Report Version Date: **7 October 2016**			
Approved for Issue Director	Name: Laura Todd	Signature: 	Date: 7/10/2016

Please Note: This document is considered uncontrolled once printed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

K+S proposal for a new solar salt project in WA

K+S is an international resources company with headquarters in Germany. It has a long history of mining and processing mineral raw materials, and is the world's largest salt producer and one of its top potash providers. K+S is considering a project in Australia to participate in supplying the growth in salt demand in Asia, and is specifically evaluating the possibility of developing and operating a new Solar Salt Project on the Western Australian (WA) coast near the town of Onslow, called the Ashburton Salt Project (the Project).

Project description

It is proposed to construct and operate a 3.5 million tonnes per annum (Mtpa) Solar Salt Project approximately 40 km southwest of the township of Onslow within the Shire of Ashburton, in the East Pilbara region of WA (Figure 1). The proposal includes the following:

- seawater intake pumps/channel/pipeline/s;
- seawater concentration ponds and salt crystallisation ponds;
- internal site roads;
- electricity generation and reticulation;
- fuel storage sites;
- a jetty and product loading facilities;
- a salt wash plant and associated ponds;
- salt stockpiles and conveyors;
- onsite buildings such as offices, storage, workshops and possibly accommodation;
- sewage treatment facilities and landfill;
- water supply bore/s;
- an airstrip;
- equipment parking and laydown areas;
- bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser;
- drainage diversion/s;
- an access road;
- a haul road for construction materials;
- service corridor/s;
- quarry and borrow pit areas for rock, clay and other construction materials; and
- potentially dredging and dredge spoil disposal.

Historical project

Straits Resources planned an earlier, much larger project, called the Yannarie project, for the area. The Yannarie project extended some 50 km southwest of the Ashburton Salt Project, and covered a much broader footprint. In 2009, Straits announced it would not proceed with the project after the EPA recommended it not be approved and the Minister for Environment subsequently directed the EPA to re-assess the proposal.

The Ashburton Salt Project is not the same as the Yannarie project. Ashburton Salt has a much smaller footprint, a smaller production capacity (3.5 Mtpa compared with 10 Mtpa) and is located much further north resulting in a significantly smaller interface with the Exmouth Gulf. K+S believes that significant differences in the project scope, size and location, as well as the adoption of new and recognised best practice management techniques, will ensure the Ashburton Salt Project can overcome concerns previously raised regarding the Yannarie project.

Development Envelope

A Development Envelope has been proposed within which the following components of the Project would be located:

- seawater intake pumps/channel/pipeline/s;
- seawater concentration ponds and salt crystallisation ponds;
- internal site roads;
- electricity generation and reticulation;
- fuel storage sites;
- a jetty and product loading facilities;
- a salt wash plant and associated ponds;
- salt stockpiles and conveyors;
- onsite buildings such as offices, storage, workshops and possibly accommodation;
- sewage treatment facilities and landfill;
- potentially water supply bore/s;
- potentially an airstrip;
- equipment parking and laydown areas;
- bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser; and
- drainage diversion/s.

The Development Envelope will be further refined and reduced during the assessment process as the locations of relevant project components and infrastructure are determined.

Ancillary infrastructure and activities

Additional ancillary infrastructure and activities are proposed outside the Development Envelope including:

- an access road;
- a haul road for construction materials;
- service corridor/s;
- quarry and borrow pit areas for rock, clay and other construction materials;
- potentially water supply bores/s
- potentially an airstrip and accommodation facilities; and
- potentially dredging and dredge spoil disposal.

Indicative locations for the access road/s and haul road are provided in Figure 1. It is not possible to provide indicative locations for the other items listed above at this stage as a range of studies are needed to determine suitable locations and minimise environmental impacts.

Bitterns (wastewater)

The wastewater produced from the solar salt process (bitterns) is essentially seawater with the majority of sodium chloride removed and remaining naturally-occurring ocean salts concentrated. No chemicals are added to the salt production process and as a result, all substances within bitterns are naturally-occurring.

It is proposed to discharge bitterns from the operation into the marine environment via a combination of infrastructure which may include a channel, dilution pond, pipeline and diffuser, which will be designed and managed to ensure effective dilution of the bitterns and minimise changes in background water quality surrounding the discharge point. The location and design of the discharge infrastructure will be determined as part of the Environmental Impact Assessment (EIA) process.

Drainage diversion/s

In order to manage hydrological impacts upstream of the proposed salt ponds, one or more drainage diversions may be required. Any drainage diversions would occur on the eastern side of the salt ponds, within the Development Envelope. This is the reason additional space has been allowed to the east of the ponds within the Development Envelope.

Access road, haul road and service corridors

Preliminary routes for the access road and haul road (for construction materials) have been provided within the referral. However, these road alignments may change during the EIA process as a result of environmental and detailed engineering studies. Service corridors required (for power, water, etc.) will also be determined during the EIA process.

Dredging

K+S is seeking to avoid or minimise dredging, most likely via the use of low draft transhipment vessels that do not require a deep shipping channel. The location and footprint of any proposed dredging and dredge spoil disposal has not yet been determined. This will be determined as part of the EIA process.

Quarry and borrow pit areas

Quarry and borrow pit areas will be required to source construction materials, such as rock and clay. The location and footprint of such areas has not yet been determined. This will be determined as part of the EIA process.

Project key characteristics

The Project's key characteristics are summarised in Table E1 below.

Table E1: Ashburton Salt Project key characteristics

Summary of the proposal		
Proposal title	Ashburton Salt Project	
Proponent name	K plus S Salt Australia Pty Ltd	
Short description	It is proposed to construct and operate a solar salt project approximately 40 km southwest of Onslow, WA. The proposal includes the construction of solar salt evaporation and crystallisation ponds and associated infrastructure/activities *(seawater intake pumps/channel/pipeline/s; seawater concentration ponds and salt crystallisation ponds; internal site roads; electricity generation and reticulation; fuel storage sites; a jetty and product loading facilities; a salt wash plant and associated ponds; salt stockpiles and conveyors; onsite buildings such as offices, storage, workshops and possibly accommodation; sewage treatment facilities and landfill; water supply bore/s; an airstrip; equipment parking and laydown areas; bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser; drainage diversion/s; an access road; a haul road for construction materials; service corridor/s; quarry and borrow pit areas for rock, clay and other construction materials; and potentially dredging and dredge spoil disposal).*	
Physical elements – within Development Envelope		
Element	**Indicative location**	**Proposed extent authorised**
Evaporation and crystallization ponds	Figure 2 (indicative layout may change)	Clearing of no more than 15,000 ha within a 67,570 ha Development Envelope
Infrastructure within Development Envelope	Figure 2 (indicative layout may change)	Clearing of no more than 2,000 ha within a 67,570 ha Development Envelope *(includes: seawater intake pumps/channel/pipeline/s; seawater concentration ponds and salt crystallisation ponds; internal site roads; electricity generation and reticulation; fuel storage sites; a jetty and product loading facilities; a salt wash plant and associated ponds; salt stockpiles and conveyors; onsite buildings such as offices, storage, workshops and possibly accommodation; sewage treatment facilities and landfill; water supply bore/s; an airstrip; equipment parking and laydown areas; bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser; and drainage diversion/s)*
Physical elements –outside Development Envelope		
Element	**Indicative location**	**Proposed extent authorised**
Access road, haul road and service corridors	Figure 1 (indicative road routes may change, service corridors to be determined through the EIA process)	To be determined through the EIA process
Quarry and Borrow Pit Areas	Locations to be determined through the EIA process	To be determined through the EIA process
Potential dredging and dredge spoil disposal	Locations to be determined through the EIA process	To be determined through the EIA process
Potential airstrip, accommodation and water supply bore/s	Locations to be determined through the EIA process	To be determined through the EIA process
Operational elements		
Element	**Indicative location**	**Proposed extent authorised**
Salt production wastewater (bitterns)	Marine discharge point designed to achieve effective dilution (to be determined through the EIA process)	Marine discharge of no more than 10 GL per annum

Preliminary environmental and integrating factors

The following preliminary environmental and integrating factors have been identified for the Project:

- Benthic communities and habitat;
- Coastal processes;
- Marine environmental quality;
- Marine fauna;
- Flora and vegetation;
- Terrestrial fauna;
- Hydrological processes;
- Inland waters environmental quality;
- Heritage;
- Rehabilitation and decommissioning; and
- Offsets.

For each of these preliminary factors the following information has been summarised in Table E2 below:

- **EPA objective** – the relevant EPA objective outlined in Environmental Assessment Guideline for Environmental Principles, Factors and Objectives (EPA, 2015).
- **Guidance** – the established policies, guidelines and standards that apply to this factor in relation to the proposal.
- **Consultation** – the need for consultation and the outcomes of any consultation in relation to any potential environmental impacts.
- **Baseline information** - the relevant characteristics of the receiving environment including regional context, known environmental values, current quality, sensitivity to impact and current level of cumulative impacts.
- **Impact assessment** – the potential impact/s that may occur to the environmental factor as a result of implementing the proposal.
- **Mitigation measures** – measures proposed to mitigate the potential environmental impacts;
- **Residual impacts** – remaining impacts expected after mitigation measures are implemented.
- **EPA objective outcome and assumptions** – a conclusion regarding whether, in the proponent's view, it will be possible to meet the relevant EPA objective, as well as any assumptions critical to the conclusion reached.

Table E2: Factors and objectives table

Factor	EPA objective and guidelines	Baseline info. available	Impact assessment	Mitigation measures	Residual impacts	Outcome
Benthic communities and habitat	To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales. Guidelines: EAG3(EPA, 2009); EAG7(EPA, 2011); GS1 (EPA, 2001); and GS 55 (EPA, 2003) (for all factors).	Detailed local historical mangrove and algal mat mapping – requires validation. High level regional coral and seagrass bed mapping – requires validation.	Currently estimated proportional loss (direct disturbance) of mangrove and algal mat communities is 0.4 and 2% of eastern Gulf mapped communities (to be reviewed during EIA). Indirect impacts will be minimised. Direct and indirect impacts to corals and seagrass beds will be minimised.	Mangroves and algal mats: • No direct clearing for salt ponds; • Minimising direct clearing for infrastructure; and • Ensuring through engineering design that tidal inundation and surface water flows are not affected significantly. Corals and seagrass beds: • Minimising direct disturbance; • Minimising elevated turbidity; • Avoiding the introduction of contaminants; • Avoiding significant changes in hydrodynamics; • Managing shipping and boat movements; and • Managing and monitoring ship ballast water/hulls to avoid pest introduction.	Minor clearing of mangroves and algal mats associated with the seawater intake/s, bitterns channel/pipeline and access roads (currently estimated at 0.4 and 2% of mangroves and algal mats respectively along the coast of the eastern Exmouth Gulf – to be reviewed during EIA). Minor changes to hydrodynamics, tidal inundation and surface water flows, but no significant impacts to Benthic Primary Producer Habitats (BPPH).	Currently estimated proportional loss of mangrove and algal mats is 0.4 and 2% respectively of eastern Gulf mapped communities (to be reviewed during EIA). Indirect impacts will be minimised. Impacts on seagrass beds and coral will be avoided and minimised. It is concluded that the EPA objective can be met.
Coastal processes	To maintain the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them. Guidelines: EPB 18 (EPA, 2012); and SPP 2.6 (WAPC, 2003).	Tidal zonation information for the area available. A sea level rise of 0.9 m by 2110 is the projection endorsed by the WA Government (WAPC, 2003).	The majority of the project footprint is located on the salt flats not considered part of the tidal zonation. Disturbance to the tidal areas will be minor for: • a small jetty; • dredging (if required); • bitterns discharge; and • other minor infrastructure. Indirect impacts to coastal morphology and processes will be minimised.	• Direct disturbance of tidal zones will be minimised by placing the majority of the project footprint on the salt flats; • The Project layout will be designed to prevent and minimise erosion, sedimentation and changes to tidal inundation; and • The project layout and design will appropriately maintain the ability of mangroves and algal mats to adjust to sea level rise.	The Project will seek to avoid or minimise significant impacts to coastal processes. Minor changes or residual impacts to local coastal processes are possible, but no significant impacts are expected.	Allowances have been made to re-locate or re-design the Project if necessary to meet the EPA objective The Project will avoid or minimise direct and indirect impacts on coastal processes. It is concluded that the EPA objective can be met.

Factor	EPA objective and guidelines	Baseline info. available	Impact assessment	Mitigation measures	Residual impacts	Outcome
Marine environmental Quality	To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected. Guidelines: EAG 3 (EPA, 2009); EAG 7 (EPA, 2011); EAG 15 (EPA, 2015); and Pilbara Coastal Water Quality Consultation Outcomes (Department of Environment, 2006).	Local marine areas have been recommended for both high and maximum levels of protection. Any discharges need to be technically justified and impacts limited in extent (EPA, 2015). Background water quality data is available and further data will be collected as part of the EIA process.	Potential impacts include: • Bitterns discharge to the ocean; • Seepage from salt ponds; • Dredging; • Disturbance of acid sulphate soils or sediment; and • Hydrocarbon spills.	• Bitterns discharge to maintain background water quality and ecosystem health at edge of mixing zone; • Comprehensive management and monitoring; • Minimise impacts to groundwater quality; • Dredging will be avoided or minimised; • Identification and management of any acid sulphate soils or sediment; and • Implementing a comprehensive Hydrocarbon and Spill Management Plan following a Hydrocarbon Spill Risk Assessment	With successful implementation of the mitigation measures, any residual impacts should be minor.	The Project will avoid or minimise direct, indirect and residual impacts on marine environmental quality. It is concluded that the EPA objective can be met.
Marine fauna	To maintain the diversity, geographic distribution and viability of fauna at the species and population levels. Guidelines: EAG 5 (EPA, 2010); and EAG 7 (EPA, 2011).	The Exmouth Gulf is habitat for marine fauna such as whales, dugongs, turtles, sharks, sea snakes, fish, and other species. A number of these are protected under State and Commonwealth legislation. The Exmouth Gulf also supports Exmouth Gulf Prawn Managed Fishery.	Potential impacts include: • Impacts to Benthic Habitat (see above); • Impacts to Marine Environmental Quality (see above); • Direct loss of marine fauna through boat strike or entrapment in seawater intake/s; • Impacts to breeding habitat of marine fauna; and • Introduction of marine pests or diseases.	• Mitigation measures for Benthic Habitat (see above); • Mitigation measures for Marine Environmental Quality (see above); • Management plans to prevent marine fauna strike and entrapment; • Identification and protection of any potential marine fauna breeding habitat; and • Managing and monitoring ship ballast water/hulls to avoid pest or disease introduction.	With successful implementation of the mitigation measures, any residual impacts should be minor.	The Project will avoid or minimise direct and indirect impacts on marine fauna. It is concluded that the EPA objective can be met.

Factor	EPA objective and guidelines	Baseline info. available	Impact assessment	Mitigation measures	Residual impacts	Outcome
Flora and vegetation	To maintain representation, diversity, viability and ecological function at the species, population and community level. Guidelines: GS 51 (EPA, 2004); PS 2 (EPA, 2000); PS 3 (EPA, 2002); EPB 20 (EPA, 2013); and Technical Guide – Flora and Vegetation Surveys for EIA (EPA and DPaW, 2015)	The flora survey of the historical Yannarie project area recorded 192 flora species and 11 vegetation types – none of these were listed as conservation significant (Biota Environmental Sciences, 2005).	Potential impacts include: • Direct clearing of vegetation: ○ The salt ponds will result in very little or no clearing of vegetation because they are located on the salt flats which are devoid of vegetation ○ It is not yet possible to quantify clearing of vegetation for other infrastructure where the location and layout has not been finalised and vegetation surveys have not yet been conducted • Indirect impacts through: ○ Changes in surface water flows ○ Changes in tidal inundation • Contamination through acid sulphate soils or hydrocarbon spills.	• Further surveys planned for northern section of project; • Minimising clearing - the salt ponds are located on the salt flats which are devoid of vegetation; and • Minimising indirect impacts as follows: ○ Ensuring tidal inundation is not altered significantly ○ Ensuring surface water flows are not altered in a way that is likely to cause significant impacts ○ Identification and management of acid sulphate soils ○ Implementing a comprehensive Hydrocarbon and Spill Management Plan following a Hydrocarbon Spill Risk Assessment.	With successful implementation of the mitigation measures, any residual impacts should be minor.	The Project will avoid or minimise direct and indirect impacts on flora and vegetation. It is concluded that the EPA objective can be met.

Factor	EPA objective and guidelines	Baseline info. available	Impact assessment	Mitigation measures	Residual impacts	Outcome
Terrestrial fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level. Guidelines: GS 20 (EPA, 2009); GS 56 (EPA, 2004); PS 3 (EPA, 2002); Technical Guide on Terrestrial Vertebrate Fauna Surveys (EPA, 2010); and EPB 20 (EPA, 2013).	A fauna survey of the historical Yannarie project area recorded 138 vertebrate taxa including 57 bird species (Biota Environmental Sciences, 2005). Based on habitat assessment 3 conservation significant terrestrial species are considered likely to occur within or near the Development Envelope: Little North-western Mastiff Bat (P1), Australian Fairy Tern (VU) and *Lerista planiventralis maryani* (P1). In addition, 33 species of Migratory Birds listed under the EPBC Act may occur locally.	Potential impacts include: • Habitat loss through project clearing; • Direct loss of fauna by vehicle or boat collisions; and • Indirect impacts such as noise, lighting or food waste causing fauna behaviour changes.	• Further surveys planned for all areas of potential disturbance; • Avoiding/minimising the disturbance of any significant fauna habitat identified through studies; • Minimising clearing of fauna habitat by locating the majority of the Project (salt ponds) on the salt flats (which are generally devoid of fauna habitat); • Minimising direct clearing and indirect impacts to mangroves (see above); • Ensuring any migratory bird foraging and roosting sites adjacent to the Project are identified and impacts avoided by careful design and management; • Management of vehicle and boat traffic to avoid collisions with fauna; and • Management of noise, lighting and food waste to prevent significant impacts on fauna.	With successful implementation of the mitigation measures, any residual impacts should be minor.	The Project will avoid or minimise direct and indirect impacts on terrestrial fauna. It is concluded that the EPA objective can be met.
Hydrological processes	To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected. Guidelines: PS 4 (EPA, 2004).	The Project is within the Ashburton River sub-catchment. During cyclonic rainfall events, surface water flows westwards accumulating within the salt flats that act as a large water compensating basin. However most of the time these salt flats are dry. Nutrient inputs into the Exmouth Gulf Wetland ecosystem are thought to come from mangroves, algal mats and creeks/rivers.	Potential impacts include: • Interfering with the ability of the salt flats to act as a compensating basin during flood events; • Salt ponds or associated infrastructure preventing adequate tidal inundation of the mud flat areas; • Project layout causing changes in surface water flows and resulting nutrient inputs; and • Seepage from the salt ponds into the groundwater, changing the salinity of the groundwater.	• Undertaking a comprehensive study of hydrology and nutrient flows; • Designing the Project layout so that the salt ponds do not interfere with the ability of the wetland to respond adequately during flood events; • Ensuring that changes in surface water flows and nutrient pathways/inputs are avoided and minimised; • Ensuring that tidal inundation and/or surface water flow is not altered significantly or in a way that could cause impacts to mangroves and algal mats; and • Minimise impacts on groundwater quality due to seepage from the salt ponds.	With successful implementation of the mitigation measures, any residual impacts should be minor.	The Project will avoid or minimise direct and indirect impacts on hydrological processes. It is concluded that the EPA objective can be met.

Factor	EPA objective and guidelines	Baseline info. available	Impact assessment	Mitigation measures	Residual impacts	Outcome
Inland waters environmental quality	To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected. Guidelines: PS 4 (EPA, 2004).	Surface water quality of the Ashburton River 10 km NE of the project is well known. Surface water quality data has not been previously collected within and adjacent to the Project – this will be done during the EIA process. Groundwater depth increases and salinity decreases in a west to east gradient from the salt flats to the inland environment. Ranging from a depth of 2 m AHD and hypersaline water (35 - 193 ppt salinity) beneath the salt flats to a depth of 15 m AHD and brackish water (2 – 13 ppt) 5 – 20 km inland of the salt flats.	Potential impacts include: • Contamination with hydrocarbons due to fuel storage activities; • Biological contamination from sewage treatment facilities; • Groundwater contamination from landfill activities; • Potential Acid Forming (PAF) material disturbance at borrow pits or a quarry leading to contamination issues; and • Erosion and scouring at drainage diversions leading to surface water contamination with sediment.	• Undertaking a comprehensive study of potential impacts to inland groundwater and surface water quality. • Designing all Project infrastructure and activities so that potential for contamination of inland groundwater and surface water is avoided and minimised. • Undertaking a Hydrocarbon Spill Risk Assessment and implementing an appropriate Hydrocarbon and Spill Management Plan.	With successful implementation of the above management measures, any residual impacts should be minor.	The Project will avoid or minimise direct and indirect impacts on inland waters environmental quality. It is concluded that the EPA objective can be met.
Heritage	To ensure that historical and cultural associations, and natural heritage, are not adversely affected. Guidelines: GS41 (EPA, 2004).	Historical Aboriginal Heritage investigations were conducted for the Yannarie project, but the project footprint proposed for the Ashburton Salt Project was not fully covered by these historical studies.	Aboriginal Heritage Sites may occur in the vicinity of the proposed project footprint. It is planned to further investigate this factor as part of the EIA process.	• Meeting all responsibilities and requirements under the *Aboriginal Heritage Act 1972;* • Ensuring appropriate cultural heritage surveys are conducted for the Ashburton Salt Project; • Where possible avoid disturbing cultural heritage sites through project design, construction and operations; and • In the event that disturbing a cultural heritage site is unavoidable, obtaining all relevant approvals under the *Aboriginal Heritage Act 1972,* prior to undertaking the disturbance.	With successful implementation of the mitigation measures, any residual impacts should be minor.	The Project will avoid or minimise direct and indirect impacts on heritage. It is concluded that the EPA objective can be met.

Factor	EPA objective and guidelines	Baseline info. available	Impact assessment	Mitigation measures	Residual impacts	Outcome
Rehabilitation and decommission-ing	To ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner. Guidelines: Guidelines for Preparing Mine Closure Plans (DMP and EPA, 2015); GS 6 (EPA, 2006); and EPB 19 (EPA, 2015).	The Ashburton Salt Project lifespan is estimated to be 40 to 100 years. Given the project is to be constructed under *Mining Act 1978* tenure, it will require a Mine Closure Plan to be prepared in accordance with the Guidelines for Preparing Mine Closure Plans (DMP and EPA, 2015). The draft Closure Plan will outline all rehabilitation, decommissioning and site closure activities for the Project.	As a Mine Closure Plan is to be prepared and implemented in accordance with the Guidelines for Preparing Mine Closure Plans (DMP and EPA, 2015), rehabilitation and decommissioning will be designed to ensure a safe, stable and non-polluting site and to the extent practicable, restore ecosystem function. Impacts associated with rehabilitation and decommissioning will be minimised.	As an Integrating Factor, Rehabilitation and Decommissioning are by definition, impact and risk mitigation measures.	With successful implementation of an approved Mine Closure Plan, any residual impacts should be minor.	It is concluded that the EPA objective can be met.
Offsets	To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets. Guidelines: WA Environmental Offsets Guidelines (Government of Western Australia, 2014); WA offsets template (Government of Western Australia, 2014); EPB 1 (EPA, 2014); and WA Environmental Offsets Policy (Government of Western Australia, 2011) GS 55 (EPA, 2003).	See above.	It is difficult to assess whether significant residual impacts will remain after all mitigation measures have been undertaken until the full EIA is completed. The Project is aiming to avoid and minimise significant environmental impacts. The information does not yet exist to determine whether any residual impacts are significant or minor – this will be determined through the EIA process.	If proposed, the use of environmental offsets will be in addition to best practice on-site environmental management, such as the proposed avoidance and mitigation measures. Environmental offsets, should they be applicable, will take account of, and contribute towards, broader State Government conservation objectives through existing programs, policies, initiatives and strategic funds.	As an Integrating Factor, if applicable, offsets will be used to compensate for significant residual environmental impacts and be designed to achieve long-term outcomes, building upon existing conservation programs and initiatives. It is however possible that some residual impacts may remain following closure, decommissioning and relinquishment.	If any significant residual environmental impacts or uncertainty is found to exist through the EIA, then K+S will seek to counterbalance them through the application of offsets. On this basis, it is concluded that the EPA objective can be met.

1 PROJECT DESCRIPTION

1.1 PROJECT PROPONENT

K+S is an international resources company with headquarters in Germany. It has a long history of mining and processing mineral raw materials, and is the world's largest salt producer and one of the top global potash providers.

K+S is considering a project in Australia to participate in supplying the growth in salt demand in Asia. The company is specifically evaluating the possibility of developing and operating a new Solar Salt project on the Western Australian (WA) coast near the town of Onslow, called the Ashburton Salt Project (the Project) – Figure 1.

EnviroWorks Consulting has been engaged by K+S to manage the Environmental Impact Assessment (EIA) and Approvals for the proposed Ashburton Salt Project.

1.2 PROPONENT CONTACT DETAILS

The proponent contact details are as follows:

Gerrit Goedecke
Managing Director
K plus S Salt Australia Pty Ltd (K+S)
Level 27 Number 44
St Georges Tce
Perth WA 6000
Phone (08) 6316 4500
Email gerrit.goedecke@ks-salt.com

Laura Todd
Managing Director
EnviroWorks Consulting
Level 29 Number 221
St Georges Tce
Perth WA 6000
Phone (08) 9221 9500
Email laura.todd@enviroworks.com.au

1.3 PROJECT SUMMARY

It is proposed to construct and operate a 3.5 million tonnes per annum (Mtpa) Solar Salt Project approximately 40 km southwest of the township of Onslow, within the Shire of Ashburton, in the East Pilbara region of WA (Figure 1). The proposal includes the following:

- seawater intake pumps/channel/pipeline/s;
- seawater concentration ponds and salt crystallisation ponds;
- internal site roads;
- electricity generation and reticulation;
- fuel storage sites;
- a jetty and product loading facilities;
- a salt wash plant and associated ponds;
- salt stockpiles and conveyors;
- onsite buildings such as offices, storage, workshops and possibly accommodation;
- sewage treatment facilities and landfill;
- water supply bore/s;
- an airstrip;
- equipment parking and laydown areas;
- bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser;
- drainage diversion/s;
- an access road;
- a haul road for construction materials;
- service corridor/s;
- quarry and borrow pit areas for rock, clay and other construction materials; and
- potentially dredging and dredge spoil disposal.

1.4 PROJECT LAYOUT

Development Envelope

A Development Envelope has been proposed within which the following components of the Project would be located (Figure 2):

- seawater intake pumps/channel/pipeline/s;
- seawater concentration ponds and salt crystallisation ponds;
- internal site roads;
- electricity generation and reticulation;
- fuel storage sites;
- a jetty and product loading facilities;
- a salt wash plant and associated ponds;
- salt stockpiles and conveyors;
- onsite buildings such as offices, storage, workshops and possibly accommodation;
- sewage treatment facilities and landfill;
- potentially water supply bore/s;
- potentially an airstrip;
- equipment parking and laydown areas;
- bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser; and
- drainage diversion/s.

The Development Envelope will be further refined and reduced during the assessment process as the locations of relevant project components and infrastructure are determined.

Ancillary infrastructure and activities

Additional ancillary infrastructure and activities are proposed outside the Development Envelope including:

- an access road;
- a haul road for construction materials;
- service corridor/s;
- quarry and borrow pit areas for rock, clay and other construction materials;
- potentially water supply bores/s
- potentially an airstrip and accommodation facilities; and
- potentially dredging and dredge spoil disposal.

Indicative locations for the access road/s and haul road are provided in Figure 1. It is not possible to provide indicative locations for the other items listed above at this stage as a range of studies are needed to determine suitable locations and minimise environmental impacts.

Bitterns (wastewater)

The wastewater produced from the solar salt process (bitterns) is essentially seawater with the majority of sodium chloride removed and remaining naturally-occurring ocean salts concentrated. No chemicals are added to the salt production process and as a result, all substances within bitterns are naturally-occurring.

It is proposed to discharge bitterns from the operation into the marine environment via a combination of infrastructure which may include a channel, dilution pond, pipeline and diffuser, which will be designed and managed to ensure effective dilution of the bitterns and minimise changes in background water quality surrounding the discharge point. The location and design of the discharge infrastructure will be determined as part of the Environmental Impact Assessment (EIA) process.

Drainage diversion/s

In order to manage hydrological impacts upstream of the proposed salt ponds, one or more drainage diversions may be required. Any drainage diversions would occur on the eastern side of the salt ponds, within the Development Envelope. This is the reason additional space has been allowed to the east of the ponds within the Development Envelope (Figure 2).

Access road, haul road and service corridors

Preliminary routes for the access road and haul road (for construction materials) have been provided within the referral (Figure 2). However, these road alignments may change during the EIA process as a result of environmental studies and detailed engineering. Service corridors required (for power, water etc.) will also be determined during the EIA process.

Dredging

K+S is seeking to avoid or minimise dredging, most likely via the use of low draft transhipment vessels which do not require a deep shipping channel. The location and footprint of any proposed dredging and dredge spoil disposal has not yet been determined. This will be determined as part of the EIA process.

Quarry and borrow pit areas

Quarry and borrow pit areas will be required to source construction materials, such as rock and clay. The location and footprint of such areas has not yet been determined. This will be determined as part of the EIA process.

1.5 PROJECT KEY CHARACTERISTICS

The Project key characteristics are summarised in Table 1 below.

Table 1: Ashburton Salt Project key characteristics

Summary of the proposal		
Proposal title	Ashburton Salt Project	
Proponent name	K+S Salt Australia	
Short description	It is proposed to construct and operate a solar salt project approximately 40 km southwest of Onslow, WA. The proposal includes the construction of solar salt evaporation and crystallisation ponds and associated infrastructure/activities *(seawater intake pumps/channel/pipeline/s; seawater concentration ponds and salt crystallisation ponds; internal site roads; electricity generation and reticulation; fuel storage sites; a jetty and product loading facilities; a salt wash plant and associated ponds; salt stockpiles and conveyors; onsite buildings such as offices, storage, workshops and possibly accommodation; sewage treatment facilities and landfill; water supply bore/s; an airstrip; equipment parking and laydown areas; bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser; drainage diversion/s; an access road; a haul road for construction materials; service corridor/s; quarry and borrow pit areas for rock, clay and other construction materials; and potentially dredging and dredge spoil disposal).*	
Physical elements – within Development Envelope		
Element	**Indicative location**	**Proposed extent authorised**
Evaporation and crystallization ponds	Figure 2 (indicative layout may change)	Clearing of no more than 15,000 ha within a 67,570 ha Development Envelope
Infrastructure within Development Envelope	Figure 2 (indicative layout may change)	Clearing of no more than 2,000 ha within a 67,570 ha Development Envelope *(includes: seawater intake pumps/channel/pipeline/s; seawater concentration ponds and salt crystallisation ponds; internal site roads; electricity generation and reticulation; fuel storage sites; a jetty and product loading facilities; a salt wash plant and associated ponds; salt stockpiles and conveyors; onsite buildings such as offices, storage, workshops and possibly accommodation; sewage treatment facilities and landfill; water supply bore/s; an airstrip; equipment parking and laydown areas; bitterns discharge infrastructure which may include a channel, dilution pond, pipeline and diffuser; and drainage diversion/s)*
Physical elements –outside Development Envelope		
Element	**Indicative location**	**Proposed extent authorised**
Access road, haul road and service corridors	Figure 1 (indicative road routes may change, service corridors to be determined through the EIA process)	To be determined through the EIA process
Quarry and Borrow Pit Areas	Locations to be determined through the EIA process	To be determined through the EIA process
Potential dredging and dredge spoil disposal	Locations to be determined through the EIA process	To be determined through the EIA process
Potential airstrip, accommodation and water supply bore/s	Locations to be determined through the EIA process	To be determined through the EIA process
Operational elements		
Element	**Indicative location**	**Proposed extent authorised**
Salt production wastewater (bitterns)	Marine discharge point designed to achieve effective dilution (to be determined through the EIA process)	Marine discharge of no more than 10 GL per annum

1.6 CONSERVATION VALUES

The Eastern Exmouth Gulf conservation values have been recognised in a range of WA Government policies including the following:

- In 1975, *The Conservation Through Reserves Committee* recognised the area's conservation potential and recommended that a series of studies on biophysical characteristics of the tidal and supratidal flats of Exmouth Gulf be conducted (EPA, 1975).
- In 1994, an indicative area was recommended for reservation consideration in the report entitled *A Representative Marine Reserve System for Western Australia by the Marine Parks and Reserves Selection Working Group* referred to as the Wilson Report (CALM, 1994).
- In 1996, the mangals from Giralia Point to Locker Point were recommended for inclusion on the *Register of the National Estate* (Carr & Livesy, 1996). It should be noted that the Register was closed in 2007 and is no longer a statutory list.
- The fringe of arid zone mangroves along the east coast of Exmouth Gulf is recognised as being of 'regional significance' in EPA Guidance Statement No. 1. (EPA, 2001).
- The *Ningaloo Coast Regional Strategy Carnarvon to Exmouth* consolidated the above Government policies and was endorsed by the WA Government and released by the WA Planning Commission in 2004 (WAPC, 2004). The strategy recommends that the southern and south-eastern mangrove areas of Exmouth Gulf and adjacent coastal waters be investigated for potential listing as a marine protected area, consistent with the findings of the Wilson Report (CALM, 1994), but noted this still required further investigation before a Government decision could be made (WAPC, 2004).

To date, no marine protected area has been listed on the eastern side of the Exmouth Gulf. The boundary of the marine protected area recommended for investigation (WAPC, 2004) is shown in Figure 3. In WA, marine protected areas can be established in areas that coincide with fishing and other industry, with management conditions. One of the categories of marine protected areas, called "marine management areas", can be gazetted for the purpose of mining as defined under the *Mining Act 1978*. Therefore, the operation of a solar salt project does not necessarily conflict with the successful implementation of a marine protected area.

However, it should be noted the Ashburton Salt Project proposed footprint and Development Envelope are located outside the recommended marine protected area boundary. This minimises the potential for future land use conflict with the proposed Ashburton Salt Project, should Government pursue future evaluation and implementation of a marine protected area, as outlined within the *Ningaloo Coast Regional Strategy Carnarvon to Exmouth* (WAPC, 2004).

1.6.1 WETLAND OF NATIONAL SIGNIFICANCE

The proposed development is located within the Exmouth Gulf East wetland (WA007) which is listed in the *Directory of Important Wetlands in Australia* (ANCA, 1993) – Figure 4. The Directory describes the significance of the wetland as "An outstanding example of tidal wetland systems of low coast of northwest Australia, with well-developed tidal creeks, extensive mangrove swamps and broad saline coastal flats." The criteria for listing the wetland are:

- It is a good example of a wetland type occurring within a biogeographic region in Australia.

- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex. Specifically, the mangroves buffer the coast from erosion, especially during cyclones, which occur in this area in most years.
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles. Specifically, the site is one of the major population centres for Dugongs in WA and its seagrass beds and extensive mangroves provide nursery and feeding areas for marine fishes and crustaceans in the Exmouth Gulf (ANCA, 1993).

The wetland consists of the following broad ecosystem units:

- Extensive salt flats along the eastern side of the wetland that act as a large compensating basin during cyclonic events – most of the time these salt flats are dry (except when flooding occurs during cyclonic events due to a combination of rainfall, surface water flows and storm surge) (Parsons Brinkerhoff, 2006). The salt flats do not support flora, vegetation or fauna habitat due to their saline nature (Biota Environmental Sciences, 2005).
- Mud flats located at the western margin of the salt flats on the ocean side that are periodically inundated by tidal flows. Algal mats form on these mud flats in a narrow tidal range in areas that are submerged an average of 3% of the time per month or less (coinciding with spring tides). Mangroves occur on the coastal fringes of the mud flats in areas that are inundated by tides on a more regular basis, often twice daily (Biota Environmental Sciences, 2005).
- Coastal rocky promontories and beaches occur at the western margin of the mud flats, directly adjacent to the ocean. These act as a roosting site for migratory birds (Biota Environmental Sciences, 2005).

Significant impacts on the wetland and its ecosystem will be avoided as described in the following sections of this referral document:

- Mangroves and algal mats – Section 5.1
- Marine environmental quality – Section 5.3
- Marine fauna – Section 5.4
- Flora and vegetation – Section 5.5
- Terrestrial fauna – Section 5.6
- Hydrological processes – Section 5.7
- Inland waters environmental quality – Section 5.8.

1.7 EPBC ACT ASSESSMENT

The Ashburton Salt Project has been referred to the Commonwealth Government under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). If the Commonwealth Government decides to assess the Project under the EPBC Act, K+S requests the Environmental Protection Authority (EPA) assess the proposal under the bilateral agreement between the State of Western Australia and the Commonwealth.

1.8 MINISTERIAL RESERVATION FOR SALT PRODUCTION

The Ashburton Salt Project, is overlapped by land designated as a Temporary Ministerial Reserve for the purpose of solar salt production (Figure 5) – reserve No TR70/5350. This is in recognition of the area's suitability for solar salt production given its high evaporation and solar radiation rates.

1.9 SECTION 19 AREA

An area overlapping the proposed Ashburton Salt Project is also designated S19/8, being a special category of land declared under Section 19 of the *Mining Act 1978* (Figure 5).

On 25 November 2014, the area was declared by the Minister for Mines under Section 19 of the *Mining Act 1978*, as exempt from Divisions 1 to 5 of Part IV of the Mining Act. This means that any overlapping mining tenements cannot be granted over that land, without the permission of the Minister.

In 2016, the Minister for Mines wrote to K+S inviting them to apply for tenements over this reservation, in recognition of K+S objectives to establish a solar salt project in the area. K+S have made the necessary applications and these are currently being assessed and processed.

2 HISTORICAL PROJECT

From 2004 to 2009, Straits Resources planned an earlier, much larger Project, called the Yannarie project, for the area. The Yannarie project extended some 50 km southwest of the Ashburton Salt Project, and it covered a much broader footprint (Figure 6). In 2009, Straits announced it would not proceed with the project after the EPA recommended it not be approved and the Minister for Environment subsequently directed the EPA to re-assess the proposal.

The Ashburton Salt Project is not the same as the Yannarie project. Ashburton Salt has a much smaller footprint (Figure 6), a smaller production capacity (3.5 Mtpa compared with 10 Mtpa) and is located much further north resulting in a significantly smaller interface with the Exmouth Gulf.

K+S believes that significant differences in the scope, size and location, as well as the adoption of new and recognised best practice management techniques, will ensure the Ashburton Salt Project can overcome concerns previously raised regarding the Yannarie project.

The K+S approach to environmental management for the Ashburton Salt Project includes the following elements not included in the historical Yannarie project:

- Locating the Project approximately 40 km southwest of Onslow, to minimise its interface with the Exmouth Gulf and a potential marine protected area that may be identified by future Government Policy (refer to Section 1.6).
- Minimising impacts to mangrove communities (recognising these are important components of the ecosystem).
- Minimising impacts on algal mat communities (recognising these are important primary producers in the local food chain).
- Not including long-term bitterns storage in the Project design, instead proposing bitterns discharge into the marine environment in a way which will ensure effective dilution of the bitterns and minimise changes in background water quality surrounding the discharge point.
- Minimising, if not eliminating, dredging of the ocean floor.

3 AVAILABLE BASELINE DATA

As described below, there is a wide range of available baseline data that can be built on through further studies to provide a comprehensive baseline data set for the Ashburton Salt Project.

3.1 YANNARIE PROJECT DATA

As shown in Figure 6, the historically proposed Yannarie project coincides with the southern portion of the proposed Ashburton Salt Project and extends some 50 km southwest. Most of the Yannarie baseline environmental study areas covered the southern portion of the proposed Ashburton Salt Project, however the northern portion was not studied.

This existing baseline data, covering the southern portion of the proposed Ashburton Salt Project, provides a good initial basis for the EIA, although some validation may be required of existing data sets. Infill baseline studies will be required to cover the northern portion of the Project area, which has not been previously studied.

It should be noted the Yannarie baseline environmental studies occurred from 2004 to 2007 (12 to 9 years ago), therefore, may be considered out of date. K+S intends to undertake fresh environmental studies covering the Ashburton Salt Project area to ensure all information is current. For example, the distribution of mangrove and algal mat communities can change over time, so the current distribution of these communities may be somewhat different to that which was mapped for the Yannarie project 11 years ago (Biota Environmental Sciences, 2005).

3.2 WHEATSTONE PROJECT DATA

The Chevron Wheatstone project is located approximately 30 km northeast of the proposed Ashburton Salt Project (Figure 7).

Most of the Wheatstone terrestrial baseline environmental studies provide useful regional information, however the study areas do not extend far enough to the southwest to cover the footprint or expected receiving environment for the Ashburton Salt Project.

The subtidal marine habitat study area for the Wheatstone project (URS, 2010) extended southwest as far as the proposed Ashburton Salt Project Development Envelope's north-eastern boundary, but did not extend any further southwest into the Development Envelope itself. This habitat mapping will be useful to build on and extend further southwest into the proposed Ashburton Salt Project Development Envelope and surrounding environment.

Similarly, the marine species tolerance limits study for the Wheatstone project (DHI Water and Environment, 2010) provides useful information on the tolerance of local marine habitat types (corals, filter feeders, seagrass, macro-algae and mangroves) to changes in water quality and sedimentation. This data will be useful to build on for assessing tolerance limits of these habitats surrounding the proposed Ashburton Salt Project.

3.3 ONSLOW SALT OPERATION DATA

Figure 7 shows the location of the Onslow Salt operation that is located approximately 35 km northeast of the proposed Ashburton Salt Project.

Publicly available information and monitoring data available in their Annual Environmental Reports may provide useful regional baseline data.

3.4 NORTH WEST SHELF JOINT ENVIRONMENTAL MANAGEMENT STUDY

The North West Shelf Joint Environmental Management Study (NWSJEMS) was a $7.7 million marine environmental study of the North West Shelf, jointly funded by CSIRO and the Western Australian Government, that commenced in 1998 with findings published in June 2007. The overarching objective was to develop and demonstrate practical science-based methods that could support integrated regional planning and multiple-use management of the North West Shelf marine ecosystem. The study area commenced from the North West Cape, near Exmouth, covering the entire Exmouth Gulf, to just short of the DeGrey River in the East and extended offshore to the 200 m isobath (refer to Figure 8).

The first major component of the study was compiling, extending and integrating information and understanding the ecosystems and human activities of the North West Shelf. This included reviews of existing information, collation of existing data, filling key gaps through collection of new data, and development of new data products such as maps and habitat classifications.

The second component was the development of a range of ecological models that combined data products with process understanding, to generate new insights into the dynamics of the North West Shelf system and provide a predictive capability. The models included ocean currents and connectivity, sediment transport, nutrient cycling and primary production, food web interactions and habitat dynamics.

The results of the *NWSJEMS* have been documented in a Summary Report (CSIRO & Department of Environment, 2007) and a series of 18 Technical Reports covering reviews of pre-existing information, accessing information, modelling of physical and biological processes, characterising human activities and impacts and evaluation of management strategies.

The data from the *NWSJEMS* provides a range of baseline data which can be used to inform the Project's local baseline environmental studies, including habitat mapping of marine and nearshore habitats (Lyne et al., 2006) within the proposed Ashburton Salt Project area.

3.5 DEPARTMENT OF FISHERIES RESEARCH

The Department of Fisheries engages in broad research activities within the Exmouth Gulf as part of its management of fisheries licences in the area.

For example, a research project is currently underway titled *Examining the relationship between fishery recruitment, essential benthic habitats and environmental drivers in Exmouth Gulf* (Department of Fisheries, 2015 ongoing). This study is examining a number of environmental factors

that influence prawn fisheries including temperature, rainfall, ocean currents and extreme weather conditions. It involves the collation and review of historical, satellite, habitat and environmental data for the Exmouth Gulf and field collection of local environmental and productivity data. This data may contain useful baseline information that can be used to inform the Ashburton Salt Project baseline environmental studies.

3.6 DATA GAPS

Whilst a broad range of baseline data are available as described above, the following data gaps currently exist and will need to be filled during the EIA process:

- Local scale detailed baseline habitat mapping, particularly in the northern part of the Project area that has not been previously studied.
- Local scale environmental quality information in areas not previously studied (for example local marine water quality within the Project potential areas of influence).
- Validation of previous baseline studies given these were mostly done between 9 and 12 years ago and some data may now be out of date.

K+S intends to undertake fresh environmental studies covering the Ashburton Salt Project area to ensure all information is current.

4 STAKEHOLDER COMMUNICATION

4.1 ACTIVITIES TO DATE

To date stakeholder communication and engagement has focussed on providing information to key stakeholders and the general community regarding:

- the proposed Project location and scale;
- K+S' commitment to environmental management;
- the proposed approach for minimising and mitigating environmental impacts and risks;
- anticipated Project timing; and
- key steps in the environmental assessment and approval process.

Stakeholder groups that have been communicated with to date include:

- media;
- politicians;
- state government agencies;
- local government;
- fishing industry Representatives;
- industry and commerce representative bodies;
- environmental interest groups;
- local community; and
- general public.

Methods of communication have included:

- media briefings;
- regulator briefings;
- meetings;
- website publications;
- correspondence (emails, phone calls and letters);
- newspaper advertising; and
- community information days.

4.2 FUTURE ACTIVITIES

K+S is in the process of developing a comprehensive stakeholder communication and engagement plan that will include:

- Strategies, actions and activities for effective of stakeholder engagement and communication; and
- stakeholder consultation activities planned as part of the environmental assessment and approval process including:
    - providing information on the Project design;
    - providing the results of key environmental studies;
    - seeking feedback from key stakeholder on environmental impacts relevant to them; and
    - incorporating stakeholder feedback into the Project design and proposed environmental management.

5 ENVIRONMENTAL AND INTEGRATING FACTORS

The following preliminary environmental and integrating factors have been identified for the Project:

- Benthic communities and habitat;
- Coastal processes;
- Marine environmental quality;
- Marine fauna;
- Flora and vegetation;
- Terrestrial fauna;
- Hydrological processes;
- Inland waters environmental quality;
- Heritage;
- Rehabilitation and decommissioning; and
- Offsets.

For each of these factors the following information has been described in the sub-sections below:

- **EPA objective** – the relevant EPA objective outlined in Environmental Assessment Guideline for Environmental Principles, Factors and Objectives (EPA, 2015).;
- **Guidance** – the established policies, guidelines and standards that apply to this factor in relation to the proposal;
- **Consultation** – the need for consultation and the outcomes of any consultation in relation to any potential environmental impacts;
- **Baseline information** - the relevant characteristics of the receiving environment including regional context, known environmental values, current quality, sensitivity to impact and current level of cumulative impacts;
- **Impact assessment** – the potential impact/s that may occur to the environmental factor as a result of implementing the proposal;
- **Mitigation measures** – measures proposed to mitigate the potential environmental impacts;
- **Residual impacts** – remaining impacts expected after mitigation measures are implemented; and
- **EPA objective outcome and assumptions** – a conclusion regarding whether, in the proponent's view, it will be possible to meet the relevant EPA objective, as well as any assumptions critical to the conclusion reached.

5.1 BENTHIC COMMUNITIES AND HABITAT

5.1.1 EPA OBJECTIVE

To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales.

5.1.2 GUIDANCE

- *Environmental Assessment Guideline 3 – Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment* (EPA, 2009)
- *Environmental Assessment Guideline 7 – Marine Dredging Proposals* (EPA, 2011)
- *Guidance Statement 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline* (EPA, 2001)
- *Guidance Statement 29 – Benthic Primary Producer Habitat (BPPH) Protection for Western Australia's Marine Environment* (EPA, 2004)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.1.3 CONSULTATION

- K+S anticipates a high level of public interest in the impact on benthic communities and habitat given these are primary producers that provide nutrients to the Exmouth Gulf ecosystem.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.
- Consultation to date has included broad information provision to stakeholders, recognising that benthic primary producer communities (particularly mangroves and algal mats) are important parts of the local ecosystem and confirming K+S is committed to minimising impacts to them.

5.1.4 BASELINE INFORMATION

Benthic Primary Producer Habitats (BPPHs) are seabed communities within which algae (e.g. macro-algae, turf and benthic micro-algae), seagrass, mangroves, corals or mixtures of these groups are prominent components.

5.1.4.1 ALGAL MATS AND MANGROVES

Key BPPH, that are relevant to the Project, are algal mats and mangroves that are located in the intertidal zone in close proximity to the Project footprint (Plates 1 and 2). These two BPPH types are located on the mud flats at the western margin of the salt flats (on the ocean side) and are periodically inundated by tidal flows. Algal mats form on the mud flats in a narrow tidal range in areas that are submerged an average of 3% of the time per month or less (with spring tides). Mangroves occur on the coastal fringes of the mud flats in areas that are inundated on a more regular basis, often twice daily by normal tides (Biota Environmental Sciences, 2005).

Mangrove communities provide a range of ecological functions on the Pilbara coast, including physical stabilisation of shorelines and sediments, provision of terrestrial and marine fauna habitats and inputs of nutrients to coastal ecosystems (Biota Environmental Sciences, 2005). In terms of mangrove communities present, by far the most abundant and widespread species in the Project area is *Avicennia marina. A. marina* is the most widespread mangrove in Western Australia and it is typically the dominant species along mangrove coastlines in the region. *Rhizophora stylosa* is the next most common and widespread species in the area. *R. stylosa* forms dense stands in more seaward areas, either as a monospecific unit or in association with taller *A. marina*. This species is also relatively widespread along the Western Australian coastline and is typically locally dominant or co-dominant in mangrove habitats from the Kimberley to Exmouth Gulf (Biota Environmental Sciences, 2005). *EPA Guidance Statement 1 Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline* (EPA, 2001) has designated the mangroves on the eastern side of the Exmouth Gulf as "regionally significant and of high conservation value" on the basis of:

- Ecological reasons pertaining to productivity, feeding grounds, and fish nurseries;
- Scientific reasons of heritage, research and education; and
- Preservation of biodiversity (EPA, 2001).

Beyond the tidal limit of the mangrove zone, extensive areas of algal or cyanobacterial mats occur on the mudflats before elevation increases into the salt flat areas. Cyanobacterial mats have been demonstrated to fill an important ecological function in coastal arid zone systems, fixing atmospheric nitrogen into biologically available forms (Biota Environmental Sciences, 2005). Algal mats essentially occur in the narrow tidal range that is not inundated by tides frequently enough for tidal currents to be strong and sediments unstable, but also not at an elevation where tidal inundation ceases completely and salinity levels become too great for cyanobacteria to tolerate (i.e. the salt flats). This equates to an elevation range of about 10 cm on the average in the flat landscape of the study area (Biota Environmental Sciences, 2005).

Figure 9 shows the preliminary Project layout overlaid on available baseline mangrove and algal mat mapping for the Project area. This mapping includes a combination of baseline datasets as follows:

- For the southern portion of the Project area, available habitat mapping undertaken for the historical Yannarie project by Biota Environmental Sciences (2005) has been used.
- For the northern portion of the Project area, Biota was commissioned to undertake a desktop mapping exercise using high resolution aerial photography in order to extend the habitat mapping further north, adjacent to the Ashburton Salt Project (Biota Environmental Sciences, 2016).

It is anticipated that the above mapping may require validation and ground truthing as part of the EIA process, given that:

- The southern data was collected 10 – 11 years ago (Biota Environmental Sciences, 2005) and the distribution of these habitats may have changed slightly.
- The northern mapping was carried out on a desktop basis (Biota Environmental Sciences, 2016) with no field validation.

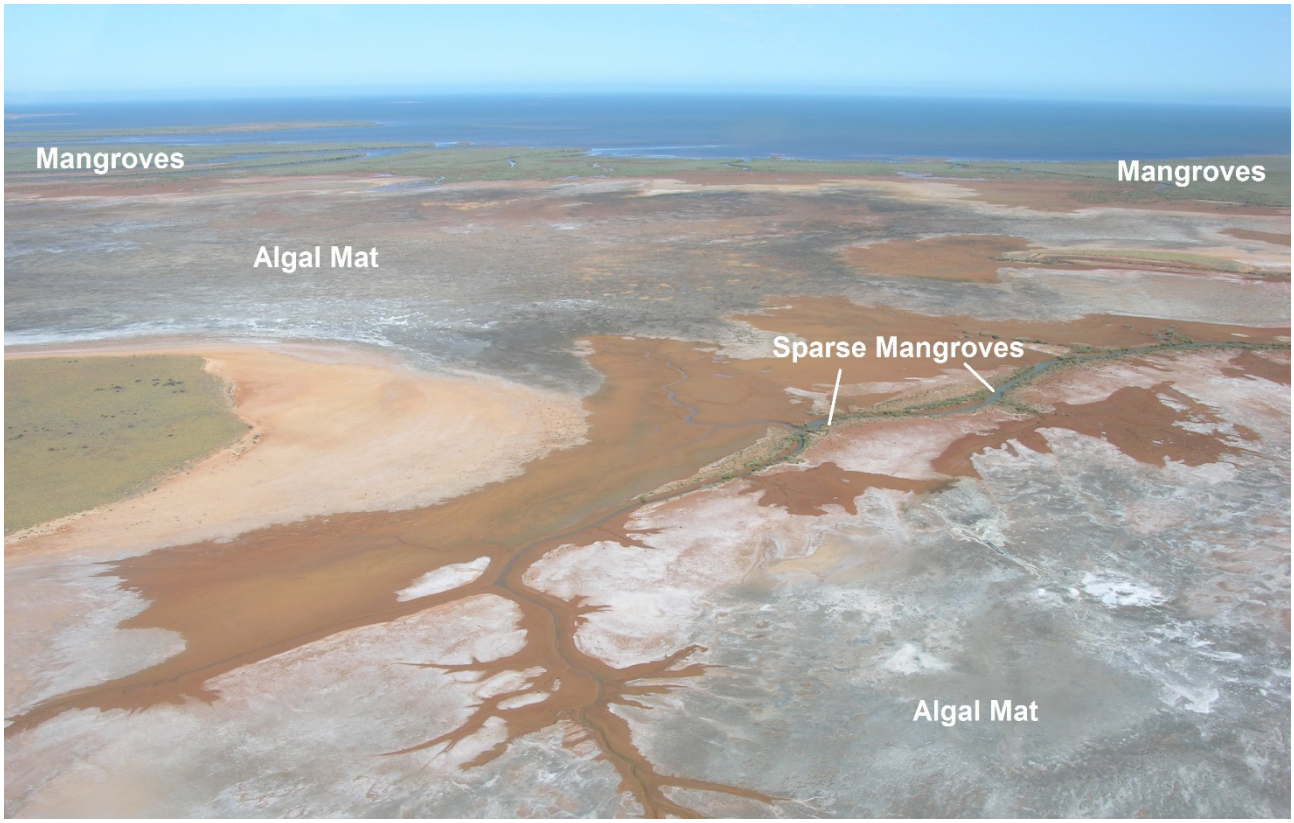


Plate 1: Typical mangrove and algal mat communities on eastern Side of Exmouth Gulf

Plate 2: Algal mat photograph near project site

5.1.4.2 SEAGRASS BEDS AND CORALS

Seagrass beds and corals are likely to exist off the coast within the marine environment, but these are considered at low risk from direct impact, because the Project footprint is located primarily on the salt flats. These habitats will be mapped and impacts minimised as part of any proposed dredging.

Offshore islands with the potential for fringing corals are identified in Figure 10. Desktop aerial photograph interpretation indicates that coral may be present surrounding these islands. It is unlikely that coral will occur directly adjacent to the coast given the high turbidity of the nearshore environment. Ground truthing will be required as part of the EIA.

No detailed seagrass bed survey has occurred adjacent to the Project area. However, information about the distribution of seagrasses around the Australian coastline has been compiled by Dr. Hugh Kirkman (CSIRO Division of Fisheries) from a review of published and unpublished sources (CSIRO, 1996). Spatial mapping from this review indicates that seagrass beds occur along the coastline adjacent to the Project area, including a seagrass bed approximately 1 km offshore from Tubridgi Point (Figure 11). Ground truthing will be required as part of the EIA.

5.1.5 IMPACT ASSESSMENT

5.1.5.1 ALGAL MATS AND MANGROVES

Direct clearing

Based on Figure 9, direct clearing of mangrove and algal map habitat has been largely avoided by ensuring the salt ponds do not overlap these habitats. However, the following infrastructure may result in some minor clearing of these habitats:

- seawater intake/s;
- bitterns discharge infrastructure (may include a channel, pipeline and dilution pond); and
- access roads.

As shown in Figure 9, approximately 11,650 ha of mangroves and 10,060 ha of algal mat have been mapped on the eastern side of the Exmouth Gulf (Biota Environmental Sciences, 2005); (Biota Environmental Sciences, 2016). It is estimated that up to 50 ha of mangroves and 200 ha of algal mat may be cleared for Project infrastructure (these estimates are preliminary only and will need to be reviewed during the EIA process). Therefore, the current estimated proportional clearing of mangroves and algal mat for the Project is 0.4% and 2% respectively (based on the Local Assessment Unit being the eastern side of the Exmouth Gulf). This will be reviewed further during the EIA process.

Indirect impacts

The proposed salt ponds are approximately 20 km long, run parallel to the coastline and do not intersect mangrove or algal mat communities (the salt ponds being located solely on the salt flats). Within the 20 km length of coastline adjacent to the proposed salt ponds, the mangrove and algal

mat abundance is much sparser than further south along the remainder of the Exmouth Gulf eastern coastline (refer to Figure 9). Potential indirect impacts to these habitats include:

- Changes to tidal inundation as a result of salt pond and infrastructure placement which may bring about changes in mangrove/algal mat health and distribution.
- Changes to surface water flows as a result of salt pond and infrastructure placement which may bring about changes in mangrove/algal mat health and distribution.
- Introduction of contaminants (hydrocarbons, acid sulphate soils or elevated salt concentration) which may bring about changes in mangrove/algal mat health and distribution.

Indirect impacts to mangroves and algal mats will be avoided as described below in Section 5.1.6.

5.1.5.2 CORALS AND SEAGRASS BEDS

Direct impacts

K+S is committed to minimising direct disturbance of corals and seagrass beds. Dredging will be minimised (or avoided if possible) and areas identified as containing coral and sea grass beds will be avoided, to the maximum extent practicable, as part of any proposed dredging program.

Indirect impacts

Potential indirect impacts to these habitats include:

- Temporary elevation of turbidity due to dredging causing light reduction or smothering of coral and seagrass beds, resulting in habitat loss.
- Introduction of contaminants (hydrocarbons, acid sulphate soils or elevated salt concentration) which may bring about changes in coral reef and seagrass health and distribution.
- Changes in hydrodynamics (water flows and movement) which may result in physical damage or stress to coral reef or seagrass habitats.
- Shipping or boat movements causing physical damage or stress to coral reef or seagrass habitats.
- Introduction of marine pests in ballast water/hulls, causing physical damage or stress to coral reef or seagrass habitats.

Indirect impacts to coral and seagrass beds will be avoided as described below in Section 5.1.6.

5.1.6 MITIGATION MEASURES

Proposed mitigation measures are outlined below.

Mangroves and algal mats

- No direct clearing of mangroves or algal mats for salt ponds.
- Minimising direct clearing of mangroves and algal mats for infrastructure such as the seawater intake/s, bitterns discharge infrastructure and roads.

- Ensuring through engineering design that tidal inundation does not change significantly or in a way that could cause significant and unacceptable impacts to mangroves and algal mats.
- Ensuring through engineering design that surface water flow patterns do not change significantly or in a way that could cause significant and unacceptable indirect impacts to mangroves and algal mats.

Corals and seagrass beds

- Minimising direct disturbance of corals and seagrass beds for any dredging proposed.
- Minimising elevated turbidity due to dredging and managing dredging to avoid impacts to coral and seagrass habitat loss (refer to Section 5.3).
- Avoiding the introduction of contaminants (hydrocarbons, acid sulphate soils or elevated salt concentration) (refer to Section 5.3).
- Avoiding changes in hydrodynamics (water flows and movement) which may result in physical damage or stress to coral reef or seagrass habitats.
- Managing shipping and boat movements so they do not cause physical damage or stress to coral reef or seagrass habitats.
- Managing and monitoring ship ballast water/hulls to avoid marine pest introduction.

5.1.7 RESIDUAL IMPACTS

Possible residual impacts to the BPPH may include:

- Minor clearing of mangroves and algal mats associated with the seawater intake/s, bitterns infrastructure and access roads (currently estimated at 0.4% and 2% per cent of mangroves and algal mats respectively along the coast of the eastern Exmouth Gulf – estimates to be reviewed during EIA process).
- Minor changes to hydrodynamics, tidal inundation and surface water flows, but no significant impacts to BPPH.

5.1.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

The current estimated proportional loss of mangrove and algal mat along the eastern Exmouth Gulf is 0.4% and 2% of mangroves and algal mats respectively - estimates to be reviewed during the EIA process.

Impacts on seagrass beds and coral will be avoided and minimised.

On this basis, it is concluded that the EPA objective can be met as the estimated small loss of BPPH is unlikely to significantly impact the structure, function, diversity, distribution and viability of these benthic communities and habitats at local and regional scales.

5.2 COASTAL PROCESSES

5.2.1 EPA OBJECTIVE

To maintain the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them.

5.2.2 GUIDANCE

- *Environmental Protection Bulletin 18 – Sea level rise* (EPA, 2012)
- *Statement of Planning Policy No. 2.6: State Coastal Planning Policy* (WAPC, 2003)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.2.3 CONSULTATION

- K+S anticipates a high level of public interest in the impact on subtidal, intertidal and supratidal zones given these zones are parts of the environment that interact with the Exmouth Gulf ecosystem.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.2.4 BASELINE INFORMATION

Tidal zonation

The subtidal, intertidal and supratidal zones can be defined as follows:

- **Subtidal zone:** is the area below the low tide water line. This area is permanently covered by water. Waves and tides continually act to move sediment in this environment.
- **Intertidal zone**: is the area that is exposed to the air at low tide and submerged at high tide. This zone is repeatedly inundated by water and exposed to air. This also represents the zone where waves routinely interact with the land, leading to transport of sediment.
- **Supratidal zone**: is situated above the high tide elevation and only occasionally is flooded, most commonly during high spring tides (the highest tides that occur just after a full moon). The most common non-tidal process acting to transport sediment in this area is wind (aeolian transport) (InTeGrate, 2016).

Within the Project area these zones broadly include (Plate 3):

- **Subtidal zone**: nearshore marine environment including potential seagrass beds.
- **Intertidal zone**: coastal beaches, lower reaches of the mudflats, parts of creeks and mangrove systems.
- **Supratidal zone**: elevated beach areas, upper reaches of mudflat zones and the algal mat areas.

Note: Algal mats have been defined as part of the supratidal zone, given they are submerged an average of 3% of the time per month or less (Biota Environmental Sciences, 2005) – likely corresponding with spring tides. The salt flats are not considered part of the supratidal zone. As described in Section 5.7, the salt flats form a vast coastal plain, which is only inundated via flooding from overland flow after major storm events (Biota Environmental Sciences, 2005). Water discharge into the salt flats occurs from the hydrological catchment, via a number of overland flow paths and drainage lines (Parsons Brinkerhoff, 2006). Storm surge may partially contribute to the inundation of the salt flats during cyclonic storm events, but this is not considered part of regular tidal processes and it would not be appropriate to include these vast coastal plains within the tidal zonation for the area.

It is anticipated that detailed mapping of the subtidal, intertidal and supratidal zones within the Project area will be undertaken as part of the EIA process.

Coastal processes

The shoreline is affected by waves (produced by wind at sea), tides (produced by the gravitational effect of the moon and sun) and sometimes also by wind itself. These lead to the following coastal processes:

- Erosion of the land by the waves, tides or wind which can re-shape and reduce the size of landforms along the coast.
- Transportation of material in the sea and along the coast by waves.
- Deposition of eroded material, creating a build-up of sediment or sand (Plate 3), leading to changes in coastal morphology such as the creation of landforms (Columbia University, 2016).

It is anticipated that the Project's potential impacts on coastal processes and any consequential impacts on the morphology of the subtidal, intertidal and supratidal zones, will be further described as part of the Project EIA.

Plate 3: Typical tidal zonation and sediment deposition along the eastern Exmouth Gulf

Sea level rise

Global mean sea levels have risen over the course of the 20th century and are predicted to continue to rise. While there is a range of predictions, a rise of 0.9 m in mean sea level by 2110 is the projection currently endorsed by the WA Government as the best for decision-making (EPA, 2012).

Sea level rise affects low-lying coastal environments and tidally influenced wetlands, estuaries and waterways connected to the marine environment. The impacts to, and responses of, individual ecosystems will vary. It is important to protect ecosystems from the impacts of damage to infrastructure caused by the effects of sea level rise and to ensure that infrastructure does not prevent ecosystems from adapting to higher sea levels (EPA, 2012).

The historical record of sea level changes demonstrates the ability of many ecosystems to adapt to changing conditions over time. In the absence of additional pressures, ecosystems may adapt to future sea level rise, provided that the rate of sea level rise does not exceed the ecosystem's resilience to that rise and no barriers to adaptation exist. For example, mangroves and algal mats

may be able to migrate inland with the gradual, sea level rise driven, inland movement of the coastline (EPA, 2012).

Mangrove and algal mat distribution within the Project area has been mapped as described in Section 5.1 (Figure 9). It is anticipated that modelling will be undertaken as part of the EIA process, to predict the potential spatial re-distribution of mangroves and algal mats that may occur in response to sea level rise.

5.2.5 IMPACT ASSESSMENT

The majority of the Project footprint is located on the salt flats that form a vast coastal plain not considered part of the tidal zonation for the area. The only potential direct disturbances to the subtidal, intertidal and supratidal zones are relatively small in the context of overall Project disturbance and include:

- construction of a small jetty;
- dredging (which will be avoided or minimised); and
- construction of bitterns discharge infrastructure, seawater intake/s and other minor infrastructure such as roads.

Indirect impacts to coastal morphology and processes will be minimised as outlined below.

5.2.6 MITIGATION MEASURES

The following mitigation measures are proposed:

- Direct disturbance of the subtidal, intertidal and supratidal zones will be minimised given the majority of the Project footprint is located on the salt flats that form a vast coastal plain not considered part of the tidal zonation for the area.
- All direct disturbance of the subtidal, intertidal and supratidal zones (for infrastructure such as the jetty, pipelines and roads) will be designed in a way that does not cause significant changes to coastal processes or morphology.
- The Project layout will be designed to prevent and minimise:
    - changes to tidal inundation;
    - erosion and scouring; and
    - sedimentation and sediment deposition.
- Once modelling has been undertaken to predict the potential spatial re-distribution of mangroves and algal mats that may occur in response to sea level rise, the proposed Project layout will be overlaid within the modelling. This will be used to predict if any changes in the spatial distribution of mangroves and algal mats are likely to occur as a result of the Project layout. If the Project layout is deemed to have a negative effect on the ability of mangroves and algal mats to adjust to sea level rise, then changes will be made to the Project layout and design (whilst remaining within the Development Envelope) to prevent this negative affect. Reiteration of the design process will occur until impacts are deemed acceptable.

5.2.7 RESIDUAL IMPACTS

The Project will avoid or minimise impacts to coastal processes. Minor changes to local coastal processes are possible, but no significant impacts are expected.

5.2.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise direct and indirect impacts on coastal processes, it is concluded that the EPA objective can be met. It will be possible to re-locate Project components or re-design the Project layout if necessary (within the Development Envelope) to meet the EPA objective.

5.3 MARINE ENVIRONMENTAL QUALITY

5.3.1 EPA OBJECTIVE

To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.

5.3.2 GUIDANCE

- *Environmental Assessment Guideline 3 – Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment* (EPA, 2009)
- *Environmental Assessment Guideline 7 – Marine Dredging Proposals* (EPA, 2011)
- *Environmental Assessment Guideline 15 – Protecting the Quality of Western Australia's Marine Environment* (EPA, 2015)
- *Pilbara Coastal Water Quality Consultation Outcomes — Environmental Values and Environmental Quality Objectives,* Department of Environment, Government of Western Australia, Marine Series Report No. 1 (Department of Environment, 2006)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.3.3 CONSULTATION

- K+S anticipates a high level of public interest in the impact on marine environmental quality given the Exmouth Gulf ecosystem is an important community and industry asset for both recreational and commercial fishing activities that are dependent on a high level of marine environmental quality.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.

- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.3.4 BASELINE INFORMATION

5.3.4.1 LEVELS OF ENVIRONMENTAL PROTECTION

The environmental quality of the coastal waters of Western Australia are managed through the EPA establishing a framework that involves setting different Levels of Environmental Protection (LEP) over particular areas of the marine environment on the basis of the existing water quality and uses. Each LEP, (defined as Maximum, High, Moderate or Low) is characterised by a different set of Environmental Quality Criteria (EQC) stating the expectation for maintenance of water quality and the abundance, biomass and diversity of the biota. These details are summarised in *Environmental Assessment Guideline 15* (EAG15) – *Protecting the Quality of Western Australia's Marine Environment* (EPA, 2015).

EAG 15 states that the EPA expects proponents of new activities to demonstrate how their proposal will meet the EPA objective for marine environmental quality. Definitions presented for these levels of protection in EAG 15 require that in Maximum LEP areas there would be no detectable change permitted in levels of contaminants or water quality variables or in the abundance, biomass and diversity of local biota due to industrial discharges. In High LEP areas, small changes in levels of contaminants or water quality variables would be tolerated but with no detectable change in the abundance, biomass and diversity of local biota (EPA, 2015).

As shown in Figure 12, adjacent to the proposed Ashburton Salt Project, the waters of Urala Creeks north and south, and the coastal waters southward of Locker Point have been recommended for Maximum Protection, whilst the waters to the north have been recommended for High Protection (Department of Environment, 2006). In addition, EPA (2015) states that a Low LEP area might be allowed around a point of discharge, but only if the discharge can be technically justified and changes to ecosystem integrity from natural background are limited in extent (EPA, 2015).

5.3.4.2 BACKGROUND WATER QUALITY

Most of the baseline water quality data available has been obtained from locations south of the proposed Ashburton Salt Project during investigations for the Yannarie project (Oceanica, 2006), or north via the Wheatstone project (MScience, 2009). These data provide a useful indication of local background water quality, although there may be some differences due to different bathymetry and geomorphology of the sampling areas. It is anticipated that site specific and local water quality baseline data will be collected as part of the EIA for the Ashburton Salt Project.

Salinity

For the Yannarie project, salinity was measured a number of times between September 2004 and December 2005 at sites along creeks south of Hope Point and in near-shore waters from Tent Point southwards (Oceanica, 2006). Salinity measurements at sites within creeks and along the coast, are relatively high compared to further offshore in Exmouth Gulf (McKinnon & Ayukai, 1996) and generally increased with distance up the creeks (Table 2). The observed salinity gradient was attributed to the high evaporation rates and low input of water from rainfall or run-off leading to a

build-up in salinity over time in the intertidal sediment and water. Oceanica (2006) noted that it would be likely that pulses of the higher salinity that builds up in the creeks would exit the creeks and disperse into the near coastal waters due to tidal exchange (Plate 4). Measured salinity in the nearshore waters ranged from 38 parts per thousand (ppt) to 41 ppt. Salinity midway along the creek ranged up to 45 ppt and an extreme of 65 ppt was measured at the head of one of the creeks (Oceanica, 2006).

Table 2: Summary of salinity data
(Oceanica, 2006)

Location	Median	80th %ile	20th %ile	Number of samples
Upper creek	43.7	53.5	38.8	19
Mid-creek	44.4	45.7	37.4	5
Mouth of creek	41.5	43.5	37.8	14
Combined creek data	42.5	46.5	38.1	39
Nearshore	37.9	40.9	35.9	8

Dissolved oxygen and pH

Dissolved oxygen (DO) levels and pH were measured by Oceanica (2006) for the historical Yannarie project.). The DO levels were all at least 99% saturation at locations ranging from upper Hope Creek to the Central Gulf. The range of pH was 8.1 to 8.2, independent of location.

Water temperature

Oceanica measured marine water temperatures adjacent to the historical Yannarie project on a monthly basis for 10 months from September 2004 to June 2005. Minimum water temperatures were measured in September 2004 and ranged from 18.1˚C to 20.6˚C (Oceanica, 2006). These values are significantly lower than those measured at the same time of year by Ayukai and Miller (1998) (22-23˚C) suggesting that, as found elsewhere along WA's coast, there can be a significant inter-annual variation in water temperatures due to the influence of the Indonesian through-flow (Oceanica, 2006). The maximum water temperatures measured by Oceanica were in mid-January 2005, with a range of 27.1˚C to 32.3˚C. The primary factors affecting temperature after season, were the time of day and the depth of water (Oceanica, 2006).

Nutrients and chlorophyll-a

Oceanica (2006) also measured ammonium, ortho-phosphorus and nitrate+nitrite concentrations on the east coast of the Gulf. The results clearly showed that ammonium concentrations were generally higher upstream in the creeks (r2=0.324; based on correlation from nearshore to upper, with nearshore set as 1 and upper set as 4). Ortho-phosphorus concentrations are also likely to increase in creeks (r2=0.125), however, there was no trend with nitrate+nitrite (r2=0.047). These results appear to confirm that processes in the mangrove/algal mat area are important for generating biologically available nutrients in the water column (Oceanica, 2006).

The chlorophyll-a monitoring results strongly suggest that the higher bio-available nutrient concentrations in the creeks are being reflected in higher phytoplankton productivity (measured as chlorophyll-a). The results also suggest that there may be a seasonal cycle in productivity with higher productivity appearing to occur in winter months (Oceanica, 2006).

Turbidity

MScience undertook a review of background water turbidity north of the Ashburton Salt Project within the Wheatstone project area (MScience, 2009). It used a combined approach of field measurements and remote sensing using four years of MODIS optical satellite images. The conclusions of the study were that the area routinely experiences relatively low turbidity, with median turbidity at both nearshore and offshore survey locations ranging from 1- 3 Nephelometric Turbidity Units (NTU) and Total Suspended Solids (TSS) ranging from 2- 5 mg/L (MScience, 2009).

However, the area experiences occasional cyclones and heavy rainfall events during the summer period, which results in elevated turbidity for a number of weeks. Based on turbidity measurements collected by a turbidity sensor deployed in the area during Cyclone Dominic in late January 2009, the median turbidity during the 24-hour period when the cyclone passed over was 77 NTU, with the 80th percentile exceeding 143 NTU. Turbidity in the Wheatstone project area remained in excess of 20 NTU for more than ten days after the passage of the cyclone due to strong discharges from the nearby Ashburton River. Even discounting the periodic effects of cyclones, the median turbidity in the nearshore area (within the 5 m isobath) was generally elevated and more variable during both summer and winter periods, averaging 7- 8 NTU, due to strong winds and wave action causing re-suspension of sediment particles in these shallow nearshore areas (MScience, 2009).

Nearshore waters in the vicinity of the Ashburton Salt Project appear to have an elevated turbidity in the vicinity of tidal creek outlets (Plate 4).

Metals

MScience undertook a review of marine water metals content, north of the Ashburton Salt Project within the Wheatstone project area. Most of the metals analysed were below the recommended Environmental Quality Criteria specified for the protection of North West Shelf ecosystems (Wenziker et al., 2006). The exceptions were zinc and aluminium (MScience, 2009).

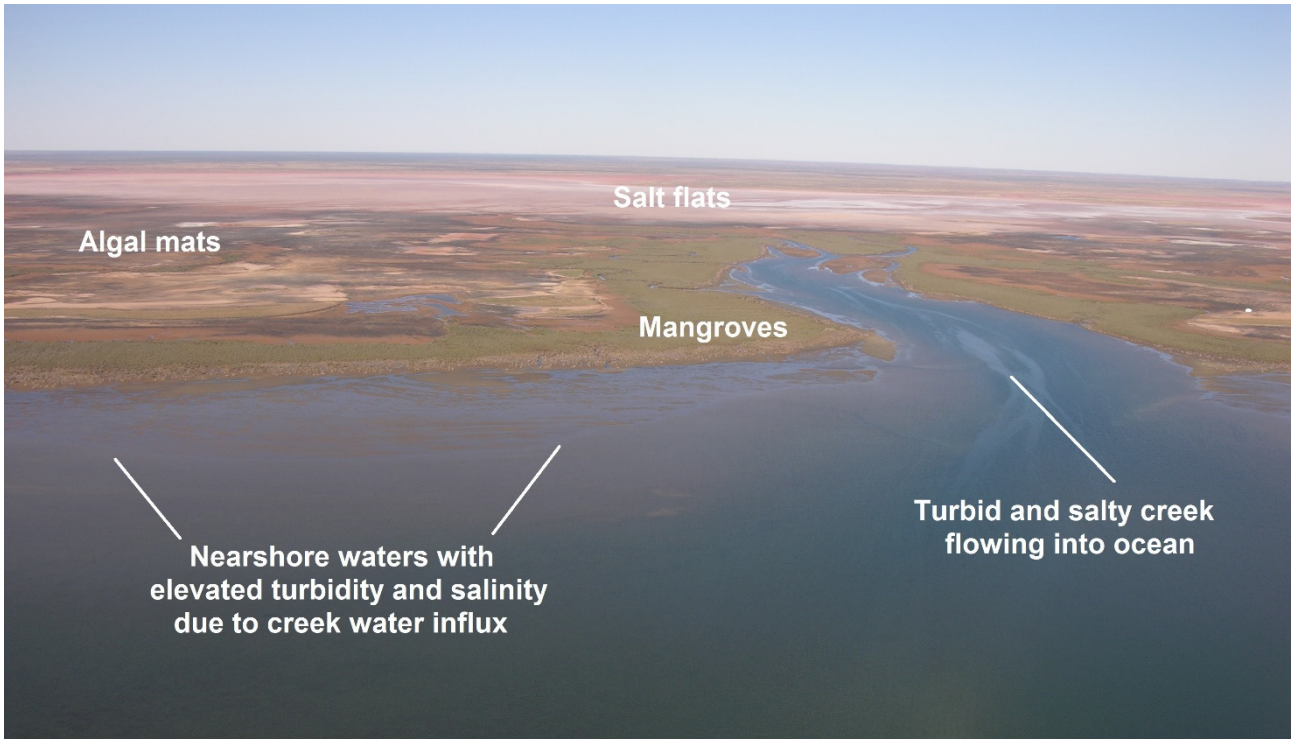


Plate 4: Typical marine water photograph at creek outlet on eastern side of Exmouth Gulf

5.3.5 IMPACT ASSESSMENT

Potential impacts to marine environmental quality resulting from the Ashburton Salt Project include:

- Bitterns discharge into the ocean causing an elevation in naturally occurring salts or metals above background that may affect marine biota.
- Seepage from salt ponds causing local changes in marine water quality (predominantly salinity) in nearby tidal creeks and inshore marine waters.
- Dredging (if undertaken) causing an elevation in water turbidity which may affect marine biota.
- Disturbance of acid sulphate soils or sediment via excavation or dredging, increasing water acidity and introducing contaminants such as metals, possibly affecting marine biota.
- Hydrocarbon spills causing water contamination and affecting marine biota.

5.3.6 MITIGATION MEASURES

The following mitigation measures are proposed:

- Discharging bitterns to the ocean via an appropriately designed and located infrastructure, to ensure adequate dilution of bitterns such that background marine water quality is achieved at the edge of an acceptable mixing zone. Bitterns discharge will be managed in a way which maintains background water quality and prevents unacceptable impacts on receiving habitats and biota as demonstrated by modelling and monitoring.
- Ensuring bitterns discharge is subject to a comprehensive management and monitoring plan.
- Undertaking a study to predict the likely seepage from salt ponds into the groundwater and surrounding tidal creeks/nearshore marine waters. The results of the study will be used to

implement design and management measures as necessary to minimise impacts on groundwater quality and potential flow-on effects to the surrounding environment.
- Dredging will be avoided or minimised if undertaken.
- Any dredging proposed, will be modelled to demonstrate turbidity related impacts on sensitive receptors (such as coral and seagrass) are as low as reasonably practicable.
- Any dredging proposed will be subject to a management and monitoring plan.
- Identifying any acid sulphate soils or sediment that could potentially be disturbed by the Project and if present, implementing an Acid Sulphate Soils Management Plan to prevent contamination arising.
- Undertaking a Hydrocarbon Spill Risk Assessment and implementing an appropriate Hydrocarbon and Spill Management Plan.

5.3.7 RESIDUAL IMPACTS

With successful implementation of the above management measures, any residual impacts should be minor.

5.3.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise direct and indirect impacts on marine environmental quality, it is concluded that the EPA objective can be met.

5.4 MARINE FAUNA

5.4.1 EPA OBJECTIVE

To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.

5.4.2 GUIDANCE

- *Environmental Assessment Guideline 5 – Protecting Marine Turtles from Light Impacts* (EPA, 2010)
- *Environmental Assessment Guideline 7 – Marine Dredging Proposals* (EPA, 2011)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.4.3 CONSULTATION

- K+S anticipates a high level of public interest in the impact on marine fauna given the Exmouth Gulf ecosystem is an important habitat for marine fauna such as whales, dugong, turtles, fish, prawns and other species.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;

- results of studies;
- predicted impacts;
- proposed management measures; and
- residual impacts and risks.

- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.
- Informal discussions have occurred with the local prawn fishing company to begin gathering information on the local prawn fishing industry and its key areas of interest regarding potential Project impacts.

5.4.4 BASELINE INFORMATION

The Exmouth Gulf is an important habitat for whales and dugongs, and supports a valuable prawn fishery. The whales and dugongs, along with sharks and reptiles (turtles, sea snakes) found in the region are protected under State and Federal legislation. Exmouth Gulf also supports a diverse array of tropical fish (Oceanica, 2006).

5.4.4.1 CONSERVATION SIGNIFICANT SPECIES

Under the *Environmental Protection and Biodiversity Protection Act (EPBC Act) 1999*, the Federal Department of Environment provides guidance on matters of national environmental significance. The EPBC Protected Matters Report relevant to the Ashburton Salt Project area is included as Appendix A. Table 3 below includes all marine species listed under State and Federal legislation as conservation significant that may occur in the Exmouth Gulf waters, identified via previous literature reviews (Oceanica, 2006) and through the EPBC Protected Matters search (Appendix A).

Table 3: Conservation significant marine species

Legislation	Status	Species
Commonwealth EPBC Act 1999. Accessed June 2016	Critically Endangered	Short-nosed Seasnake *Aipysurus apraefrontalis* Bar-tailed Godwit (menzbieri) Limosa lapponica menzbieri (also Migratory bird)
	Endangered	Blue Whale *Balaenoptera musculus,* Southern Right Whale *Eubalaena australis* Loggerhead Turtle *Caretta caretta* Leatherback Turtle *Dermochelys coriacea* Southern Giant-Petrel *Macronectes giganteus* (also Migratory bird)
	Vulnerable	Fin Whale *Balaenoptera physalus* Humpback Whale *Megaptera novaeangliae* Sei Whale *Balaenoptera borealis* Australian Sea Lion *Neophoca cinerea* Flatback Turtle *Natator depressus* Green Turtle *Chelonia mydas* Hawksbill Turtle *Eretmochelys imbricata* Great White Shark *Carcharodon carcharias* Grey Nurse Shark *Carcharias taurus* Whale Shark *Rhincodon typus* Dwarf Sawfish *Pristis clavata* Green Sawfish *Pristis zijsron* Campbell Albatross *Thalassarche impavida* (also Migratory bird) Bar-tailed Godwit (baueri) *Limosa lapponica baueri* (also Migratory bird)
	Migratory marine species (birds not included)	Antarctic Minke Whale *Balaenoptera bonaerensis* Sei Whale *Balaenoptera borealis* Bryde's Whale *Balaenoptera edeni* Blue Whale *Balaenoptera musculus* Fin Whale *Balaenoptera physalus* Dugong *Dugong dugon* Southern Right Whale *Eubalaena australis* Humpback Whale *Megaptera novaeangliae*

Legislation	Status	Species
		Killer Whale *Orcinus orca* Sperm Whale *Physeter macrocephalus* Indo-Pacific Humpback Dolphin *Sousa chinensis* Spotted Bottlenose Dolphin *Tursiops aduncus (Arafura/Timor Sea populations)* Loggerhead Turtle *Caretta caretta* Green Turtle *Chelonia mydas* Leatherback Turtle *Dermochelys coriacea* Hawksbill Turtle *Eretmochelys imbricata* Flatback Turtle *Natator depressus* Great White Shark *Carcharodon carcharias* Whale Shark *Rhincodon typus* Reef Manta Ray *Manta alfredi* Giant Manta Ray *Manta birostris* Dwarf Sawfish *Pristis clavata* Green Sawfish *Pristis zijsron*
	Listed marine Species	Helen's Pygmy Pipehorse *Acentronura larsonae* Braun's Pughead Pipefish *Bulbonaricus brauni* Three-keel Pipefish *Campichthys tricarinatus* Pacific Short-bodied Pipefish *Choeroichthys brachysoma* Muiron Island Pipefish *Choeroichthys latispinosus* Pig-snouted Pipefish *Choeroichthys suillus* Ringed Pipefish *Doryrhamphus dactyliophorus* Cleaner Pipefish *Doryrhamphus janssi* Many-banded Pipefish *Doryrhamphus multiannulatus* Flagtail Pipefish *Doryrhamphus negrosensis* Ladder Pipefish *Festucalex scalaris* Tiger Pipefish *Filicampus tigris* Brock's Pipefish *Halicampus brocki* Mud Pipefish *Halicampus grayi* Glittering Pipefish *Halicampus nitidus* Spiny-snout Pipefish *Halicampus spinirostris* Ribboned Seadragon *Haliichthys taeniophorus* Beady Pipefish *Hippichthys penicillus* Western Spiny Seahorse *Hippocampus angustus* Spiny Seahorse *Hippocampus histrix* Spotted Seahorse, Yellow Seahorse *Hippocampus kuda* Flat-face Seahorse *Hippocampus planifrons* Three-spot Seahorse *Hippocampus trimaculatus* Tidepool Pipefish *Micrognathus micronotopterus* Rock Pipefish *Phoxocampus belcheri* Pipehorse *Solegnathus hardwickii* Indonesian Pipefish *Solegnathus lettiensis* Blue-finned Ghost Pipefish *Solenostomus cyanopterus* Rough-snout Ghost Pipefish *Solenostomus paegnius* Double-ended Pipehorse *Syngnathoides biaculeatus* Bend Stick Pipefish *Trachyrhamphus bicoarctatus* Straight Stick Pipefish *Trachyrhamphus longirostris* Dugong *Dugong dugon* New Zealand Fur Seal *Arctocephalus forsteri* Australian Sea Lion *Neophoca cinerea* Horned Seasnake *Acalyptophis peronii* Short-nosed Seasnake *Aipysurus apraefrontalis* Dubois' Seasnake *Aipysurus duboisii* Spine-tailed Seasnake *Aipysurus eydouxii* Olive Seasnake *Aipysurus laevis* Stokes' Seasnake *Astrotia stokesii* Spectacled Seasnake *Disteira kingii* Olive-headed Seasnake *Disteira major* Elegant Seasnake *Hydrophis elegans* Turtle-headed Seasnake *Emydocephalus annulatus* North-western Mangrove Seasnake *Ephalophis greyi* Spotted Seasnake *Chitulia ornate* (previously: *Hydrophis ornatus*) Yellow-bellied Seasnake *Pelamis platurus* Loggerhead Turtle *Caretta caretta* Green Turtle *Chelonia mydas* Leatherback Turtle *Dermochelys coriacea* Hawksbill Turtle *Eretmochelys imbricata* Flatback Turtle *Natator depressus* Fork-tailed Swift *Apus pacificus* Great Egret *Ardea modesta* (previously: *Ardea alba*) Cattle Egret *Ardea ibis* Oriental Plover *Charadrius veredus* Oriental Pratincole *Glareola maldivarum* White-bellied Sea-Eagle *Haliaeetus leucogaster*

Legislation	Status	Species
		Barn Swallow *Hirundo rustica* Silver Gull *Chroicocephalus novaehollandiae* (previously: *Larus novaehollandiae*) Bar-tailed Godwit *Limosa lapponica* Southern Giant-Petrel *Macronectes giganteus* Rainbow Bee-eater *Merops ornatus* Grey Wagtail *Motacilla cinerea* Yellow Wagtail *Motacilla flava* Osprey *Pandion haliaetus* Wedge-tailed Shearwater *Ardenna pacifica* Sooty Tern *Onychoprion fuscata* (previously: *Sterna fuscata*) Fairy Tern *Sternula nereis* (previously: *Sterna nereis*) Campbell Albatross *Thalassarche impavida*
	Whales and other cetaceans	Minke Whale *Balaenoptera acutorostrata* Antarctic Minke Whale *Balaenoptera bonaerensis* Sei Whale *Balaenoptera borealis* Bryde's Whale *Balaenoptera edeni* Blue Whale *Balaenoptera musculus* Fin Whale *Balaenoptera physalus* Common Dolphin *Delphinus delphis* Southern Right Whale *Eubalaena australis* Pygmy Killer Whale *Feresa attenuata* Short-finned Pilot Whale *Globicephala macrorhynchus* Risso's Dolphin *Grampus griseus* Pygmy Sperm Whale *Kogia breviceps* Dwarf Sperm Whale *Kogia simus* Fraser's Dolphin *Lagenodelphis hosei* Humpback Whale *Megaptera novaeangliae* Blainville's Beaked Whale *Mesoplodon densirostris* Killer Whale *Orcinus orca* Melon-headed Whale *Peponocephala electra* Sperm Whale *Physeter macrocephalus* False Killer Whale *Pseudorca crassidens* Indo-Pacific Humpback Dolphin *Sousa chinensis* Spotted Dolphin *Stenella attenuata* Striped Dolphin *Stenella coeruleoalba* Long-snouted Spinner Dolphin *Stenella longirostris* Rough-toothed Dolphin *Steno bredanensis* Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) *Tursiops aduncus (Arafura/Timor Sea populations)* Spotted Bottlenose Dolphin *Tursiops aduncus* Bottlenose Dolphin *Tursiops truncatus s. str.* Cuvier's Beaked Whale *Ziphius cavirostris*
Western Australian Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 2015	Schedule 1: critically endangered fauna (CR)	Short-nosed Seasnake *Aipysurus apraefrontalis*
	Schedule 2: endangered fauna (EN)	Blue Whale *Balaenoptera musculus* Loggerhead Turtle *Caretta caretta* Fin Whale *Balaenoptera physalus* Sei Whale *Balaenoptera borealis*
	Schedule 3: vulnerable fauna (VU)	Southern Right Whale Eubalaena australis Australian Sea Lion *Neophoca cinerea* Leatherback Turtle Dermochelys coriacea Flatback Turtle *Natator depressus* Green Turtle *Chelonia mydas* Hawksbill Turtle *Eretmochelys imbricata* Great White Shark *Carcharodon carcharias* Grey Nurse Shark *Carcharias taurus* Green Sawfish *Pristis zijsron* Campbell Albatross *Thalassarche impavida* Bar-tailed Godwit Limosa lapponica Sperm Whale *Physeter macrocephalus*
	Schedule 5: Migratory birds - international agreement (IA)	See Table 5: Migratory Birds Listed under EPBC Act 1999
	Schedule 6: conservation dependent fauna (CD)	Humpback Whale *Megaptera novaeangliae*
	Schedule 7: Other specially protected fauna (OS)	Whale Shark *Rhincodon typus* Dugong *Dugong dugon* New Zealand Fur Seal *Arctocephalus forsteri*

5.4.4.2 WHALES

The migration of Humpback whales both north and south past Exmouth Gulf follows predictable but complicated patterns each season. In summary:

1. Humpback whales are found in Exmouth Gulf from early August until late November each year.
2. Whale numbers peak inside the Gulf during the first two weeks of October, coinciding with the arrival of southbound cow/calf pods from the Kimberley region.
3. Cow/calf pods can rest and nurse inside the Gulf for periods of between one and two weeks before continuing their southern migration. This makes the Gulf a critical resting area for this portion of the population. It is likely that water temperature plays a role in determining when whales, particularly cow/calf pairs trying to minimise metabolic expenditures, enter Exmouth Gulf. Cow/calf numbers inside the Gulf peak during the first two weeks of October, at a similar time that the sea surface temperature inside the Gulf becomes equal to that found offshore at the same latitude.
4. Adult males can remain in Exmouth Gulf, or the immediate area, for periods up to 25 days and perhaps longer.
5. Males enter Exmouth Gulf to find or attract females with which to mate. They use a variety of competitive techniques including fighting and singing to attract females.
6. Whales are found predominantly in water depths greater than 7 m with the greatest number of whales being sighted in the deepest (~20 m) portions of the Gulf.
7. A unique behaviour (mud-rolling) has been observed in the Gulf. The function of this behaviour is not clear but it may be linked to parasite removal, or wound healing/packing after competitive battles (Oceanica, 2006).

Surveys of Humpback whales within the Exmouth Gulf undertaken by the Centre for Whale Research (CWR) in 2004 and 2005 recorded 539 Humpback pods (consisting of 848 whales and 125 calves). The locations recorded show that the preferred Humpback whale resting area in the Gulf is within the deeper waters (15–20 m) of the western Gulf. Surveys also show no observable difference between the preferred habitat of cow/calf pods and that of pods without calves (Centre for Whale Research, 2005).

Figure 13 shows the location of all pods of whales sighted via aerial surveys in 2004/2005 (Centre for Whale Research, 2005).

5.4.4.3 DUGONGS

During the 2004 and 2005 surveys by the CWR, 1567 dugongs were sighted with peak numbers observed during the months of May and November. Herds containing cow/calf pairs accounted for 14% (86/610) of all herd sightings. Dugongs were predominantly sighted in the south-eastern portion of the Gulf in water less than 6 m deep. Figure 14 shows the location of dugongs recorded in the 2004 and 2005 surveys (Centre for Whale Research, 2005).

In 2010, Chevron commissioned RPS to undertake a dugong aerial survey in both the immediate vicinity of the coastal site of the Wheatstone project and in Exmouth Gulf (as a comparison site). The survey was undertaken during August 2010 (RPS, 2010). The results were as follows:

1. The estimated population of dugongs within the Exmouth Gulf was 1760 (95% Confidence Interval (CI): 1,369–2,088).
2. The density of dugongs in the Exmouth Gulf was estimated to be 0.59 (95% CI: 0.46–0.70) dugongs per km^2.
3. Within Exmouth Gulf, most dugongs were distributed in the intertidal area of the gulf's eastern coast, but were also associated with offshore reef habitat further north.
4. Thirty-nine dugongs were recorded as foraging in Exmouth Gulf, while the proportion of feeding dugongs compared with the total number of animals observed was 79%.
5. Dugongs were primarily foraging in waters less than 10 m deep, and within 5 km of the coast or islands.
6. Solitary animals made up the majority of size classes observed, with most herds consisting of two animals.
7. Herds of up to eight animals were recorded within Exmouth Gulf.

Figure 15 shows the location of dugongs recorded in the 2010 survey (RPS, 2010).

The differences in distribution of dugongs observed by the CWR (2005) and RPS (2010) as shown in Figures 14 and 15 are likely due to different sampling density and the times of the year the surveys were undertaken. The CWR conducted 17 aerial flights at different times ranging throughout the year in 2004 and 2005, whereas RPS undertook flights on only two days from the 7-8 August 2010. Therefore, the CWR may provide a more comprehensive picture of overall dugong seasonal activity within the Exmouth Gulf, although this study was conducted over 10 years ago and may not account for more recent changes in population dynamics (given dugong populations can be transient).

5.4.4.4 TURTLES

Four species of marine turtle are known to occur in the region: Hawksbill Turtle (*Eretmochelys imbricata*); Flatback Turtle (*Natator depressus*); Green Turtle (*Chelonia mydas*) and Loggerhead Turtle *Caretta caretta*. The Green Turtle is the most common to the Ningaloo region. It is a large (up to 205 kg) herbivorous reptile of tropical and subtropical waters and its diet consists of algae and seagrasses. In some areas they are recorded as feeding only on algae, while in others they feed solely on seagrasses. Of the four species, only the Green Turtle eats seagrasses regularly and on a large scale (Oceanica, 2006).

The main nesting period for each of the four turtle species is:

- Hawksbill: July to March.
- Green: September to March.
- Flatback: September to March.
- Loggerhead: October to March.

Turtles are most vulnerable during the nesting period when they congregate in shallow water near the breeding beaches, come ashore to lay eggs, and subsequently when the hatchlings make their way across the beaches to the water.

During the 2004 and 2005 surveys by the CWR, 835 turtles were sighted. Turtles were not able to be identified to species level at the time of sighting. However, boat-based sightings by CWR suggest that the principle turtle species in Exmouth Gulf during the August to November period is the Green

Turtle (*Chelonia mydas*). Hawksbill Turtles (*Eretmochelys imbricata*) are also frequently sighted in mangrove creeks.

Figure 16 shows the location of all turtles sighted via aerial surveys in 2004 and 2005 (Centre for Whale Research, 2005). It is possible that turtles may nest in sandy beach areas adjacent to the proposed Ashburton Salt Project, although no nesting site survey has been completed in these areas to date. It is anticipated that K+S will undertake further investigations into turtle nesting in the vicinity of the Project area.

5.4.4.5 PRAWNS AND OTHER COMMERCIAL FISHERY SPECIES

The Exmouth Gulf Prawn Managed Fishery (EGPMF)is the only commercial fishery that operates continuously in the Exmouth Gulf and is one of Western Australia's three most valuable managed fisheries. It is the second largest prawn fishery in Western Australia after the Shark Bay Prawn Fishery. The EGPMF targets Western King Prawns (*Penaeus latisulcatus*) and Brown Tiger Prawns (*P. esculentus*), with lesser, but still commercially significant, catches of Endeavour Prawns (*Metapenaeus endeavouri*) and occasionally Banana Prawns (*P. merguiensis*). The EGPMF is the second largest prawn trawl fishery in WA, with a landed value in 2011 of around $11 million per annum (Department of Fisheries, 2015).

The only other commercial fishery currently operating in the Gulf is the small scale Exmouth Gulf Beach Seine Fishery which does not operate every year (Department of Fisheries, 2015).

5.4.5 IMPACT ASSESSMENT

The following potential impacts may occur to marine fauna:

- Impacts to or reductions of benthic communities and habitat, causing a reduction in ecosystem productivity and flow-on affects within the food chain, consequentially impacting marine fauna (as outlined in Section 5.1). For example:
    - Dredging impacting seagrass beds, which are important habitat for dugong, turtle and prawns.
    - Reductions in mangrove or algal mat communities resulting in fauna habitat loss, as well as reduced nutrient flows into the Exmouth Gulf.
    - Impacts to coral reefs, with consequent impacts to marine fauna that rely on the reefs.
- Changes in marine environmental quality, consequentially impacting marine fauna (as outlined in Section 5.3). For example:
    - Bitterns discharge into the ocean causing an elevation in naturally occurring salts or metals above background, which may affect marine biota.
    - Seepage from salt ponds causing local changes in marine water quality (predominantly salinity) in nearby tidal creeks and inshore marine waters, which may affect marine biota.
    - Dredging (if undertaken) causing an elevation in water turbidity which may affect marine biota.
    - Disturbance of acid sulphate soils or sediment via excavation or dredging, increasing water acidity and introducing contaminants such as metals, possibly affecting marine biota.
    - Hydrocarbon spills causing water contamination and affecting marine biota.

- Direct loss of marine fauna through boat strikes.
- Direct loss of marine fauna via entrapment in seawater intake/s.
- Impacts to breeding habitat of marine fauna, for example sea turtle nesting grounds (if they exist within the Project area) such as direct disturbance or lighting disturbance.
- Introduction of marine pests or diseases in ballast water or on ship hulls, causing physical damage or stress to marine biota.

5.4.6 MITIGATION MEASURES

The following mitigation measures are proposed:

- Mitigation measures to prevent impacts to benthic communities and habitat as outlined in Section 5.1.
- Mitigation measures to prevent impacts to marine environmental quality as outlined in Section 5.3.
- Management plans for shipping and Project related boat traffic to prevent marine fauna strikes.
- Design and management of the seawater intake/s to prevent or minimise fauna entrapment.
- Identification of any potential marine fauna breeding habitat, within the Project area of influence, and ensure appropriate Project design and management to prevent impacts.
- Managing and monitoring ship ballast water/hulls to avoid pest or disease introduction.

5.4.7 RESIDUAL IMPACTS

With successful implementation of the above management measures, any residual impacts should be minor.

5.4.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise direct and indirect impacts on marine fauna, it is concluded that the EPA objective can be met.

5.5 FLORA AND VEGETATION

5.5.1 EPA OBJECTIVE

To maintain representation, diversity, viability and ecological function at the species, population and community level.

5.5.2 GUIDANCE

- *Guidance Statement 51 – Terrestrial Flora and Vegetation Surveys for environmental impact assessment in WA* (EPA, 2004)
- *Position Statement 2 – Environmental Protection of Native Vegetation in WA* (EPA, 2000)
- *Position Statement 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002)

- *Environmental Protection Bulletin 20 - Protection of naturally vegetated areas through planning and development* (EPA, 2013)
- *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA and DPaW, 2015)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.5.3 CONSULTATION

- K+S anticipates a moderate level of public interest in the impact on flora and vegetation.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.5.4 BASELINE INFORMATION

The flora survey of the historical Yannarie project area recorded 192 flora species – none of these were listed as conservation significant. The Cape Range area is a meeting area between two different climates: southwest WA with its winter rainfall, and northern WA with its cyclonic summer rainfall. As a result of this climate meeting zone, some local plant species are at the boundaries of their known distribution. A number of the flora species recorded during the survey of the Yannarie project area were found to be at the geographical boundaries of their distribution. There were twenty-one (21), sixteen (16) and four (4) flora species found at the northern, western and southern ends of their distribution respectively (totalling over 20% of the recorded flora at distributional limits) (Biota Environmental Sciences, 2005).

Eleven (11) terrestrial vegetation types were recorded from the Yannarie project area during the survey, representing three broad groupings based on landform position. None of these represent Threatened Ecological Communities (TECs) or vegetation types that are otherwise of special conservation significance (Biota Environmental Sciences, 2005).

5.5.5 IMPACT ASSESSMENT

The following potential impacts may occur to vegetation and flora:

- Direct clearing:
    - The salt ponds will result in very little or no clearing of vegetation because they are located on the salt flats which are devoid of vegetation (Plate 5).
    - It is not yet possible to quantify clearing of vegetation for other infrastructure where the location and layout has not been finalised and vegetation surveys have not yet been conducted.

- Indirect impacts through:
    - changes in surface water flows;
    - changes in tidal inundation; and
    - contamination through acid sulphate soils or hydrocarbon spills.

5.5.6 MITIGATION MEASURES

Impacts are proposed to be minimised through the following mitigation measures:

- Minimising clearing of terrestrial vegetation by locating the majority of the Project (salt ponds) on the salt flats, which are devoid of vegetation (Plate 5).
- Minimising indirect impacts as follows:
    - Ensuring through engineering design that tidal inundation is not impeded significantly.
    - Ensuring through engineering design that surface water flows are not altered in a way that could cause significant indirect impacts to mangroves and algal mats.
    - Identifying any acid sulphate soils that could potentially be disturbed by the Project and if present implementing, as appropriate, an Acid Sulphate Soils Management Plan to prevent contamination arising.
    - Undertaking a Hydrocarbon Spill Risk Assessment and implementing, as appropriate, a Hydrocarbon and Spill Management Plan.

5.5.7 RESIDUAL IMPACTS

With successful implementation of the above management measures, any residual impacts should be minor.

5.5.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise direct and indirect impacts on flora and vegetation, it is concluded that the EPA objective can be met.

5.6 TERRESTRIAL FAUNA

5.6.1 EPA OBJECTIVE

To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.

5.6.2 GUIDANCE

- *Guidance Statement 20 – Sampling of Short Range Endemic Invertebrate Fauna for environmental impact assessment in WA* (EPA, 2009)
- *Guidance Statement 56 – Terrestrial Fauna Surveys for environmental impact assessment in WA* (EPA, 2004)
- *Position Statement 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002)

- *Technical Guide on Terrestrial Vertebrate Fauna Surveys for environmental impact assessment* (EPA, 2010)
- *Environmental Protection Bulletin 20 - Protection of naturally vegetated areas through planning and development* (EPA, 2013)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.6.3 CONSULTATION

- K+S anticipates a high level of public interest in the impact on terrestrial fauna given the Project area coincides with an area that is listed as a Nationally Important Wetland (Figure 4), known as a habitat for migratory birds. Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.6.4 BASELINE INFORMATION

A fauna survey of the Yannarie project area recorded 138 vertebrate taxa including 57 bird species (Biota Environmental Sciences, 2005).

5.6.4.1 TERRESTRIAL CONSERVATION SIGNIFICANT FAUNA (NON-MIGRATORY)

Previous database searches and literature reviews indicated that several conservation significant terrestrial fauna species may be present in the area surrounding the Yannarie project (Biota Environmental Sciences, 2005).

Table 4 lists potential conservation significant terrestrial fauna in the area based on the previous Yannarie survey and the EPBC protected matters search (Appendix A).

Based on habitat assessment, only three of these species are considered likely to occur in the Project Development Envelope due to habitat suitability:

- Little North-western Mastiff Bat, *Mormopterus loriae coburgiana,* Priority 1 – likely to occur in mangroves.
- Australian Fairy Tern, *Sternula nereis nereis,* Vulnerable - Likely to occur along coastal beaches. Recorded previously at Tent and Hope Point (Biota Environmental Sciences, 2005).
- *Lerista planiventralis maryani*, Priority 1 - Could occur in sandy dune habitats.

It is possible that the other species listed in Table 4 below may occur in the vicinity of project ancillary infrastructure such as the access/haul roads (Figure 1 provides indicative road routes which may change), service corridors, borrow pits and a quarry (the location and footprint of which are yet to be defined).

Table 4: Potential conservation significant terrestrial fauna

Common Name	Species Name	State Level	Federal Level	Likelihood of Occurrence in Development Envelope
Bilby	*Macrotis lagotis*	Schedule 3 (Vulnerable)	Vulnerable	Unlikely – habitat unsuitable
Orange Leaf-nosed Bat	*Rhinonicteris aurantius*	Schedule 3 (Vulnerable) – Pilbara form, Priority 4 – other form	Vulnerable	Unlikely – habitat unsuitable
Night Parrot	*Pezoporus occidentalis*	Schedule 1 (Critically Endangered)	Endangered	Unlikely – very few records in WA, may be locally extinct
Australian Fairy Tern	*Sternula nereis nereis*	Schedule 3 (Vulnerable)	Vulnerable	Likely to occur along coastal beaches. recorded previously at Tent and Hope Point (Biota Environmental Sciences, 2005).
Pilbara Olive Python	*Liasis olivaceus barroni*	Schedule 3 (Vulnerable)	Vulnerable	Unlikely – habitat unsuitable
Mulgara	*Dasycercus cristicauda*	Priority 4	Vulnerable	Unlikely – habitat unsuitable
Northern Quoll	*Dasyurus hallucatus*	Schedule 2 (Endangered)	Endangered	Unlikely – habitat unsuitable
Peregrine Falcon	*Falco peregrinus*	Schedule 7 (OS)	-	Unlikely – habitat unsuitable (no roosting sites)
N/A	*Lerista planiventralis maryani*	Priority 1	-	Could occur in sandy dune habitats
Little North-western Mastiff Bat	*Mormopterus loriae coburgiana*	Priority 1	-	Likely to occur in mangroves
Lakeland Downs Mouse	*Leggadina lakedownensis*	Priority 4	-	Unlikely – habitat unsuitable
Western Pebble-mound Mouse	*Pseudomys chapmani*	Priority 4	-	Unlikely – habitat unsuitable
Grey Falcon	*Falco hypoleucos*	Schedule 3 (VU)	-	Unlikely – habitat unsuitable

5.6.4.2 EPBC LISTED MIGRATORY BIRDS

Several migratory bird species listed under the *EPBC Act 1999* were recorded during surveys for the Yannarie project (Biota Environmental Sciences, 2005). The most abundant species in the study area were the Grey-tailed Tattler, Red-necked Stint, Bar-tailed Godwit and Greater Sand Plover. The number of individuals occurring in the Yannarie project area was relatively low considering the size of the area involved and the number of individuals that some sites along the Pilbara coast support (such as Barrow Island). This may be due to the extensive fringing mangroves, which may

discourage wading birds that prefer to roost on beaches, rocky promontories and other open areas (Biota Environmental Sciences, 2005).

Migratory bird sightings occurred predominantly within the mudflat areas and coastal beaches. The salt flats were generally devoid of birds (Plate 5). Roosting sites were identified along the coastal beaches and near shore islands from Tent Point southwards. No surveys for roosting sites occurred north of Tent Island (therefore the beaches and mudflats adjacent to the Ashburton Salt Project were not surveyed) (Biota Environmental Sciences, 2005).

Table 5 lists 33 potential migratory bird species listed under the EPBC Act, which may occur locally based on the previous Yannarie project survey and the EPBC protected matters search (Appendix A).

Table 5: Migratory birds listed under EPBC Act 1999

Common Name	Species Name	EPBC Act Status
Osprey	*Pandion haliaetus*	Migratory
Bar-tailed Godwit (menzbieri)	*Limosa lapponica menzbieri*	Critically Endangered, Marine and Migratory
Bar-tailed Godwit (baueri)	*Limosa lapponica baueri*	Vulnerable, Marine and Migratory
Whimbrel	*Numenius phaeopus*	Migratory
Eastern Curlew	*Numenius madagascariensis*	Migratory
Common Greenshank	*Tringa nebularia*	Migratory
Common Sandpiper	*Actitis hypoleucos*	Migratory
Grey-tailed Tattler	*Tringa brevipes*	Migratory
Terek Sandpiper	*Xenus cinereus*	Migratory
Ruddy Turnstone	*Arenaria interpres*	Migratory
Great Knot	*Calidris tenuirostris*	Migratory
Red Knot	*Calidris canutus*	Migratory
Sanderling	*Calidris alba*	Migratory
Red-necked Stint	*Calidris ruficollis*	Migratory
Sharp-tailed Sandpiper	*Calidris acuminata*	Migratory
Curlew Sandpiper	*Calidris ferruginea*	Migratory
Grey Plover	*Pluvialis squatarola*	Migratory
Pacific Golden Plover	*Pluvialis fulva*	Migratory
Lesser Sand Plover	*Charadrius mongolus*	Migratory
Greater Sand Plover	*Charadrius leschenaultii*	Migratory
Oriental Plover	*Charadrius veredus*	Migratory
Caspian Tern	*Hydroprogne caspia*	Migratory
Common Tern	*Sterna hirundo*	Migratory
Little Tern	*Sternula albifrons*	Migratory
Bridled Tern	*Onychoprion anaethetus*	Migratory
Barn Swallow	*Hirundo rustica*	Migratory
Grey Wagtail	*Motacilla cinerea*	Migratory
Yellow Wagtail	*Motacilla flava*	Migratory
Oriental Pratincole	*Glareola maldivarum*	Migratory
Fork-tailed Swift	*Apus pacificus*	Migratory
Southern Giant Petrel	*Macronectes giganteus*	Endangered, Marine and Migratory
Wedge-tailed Shearwater	*Puffinus pacificus*	Migratory
Campbell Albatross	*Thalassarche impavida*	Vulnerable, Marine and Migratory

Plate 5: Typical salt flats lacking flora and fauna habitat

5.6.5 IMPACT ASSESSMENT

The following potential impacts may occur to terrestrial fauna:

- Habitat loss through Project clearing for example:
  - Mangroves are habitat for some specialised species such as Grey-tailed Tattlers, Whimbrels and Little North-western Mastiff Bats.
  - The mudflat areas are a preferred foraging habitat for migratory wading birds.
  - The coastal beaches are a preferred roosting habitat for the majority of migratory birds.
  - Significant fauna habitat may occur the vicinity of project ancillary infrastructure such as the access/haul roads (Figure 1 provides indicative road routes which may change), service corridors, borrow pits and a quarry (the location and footprint of which are yet to be defined).
- Direct loss of fauna by vehicle or boat strikes.
- Indirect impacts such as noise, lighting or food waste causing fauna behaviour changes.

5.6.6 MITIGATION MEASURES

- Undertaking appropriate terrestrial fauna studies for the entire project footprint to identify significant species and habitat.
- Avoiding or minimising the disturbance of any significant fauna habitat identified through the above studies.

- Minimising clearing of fauna habitat by locating the majority of the Project (salt ponds) on the salt flats (which are generally devoid of fauna habitat – Plate 5).
- Minimising direct clearing and indirect impacts to mangroves (as described in Section 5.1).
- Ensuring any migratory bird foraging and roosting sites adjacent to the Ashburton Salt Project are identified and impacts avoided by careful design and management.
- Management of vehicle and boat traffic to avoid collisions with fauna.
- Management of noise, lighting and food waste to prevent impacts on fauna.

5.6.7 RESIDUAL IMPACTS

With successful implementation of the above management measures, any residual impacts should be minor. Experience at other solar salt fields has indicated a potential benefit for migratory birds and other shorebirds where the salt ponds have developed into significant habitat. attracting migratory species (Marin-Estrella, 2014).

5.6.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise direct and indirect impacts on terrestrial fauna, it is concluded that the EPA objective can be met.

5.7 HYDROLOGICAL PROCESSES

5.7.1 EPA OBJECTIVE

To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.

5.7.2 GUIDANCE

- *Position Statement 4 – Environmental Protection of Wetlands* (EPA, 2004)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.7.3 CONSULTATION

- K+S anticipates a high level of public interest in the impact on hydrological processes given the Project area coincides with an area that is listed as a Nationally Important Wetland. Maintenance of the hydrological processes of the area will be important to maintaining wetland processes and surface water/nutrient flows.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and

- residual impacts and risks.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.7.4 BASELINE INFORMATION

5.7.4.1 CATCHMENT

Hydrographic catchment boundaries have been defined by the Department of Water (DoW) for more than 3400 key sites on watercourses throughout Western Australia. The sub-catchments dataset contains polygons from which the catchment boundaries are derived. The Ashburton Salt Project is within the Ashburton River catchment and sub-catchment (Figure 17).

5.7.4.2 SURFACE FLOWS

Surface flows within the Ashburton River catchment exhibit a complex inter-relationship at a landscape scale between water courses, locations, floodplains, clay pans and a suite of longitudinal and network sand dunes. In addition, due to the arid climate and very high evaporation rate, the occurrence of overland flow is rare and is usually only associated with tropical cyclone events. The hydrology of the region is one of extremes, experiencing both severe droughts and major floods (URS, 2010).

Within the Ashburton River sub-catchment, creek lines discharge over the coastal flats towards the ocean, often via braided flow-paths. Creek flows in this region are mostly a direct response to rainfall, which is highly seasonal and variable. Most run-off occurs during the period from January to March, with peak flows consistently being recorded in February, usually as a result of major storms and cyclones. Catchment and sub-catchment discharge points are frequently a combination of direct ocean outlets, dispersal through salt flats and coastal mangrove systems, and infiltration via groundwater seeps (URS, 2010).

A hydrological study was undertaken for the historical Yannarie project (Parsons Brinkerhoff, 2006). The assessment found that during heavy rainfall events, surface water flows are likely to be captured in unnamed creeks and basins to the east of the salt flats. Some of this surface water is lost via evaporation and infiltration, whilst some flows westward towards the coast, accumulating within the salt flats that act as a large compensating basin accumulating water during cyclonic events (Figure 17 and Plate 6). However most of the time these salt flats are dry. In the vicinity of the Ashburton Salt Project, there are a number of sub-catchment surface water discharge points to the salt flats as shown in Figure 17 (Parsons Brinkerhoff, 2006).

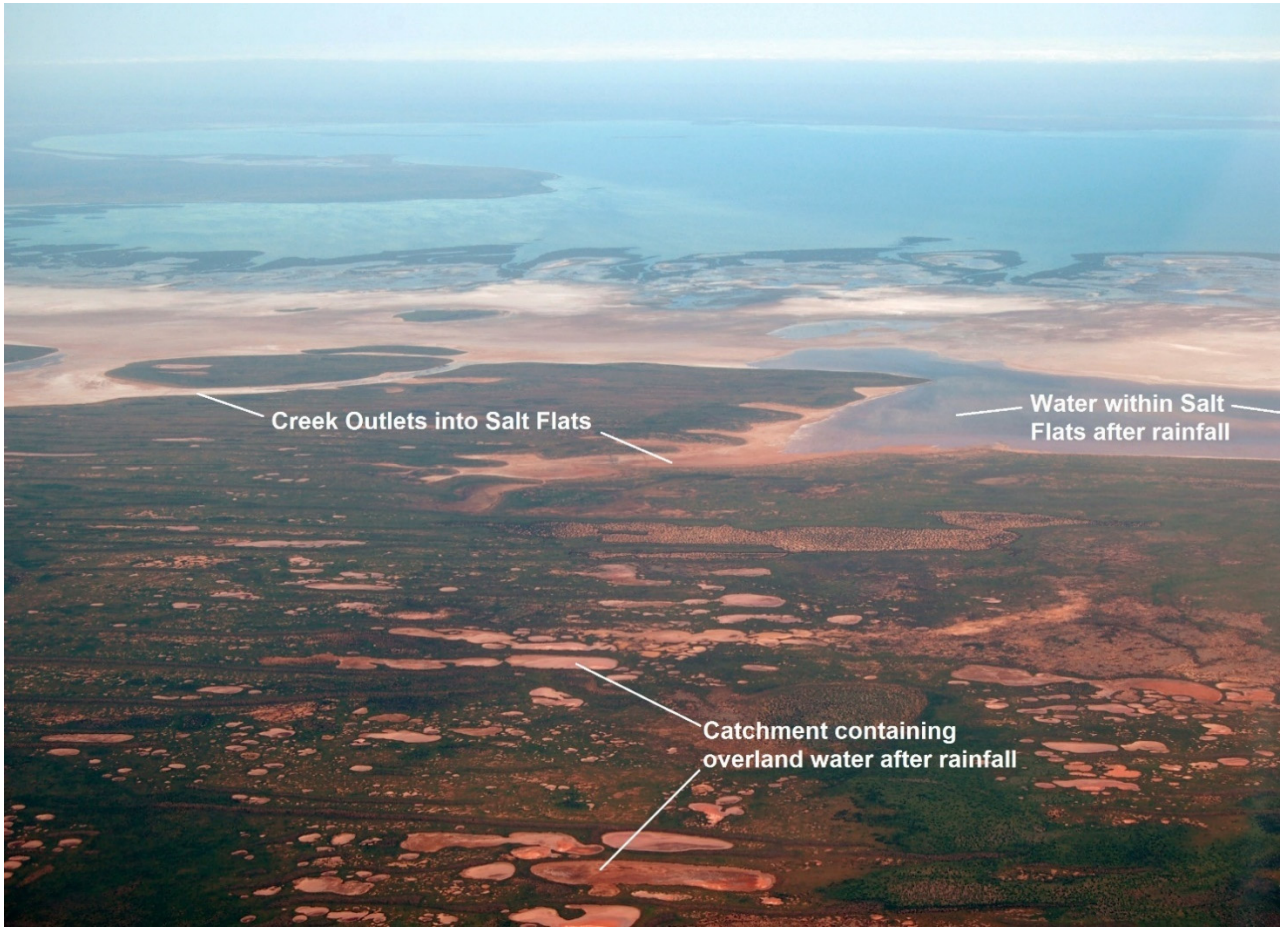


Plate 6: Aerial photograph of typical local catchment after cyclonic rainfall

5.7.4.3 COASTAL WETLAND

As outlined in Section 1.6.1, the proposed development is located within the Exmouth Gulf East wetland (WA007) which is listed in the *Directory of Important Wetlands in Australia* (ANCA, 1993) – Figure 4. The Directory describes the significance of the wetland as "An outstanding example of tidal wetland systems of low coast of northwest Australia, with well-developed tidal creeks, extensive mangrove swamps and broad saline coastal flats." The wetland consists of the following broad ecosystem units:

- **Extensive salt flats**: along the eastern side of the wetland – most of the time these are dry (except when flooding occurs during cyclonic rainfall events due to a combination of rainfall, surface water flows and storm surge). The salt flats do not support flora, vegetation or fauna habitat due to their saline nature (Biota Environmental Sciences, 2005).
- **Mud flats**: these sit at the western margin of the salt flats on the ocean side and are periodically inundated by tidal flows. Algal mats form on these mud flats in a narrow tidal range in areas that are submerged an average of 3% of the time per month or less (associated with spring tides). Mangroves occur on the coastal fringes of the mud flats in areas that are inundated on a more regular basis, often twice daily (associated with daily tides) (Biota Environmental Sciences, 2005).

- **Coastal rocky promontories and beaches:** these sit in sandy and rocky areas at the western margin of the mud flat, adjacent to the ocean. They can often also experience tidal inundation (Biota Environmental Sciences, 2005).

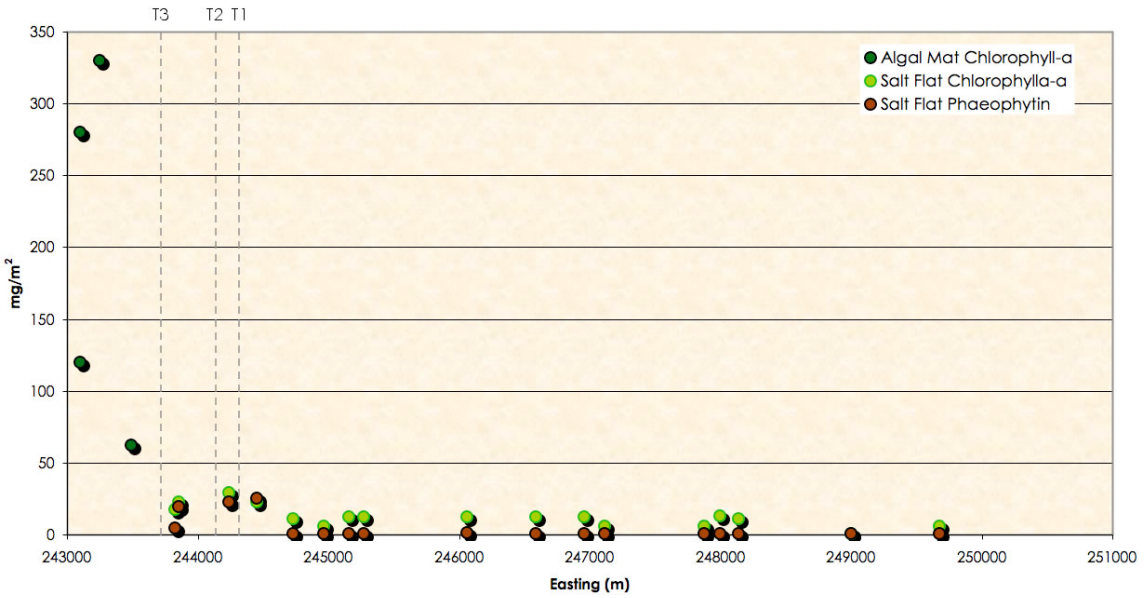
5.7.4.4 SURFACE WATER FLOWS AND COASTAL ECOSYSTEM NUTRIENT INPUTS

Mangroves

Mangrove communities are known as one of the key benthic communities that contribute nutrients into coastal ecosystems. The cycling of carbon from inorganic to organic forms through mangrove ecosystems is one of the better studied and important contributors to coastal productivity. Nitrogen, phosphorus and sulphur also cycle through inorganic and organic forms in mangrove ecosystems and are also fundamental components of autotrophic and heterotrophic proteins, biochemical energy systems and other organic compounds. These nutrients are then exported into the coastal ecosystems via the food chain, tidal flushing and with surface water flows after rainfall (Biota Environmental Sciences, 2005).

Algal mats

Biota Environmental Sciences (2005) found that another important contributor of nutrient inputs to the coastal ecosystems was the cyanobacterial algal mats that occur just beyond the tidal range of the mangroves (before the elevation increases to the salt flat areas). Cyanobacterial mats have been demonstrated to fill an important ecological function in coastal arid zone systems, fixing atmospheric nitrogen into biologically available forms. Nitrogen is exported into the ecosystem through the food chain, via tidal flushing and with surface water flows after rainfall. Biota Environmental Sciences undertook sampling of the algal mats for phaeophytin and chlorophyll-a (indicator pigments of photosynthetic activity) which showed elevated levels indicative of the biological activity with the algal mats (refer to Graph 1below) (Biota Environmental Sciences, 2005).



Graph 1: Chlorophyll-a and phaeophytin values from superficial sediment samples collected across the salt flat (dashed lines indicate approximate location of eastern edge of active algal mat on each of the three transects)
(Biota Environmental Sciences, 2005)

Salt flats

Salt flats have been suggested as having a role in large-scale nutrient cycles in other more tropical localities (Ridd et. al., 1997). There are significant differences however, between the tropical system examined in the Ridd et al. studies and the Ashburton Salt Project salt flat area. These differences highlight the distinction between other tropical studies and the arid landscape feature that has been defined as “salt flat” in this Project. The Ridd et al. (1997) study area was:

- A narrow area of tropical salt flat situated between chenier dune ridges near Cocoa Creek close to Cape Cleveland, Townsville (as opposed to an extensive arid salt flat plain in the case of the Ashburton Salt Project).
- Only 1 km from the ocean to the hinterland (between 5 and 10 km separation for the Ashburton Salt Project).
- A tropical salt flat regularly inundated by the tide on normal cycles; 4-6 days routinely each month (in the Ashburton Salt Project area only very infrequent and episodic flooding of the arid salt flat occurs after cyclonic rainfall).
- A tropical salt flat that was partly covered by algal mat (the algal mat does not occur on the salt flat in the vicinity of the Ashburton Salt Project) (Biota Environmental Sciences, 2005).

Superficial sediment samples from three transects across the salt flat were analysed for chlorophyll-a and phaeophytin by Biota as part of studies for the historical Yannarie Project. The results of this are presented in Graph 1 above. Both phaeophytin and chlorophyll-a dropped from elevated levels within algal mats, to close to detection limits on the salt flat itself. These findings suggest it is unlikely that the Project area salt flats play a significant role in providing nutrient inputs into the coastal ecosystem (Biota Environmental Sciences, 2005). Further work will be undertaken to examine this hypothesis as part of the Project EIA process.

Creek systems

As shown in Figure 17 depicting the local catchment after rainfall, creek lines discharge over the salt flats towards the ocean. The discharge points are frequently a combination of direct ocean outlets, dispersal through salt flats and coastal mangrove systems, and infiltration via groundwater seeps (URS, 2010). There are a number of creek discharge points, both to the salt flats (which act as a large compensating basin) and directly into the ocean as shown in Figure 17 (Parsons Brinkerhoff, 2006).

Nitrogen (N) and phosphorus (P) are considered to be the key nutrients in creek systems due to their influence on biological activity in estuarine and marine environments. Terrigenous sediments inherently contain N and P as a consequence of the degeneration of organic matter. During periods of increased creek discharge, the release of N and P can play important roles in structuring primary productivity. An understanding of the nutrients contained within creek discharge waters is of critical importance in order to assess the influence of nutrient loads on the receiving waters.

URS (2010) conducted an assessment of nutrient load within the Ashburton River system located approximately 30 km northeast of the proposed Ashburton Salt Project. Levels of total N and P discharged annually from the Ashburton River were highly variable and closely reflect annual water flow volumes. The flow rates experienced between 1973 and 2008 cover a broad spectrum of annual

discharges from the Ashburton River, therefore future discharges are likely to be within this range. The mean annual discharge of these nutrients was calculated to be 405.1 tonnes/yr of nitrogen and 134.2 tonnes/yr of P (URS, 2010). Whilst the Ashburton River system is north of the Ashburton Salt Project, and larger in size than overland local creeks, it provides a useful indication that nutrient inputs into the Exmouth Gulf Wetland might also be expected from some of the overland smaller creek systems in the vicinity of the Project area.

It is anticipated that nutrient inputs from creek systems and their effect on coastal ecosystem productivity will be further investigated as part of the EIA process.

5.7.5 IMPACT ASSESSMENT

Potential impacts to hydrological processes include:

- Construction of salt ponds on the salt flats interfering with the ability of the salt flats to act as a compensating basin during flood events and potential flow-on effects to the Exmouth Gulf wetland ecosystem.
- Salt ponds or associated infrastructure preventing adequate tidal inundation of the mud flat areas of the wetland, resulting in impacts to mangrove and algal mat communities.
- Project layout causing changes in surface water flows and consequential changes in nutrient inputs into the Exmouth Gulf coastal ecosystems.
- Seepage from the salt ponds into the groundwater, changing the salinity of the groundwater and potential flow-on effects to the surrounding environment.

5.7.6 MITIGATION MEASURES

Proposed mitigation measures include:

- Undertaking a comprehensive study of hydrology and nutrient flows in the Project area to investigate the existing surface water flow regime and nutrient pathways.
- Designing the Project layout so that the salt ponds do not interfere with the ability of the wetland to respond adequately during flood events.
- Designing the Project layout to ensure that detrimental changes in surface water flows and nutrient pathways/inputs are avoided and minimised.
- Ensuring through engineering design that tidal inundation and/or surface water flow is not altered significantly or in a way that could cause unacceptable impacts to mangroves and algal mats.
- Undertaking a study to predict the likely seepage from salt ponds into the groundwater. The results of the study will be used to implement design and management measures as necessary to avoid impacts on groundwater quality and potential flow-on effects to the surrounding environment.

5.7.7 RESIDUAL IMPACTS

With successful implementation of the above management measures, any residual impacts should be minor.

5.7.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise direct and indirect impacts on hydrological processes, it is concluded that the EPA objective can be met.

5.8 INLAND WATERS ENVIRONMENTAL QUALITY

5.8.1 EPA OBJECTIVE

To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.

5.8.2 GUIDANCE

- *Position Statement 4 – Environmental Protection of Wetlands* (EPA, 2004)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.8.3 CONSULTATION

- K+S anticipates a moderate level of public interest in the impact on inland waters environmental quality will be high given the Development Envelope currently extends approximately 10 km inland from the salt flats (to allow for potential drainage diversions) and potential impacts to surface water and groundwater could occur from project activities.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.8.4 BASELINE INFORMATION

5.8.4.1 SURFACE WATER

As described in Section 5.7 above, the Ashburton Salt Project is within the Ashburton River catchment and sub-catchment (Figure 17).

The Ashburton River itself is located approximately 10 km north east of the Development Envelope. The Ashburton River is generally fresh, with Total Dissolved Solids (TDS) (a measure of salinity) being around 133 mg/L (Ruprecht and Ivanescu, 2000). This is similar to other rivers in the Pilbara region (TDS range 50 - 1,000 mg/L). Salinity in the Ashburton River, and all Pilbara region rivers,

generally decreases with increasing flow and becomes more saline during times of low flow (URS, 2010).

Total suspended solids (TSS) and turbidity in the Ashburton River are generally low, and generally increase with increasing flow. The turbidity of the Ashburton River ranges from less than 10 NTU over a range of flows, from 30 m^3/sec to 250 m^3/sec, to 3,300 NTU at a flow rate of around 250 m^3/sec. The flow weighted turbidity for Ashburton River is 1,705 NTU, which is higher than other Pilbara river sites, which range from 10 - 587 NTU (Ruprecht and Ivanescu, 2000).

Inland surface water quality data has not been previously collected within and adjacent to the Ashburton Salt Project area, presumably due to accessibility issues. However, it is assumed when the salt flats flood, due to a combination of cyclonic rainfall and storm surge the water quality would be reflective of these two process (i.e. somewhat saline due to the influx of ocean water from storm surge and with high turbidity due to erosion from flooding of the inland catchment). Further information will be collected during the EIA process.

5.8.4.2 GROUNDWATER

A hydrogeology study was conducted for the historical Yannarie project (Parsons Brinkerhoff, 2005). Hydrogeological field investigations were carried out, including a bore census and testing. Water level information was obtained from 38 sites, and information on water chemistry was available from 41 sites. The following broad findings were obtained:

- Beneath the salt flats groundwater is shallow (ranging from 2 – 4 mAHD) and hypersaline (35 – 193 ppt).
- From the landward edge of the salt flats progressing 5 km inland groundwater is still shallow but depth increases marginally (ranging from 4 – 5 mAHD) and groundwater becomes saline (13 – 35 ppt).
- From 5 – 20 km inland of the salt flats groundwater depth increases further (ranging from 5 – 15 mAHD) and groundwater becomes brackish (2 – 13 ppt). Some fresh water pockets / lenses may exist within this area, but site specific groundwater investigations have not occurred to determine this (Parsons Brinkerhoff, 2005).

Further information will be collected during the EIA process.

5.8.5 IMPACT ASSESSMENT

Potential impacts on surface water or groundwater quality of inland waters from the project include:

- Contamination with hydrocarbons due to fuel storage activities.
- Biological contamination from sewage treatment facilities.
- Groundwater contamination from landfill activities.
- Potential Acid Forming (PAF) material disturbance at borrow pits or a quarry leading to contamination issues.
- Erosion and scouring at drainage diversions leading to surface water contamination with sediment.

5.8.6 MITIGATION MEASURES

Proposed mitigation measures include:

- Undertaking a comprehensive study of potential impacts to inland groundwater and surface water quality.
- Designing all Project infrastructure and activities so that potential for contamination of inland groundwater and surface water is avoided and minimised.
- Undertaking a Hydrocarbon Spill Risk Assessment and implementing an appropriate Hydrocarbon and Spill Management Plan.

5.8.7 RESIDUAL IMPACTS

With successful implementation of the above management measures, any residual impacts should be minor.

5.8.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given the Project will avoid or minimise impacts on inland waters environmental quality, it is concluded that the EPA objective can be met.

5.9 HERITAGE

5.9.1 EPA OBJECTIVE

To ensure that historical and cultural associations, and natural heritage, are not adversely affected.

5.9.2 GUIDANCE

- *Guidance Statement 41 – Assessment of Aboriginal Heritage* (EPA, 2004)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.9.3 CONSULTATION

- K+S anticipates a moderate level of public interest in the impact on aboriginal heritage given the Project may coincide with aboriginal heritage sites.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - studies proposed;
    - methodology of studies;
    - results of studies;
    - predicted impacts;
    - proposed management measures; and
    - residual impacts and risks.
- Consultation to date has included:

- Broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.
- Broad information provision to aboriginal stakeholders and their representatives indicating the location of the Project and commitment to avoid and minimise impacts to aboriginal sites.

5.9.4 BASELINE INFORMATION

The WA *Aboriginal Heritage Act 1972* protects places and objects that may be of importance and significance to Aboriginal people in Western Australia. The Department of Aboriginal Affairs maintains a register of Aboriginal sites that are protected under the Aboriginal Heritage Act. It is an offence under the legislation to disturb an Aboriginal site without prior approval. 'Disturb' is defined as "...excavate, destroy, damage, conceal, or in any way alter any Aboriginal site without prior authorisation of the Registrar of Aboriginal sites and/or consent of the Minister for Indigenous Affairs".

Historical Aboriginal Heritage investigations were conducted for the Yannarie project, but the project footprint proposed for the Ashburton Salt Project was not fully covered by these historical studies.

5.9.5 IMPACT ASSESSMENT

Aboriginal Heritage Sites may occur in the vicinity of the proposed Project footprint. It is planned to further investigate this as part of the Project EIA process.

5.9.6 MITIGATION MEASURES

Proposed mitigation measures include:

- Meeting all responsibilities and requirements under the *Aboriginal Heritage Act 1972.*
- Ensuring appropriate cultural heritage surveys are conducted for the Ashburton Salt Project.
- Where possible avoid disturbing cultural heritage sites through Project design, construction and operations.
- In the event disturbing a cultural heritage site is unavoidable, consulting with aboriginal stakeholders and obtaining all relevant approvals under the *Aboriginal Heritage Act 1972,* prior to undertaking the disturbance.

5.9.7 RESIDUAL IMPACTS

With implementation of the above mitigation measures, residual impacts should be acceptable.

5.9.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

With implementation of the above mitigation measures, it is concluded that the EPA objective can be met.

5.10 REHABILITATION AND DECOMMISSIONING

5.10.1 EPA OBJECTIVE

To ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner.

5.10.2 GUIDANCE

- *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015)
- *Guidance Statement 6 – Rehabilitation of Terrestrial Ecosystems* (EPA, 2006)
- *Environmental Protection Bulletin 19 - EPA involvement in mine closure* (EPA, 2015)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.10.3 CONSULTATION

- K+S anticipates a moderate level of public interest in the impact on rehabilitation and decommissioning given this is an important part of any project life cycle.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - preparation of a draft Mine Closure Plan and updated Closure Plans throughout the Project life cycle; and
    - implementation of an approved Mine Closure Plan at the appropriate time.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts throughout the entire Project life cycle.

5.10.4 BASELINE INFORMATION

The Ashburton Salt Project lifespan is estimated to be 40 to 100 years. Given the Project is to be constructed under *Mining Act 1978*tenure, it will require a Mine Closure Plan to be prepared in accordance with the *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015).

The Closure Plan will outline all rehabilitation, decommissioning and site closure activities for the Project prior to relinquishment.

5.10.5 IMPACT ASSESSMENT

As 'Rehabilitation and Decommissioning' is an Integrating Factor, it is of itself an environmental impact and risk mitigation measure that is comprehensively dealt with through the preparation and implementation of an approved Mine Closure Plan. A draft Mine Closure Plan will be prepared and implemented in accordance with the *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015) and regular updates to the Plan will occur over the life of the Project.

5.10.6 MITIGATION MEASURES

Preparation and implementation of a Mine Closure Plan in accordance with the *Guidelines for Preparing Mine Closure Plans* (DMP and EPA, 2015).

5.10.7 RESIDUAL IMPACTS

Residual impacts of Project implementation will be mitigated throughout the life of the Project by regular review, update and implementation the approved Closure Plan.

5.10.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

Given K+S commits to preparing and implementing an approved Mine Closure Plan, it is concluded that the EPA objective can be met.

5.11 OFFSETS

5.11.1 EPA OBJECTIVE

To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.

5.11.2 GUIDANCE

- *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014)
- *WA offsets template* (Government of Western Australia, 2014)
- *Environmental Protection Bulletin 1 – Environmental Offsets* (EPA, 2014)
- *WA Environmental Offsets Policy* (Government of Western Australia, 2011)
- *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* (EPA, 2003)

5.11.3 CONSULTATION

- K+S anticipates a high level of public interest in offsets given such measures may be required to compensate for significant residual impacts.
- Consultation with regulatory agencies, stakeholders and the community will be required regarding:
    - likely significant residual impacts; and
    - offsets proposed.
- Consultation to date has included broad information provision to stakeholders indicating the location of the Project and commitment to avoid and minimise environmental impacts.

5.11.4 BASELINE INFORMATION

Refer to previous sections for baseline information on the existing environment.

5.11.5 IMPACT ASSESSMENT

It is difficult to assess whether significant residual impacts may occur until the full EIA is completed. The Project is aiming to avoid and minimise significant environmental impacts. However, it is possible that some residual impacts may remain after implementation of mitigation measures. The information does not yet exist to determine whether these residual impacts are likely to be significant or minor. This will be determined through the EIA process, although the proponent's preliminary view is that they will be minor.

5.11.6 MITIGATION MEASURES

As an Integrating Factor, the potential use of environmental offsets will be in addition to responsible and best practice on-site environmental management, such as the avoidance and mitigation measures proposed. Environmental offsets will take account of, and contribute towards, broader State Government conservation objectives through existing programs, policies, initiatives and strategic funds.

5.11.7 RESIDUAL IMPACTS

Offsets, if applicable, will be used to compensate for significant residual environmental impacts and be designed to achieve long-term outcomes, building upon existing conservation programs and initiatives.

5.11.8 EPA OBJECTIVE OUTCOME AND ASSUMPTIONS

If any significant residual environmental impacts or uncertainty is found to exist through the EIA process, then K+S will seek to counterbalance them through the application of offsets. On this basis, it was concluded that the EPA objective can be met.

6 GLOSSARY

6.1 UNITS, SYMBOLS AND PREFIXES

Not necessarily referenced

6.1.1 UNITS

g	Gram; a unit used to express weight
L	Litre; a unit used to express volume
m	Metre; a unit used to express length
bcm	Bank cubic meters; a unit used to describe the volume of in-situ rock
dB	Decibel; unit used to express sound intensity
h	Hour; a unit used to express time
ha	Hectare; a unit used to express area
m2	Square metre; a unit used to express area
m3	Cubic metre; unit used to express volume.
NTU	Nephelometric Turbidity Units.
V	Volt; a unit used to express the potential difference across a conductor
VA	Volt-amp; a unit used to express apparent power; is equal to voltage applied multiplied by current drawn
VPD	Vehicles per day
yr	Year
s	Second; a unit used to express time
ppm	Parts per million; a unit used to express concentration
ppt	Parts per thousand; a unit used to express concentration
T	Tonne

6.1.2 SYMBOLS

%	percentage (proportion out of one hundred)
/	Per
p	per
$	Australian dollars
a	annum; year
°C	degree Celsius

6.1.3 PREFIXES

G	10^{9}
M	10^{6}
k	10^{3}
d	10^{-1}
c	10^{-2}
m	10^{-3}.
µ	10^{-6}
n	10^{-9}

6.2 WORDS AND ABBREVIATIONS

Not necessarily referenced

Term	Definition/expansion
AHD	Australian Height Datum.
amenity	The desirability of an area.
amphibians	Animals (such as frogs) adapted to live both on land and in water.
ARI	Average Recurrence Interval; a measure of the rarity of a rainfall event.
artefact	Anything made by human workmanship, particularly by previous cultures (such as chipped and modified stones used as tools).
background	The conditions (e.g., noise levels, bird populations) already present in an area before the commencement of a specific activity (e.g., a mining operation).
best practice	A best practice is a process, technique, or use of technology, equipment or resource that has a proven record of success.
bioregion	A complex land area composed of a cluster of interacting ecosystems that are repeated in similar form. It describes the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation. It is based on the Interim Biogeographic Regionalisation for Australia (see IBRA).
biodiversity	The diversity of different species of plants, animals and microorganisms, including the genes they contain, in the ecosystem of which they are part.
bore	A well, usually of less than 20 cm diameter, sunk into the ground and from which water is pumped.
bund	An earth, rock, or concrete embankment constructed to prevent the in-flow or outflow of liquids or the transmission of noise.
catchment	The entire land area from which water (e.g., rainfall) drains to a specific water course or waterbody.
clay	A discrete mineral species, belonging to the layered silicate group of less than 2 microns in diameter.
compaction	The process of close packing of individual grains in a soil or sediment as a response to pressure.
compensation basin	A low lying area of land that is inundated with water during rainfall events, drawing water from the surrounding higher elevation land, thereby having a water compensation effect.
concentration	The amount of a substance per unit of mass or volume of the medium in which it occurs.
conservative	A prediction, assumption, or measurement that errs on the side of safety.
contractor	A specialist brought in to perform a specific task, such as the construction of mine infrastructure or the excavation (mining) of the open pit.
DER	Department of Environment Regulation (WA).
DoTEE	Department of the Environment and Energy (Federal).
DPaW	Department of Parks and Wildlife (WA).
density	The mass of a substance divided by its volume.
DoCEP	Department of Consumer and Employment Protection (WA).
DoW	Department of Water (WA).
DRF	Declared Rare Flora.
ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
emission	A discharge of a substance (e.g., dust) into the environment.
endemic	Native to, or restricted to, a certain country or area.

Term	Definition/expansion
environment	A general term for all the conditions (physical, chemical, biological and social) in which an organism or group of organisms (including human beings) exists.
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).
erosion	The wearing away of the land surface (whether natural or artificial) by the action of water, wind and ice.
fauna	A general term for animals (birds, reptiles, marsupials, fish etc.), particularly in a defined area or over a defined time period.
feed	Material being fed into a process.
flora	A general term for plants, particularly those found in a defined area or characteristic of a defined time period.
foraging	Searching for food over a wide area.
grade	The concentration of metal, e.g., iron either in an individual rock sample or averaged over a specified volume of rock.
gradient	Rate of change of a given variable (such as temperature or elevation) with distance.
greenhouse gases	Carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride.
ground vibration	Vibration transmitted through the ground following blasting.
groundwater	All waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.
habitat	The particular local environment occupied by an organism.
hydrology	The study of water, particularly its movement in streams, rivers, or underground.
infrastructure	The supporting installations and services that supply the needs of a project.
introduced	Introduced to a particular environment; exotic.
invertebrates	Commonly, animals without a backbone (jellyfish, worms, molluscs, etc.).
irrigation	The artificial flooding of agricultural land to promote cultivation.
landform	A specific feature of a landscape (such as a hill) or the general shape of the land.
load	The amount of a substance discharged into a body of water (e.g., salt or sediment); usually expressed as mass over a specified time (e.g., tonnes per year).
MBGL	Meters Below Ground Level.
model	A mathematical simulation of a natural system (such as the variation of particulate levels within a lake) used to predict how the system will change with time, particularly where external changes have been imposed upon it (such as from mining operations).
monitoring	Systematic sampling and, if appropriate, sample analysis to record changes over time caused by impacts such as mining.
native	Belonging to, or found naturally, in a particular environment.
natural	Existing in, or formed by, nature (generally excludes anything obviously modified by human beings).
neutral	Neither acidic nor basic (e.g., a pH equal to 7.0).
nutrients	Generally, refers to nitrogen and phosphorus, which are essential for biological growth.
operations	Mining and mineral/ore processing activities.
ORV	Off road vehicles.
passive	Performing a function without electrical or mechanical action or movement.
PER	Public environmental review.

Term	Definition/expansion
pH	Potential of hydrogen; a measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral and 14 is most basic (alkaline).
Prescribed Premise	A premise that falls into the categories prescribed in Schedule 1 of the *Environmental Protection Regulations 1987*.
Project area	the total area covered by the project, including clearing, processing plant, stockpiles, haul road, rail siding, port facilities etc.
quadrat	A square measuring area used in ecological studies such as the distribution of plants or animals in an area. Quadrats can vary in size depending largely on the focus of the study.
receptor	A designated place at which an impact may occur (e.g., a dwelling).
recharge	The addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.
rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
reptiles	Cold-blooded vertebrates, including lizards, snakes, turtles, and crocodiles.
residual impacts	Impacts from an activity (e.g., mining) that remain after mitigation measures.
richness (of fauna or flora)	A measure of the diversity of species in a given area or assemblage.
runoff	That portion of precipitation (rain, hail and snow) that flows from a specific area as water.
silt	Sediment with particles finer than ore and coarser than clay, i.e., 2 to 63 microns.
species	A taxonomic grouping of organisms that is able to interbreed with each other but not with members of other species.
stockpile	A pile used to store material (such as salt) for future use.
stockpiled	Stored in a stockpile.
stripping	Removal of vegetation and topsoil.
surface water	Water flowing over, or contained on, a landscape (e.g., runoff, streams, lakes, etc.).
taxa	Plural of taxon.
taxon	A group or category, at any level, in a system for classifying plants or animals. An animal or plant group having natural relations.
TEC	Threatened Ecological Community.
topography	Physical relief and contour of a region.
topsoil	Upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.
TPS	Town Planning Scheme.
variable	Not constant, subject to change.
vibration	Oscillating movement.
WAPC	Western Australian Planning Commission.
water balance	The sum of the inputs and outputs and changes in storage levels of water in a given locality.
water quality	Degree of the lack of contamination of water.
water table	The surface of the groundwater, below which soil and rock are saturated.
watercourse	Stream or river, running water.
weed	Any plant (in particular an herbaceous one) that survives in an area where it is harmful or troublesome to the desired land use.
wetland	A low-lying area regularly inundated or permanently covered by shallow water.

7 REFERENCES

ANCA. (1993). *A Directory of Important Wetlands in Australia, Australian Nature.* Canberra: Government of Australia.

Biota Environmental Sciences. (2005). *Yannarie Salt Project Fauna and Fauna Assemblage Survey.* Perth: Prepared for Straits Salt.

Biota Environmental Sciences. (2005). *Yannarie Salt Project Flora and Vegetation Assessment - Baseline Botanical Survey.* Perth: Prepared for Straits Salt.

Biota Environmental Sciences. (2005). *Yannarie Salt Project Mangrove and Coastal Ecosystem Study Baseline Ecological Assessment.* Perth: Prepared for Straits Salt Pty LTd.

Biota Environmental Sciences. (2016). *Desktop Maps of Mangrove and Algal Mat Distribution Adjacent to Ashburton Salt Project.* Perth: Unpublished Mapping Data Prepared for K+S.

CALM. (1994). *A Representative Marine Reserve System for Western Australia, Report of the Marine Parks and Reserves Selction Working Group.* Perth: Government of Western Australia.

Carr & Livesy. (1996). *Pilbara Mangrove Study, Final Report to the Heritage Council of Western Australia.* Perth: Murdoch University.

Centre for Whale Research. (2005). *Final Report Distribution and abundance of humpback whales and other mega-fauna in Exmouth Gulf, WA, during October/November 2004.* Perth: Report Prepared for Straits Salt.

Columbia University. (2016). *Coastal Processes.* http://www.columbia.edu/~vjd1/coastal_basic.htm.

CSIRO & Department of Environment. (2007). *Final Report of the Joint Environmental Management Study.* Perth: CSIRO & Department of Environment.

CSIRO. (1996). *Seagrass - Coastal and Marine Information Systeem (CAMRIS).* . Canberra: Dataset within ERIN (Environmental Rsources Information Network). .

Department of Environment. (2006). *Pilbara Coastal Water Quality Consultation Outcomes — Environmental Values and Environmental Quality Objectives, Department of Environment, Government of Western Australia, Marine Series Report No. 1.* Perth: Government of Western Australia.

Department of Fisheries. (2015 ongoing). *Examining the relationship between fishery recruitment, essential benthic habitats and environmental drivers in Exmouth Gulf.* Perth: Department of Fisheries.

Department of Fisheries. (2015). *Status reports of the fisheries and aquatic resources of Western Australia 2014/15 - State of the fisheries.* Perth: Government of Western Australia.

DHI Water and Environment. (2010). *The Wheatstone Project Tolerance Limits Report.* Perth: Prepared for Chevron Australia Pty. Ltd.

DMP and EPA. (2015). *Guidelines for Preparing Mine Closure Plans.* Perth: Government of Western Australia.

EPA. (1975). *Conservation Reserves for Western Australia System 9 Report.* Perth: Government of Western Australia.

EPA. (2000). *Position Statement 2 – Environmental Protection of Native Vegetation in WA.* Perth: Government of Western Australia.

EPA. (2001). *Guidance Statement 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline.* Perth: Government of Western Australia.

EPA. (2002). *Position Statement 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection* . Perth: Government of Western Australia.

EPA. (2003). *Guidance Statement 55 - Implementing best practice in proposals submitted to the environment impact assessment process* . Perth: Government of Western Australia.

EPA. (2004). *Guidance Statement 41 – Assessment of Aboriginal Heritage .* Perth : Government of Western Australia.
EPA. (2004). *Guidance Statement 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA.* Perth: Government of Western Australia.
EPA. (2004). *Guidance Statement 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in WA .* Perth: Government of Western Australia.
EPA. (2004). *Position Statement 4 – Environmental Protection of Wetlands.* Perth: Government of Western Australia.
EPA. (2006). *Guidance Statement 6 – Rehabilitation of Terrestrial Ecosystems.* Perth: Government of Western Australia.
EPA. (2009). *Environmental Assessment Guideline 3 – Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment.* Perth: Government of Western Australia.
EPA. (2009). *Guidance Statement 20 – Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in WA .* Perth: Government of Western Australia.
EPA. (2010). *Environmental Assessment Guideline 5 – Protecting Marine Turtles from Light Impacts.* Perth: Government of Western Australia.
EPA. (2010). *Technical Guide on Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment.* Perth: Government of Western Australia.
EPA. (2011). *Environmental Assessment Guideline 7 – Marine Dredging Proposals.* Perth: Government of Western Australia.
EPA. (2012). *Environmental Protection Bulletin 18 – Sea level rise .* Perth : Government of Western Australia.
EPA. (2013). *Environmental Protection Bulletin 20 - Protection of naturally vegetated areas through planning and development.* Perth: Government of Western Australia.
EPA. (2014). *Environmental Protection Bulletin 1 – Environmental Offsets.* Perth: Government of Western Australia.
EPA. (2015). *Environmental Assessment Guideline 15 – Protecting the Quality of Western Australia's Marine Environment.* Perth: Government of Western Australia.
EPA. (2015). *Environmental Assessment Guideline for Environmental principles, factors and objectives.* Perth: Government of Western Australia.
EPA. (2015). *Environmental Protection Bulletin 19 - EPA involvement in mine closure.* Perth: Government of Western Australia.
EPA and DPaW. (2015). *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment.* Perth: Government of Western Australia.
Government of Western Australia. (2011). *WA Environmental Offsets Policy.* Perth: Government of Western Australia.
Government of Western Australia. (2014). *WA Environmental Offsets Guidelines.* Perth: Government of Western Australia.
Government of Western Australia. (2014). *WA offsets template.* Perth: Government of Western Australia.
InTeGrate. (2016). *Coastal Processes, Hazards and Society: Nearshore, Beaches and Dunes.* https://www.e-education.psu.edu/earth107/node/584.
Lyne et al. (2006). *Ecosystem characterisation of Australia's North West Shelf.* Perth: CSIRO & Department of Environment.
Marin-Estrella. (2014). *Dampier Salts sites and ponds and their importance for migratory and other shorebirds - preliminary results ABC Article.* Perth: http://www.abc.net.au/news/2014-10-13/shorebirds-salt-pools-study/5807894.

McKinnon & Ayukai. (1996). *Copepod egg production and food resources in Exmouth Gulf.* Western Australia: Marine and Freshwater Research. Vol. 47, pp. 595-603.

MScience. (2009). *Wheatstone LNG Development - Baseline Water Quality.* Perth: Report to Chevron Australia.

Oceanica. (2006). *Marine and coastal environment of eastern Exmouth Gulf.* Perth: Report to Straits Salt.

Parsons Brinkerhoff. (2005). *Superficial Aquifer Hydrogeology of the Yannarie.* Perth: Unpublished Report Prepared for Straits Resources.

Parsons Brinkerhoff. (2006). *Surface Hydrology for the Yannarie Salt Project.* Perth: Prepared for Straits Salt.

Ridd et. al. (1997). *Water, salt and nutrient fluxes of tropical tidal salt flats.* Mangroves and Salt Marshes, 1: 229-238.

RPS. (2010). *Dugong Aerial Survey Report Wheatstone Project.* Perth: Prepared for Chevron Australia.

Ruprecht and Ivanescu. (2000). *Surface Hydrology of the Pi/bwa Region - Summary Reporl.* Perth: Waters and Rivers Commission (now Department of Water).

URS. (2010). *Project Wheatstone Ashburton River Flow and Discharges Study.* Perth: Prepared for Chevron Australia.

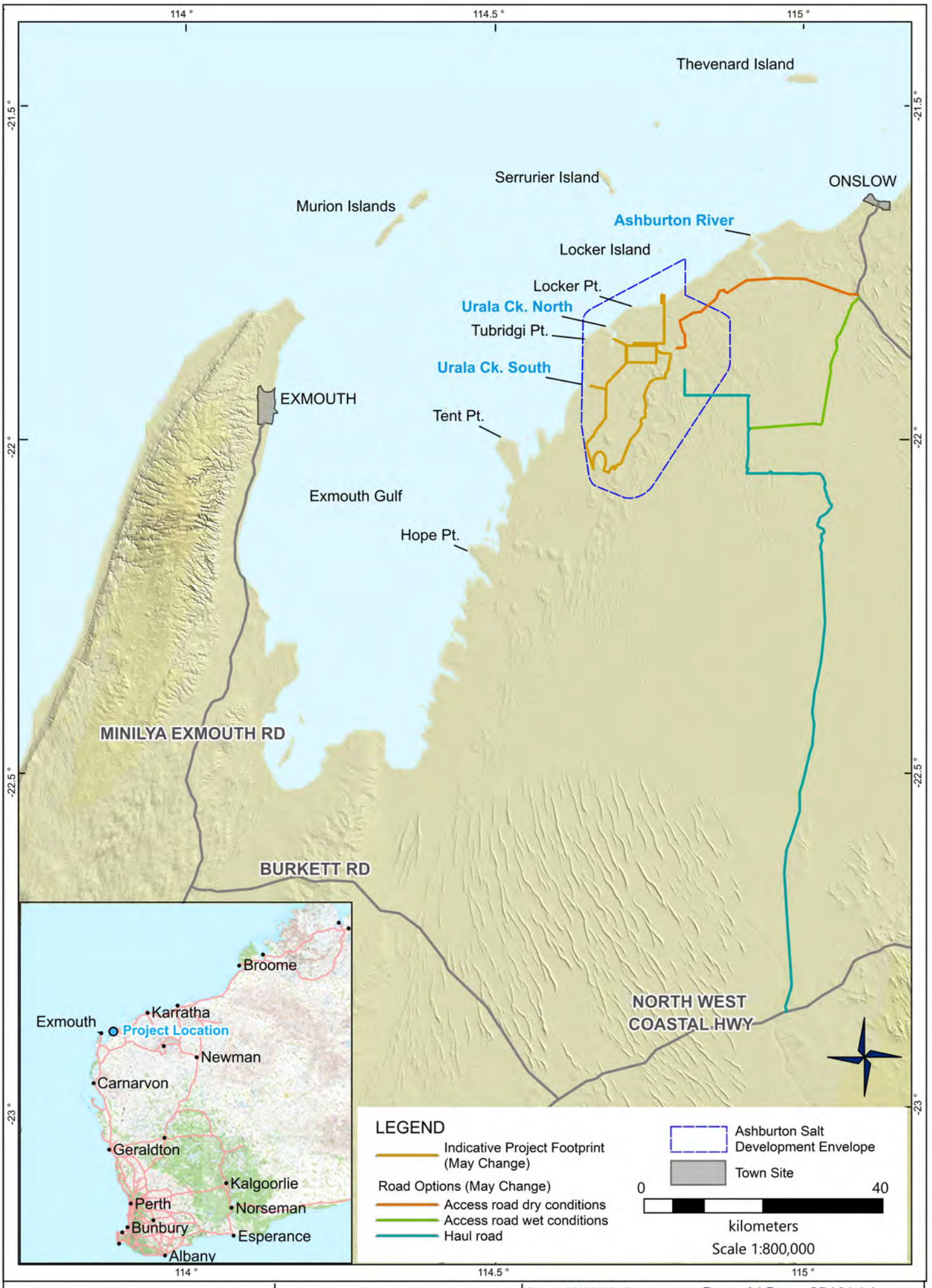
URS. (2010). *Survey of Subtidal Habitats off Onslow WA.* Perth: Prepared for Chevron Australia.

WAPC. (2003). *Statement of Planning Policy No. 2.6: State Coastal Planning Policy.* Perth: Government of Western Australia.

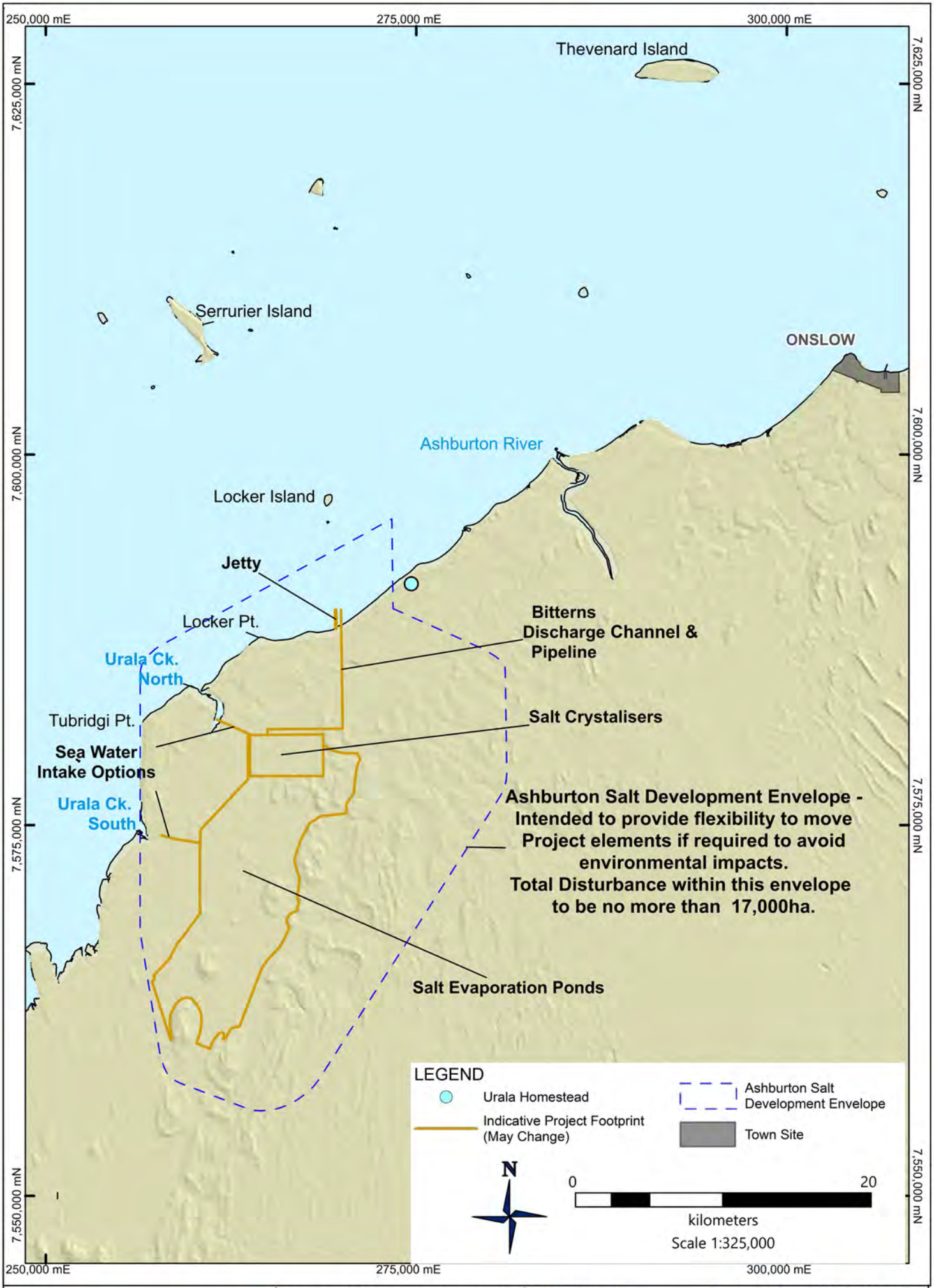
WAPC. (2004). *Ningaloo Coast Regional Strategy Carnarvon to Exmouth.* Perth: Government of Western Australia.

Wenziker et al. (2006). *Background quality for coastal marine waters of the North West Shelf.* Perth: North West Shelf Joint Environmental Study Technical Report 18.

8 FIGURES



K+S Experience growth. / EnviroWorks CONSULTING	**Fig. 1** **Ashburton Salt Project Location**	Date: 12/09/2016 Paper: A4 P GDA94, L.L Data Source: 4A, NWSH File Info: K04_J03_Site_Regional_Pastoral_120916



Experience growth.

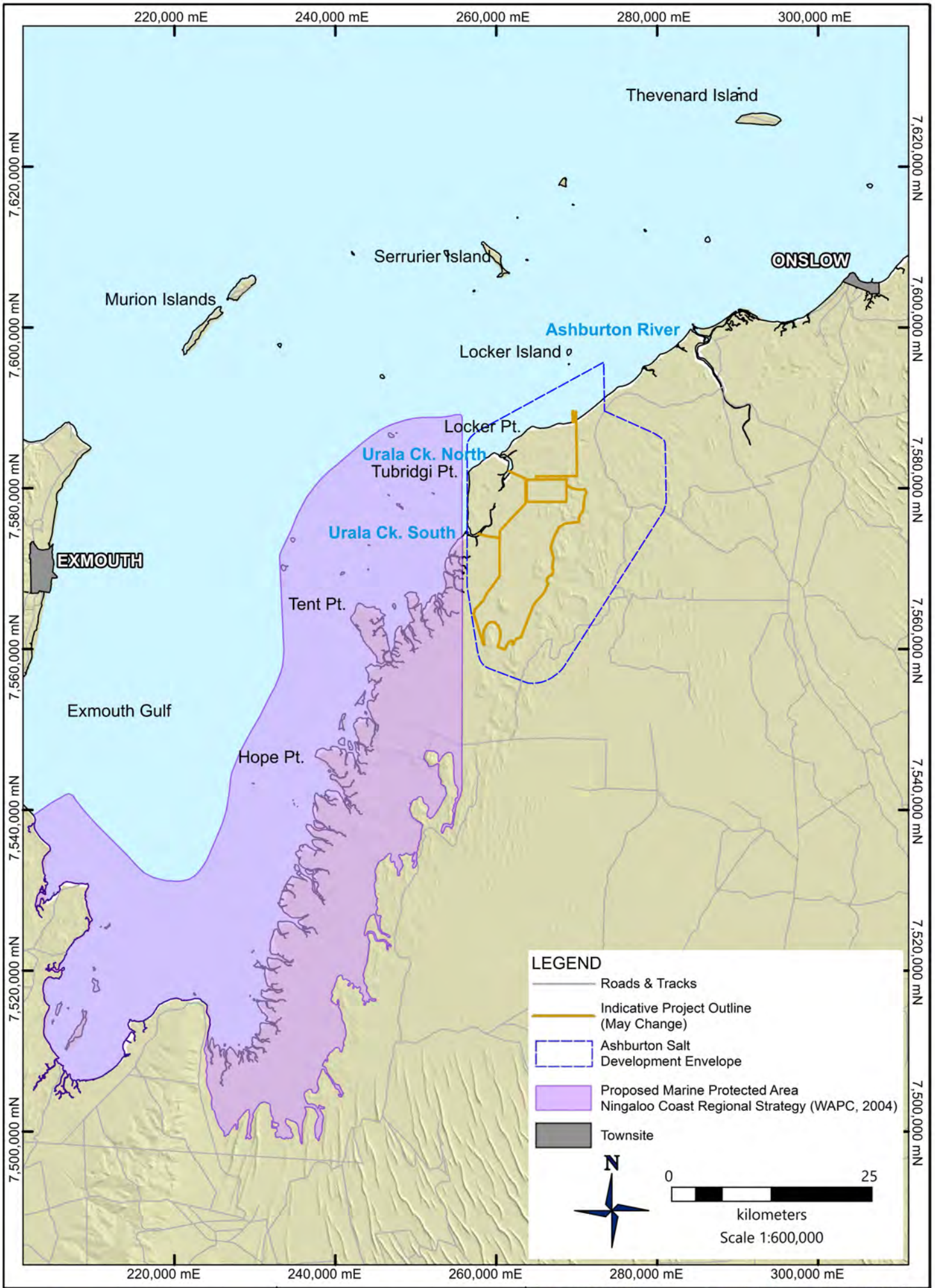
EnviroWorks CONSULTING

Fig 2. Ashburton Salt Project Development Envelope & Indicative Footprint

Date: 02/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 4E, NWSH

File Info: K04_J03_Project_Layout_020816



Experience growth.

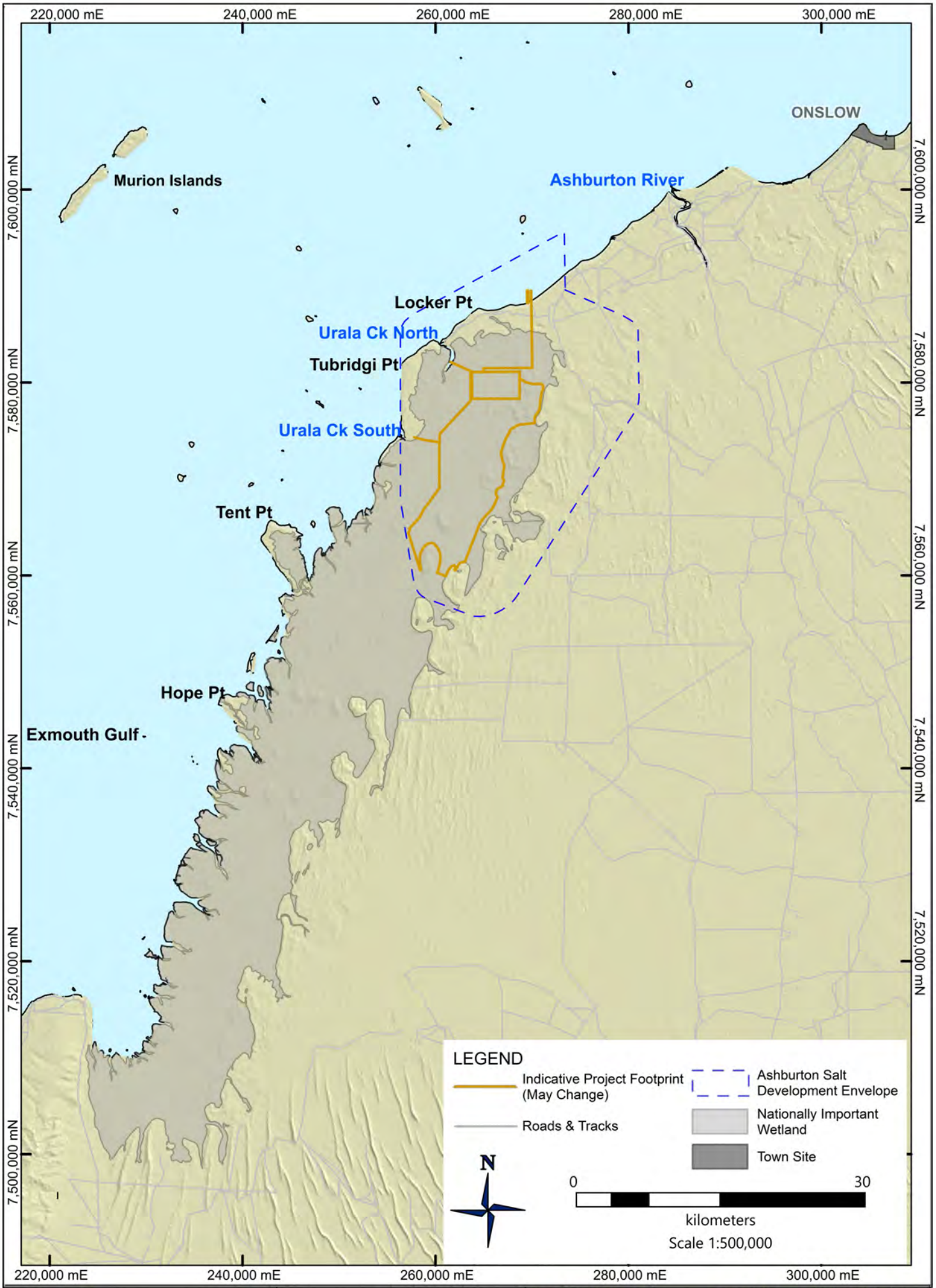
EnviroWorks CONSULTING

Fig 3.
Potential Marine Protected Area

Date: 11/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 9A

File Info: K04_J03_Marine_Protected_Area_110816.WOR

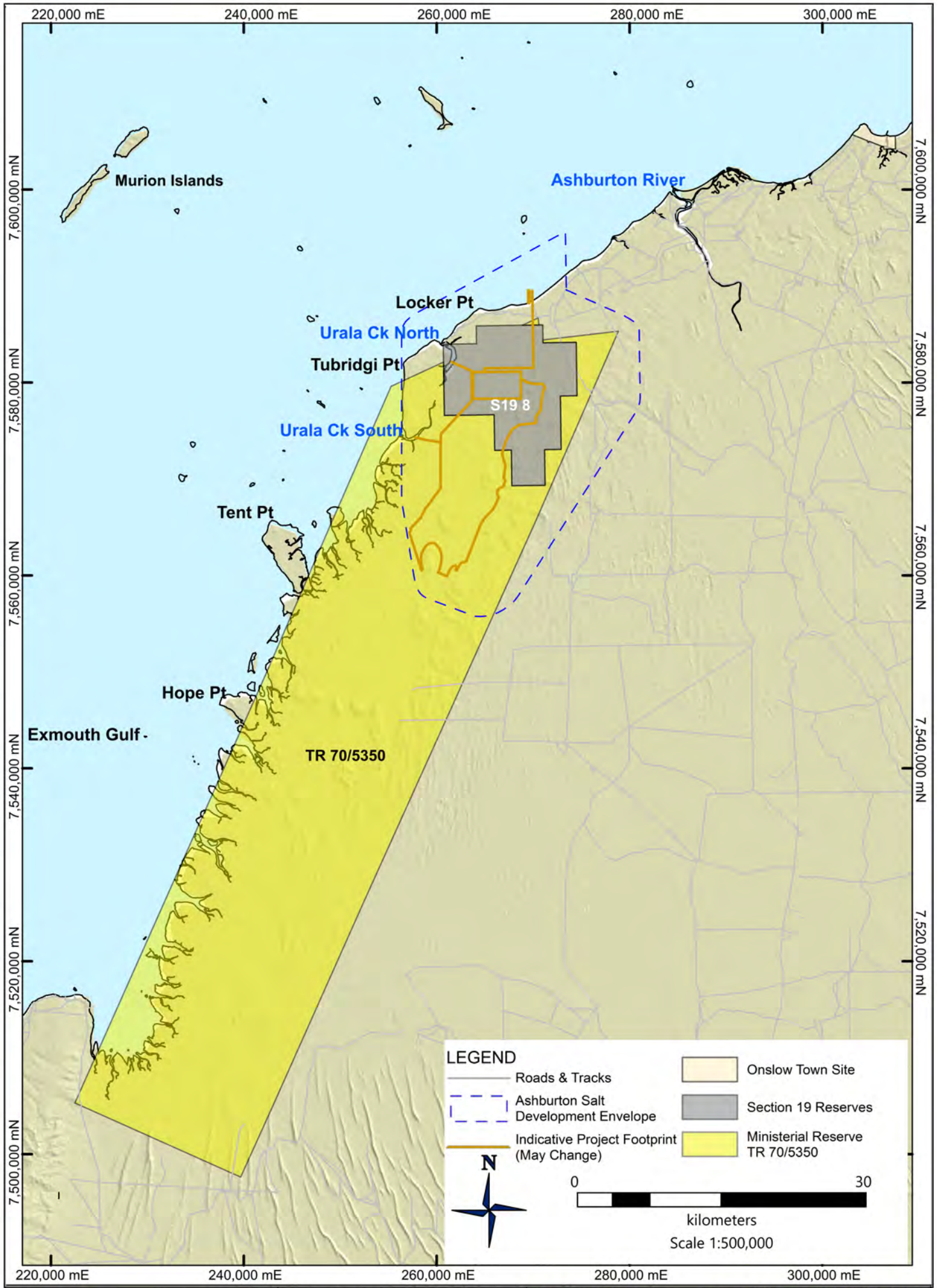


Experience growth.

EnviroWorks CONSULTING

Fig 4.
Nationally Important Wetland

Date: 10/08/2016	Paper: A4 P	GDA94, MGA50
Data Source: 4A, 21AC		
File Info: K04_J03_Nat_Wetlands_100816		



Experience growth.

EnviroWorks CONSULTING

Fig 5. Ministerial Reserve for Salt Production and Section 19 Area

Date: 12/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 9A, 15I

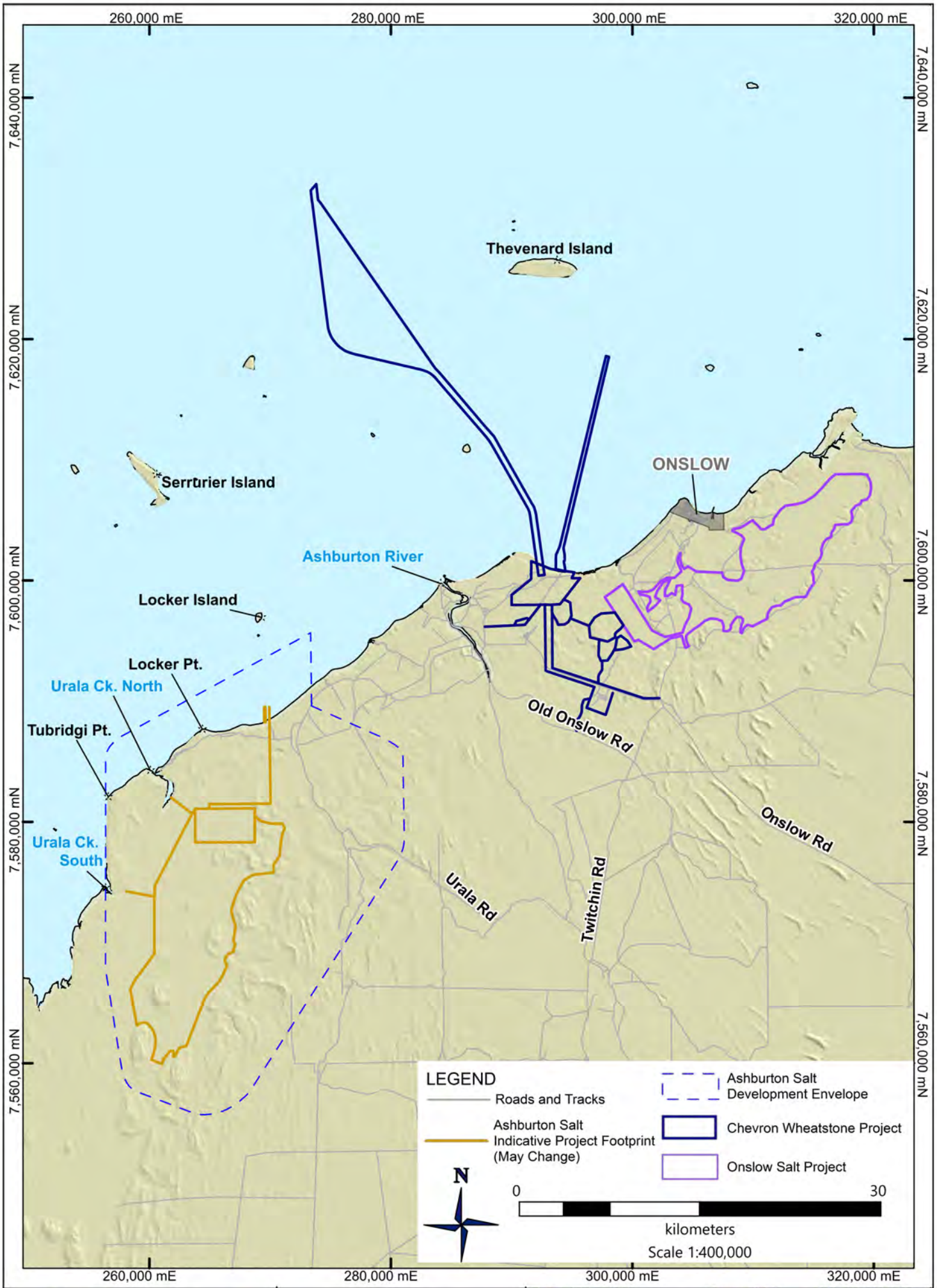
File Info: K04_J03_Min_Res_S19_120816

Experience growth.

EnviroWorks CONSULTING

Fig 6. Comparison of Ashburton Salt Project and Historical Yannarie Project

Date: 12/08/2016	Paper: A4 P	GDA94, MGA50
Data Source: 4A, 4E, 9A		
File Info: K04_J03_Ashburton_Salt_Vs_Yannarie_120816		



Experience growth.

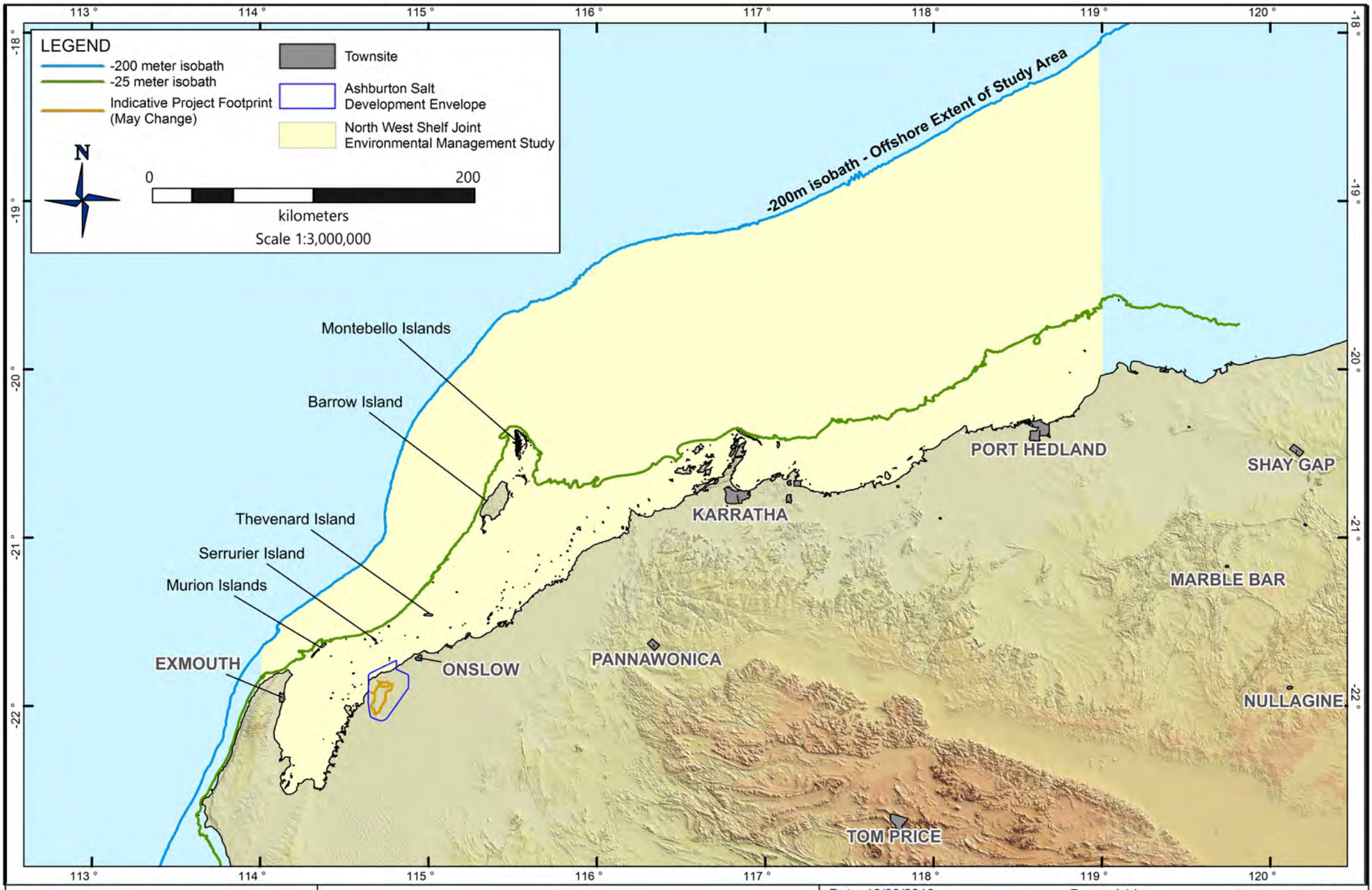
EnviroWorks CONSULTING

Fig 7.
Location of Wheatstone and Onslow Salt Operations

Date: 12/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 4E, 9A, 17C

File Info: K04_J03_Regional_Industry_120816



Experience growth.

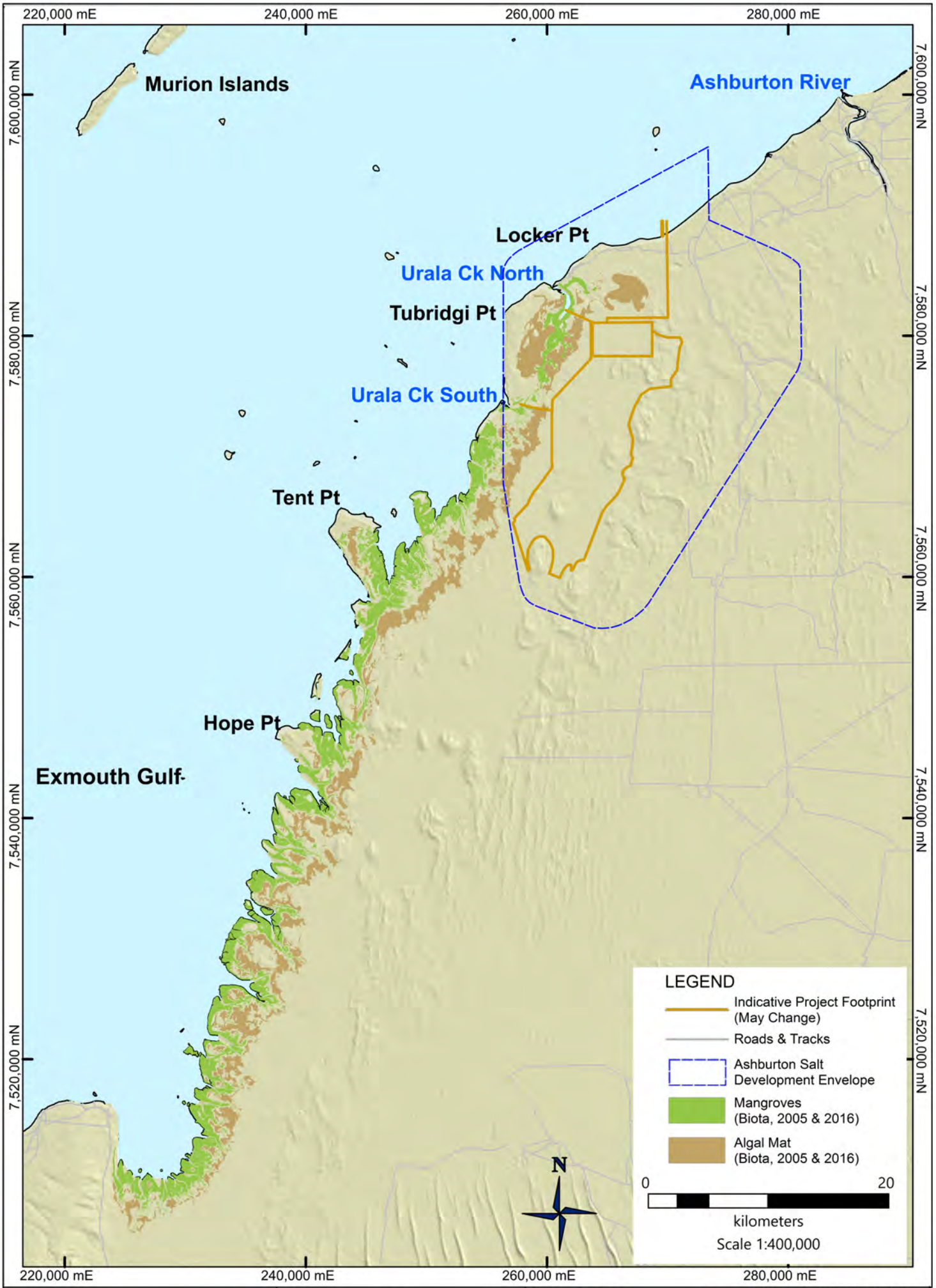
EnviroWorks CONSULTING

Fig 8.
North West Shelf Joint Environmental Management Study Area

Date: 12/08/2016 | Paper: A4 L | GDA94, Lat Long

Data Source: 4E, 4L, 5B, 9A

File Info: K04_J03_NWSJEMS_Study_Area_120816



Experience growth.

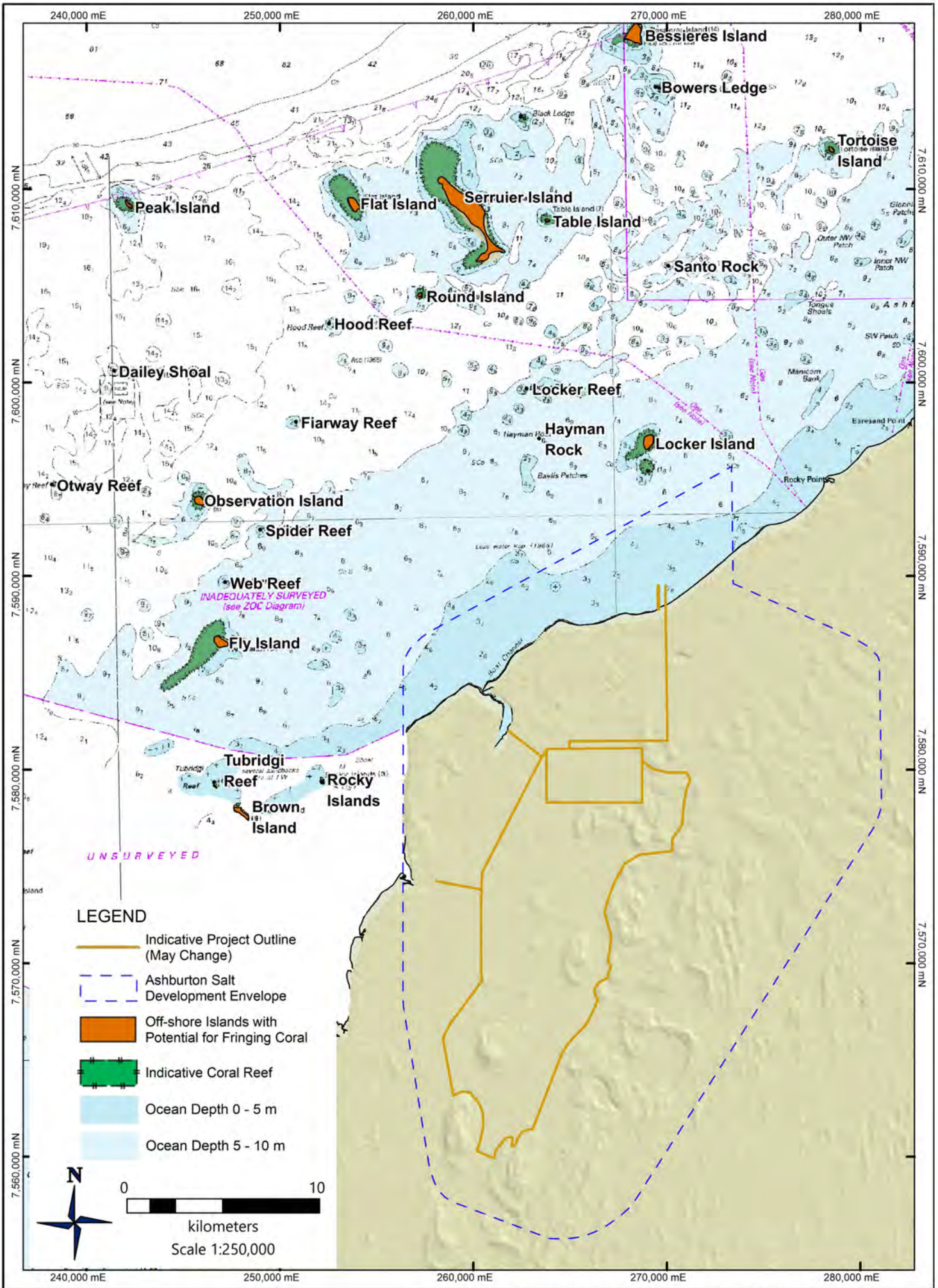
EnviroWorks CONSULTING

Fig 9.
Algal Mat and Mangrove Distribution

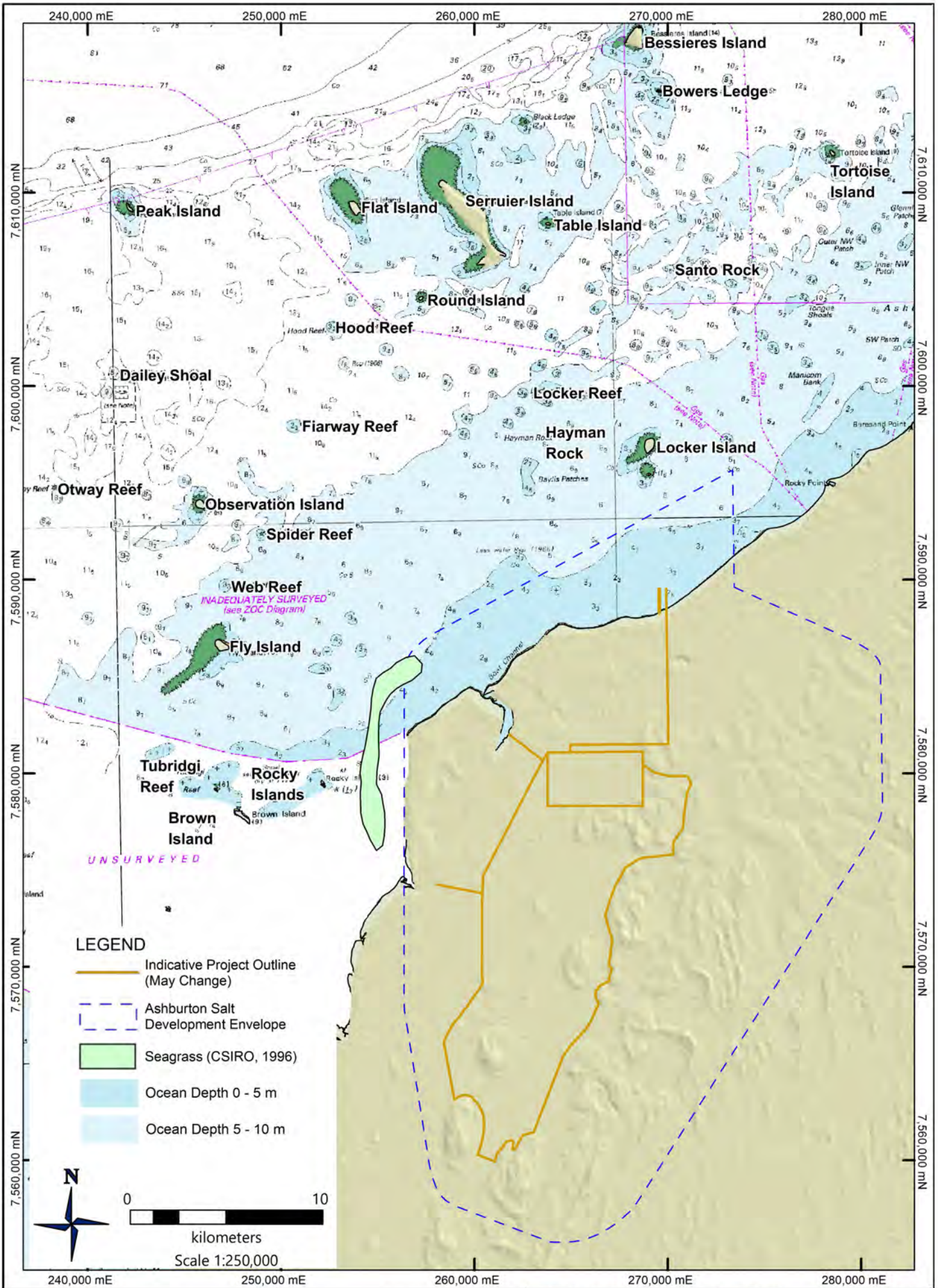
Date: 12/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 4E, 9A, 23C

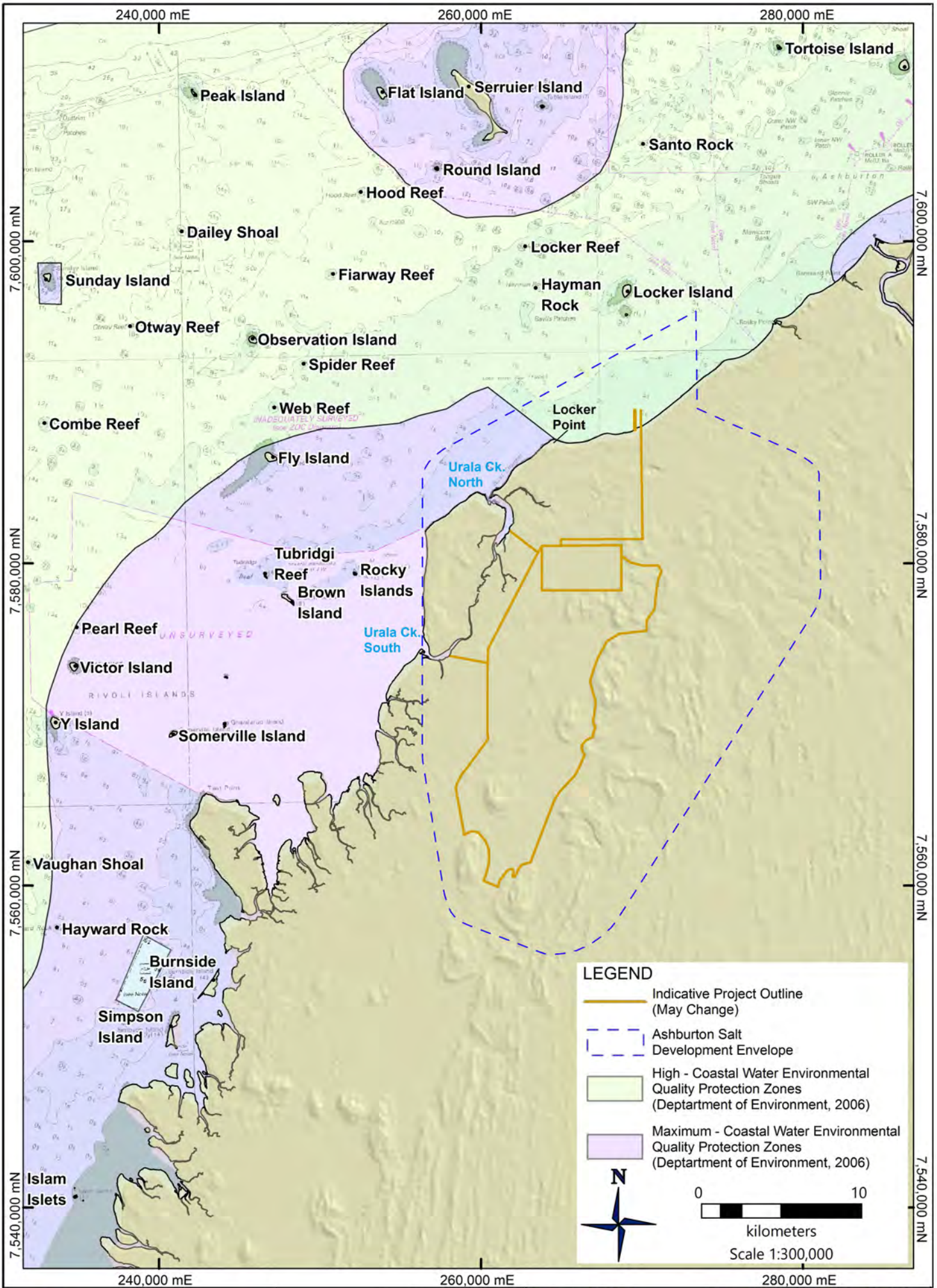
File Info: K04_J03_AlgalMat_Mangrove_120816



Experience growth. EnviroWorks CONSULTING	**Fig 10. Indicative Coral Reef Mapping**	Date: 15/08/2016 Paper: A4 P GDA94, MGA50 Data Source: 5A, 9A, File Info: K04_J03_Indicative Coral_120916



K+S Experience growth. / EnviroWorks CONSULTING	**Fig 11. Indicative Seagrass Mapping**	Date: 15/09/2016 Paper: A4 P GDA94, MGA50 Data Source: 5A, 9A, File Info: K04_J03_Indicative Seagrass_120916



K+S Experience growth.

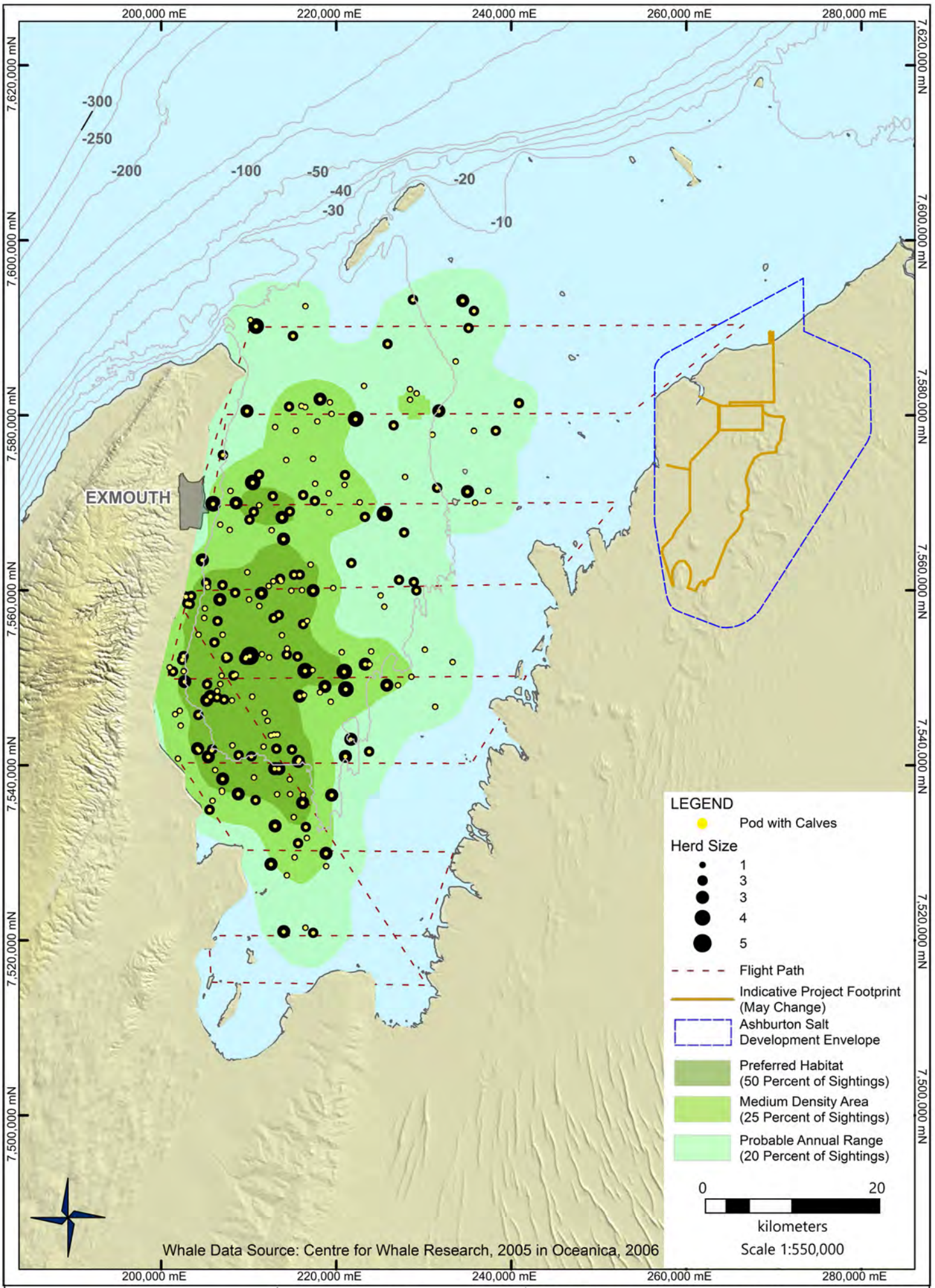
EnviroWorks CONSULTING

Fig 12.
Coastal Water Environmental Quality Protection Zones

Date: 15/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 5A, 9A,

File Info: K04_J03_ENV_Proctection_Zone_150816

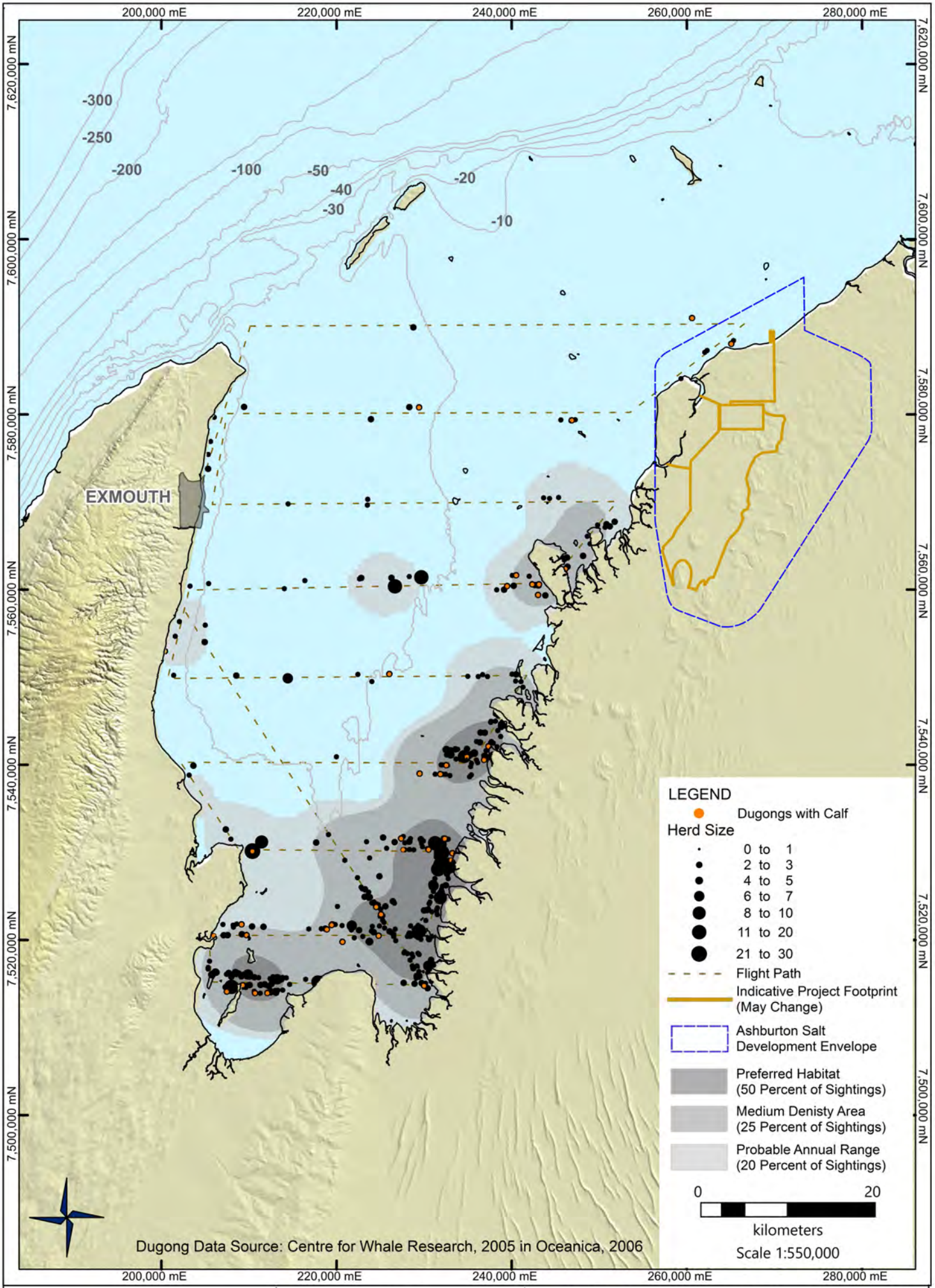


Experience growth.

EnviroWorks CONSULTING

Fig 13.
Location of all Pods of Whales in Aerial Surveys 2004/2005

Date: 27/08/2016	Paper: A4 P	GDA94, MGA50
Data Source: 4A, 4E, 9A		
File Info: K04_J03_Whales_Aerial_Survery_V2_270816		



Experience growth.

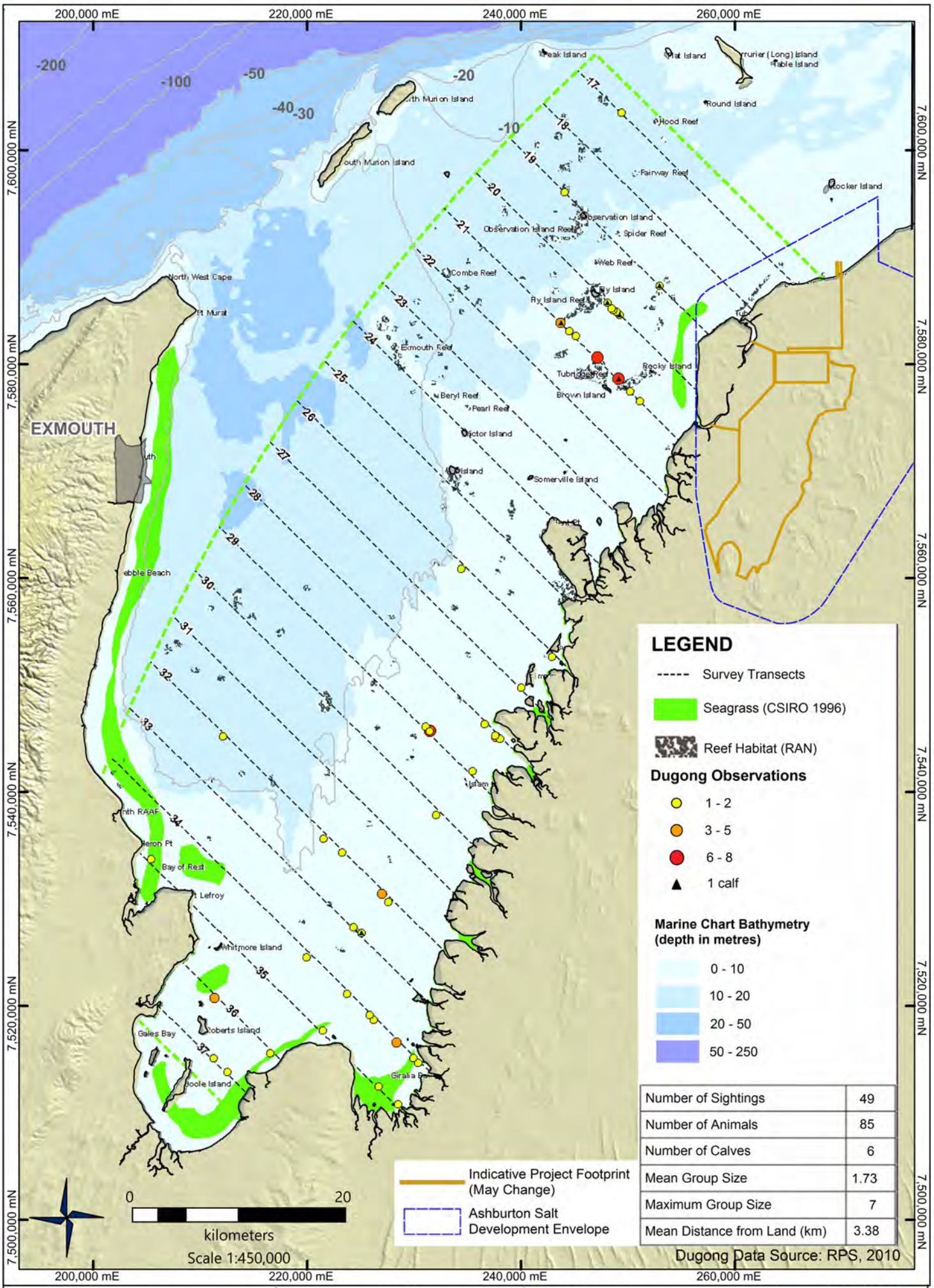
EnviroWorks CONSULTING

Fig 14.
Location of Dugongs in Aerial Surveys 2004/2005

Date: 27/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 4E, 9A

File Info: K04_J03_Dugong_Aerial_Survery_V2_270816



Experience growth.

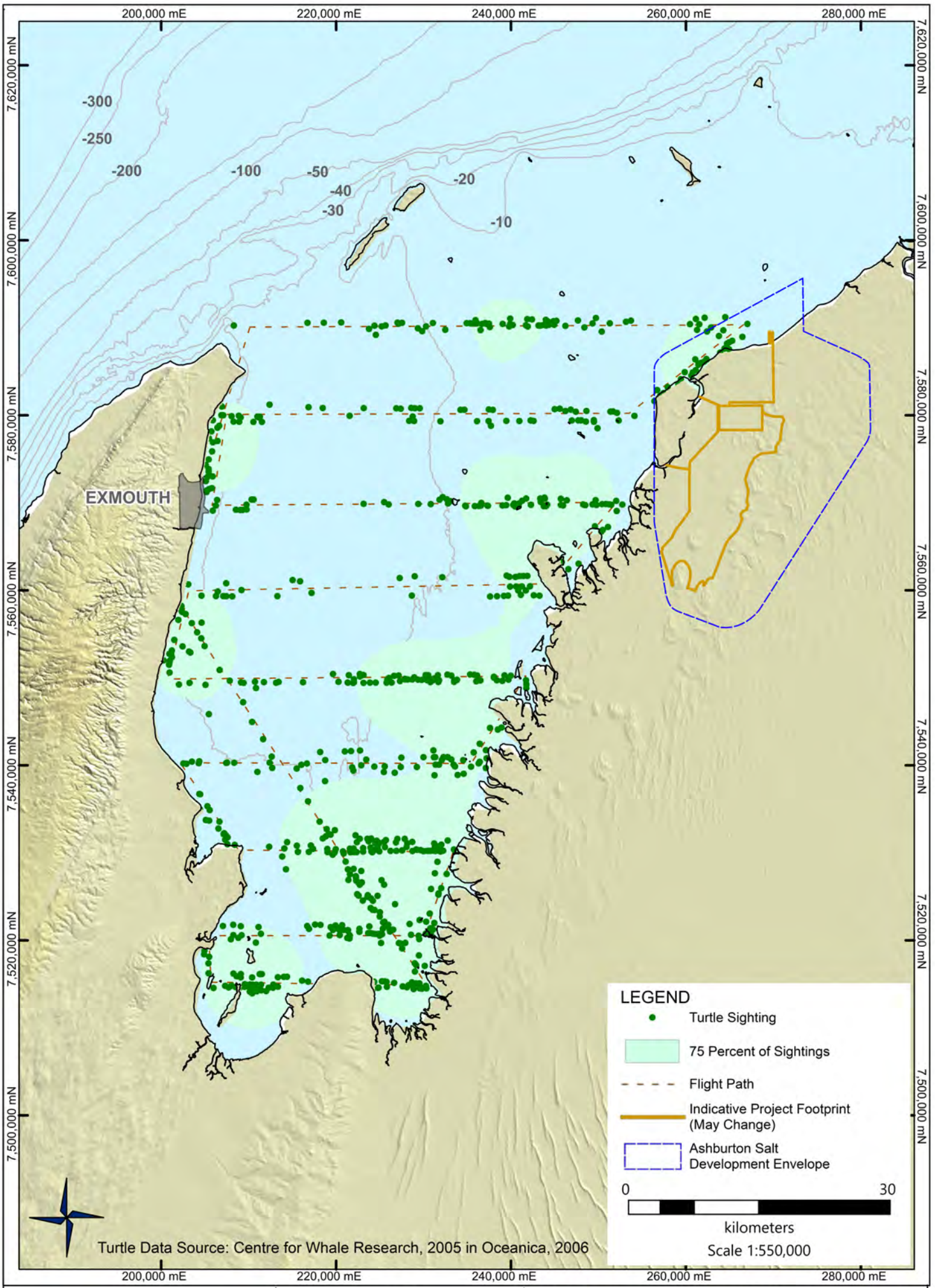
EnviroWorks CONSULTING

Fig 15.
Location of Dugongs Recorded in Aerial Surveys 2010

Date: 15/08/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 4E, 9A

File Info: K04_J03_Dugong_Observations_2010_150816

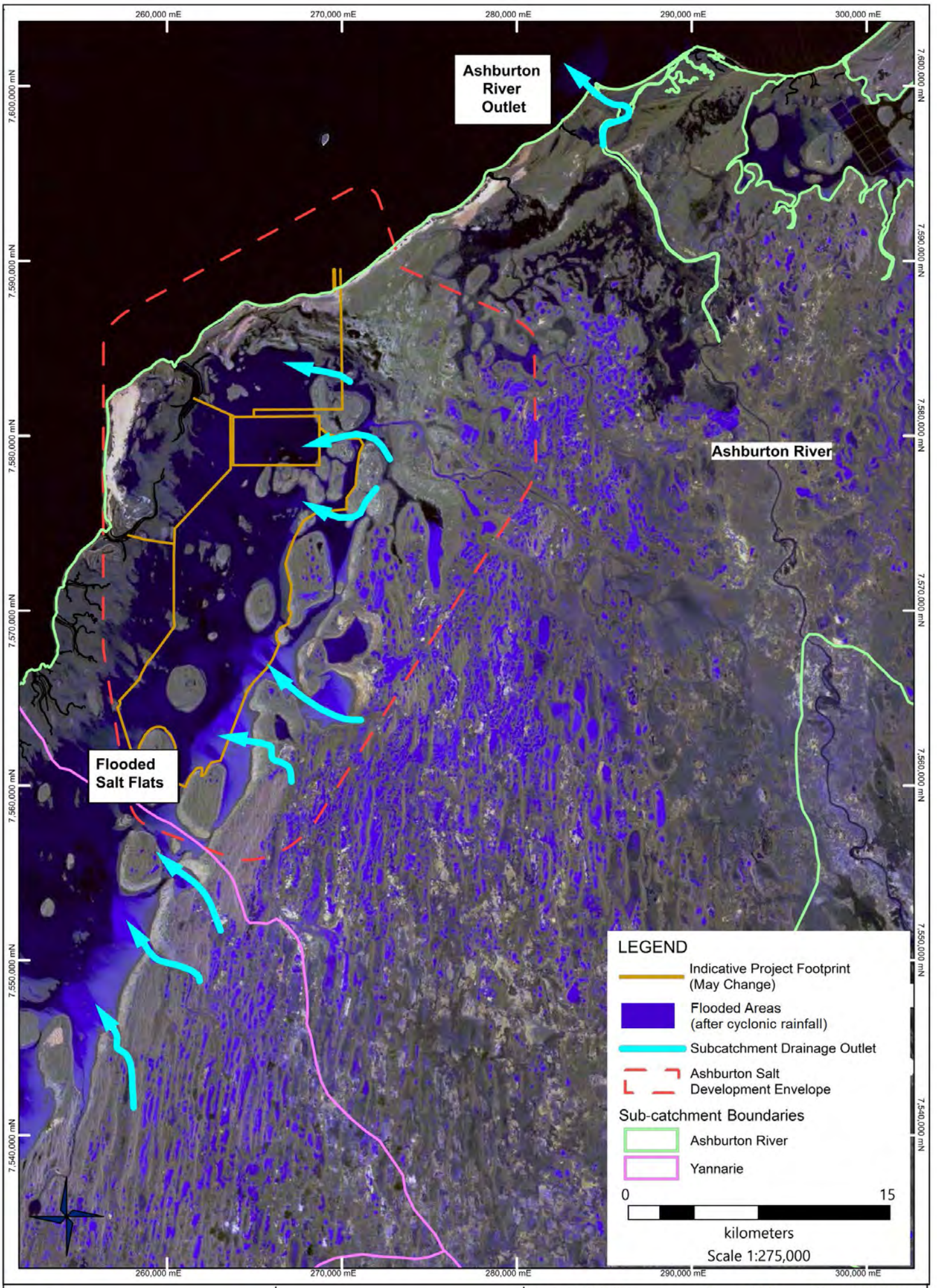


Experience growth.

EnviroWorks CONSULTING

Fig 16.
Location of Turtles in Aerial Surveys 2004/2005

Date: 27/08/2016	Paper: A4 P	GDA94, MGA50
Data Source: 4A, 4E, 9A		
File Info: K04_J03_Turtle_Aerial_Survery_V2_270816		



Experience growth.

EnviroWorks CONSULTING

Fig 17. Hydrology

Date: 12/09/2016 Paper: A4 P GDA94, MGA50

Data Source: 4A, 4E, 9A

File Info: K04_J03_Hydrographics_120916

APPENDIX A. EPBC PROTECTED MATTERS SEARCH REPORT

Australian Government
Department of the Environment

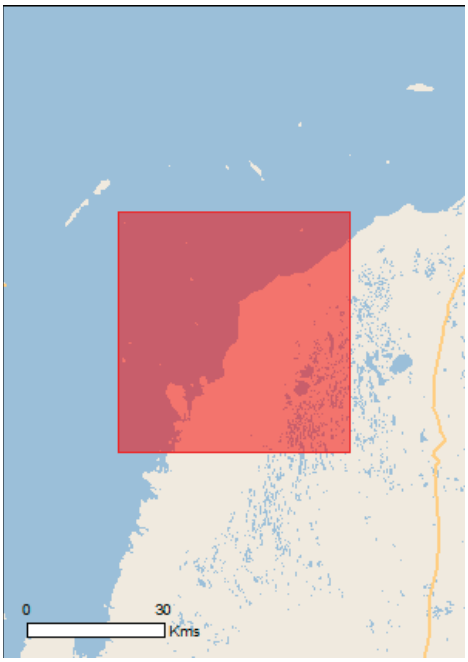
EPBC Act Protected Matters Report

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.

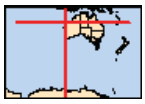
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 26/08/16 03:41:30



Coordinates
Buffer: 0.0Km



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:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	21
Listed Migratory Species:	30

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. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

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:	67
Whales and Other Cetaceans:	13
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.

State and Territory Reserves:	7
Regional Forest Agreements:	None
Invasive Species:	10
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties		[Resource Information]
Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Limosa lapponica baueri		
Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri		
Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis		
Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Breeding likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [331]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Reptiles		
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may 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 likely to occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Migratory Wetlands Species		
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to 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 may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur

Name	Threatened	Type of Presence within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may 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
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to 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	Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		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 aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		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

State and Territory Reserves [Resource Information]

Name	State
Burnside And Simpson Island	WA
Gnandaroo Island	WA
Locker Island	WA
Rocky Island	WA
Tent Island	WA
Victor Island	WA
Y Island	WA

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		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
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		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Exmouth Gulf East	WA

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 and National Heritage properties, Wetlands of International and National 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.

Coordinates

-22.1198 114.40747,-21.68309 114.40747,-21.68309 114.86023,-22.1198 114.86023,-22.1198 114.40747

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:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian 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
Forestry Corporation, 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.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111