



ARROW LNG PLANT

ENVIRONMENTAL IMPACT STATEMENT ➤

EXECUTIVE SUMMARY



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Project Director	Barton Napier		
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Arrow CSG (Australia) Pty Ltd

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CR 7033_7_v3


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1 INTRODUCTION

This document provides a summary of the environmental impact statement (EIS) prepared for the Arrow LNG Plant (the project). The main findings of the impact assessment process are presented, focusing on the key impacts of the project, and how Arrow Energy proposes to manage these impacts.

The EIS is supported by a series of technical studies carried out by specialists in relevant environmental, social, economic, health and safety disciplines. These studies, together with the main EIS document, are available for viewing and review, and can be accessed in electronic, interactive form at: www.arrowenergy.com.au. Copies of the EIS can also be obtained on compact disc by contacting 1800 038 856 or emailing arrowlng@arrowenergy.com.au. Hard copies can be ordered by phone or email at a small cost (see Arrow Energy's website for details).

1.1 Project Outline

Arrow CSG (Australia) Pty Ltd (Arrow Energy) is the proponent for the Arrow LNG Plant. Arrow Energy proposes to develop a liquefied natural gas (LNG) plant on Curtis Island off the central Queensland coast, near Gladstone. The site is part of an area designated for industrial development by the Queensland Government.

The project, known as the Arrow LNG Plant, is part of the larger Arrow LNG Project which aims to commercialise coal seam gas reserves in the Surat and Bowen basins (Figure 1). A feed gas pipeline will transport the gas from the Arrow Surat Pipeline near the Gladstone City Gate, across Port Curtis via a tunnel to a LNG plant on Curtis Island (Figure 2). LNG carriers will transport the LNG to overseas markets.

The main parts of the Arrow LNG Plant include: a LNG plant and jetty (to berth LNG carriers); marine logistics and support facilities on Curtis Island and the mainland for transporting materials and personnel to and from the island; a pipeline installed in a tunnel bored from the mainland to Curtis Island to supply gas to the LNG plant; and dredging works in Port Curtis to allow vessels to access the jetty and marine logistics facilities.

The LNG plant will be developed in two stages with a nominal capacity of 16 million tonnes per annum (Mtpa) of LNG, with potential for up to 18 Mtpa. The first stage will see the construction of two LNG 'trains' (purification and liquefaction facilities) with a nominal capacity of 4 Mtpa which will begin producing LNG in 2017 and 2018 respectively. Construction of the third and fourth trains is expected to commence five years after the completion of stage 1 (although the timing will depend on market conditions and project financial decisions) (Figure 3).

1.2 Arrow Energy

Arrow CSG (Australia) Pty Ltd (Arrow Energy) is owned by Arrow Energy Holdings Pty Ltd (Arrow), a joint venture between subsidiaries of Royal Dutch Shell PLC (Shell) and PetroChina Company Limited (PetroChina).

Shell is an internationally recognised leader in LNG production and has delivered some of the world's largest and most complex LNG projects in the past 40 years, including facilities in Qatar, Nigeria, Russia and southeast Asia. Through its subsidiary, Shell International Trading and Shipping Company Limited, Shell operates one of the largest LNG carrier fleets in the world.

PetroChina is a subsidiary of China's largest state-owned oil and gas producer and distributor, China National Petroleum Corporation, and is one of the world's largest oil and gas companies. PetroChina brings extensive experience in exploration, refining and marketing of oil and natural gas in China and other countries.

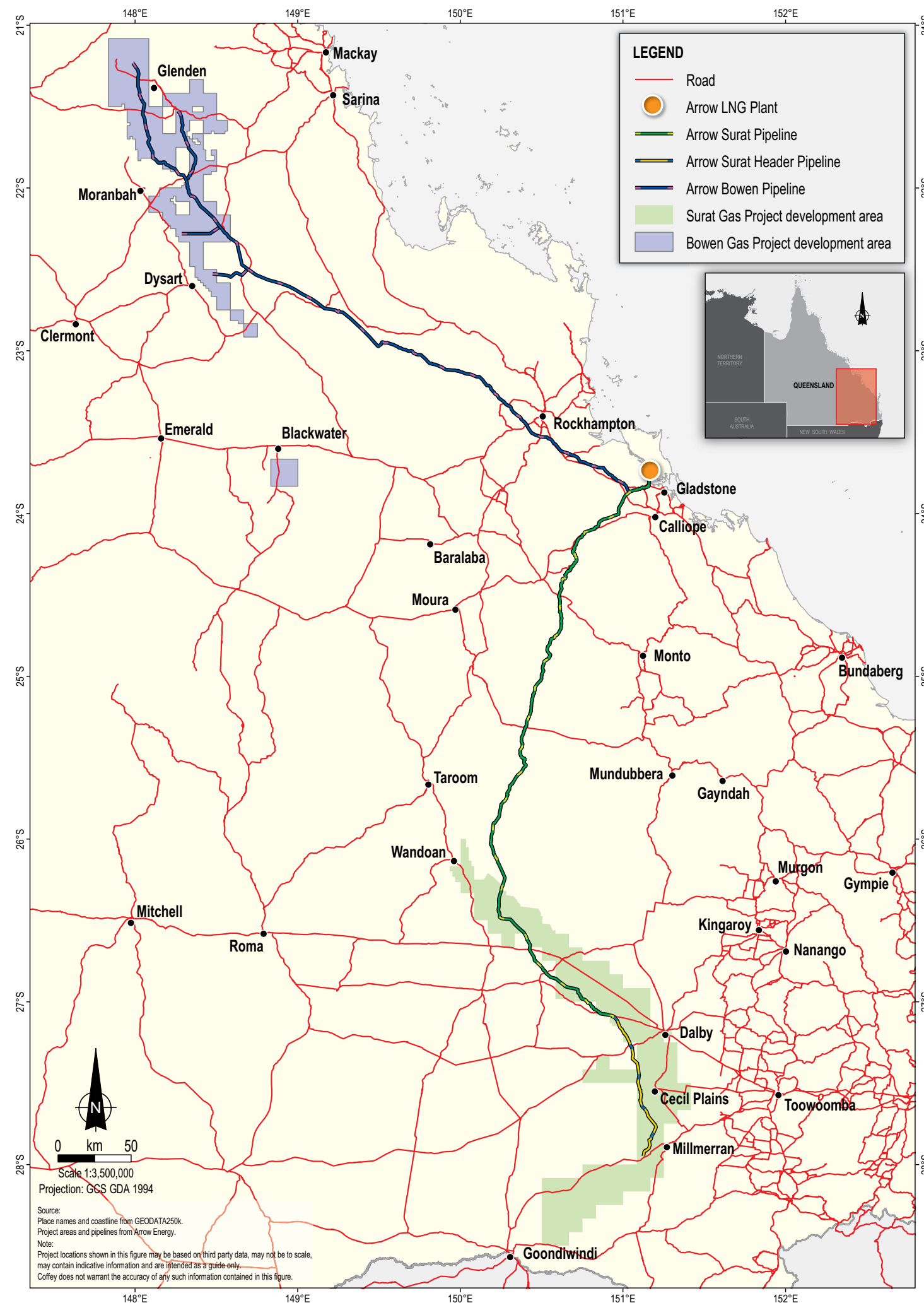


Figure 1 Arrow LNG Project

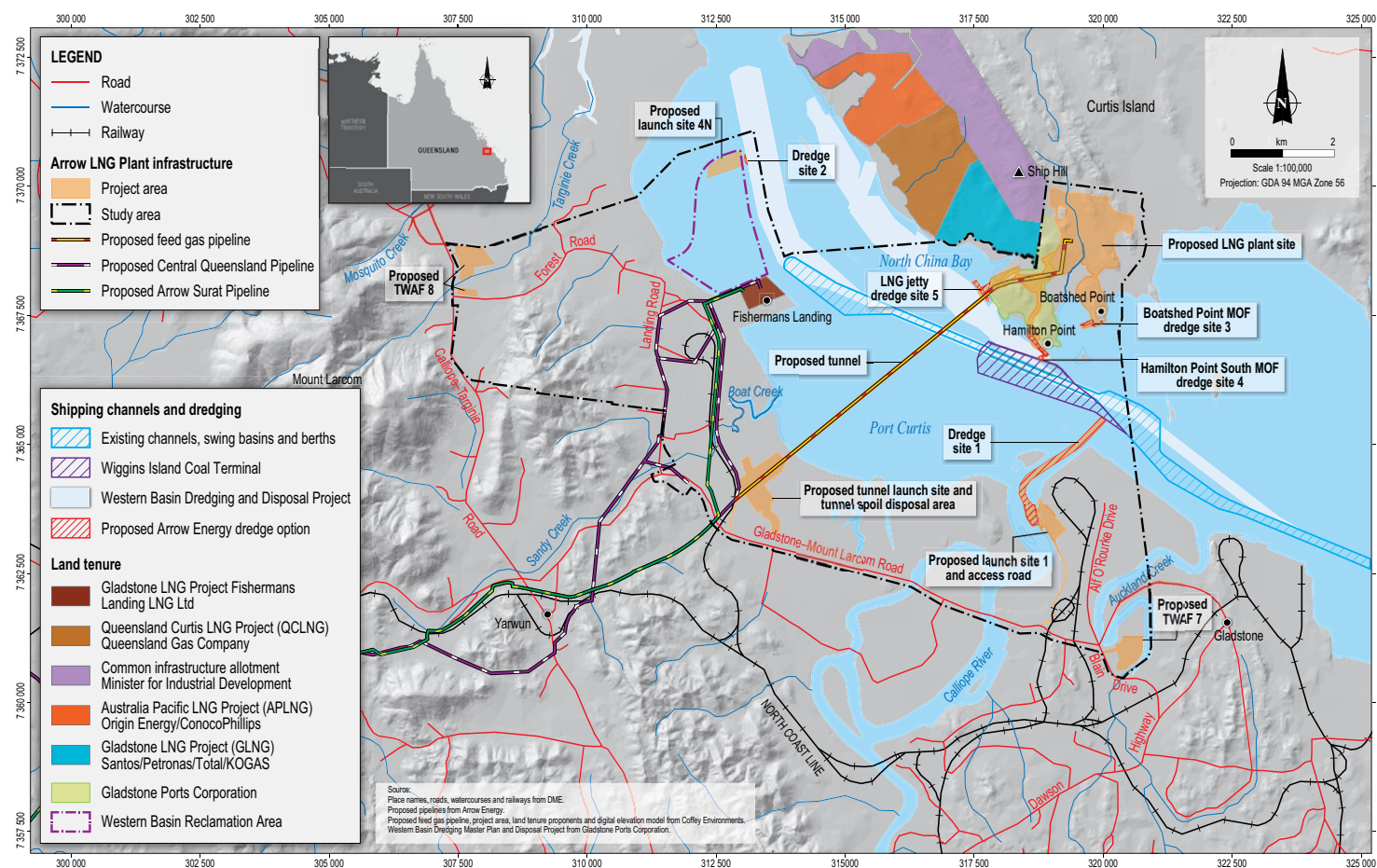


Figure 2 Site locality

Arrow is a Queensland based energy company with interests in coal seam gas field production, gas pipelines and electricity generation. The company has interests in more than 65,000 km² of petroleum tenures, mostly within Queensland's Surat and Bowen basins. The company's existing operations account for approximately 20% of Queensland's overall gas production.

Arrow is committed to the sound management of health, safety and the environment throughout all its business activities. Accordingly, the project will operate under a comprehensive set of policies and procedures that make up the company's health, safety and environmental management system.

Arrow Energy's registered office address in Australia is:

'AM-60' Level 19
42 Albert Street
Brisbane QLD 4000
AUSTRALIA

All project enquiries should be sent to:

Arrow LNG Plant
Reply Paid 81
Hamilton QLD 4007
Australia
Phone: 1800 038 856

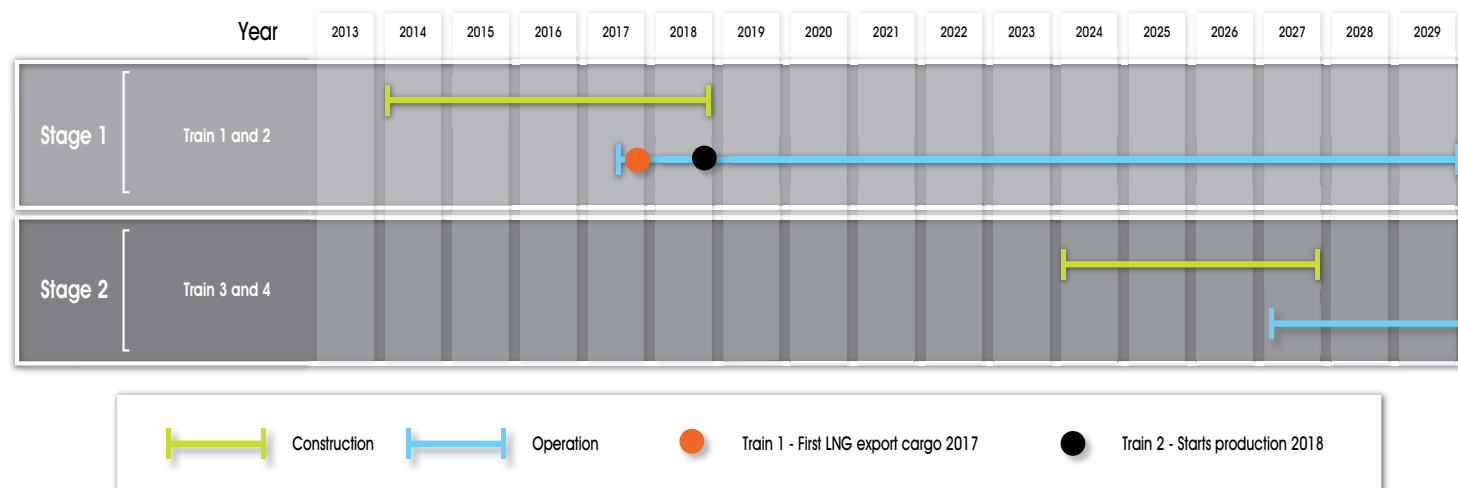


Figure 3 Arrow LNG Plant project staging

2 EIS PROCESS AND APPROVALS

The Arrow LNG Plant will require numerous approvals prior to the start of construction and operation of the project. The EIS informs, and is part of, the various approval processes required for the project. The EIS process is illustrated in Figure 4 (see Arrow Energy's website for details).

2.1 Legal Framework

On 12 June 2009, the Queensland Coordinator-General declared the Arrow LNG Plant a 'significant project' under the State Development and Public Works Act 1971 (SDPWO Act) for which an EIS is required.

The project is also covered by Commonwealth legislation, principally the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) which applies to any part of the project that is likely to have a significant impact on matters of national environmental significance.

Two referrals were made by the then project proponent, Shell CSG (Australia) Pty Ltd (now Arrow Energy), to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities. The project was declared a 'controlled action' and requires formal assessment and approval under the EPBC Act, specifically for its potential to impact on World Heritage properties, National Heritage places, listed threatened species and communities and listed migratory birds.

Arrow Energy has sought a variation to the scope of both referrals to include additional mainland support facilities and the feed gas pipeline tunnel crossing under Port Curtis.

A bilateral agreement between the Queensland and Commonwealth governments means the project will be assessed under the Queensland SDPWO Act. The EIS process under this act is deemed to meet the requirements of the Commonwealth EPBC Act.

The EIS process in Queensland is managed by the Department of Employment, Economic Development and Innovation (DEEDI) on behalf of the Coordinator-General. Relevant Commonwealth, Queensland and local government authorities are expected to be invited to participate in the EIS process as advisory agencies.

The project will require a major hazard facility licence under the Dangerous Goods Safety Management Act 2001 (Qld), as well as a petroleum facility and pipeline licence under the Queensland Petroleum and Gas (Production and Safety) Act 2004. Specific environmental authorities for the project will be issued under the Queensland Environmental Protection Act 1994 and will form part of these licences. Additional approval permits and licences will be required for the project under a range of legislation and regulations.

2.2 EIS Process

The EIS aims to examine and address all environmental, social and economic impacts of the project. The EIS assesses the current design and planning for the project, and describes how the Arrow LNG Plant will be designed, planned, constructed, operated and eventually decommissioned.

The document provides government agencies and decision makers with the necessary information to understand the need for the project and to assess its impacts. The EIS includes the information required by the terms of reference for the project prepared by the Coordinator-General.

Importantly, the EIS also provides interested persons and organisations with information on the project, its potential impacts, and an explanation of how Arrow Energy will manage environmental, social and economic impacts.

The impact assessments presented in the EIS are based on the findings of technical environmental, social and economic studies and the extensive consultation Arrow Energy has undertaken in the Gladstone region.

The EIS, upon submission to the Coordinator-General, is published for public comment. Arrow Energy will summarise and address the comments presented in each submission and provide a supplementary report to the EIS to the Coordinator-General. The Coordinator-General will prepare an EIS evaluation report, which will include any conditions that should be attached to licences, environmental authorities or other approvals required for the project to proceed.

2.3 Consultation and Communications

Consultation and communication with local communities and stakeholders with an interest in the Arrow LNG Plant commenced in January 2010, continued throughout the EIS process, and will continue for the life of the project.

Arrow Energy recognised that different members of the community and interested groups have differing needs for consultation and tailored its activities accordingly. Opportunities were provided for stakeholders to attend briefings, meetings, community consultation sessions, and forums on specific issues such as LNG safety, fishing and boating, and the environment. Printed material was made available at meetings and on the Arrow Energy website.

Articles were published in local newspapers and school newsletters, and postcards circulated in popular community places such as shops and council offices. A 1800 freecall number, dedicated project email address and freepost service were established and will be maintained throughout project consultation.

Consultation has increased stakeholder awareness and understanding of the project and helped Arrow Energy to identify areas of concern and so develop, where possible, measures to address these concerns. Overall, the relationships developed with landowners and occupiers, government stakeholders, industry and community groups throughout the consultation period have demonstrated the benefits of working closely with the local community.

Further community consultation sessions are planned during the public notice period of this EIS. The purpose will be to advise stakeholders that the EIS is available for review, provide further information to the community on potential impacts and proposed mitigation measures, and inform stakeholders as to how submissions may be made to the Coordinator-General.

After the conclusion of the EIS process, Arrow Energy is committed to maintaining ongoing relationships with project stakeholders and the wider community. Arrow Energy expects to open a community information centre in Gladstone in the first quarter of 2012.

3

PROJECT RATIONALE

The Arrow Surat and Bowen basin petroleum tenures contain significant coal seam gas resources suitable for domestic supply and conversion to LNG for export. The Arrow LNG Plant forms part of Arrow's vision to increase value to its operations and the Queensland economy by commercialising these coal seam gas reserves.

3.1 LNG Demand and Markets

LNG is a global commodity and comprises around 7% of global gas sales. Production is predicted to increase from 2007 levels of 165 Mtpa to between 245 and 340 Mtpa by 2015. In 2009-10, LNG contributed \$7.8 billion to Australia's export income and Australian LNG production is predicted to rise from 18 million tonnes in 2010 to 40 million tonnes per annum by 2015.

Australia's main LNG markets are Japan, Korea and China. Additional markets are expected to develop in India, Thailand, Chinese Taipei and Singapore. Australia's proximity to these existing and new markets provides a significant competitive advantage for local LNG producers.

Australian gas consumption has increased on average by 3.1% per annum over the five years ending 2008-09 and annual growth is predicted of between 3% and 4.8% to at least 2030, largely dominated by power generation.

3.2 Alternatives Considered

Starting in 2008, the project has undergone a systematic process of identifying and evaluating alternatives such as location, LNG plant design, and construction methods. Some alternatives remain under investigation, as further design of the facilities and consideration of construction methods is required to inform a decision.

Arrow Energy has, and continues to participate in, discussions with the Queensland Government and other LNG proponents to identify opportunities to rationalise and co-locate infrastructure.

3.2.1 LNG Plant

A site selection study was undertaken to assess the Curtis Island location against other potential sites along the Queensland coast between Brisbane and Townsville. The study short listed four alternative locations near Townsville, Mackay, Bundaberg and Brisbane. None of these sites presented significant technical, environmental or commercial advantages over the Curtis Island site, which was selected as the LNG plant site location. Arrow Energy was granted exclusive rights to investigate the feasibility of developing an LNG plant at the southern end of the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA), to the southeast of three other proposed LNG facilities.

The LNG plant site on Curtis Island offers stable geology, minimal dredging to access to shipping channels within a sheltered harbour, remoteness from existing population centres and is within an industry precinct declared to facilitate development of LNG plants.

3.2.2 Ancillary Infrastructure

Sites were considered for ancillary infrastructure required to support the construction and operation of the LNG plant. Infrastructure includes the jetty to accommodate LNG carriers on Curtis Island (LNG jetty), an offloading facility for materials being transported to Curtis Island ('materials offload facility' or MOF) with a jetty on Curtis Island for personnel transport, a mainland site and other facilities required to transport material and people to the island ('launch site'), a construction camp, a site for the entrance of the tunnel on the mainland ('tunnel launch site') as well as a temporary workers accommodation facility ('TWAF'), which may be required if the construction camp on Curtis Island has insufficient capacity during periods of peak construction.

The current LNG jetty site (see Figure 2) provides the best location for proximity to shipping channels and the LNG loading lines that transfer LNG from the storage tanks to LNG carriers. Boatshed Point is the preferred location for the materials offloading facility (MOF) however there are two alternative locations under consideration at Hamilton Point South and the GLNG Hamilton Point MOF. The final design is not yet complete and all options remain under investigation.

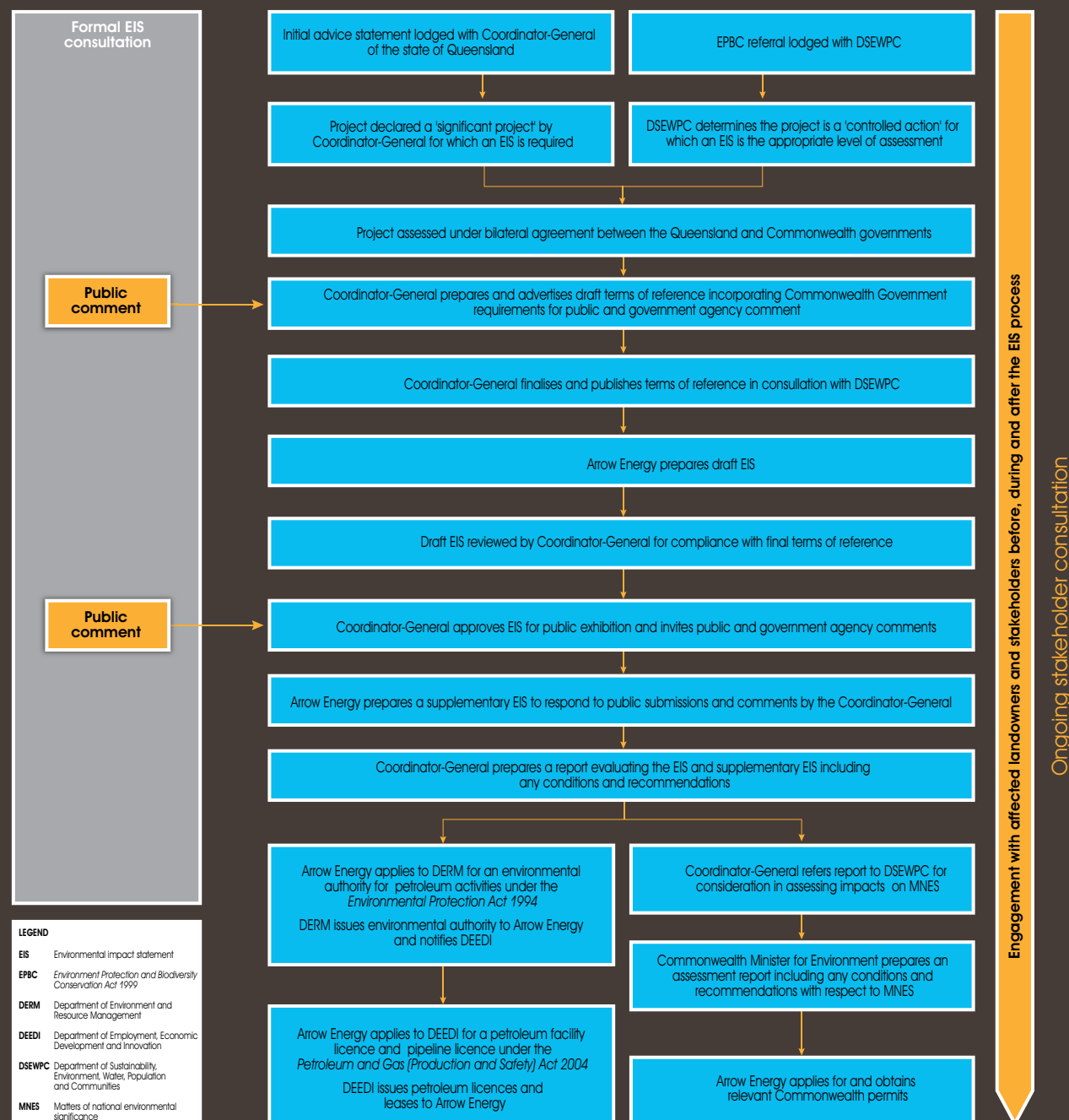


Figure 4 Environmental impact statement assessment process

Five potential mainland launch sites were investigated during a site selection study, which looked at land ownership, available land size, access to Port Curtis in all weather conditions and proximity to power, sewerage and water services. Following this investigation, it was determined that launch site 1 is the preferred option, although launch site 4N may be a feasible option. Launch site 1 is located on the Calliope River adjacent to the RG Tanna Coal Terminal. Launch site 4N is located on the yet to be constructed Western Basin Reclamation Area (see Figure 2).

Safety and logistics have governed the selection of Boatshed Point as the location for the construction camp. Siting the camp as close as possible to the LNG plant site reduces risks associated with daily transport of construction personnel, and also allows for improved transportation logistics.

Final site selection of the TWAF will depend on selection of the mainland launch site. Of eight TWAF sites investigated, TWAF 8 and TWAF 7 continue to be considered due to their respective proximity to launch site 4N and launch site 1. TWAF 7 is located on the former Gladstone Power Station No 7 fly-ash pond adjacent to Gladstone (Plate 1), and TWAF 8 northwest of Fishermans Landing, at the northeast corner of Forest Road and Calliope–Targinie Road.

3.2.3 Feed Gas Pipeline

Arrow Energy has consulted with the Queensland Government and other LNG proponents to evaluate a bundled crossing of The Narrows and the associated benefits of co-locating feed gas pipeline infrastructure. The option would see the mainland feed gas pipeline route follow the Northern Infrastructure Corridor Sub-Precinct of the GSDA.

Due to differing project timeframes and environmental and cultural issues, the decision was made to pursue a direct crossing of Port Curtis. The crossing option under consideration is to install the feed gas pipeline in a bored tunnel between shafts on the mainland and Curtis Island. This crossing option will see the mainland section of the feed gas pipeline following the Western Corridor Sub-Precinct and the Boat Creek Corridor Sub-Precinct of the GSDA. A range of other crossing methodologies including directional drilling, micro-tunnelling and open cut were considered during the concept design process.



3.2.4 Dredge Spoil Disposal Sites

To support the installation and operation of marine facilities, dredging will be required at the mainland launch site, LNG jetty and the MOF. Options for dredge spoil disposal include the Western Basin Reclamation Area, the East Banks Sea Disposal Site, or a new site. The Western Basin Reclamation Area is the preferred option for disposal of dredge spoil and its use would be consistent with the Port of Gladstone Western Basin Master Plan and associated environmental approvals.

3.3 Impacts of not Proceeding

Should the project not proceed, potential environmental and social impacts would be avoided, including impacts on land, water and air, and the associated physical, biological, social and cultural impacts.

Significant economic benefits would not be realised, including an estimated \$15 billion initial investment and annual operating costs of \$750 million. Local, regional and state economies would not benefit from these investments and revenue to the Queensland and Australian governments from taxes and duties would be forfeited.

Opportunities for local businesses would be diminished and the direct creation of approximately 3,715 jobs during stage one of project construction, a further 2,330 jobs during stage two of project construction and up to 600 long-term jobs created during the project's operational phase would not occur. Finally, the opportunity to reinforce Australia's position as a global energy producer would be compromised.

4 PROJECT DESCRIPTION

The Arrow LNG Plant has three key components; the LNG plant and its supporting infrastructure, the feed gas pipeline (and tunnel), and dredging activities. Each of these components is described below.

4.1 LNG Plant

The LNG plant will be located on the southwestern side of Curtis Island. The Curtis Island Industry Precinct is located outside the Great Barrier Reef Marine Park but inside the Great Barrier Reef World Heritage Area. The World Heritage area extends to the mainland low water mark of the Queensland coast (Figure 5)

Figure 6 illustrates the proposed layout of the site on Curtis Island. The site is within the 1,500 ha Curtis Island Industry Precinct of the GSDA. This area has been gazetted for industrial development by the Queensland Government. Three other LNG plants have been approved for development within this area.

The LNG plant will process coal seam gas to remove impurities, followed by cooling to approximately -163°C (Figure 7). At this temperature, the gas forms a liquid natural gas (LNG) which has considerably less volume (1/600th) than in its gaseous state and can be shipped to markets overseas.

The LNG plant will have a nominal capacity of 16 Mtpa, however may produce up to 18 Mtpa of LNG using four LNG trains to process and liquefy the gas. Each train will be able to produce 4 to 4.5 Mtpa of LNG. LNG will be stored in large fully contained or membrane tanks on the site operating at -163°C standing 40 to 45 m high. LNG carriers will enter Port Curtis and will berth at the jetty at Hamilton Point. Carriers will be loaded with LNG from the tanks through specially constructed LNG loading lines.

Other infrastructure at the LNG plant site will include a 110 m high flare stack, power generators, administrative buildings and workshops (Figure 8). Services needed to operate the plant include electricity and water supply, sewage and waste disposal and telecommunications. Power for the LNG plant will be supplied from the electricity grid (mains power), gas turbine generators, or a combination of both and consequently, four power supply options have been assessed in the EIS. Water will be supplied from a stand-alone desalination plant on the island, with sewage and greywater treated at an on-site effluent treatment plant. Arrow Energy is also considering an alternative option of importing fresh water supplied by Gladstone Area Water Board (GAWB) from the mainland, and export of domestic sewage, grey water and effluent from LNG operations to Gladstone Regional Council's sewerage system. Arrow Energy is working with GAWB, the Gladstone Regional Council (GRC) and other LNG proponents to review the feasibility of this option.

Other infrastructure required to support the construction and operation of the LNG plant include:

- A materials offloading facility (MOF) for the offloading of preassembled modules, equipment, supplies and construction bulk materials (i.e., aggregate) and jetty to transfer personnel to ferries travelling to and from the island from the mainland. Three sites are currently being considered. Boatshed Point (Plate 2) (the preferred option) and Hamilton Point South have been assessed in the EIS, while the GLNG Hamilton Point MOF is assessed as part of the Gladstone LNG Project EIS and subsequent approvals.
- A marine facility ('mainland launch site') at one of two locations; on the Western Basin Reclamation Area (launch site 4N) and a site at the mouth of the Calliope River (launch site 1). The facility will include a passenger terminal, jetties, a barge or roll-on, roll-off facility, waiting areas, car parking, laydown areas, workshops, storage sheds and a bulk handling facility. Launch site 1 is Arrow Energy's preferred site.

Temporary camps will be constructed to accommodate up to 3,500 people during the construction phase. The main accommodation camp will cater for up to 2,500 workers and will be located on Curtis Island at Boatshed Point.

In addition, a temporary facility to accommodate up to 1,000 workers may be constructed on the mainland should the construction camp on Curtis Island have insufficient capacity during periods of peak construction. Two options for the location of this facility are being considered on the mainland, including a site near Gladstone (TWAF 7) and a pastoral property near Targinnie (TWAF 8).

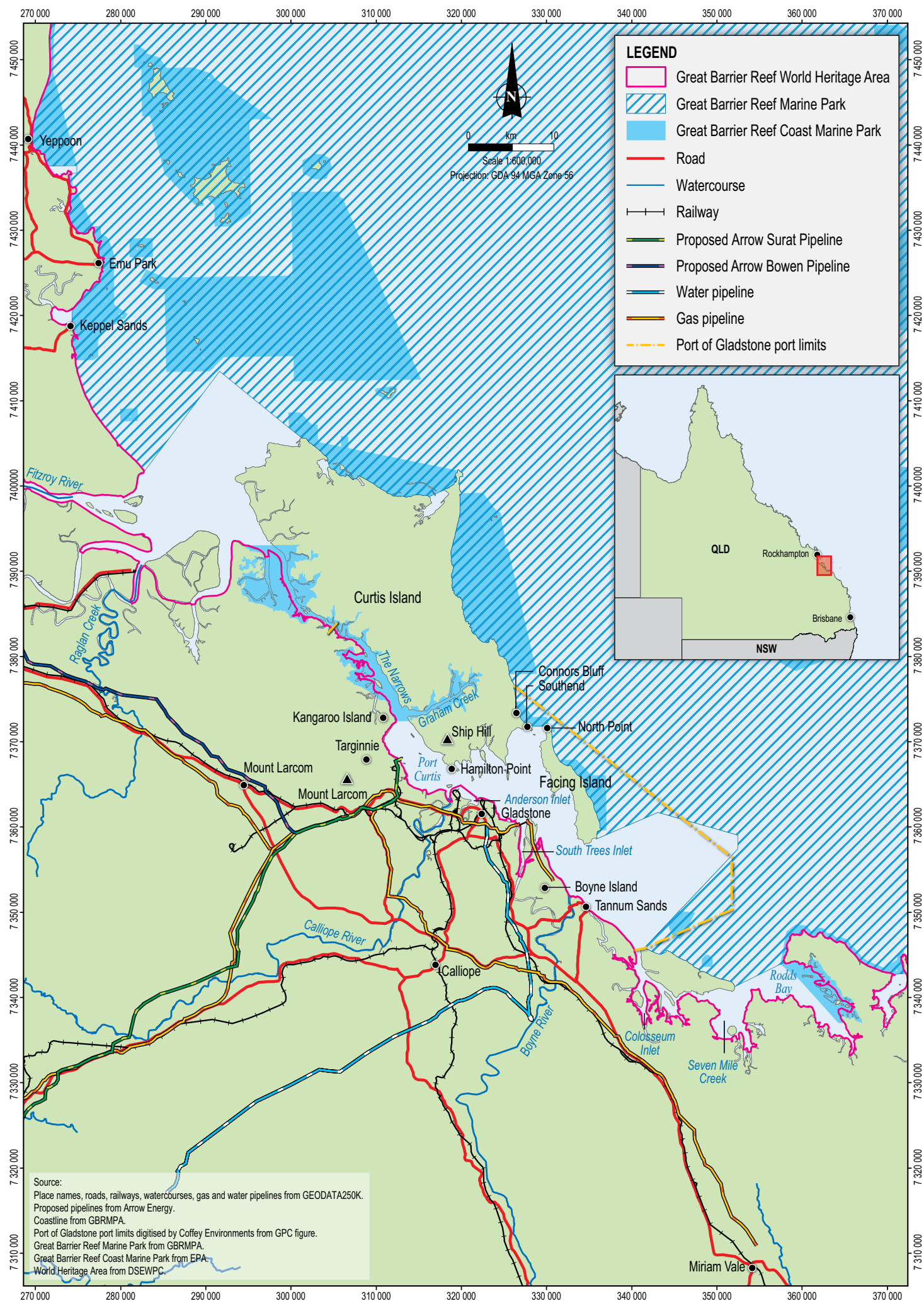


Figure 5 Regional context



- 1 Aerial view of TWAF 7
- 2 Mudflats near Boatshed Point on Curtis Island.
- 3 Typical segmentally lined tunnel



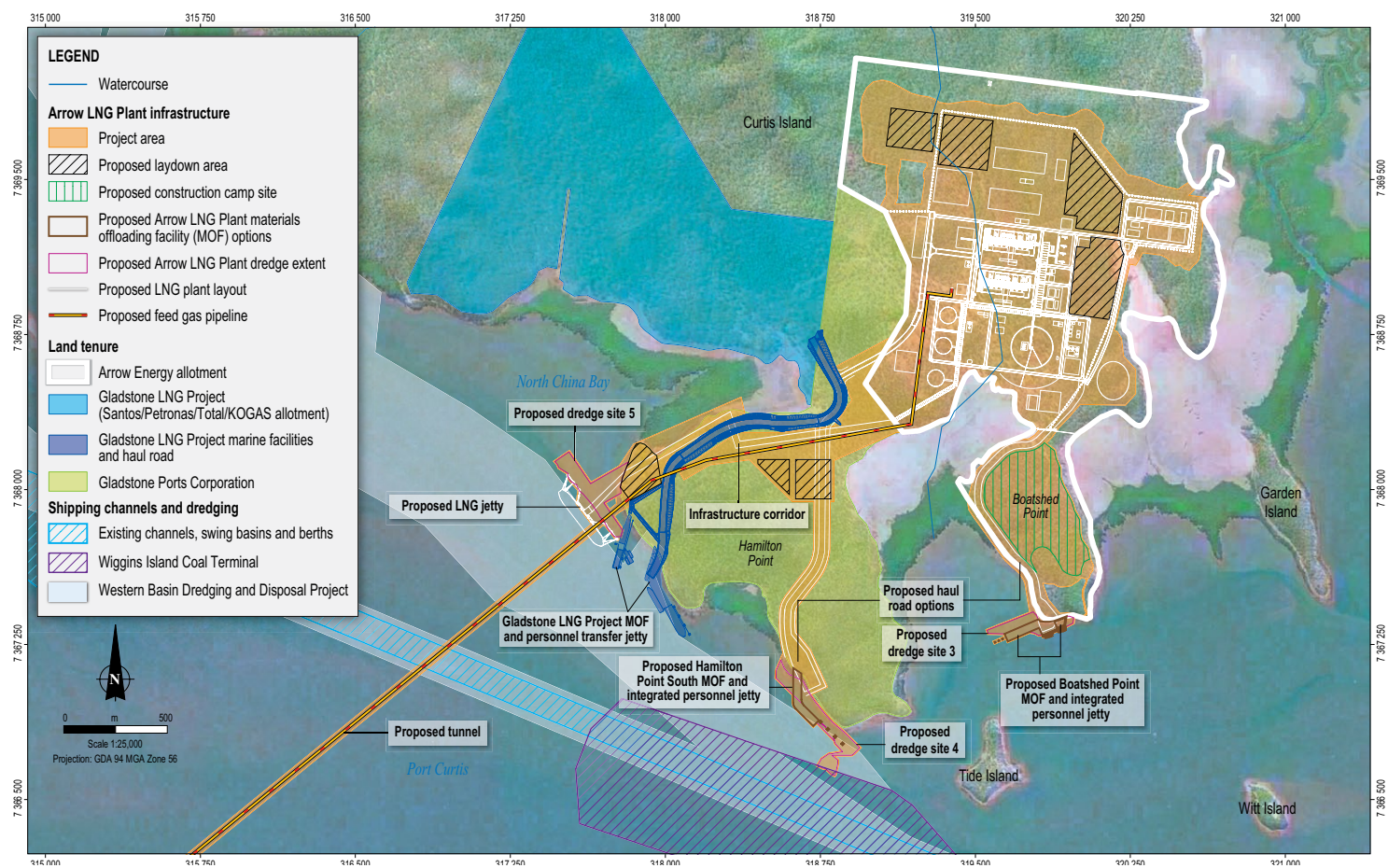


Figure 6 LNG plant and ancillary facilities

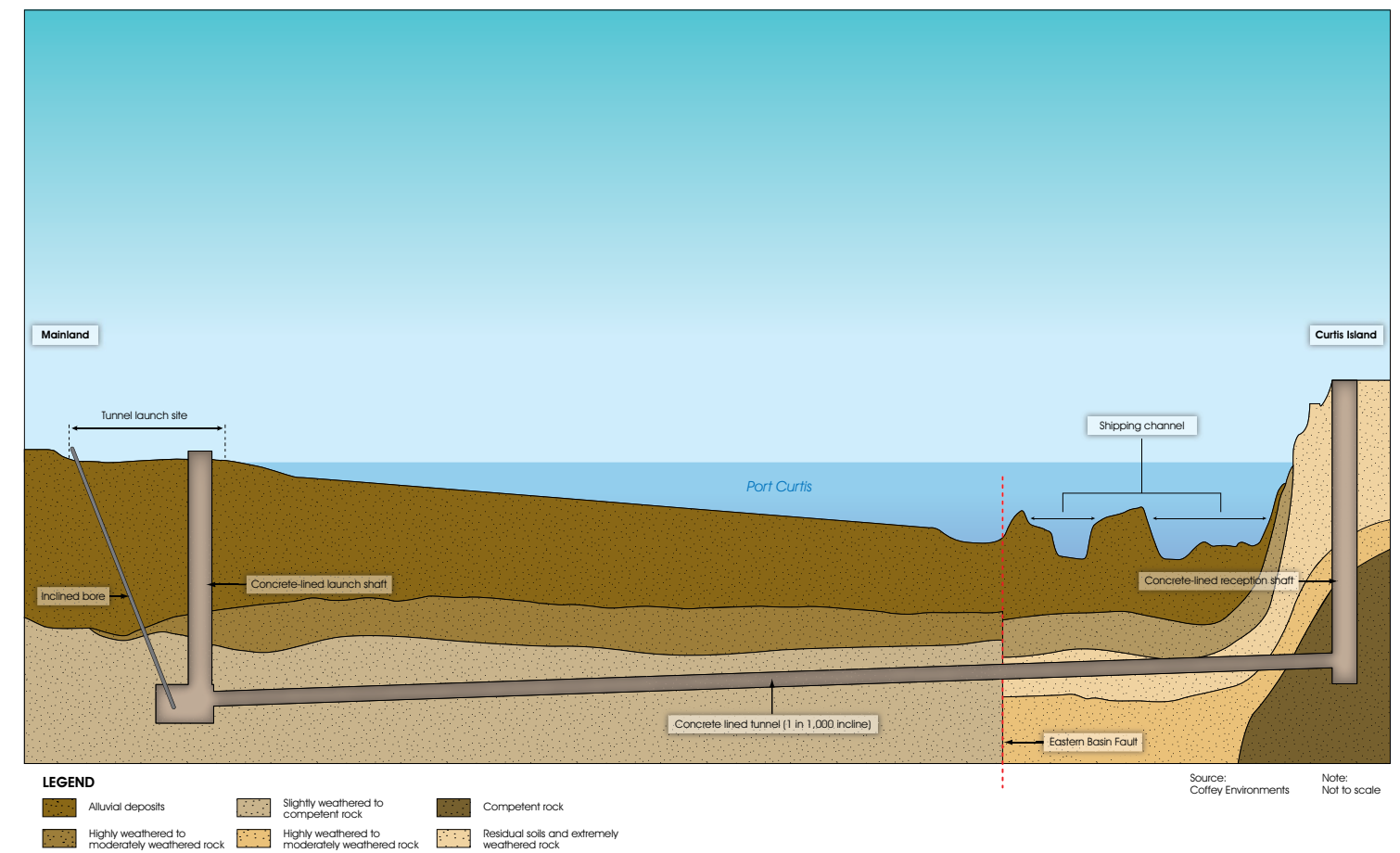


Figure 8 Port Curtis feed gas pipeline crossing - tunnel option

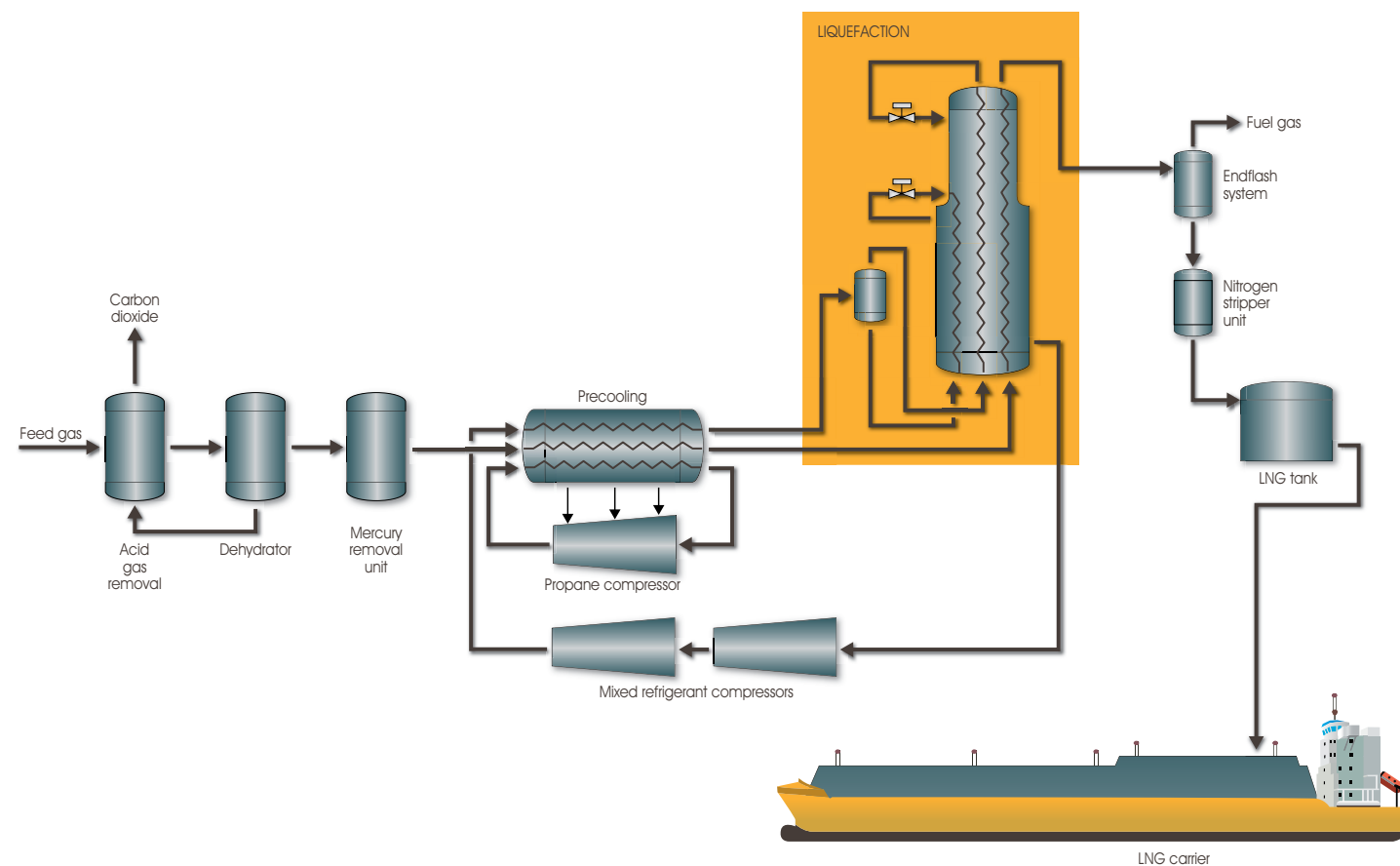


Figure 7 LNG process schematic

4.2 Feed Gas Pipeline

A single nominal 48" (1,219 mm) internal diameter high pressure gas pipeline will be built between the Arrow Surat Pipeline, adjacent to Rio Tinto's Yarwun alumina refinery (near the Gladstone-Mt Larcom Road) and the LNG plant on Curtis Island. The pipeline is proposed to deliver gas to the LNG plant at a nominal pressure of 7.3 MPag, achieved by compression at the coal seam gas fields.

The pipeline will be approximately 9 km long and for approximately 6 km of its length will be placed within a tunnel below the seabed of Port Curtis. The pipeline will be buried over its remaining lengths on the mainland and Curtis Island.

The feed gas pipeline will be designed, constructed and operated in accordance with Australian Standard AS 2885 Pipelines – Gas and liquid petroleum (AS 2885) which sets out the requirements for design, construction, commissioning, operation and maintenance, and decommissioning of high pressure gas pipelines. As required by the standards, Arrow Energy has and will continue to carry out risk assessments to ensure the pipeline is designed, built and operated in a safe manner.

The first section of the pipeline will be buried and will run from the Arrow Surat Pipeline to the start of the tunnel, at a site south of Fishermans Landing, just south of Boat Creek. This section of pipeline will be constructed using conventional trenching methods within a 40-m-wide construction right of way.

The next section of the feed gas pipeline will traverse Port Curtis in a tunnel to be bored under the harbour (Figure 8).

The tunnel will be excavated by a tunnel boring machine. Vertical shafts will be built at the 'tunnel launch shaft' on the mainland and on Curtis Island where the feed gas pipeline emerges ('tunnel reception shaft'). The launch shaft will be approximately 10 m wide to allow the tunnelling machine and other tunnelling equipment and supplies to be lowered into position. The shaft will be approximately 35 m deep so the base of the shaft is located in suitable rock for the tunnelling. A platform with a reinforced concrete pavement surface will be built around the launch shaft to provide a stable working surface to support the tunnel boring activities. The layout of the tunnel launch site is shown in (Figure 9). The tunnel will have an excavated diameter of up to approximately 6 m. Material excavated from the tunnel will be deposited adjacent to the launch shaft. Tunnelling is expected to take approximately 33 months and is proposed to begin in 2014.

From the tunnel reception shaft on Hamilton Point, the remaining section of the feed gas pipeline will run underground to the LNG plant, parallel to the above ground LNG loading lines. This section will also be constructed using conventional trenching methods within a 40 m wide construction right of way.

If an electrical plant power option is chosen, a power connection provided by a third party may be installed within the tunnel. Other infrastructure, such as communication cables, water and wastewater pipelines, may also be accommodated within the tunnel (Plate 3)s.

4.3 Dredging

The project includes some dredging of the seabed in Port Curtis and in the riverbed at the mouth of the Calliope River. The dredging will create deep enough areas for construction vessels to access the marine facilities on Curtis Island, and the launch site on the mainland. Some ongoing dredging to maintain navigable depths for vessels accessing launch site 1 may be needed in the Calliope River.

Arrow Energy has identified five potential dredge sites (see Figure 2) although only three will be required for the project. These sites are the mainland launch site (1 or 4N), the Boatshed Point or Hamilton Point MOF location, and the LNG jetty in North China Bay.

Dredging at these sites (depending on the options chosen) will generate a maximum volume of approximately 1 million m³ of material. The majority of this material will come from dredging the Calliope River (maximum 900,000 m³) required if launch site 1 is chosen. Dredging at each site will be carried out by cutter suction dredgers or backhoe dredgers and is expected to take up to four weeks depending on the site. Dredging is proposed to commence in 2014.



The Arrow Energy dredging is additional to the much larger dredging program being carried out by the Gladstone Ports Corporation to improve shipping access within Port Curtis. The environmental impacts of this dredging activity have been assessed separately through the EIS process for the Western Basin Dredging and Disposal (WBDD) Project.

Arrow Energy will seek to coordinate its dredging activities with those of the Gladstone Ports Corporation where possible. Similarly, the preferred option for disposal of dredged material is to place it in the Western Basin Reclamation Area. The impacts of the placement of dredged material into the reclamation area and the ongoing management of the site are covered in the WBDD Project EIS and subsequent approvals.

Dredge spoil disposal options will be discussed with the Gladstone Ports Corporation and relevant government agencies. Arrow Energy's preference is to place dredged material into existing and proposed disposal sites that already have government approval.

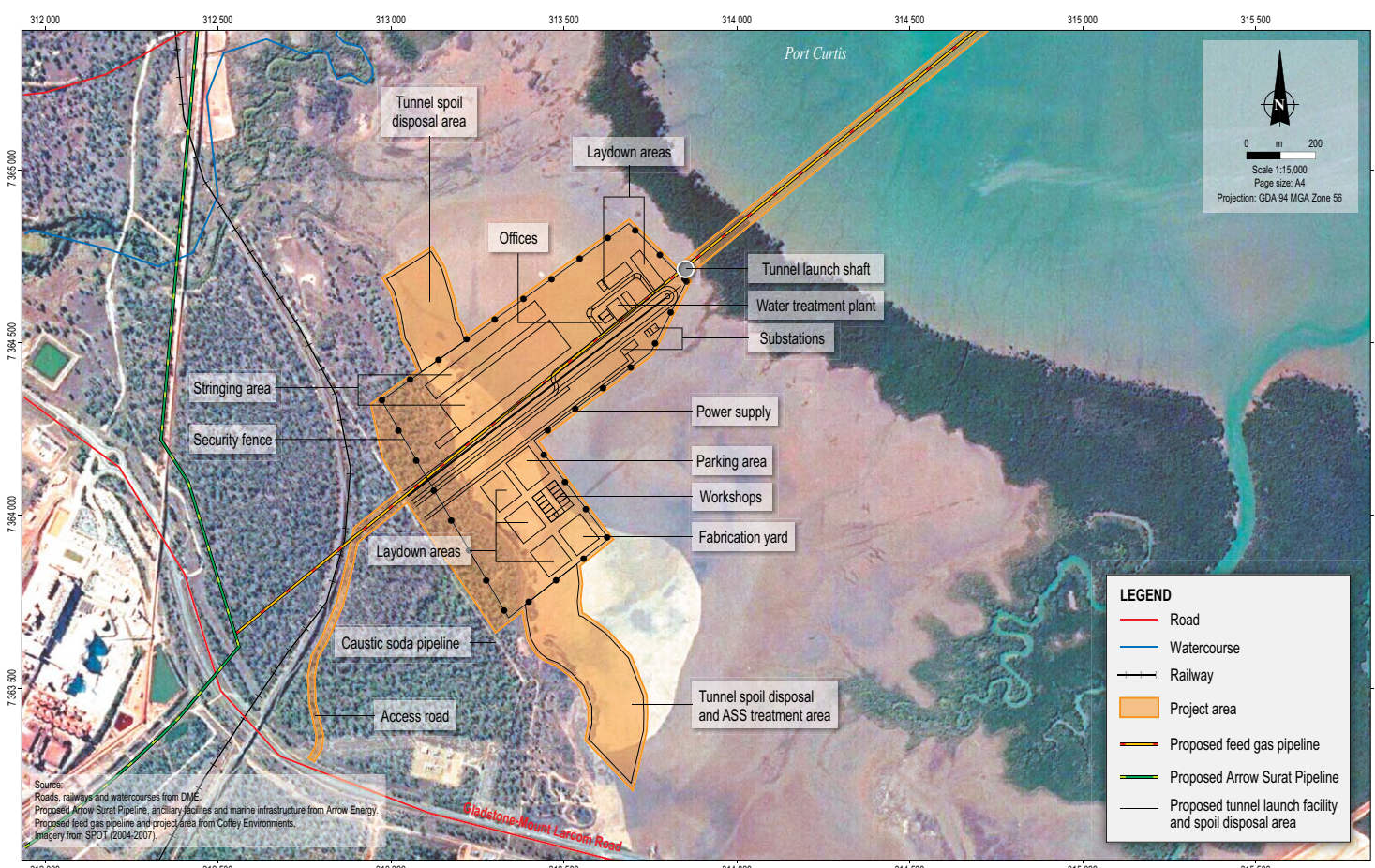


Figure 9 Conceptual layout of tunnel launch site

5 ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACTS

The principal environmental, social and economic impacts of the project are summarised below. Arrow Energy has committed to implement a number of measures to avoid, reduce and manage these impacts to acceptable levels. The key measures are also described here.

5.1 Climate Change Adaptation

Projected changes in climate have been taken into account in the planning and design of the Arrow LNG Plant and will reduce the project's vulnerability to potential climate change impacts. Climate change risks will continue to be taken into account through the detailed design phases of the project.

Changing climate is likely to increase the risks associated with extreme climatic events such as cyclones and storm surge. The LNG plant design has considered inundation and erosion from tidal storm surges including predicted increased frequencies of severe weather events. Predicted drier conditions caused by declining rainfall, will increase evaporation and combined with higher temperatures will increase the bushfire risk and appropriate fire breaks will be designated around the LNG plant boundary. Increased temperatures may also affect the workforce, with risks to the health of workers from heat stress and insect-borne diseases.

Arrow Energy will remain apprised of climate change projections within government and scientific communities, and will consider future adaptation requirements as relevant to the project. Health and safety plans for workers at the site will also address health risks associated with working in a hot climate.

5.2 Geology, Landform and Soils

The coastal landscape of the project area is dominated by its surrounding landforms including the hogsback ridges on Curtis Island, Mount Larcom, the coastal plains of Port Curtis, and Targinie State Forest (Plate 4). Soils vary throughout this area, and include marine clays, silty clay loams, alluvial sands and rocky soils.

Most soils in the project area are of Class C or Class D agricultural land, predominantly used for grazing beef cattle (where industrial or residential development has not occurred). Class A agricultural land is located within the TWAF 8 site, although the site is currently covered in bushland and is not developed or used for farming purposes.

Construction activities will cause large-scale topographic alteration of the LNG plant site and will have the greatest influence on the landform and soils. Substantial ground disturbance will occur here following the removal of vegetation. Extensive earthworks will create a series of platforms and ridges which will involve both cut and fill of parts of the site to achieve level areas.

Exposed earth creates an opportunity for increased erosion, with material being transported into streams or the sea during heavy rainfall. These impacts will be controlled through the implementation of good practice site construction methods. A barrier and sediment control pond will trap sediment leaving the LNG plant site before it enters Port Curtis or other surface waters. Areas for rehabilitation will be managed progressively and stabilised to reduce prolonged exposure of soils.

Construction of the feed gas pipeline tunnel will excavate approximately 223,000 m³ of soils and rock which will be placed adjacent to the tunnel shaft. The tunnel spoil placement area will be designed to minimise impacts associated with ground compaction, erosion, and surface water runoff such that a self-sustaining landform is achieved.

If the TWAF 8 site is chosen, approximately 9.5 ha of Good Quality Agricultural Land (GQAL) will be removed from potential use for agriculture during the construction period for the project. Other project sites, including the mainland launch site 1 have been significantly modified through human activity and little if any of the original soil structure and landform remains.

5.3 Land Contamination and Acid Sulfate Soils

Construction and operation activities could disturb soils that are contaminated as a result of past activities, potentially spreading contamination to a wider area. No land parcels within the project area are currently listed on the Environmental Management Register or the Contaminated Land Register although a disused ‘cattle dip’ has been identified on the LNG plant site on Curtis Island and is a notifiable activity under the Environmental Protection Act.

Other known sources of contaminants identified on Curtis Island include corroded drums and battery stockpiles, and other hazardous wastes. On the mainland, known sources include the former ash ponds on which TWAF 7 and launch site 1 are located.

Further assessment of known and potentially contaminated areas will be carried out prior to construction to assess risks to workers and the environment, including on Curtis Island and at mainland sites. Contaminated soils will be managed or remediated to meet current Queensland guidelines. Procedures will also be in place throughout all phases of the project to minimise the risk of further contamination of soils from accidental spills of chemicals and oils. An emergency response plan will be developed and will include provisions for spill contingency. Material safety data sheets for hazardous substances used and stored on site will also be available at the LNG plant and other project sites to aid in the identification of appropriate methods for managing and cleaning up spills.

In the Gladstone region, acid sulfate soils (ASS) usually occur in marine and estuarine mud below 2.5 m AHD. When exposed to air, ASS can generate sulfuric acid from oxidation of sulphide minerals in the soils, impacting on water and soil quality. Low lying (<5 m AHD) coastal areas where excavation and dredging works are proposed are likely to contain ASS, with the exception of TWAF 8. Construction activities involving the use of acidic, non-acid sulfate soils as fill also have the potential to release acidic leachates.

An ASS management plan will be developed during the design phase of the project and will specify how disturbances of ASS at project sites should be managed, in accordance with relevant Queensland policies and guidelines.

5.4 Surface Water Hydrology and Water Quality

Many of the waterways flowing into Port Curtis are influenced by tides including the Calliope River and Auckland Creek. Other watercourses in the project area are generally small and ephemeral streams and only flow after heavy rain. Surface water runoff from the upper reaches of waterways is likely to be influencing water quality within the area.

The only recognised fresh watercourses close to the project area are Boat Creek, north of the mainland tunnel entry shaft and Targinie Creek near TWAF 8. Boat Creek is at least 500 m from the tunnel site and is unlikely to be impacted (Plate 5). Any crossings required of Targinie Creek will be constructed to minimise disturbance within the stream bed and vegetated stream banks (riparian zone).

Ephemeral streams pass through the LNG plant site on Curtis Island and flow rates in these streams could be significant with heavy rainfall (Plate 6). Several of these waterways will be filled in during construction and their water diverted around the LNG plant. The diversions will be designed so erosion, and deposition of material, does not occur at greater than natural rates.

Sediment and erosion control measures will be in place at all construction sites to prevent sediment entering watercourses and the sea. Control measures implemented will be specific and appropriate to the construction phases. Fuel, oil and chemicals will be stored in contained storage areas away from watercourses and appropriate spill prevention and response plans will be developed to cover project activities including the types and quantities of fuel, oil and chemicals held at each site.

The increase in hard surfaces at the LNG plant and other project sites will increase runoff rates. All surface water generated from the LNG plant site will be managed by a stormwater treatment system to ensure discharged water quality complies with regulatory requirements.

Some parts of the LNG plant site will be inundated by a 1:100 year flood event (presenting a low to moderate flooding hazard). The tunnel site is also located within a zone of flood inundation from Boat Creek (for the 10 year flood event). Sensitive project infrastructure at these sites will be located to avoid the 1:100 year event where practical and project infrastructure located within these areas will be protected from flood inundation.



- 4 Site of proposed LNG plant on Curtis Island looking towards the mainland.
- 5 Mudflats at the proposed site of the mainland tunnel entry shaft and tunnel spoil disposal area looking towards Boat Creek.
- 6 Ephemeral stream, LNG plant site, Curtis Island



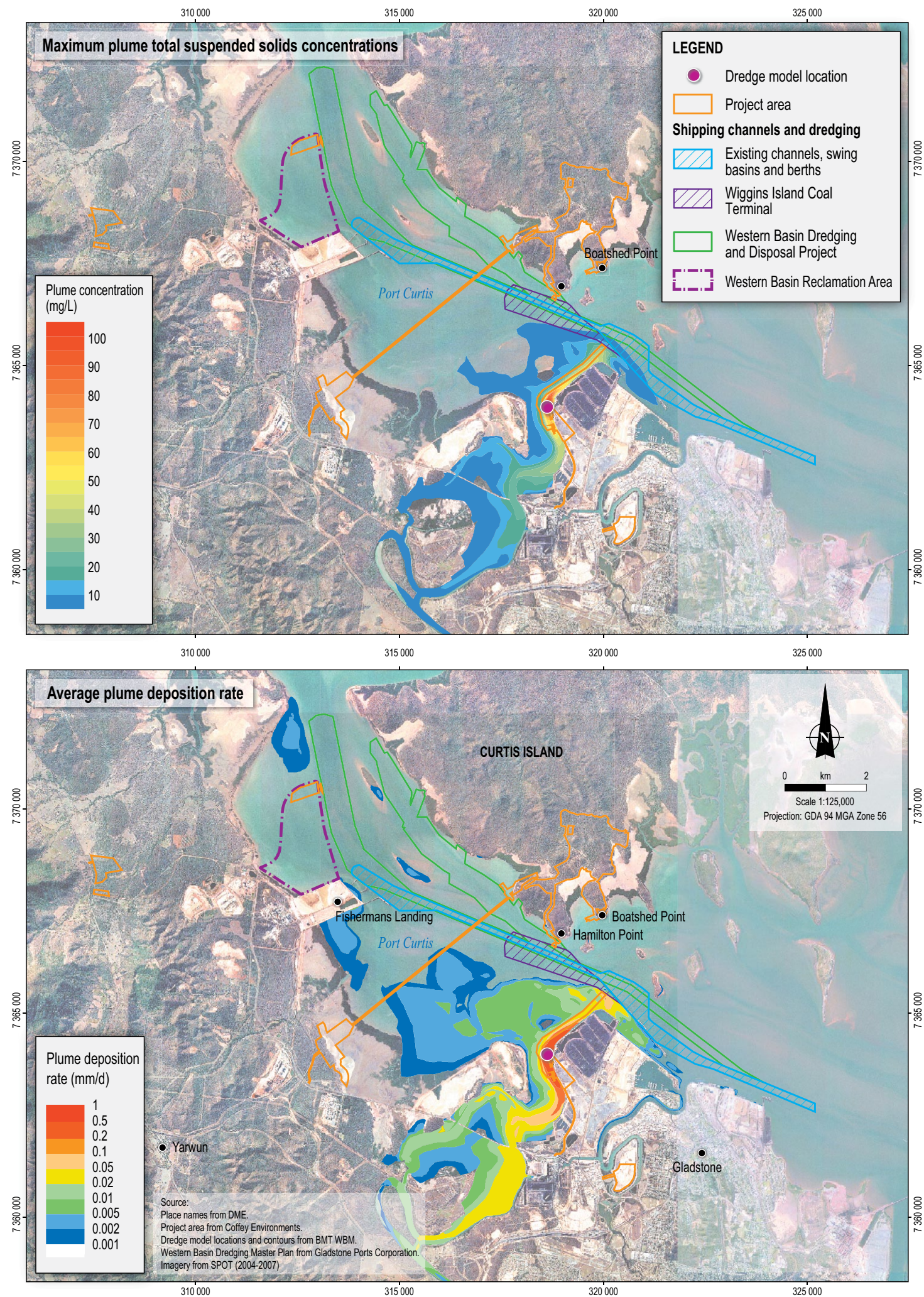


Figure 10 Dredge model site 1 – modelled dredge plume maximum TSS concentrations and average deposition rate

5.5 Groundwater

Groundwater is likely to occur throughout the project area in shallow, unconfined aquifers. Deeper aquifers located in bedrock may occur at higher areas of the LNG plant site, TWAF 7 and TWAF 8. Confined aquifers are only likely to occur at the LNG plant site on Curtis Island. These higher value confined (bedrock) aquifers are unlikely to be affected by the project activities as the design and operation of the plant will limit opportunities for contaminants to enter this system.

Groundwater in these aquifers is generally of poor quality ranging from marginally fresh to brackish and saline water. Yields are low and water is generally unsuitable for drinking, stock watering and irrigation, and consequently groundwater in the area does not appear to be used for water supply.

The clearance of land, earthworks and construction activities at all project sites may reduce rainwater infiltration and so the recharge of shallow groundwater systems. Construction will compact underlying shallow aquifers and groundwater levels may be temporarily lowered when excavations for the feed gas pipeline and the tunnel shaft at Hamilton Point are 'dewatered' to allow for specific construction activities to proceed. The extent and duration of construction dewatering will be minimised as much as practicable.

Groundwater systems can become contaminated through unintentional spills and leaks of hazardous materials such as fuels and lubricants. If not properly cleaned up, these substances can enter shallow groundwater and migrate to deeper groundwater systems. The drainage systems at the LNG plant have been designed so that accidental releases of hazardous substances can be intercepted and detailed spill response procedures will be in place at all project sites. Fuels, chemicals and hazardous wastes will be stored in storage facilities designed to contain any leaks that might occur and that meet relevant Australian standards. Workers will be trained in how to respond to any spill and equipment will be positioned around sites to enable a rapid response.

5.6 Coastal Processes

Port Curtis is a shallow coastal basin, situated directly offshore from Gladstone and separated from the Coral Sea by Facing and Curtis islands, which protect the port from ocean swells. The Calliope River flows into Port Curtis and is influenced by tides 25 km upstream of the river mouth.

Tides, water velocities and deposition rates will be changed through the dredging of approximately 1 million m³ of seabed material in Port Curtis, with the majority of dredging planned for the Calliope River to provide and maintain access to launch site 1. At the Calliope River, the dredging will widen and deepen the river bed, lower the bar at the river mouth and decrease low tide water levels during spring tides by up to 0.8 m. This influence will extend up to 12 km up the river. The dredging will potentially lessen the severity of flood events in the river.

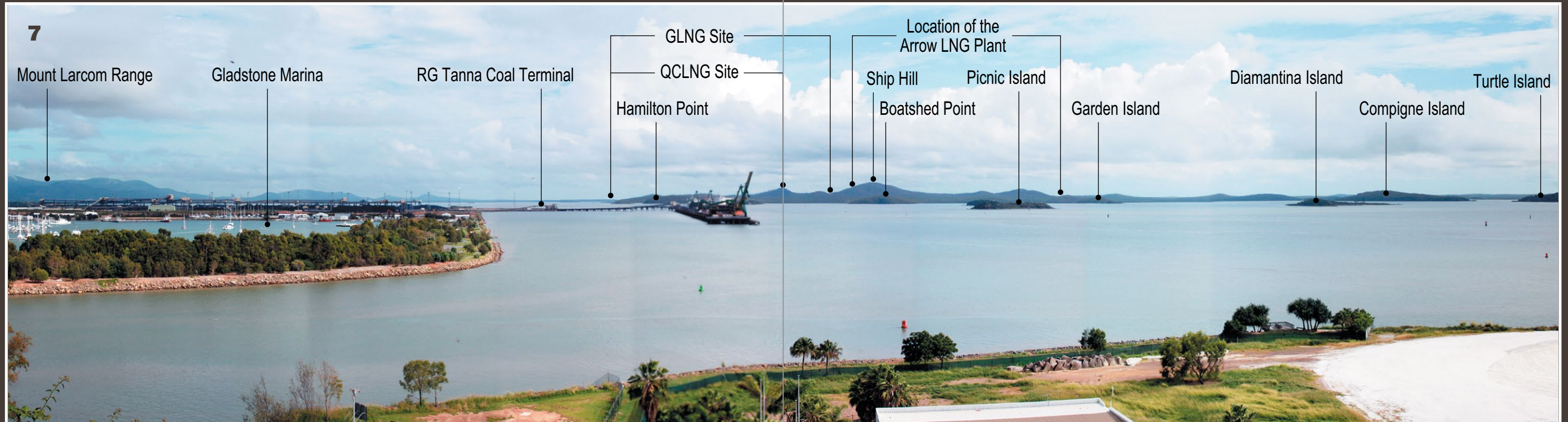
Rates of sediment deposition will also increase in the Calliope River, and ongoing maintenance dredging may be required to remove accumulated sediment. Overall, impacts are expected to be short term and a dredge management plan will be developed to manage these activities.

Project infrastructure will not affect wave heights during extreme events and the day-to-day wave climate within Port Curtis will not be affected at the majority of locations assessed for the EIS. The MOF will reduce wave action on either side of the structure, leading to a small localised build-up of silt. Sand transport may increase from adjacent to the Hamilton Point South MOF site to the southeast and may decrease in and around the LNG jetty swing basin and to the east of Boatshed Point.

5.7 Marine Water Quality and Sediment

A large amount of marine water quality data has been collected in Port Curtis for other studies and projects, and further data was collected for the project. When compared to the greater Port Curtis area, water quality in the vicinity of the project sites on Curtis Island is generally good, although turbidity is naturally elevated as strong tidal currents re-suspend sediment. Visibility is generally less than 2 m. Concentrations of some metals can be higher than those for oceanic seawater, however, concentrations of most metals are not elevated above typical seawater concentrations. No apparent trend exists in the location or depth of the occurrence of metals in sediments.

Dredging to support the construction of the marine facilities will cause plumes of suspended sediment to form in the water column and deposit material on the seafloor. Sediment deposition is greatest at the dredge location itself and gradually reduces with distance. Much of this material will be redredged and taken onboard the dredging vessel or barges. Dredging at project sites will take up to four weeks. Based on the period of dredging at each site, the maximum thickness of the material settling on the seafloor will be greatest at launch site 1 (75 mm thickness) and least at the LNG jetty (21 mm) (Figure 10). Maintenance dredging is likely to be required in the Calliope River to maintain access to launch site 1.



View from Auckland Point (Viewpoint 1)



Artistic impression (visualisation) showing potential view from Auckland Point



Other project activities will affect water quality although to a much lesser extent. These include through the disturbance of the sea floor during the installation of piles at the mainland launch site, MOF and LNG jetty and from propeller wash from vessels navigating shallow waters.

Geotechnical investigations will be carried out prior to construction in marine areas to provide information for the design of foundations and facilities and the planning of dredging activities. Sediment samples will be obtained from cores drilled in the sea bed and underlying sediments to further characterise marine sediments disturbed during construction. The sampling results will provide information to inform the development of the dredge management plan. The plan will amongst other measures, specify requirements for water quality monitoring and actions to be taken to minimise impacts of dredging on sensitive areas should water quality monitoring data show performance criteria are exceeded.

Some direct discharges are planned including the disposal of small volumes of excess water at the tunnel launch site from tunnelling operations. Water used to test the integrity of the feed gas pipeline and the LNG tanks (up to approximately 250,000 m³) will be discharged to Port Curtis. These discharges will be tested and treated to meet applicable water quality criteria prior to discharge.

Brine produced during the desalination process to supply fresh water to the LNG plant will be discharged along with stormwater through an outfall at Boatshed Point. Local increases in salinity at and around the outfall are expected although modelling shows that relevant water quality criteria will be achieved within 10 m. The outfall itself will be designed to maximise dilution.

5.8 Terrestrial Ecology

The project area is located within the Southeast Queensland bioregion, an area with broadly similar groups of terrestrial species and communities. Many of these species have conservation value and include vegetation communities listed as endangered or critically endangered by the Commonwealth Government (Figure11). Three species of animal listed under the EPBC Act or Nature Conservation Act 1992 (Qld) were recorded within the study area and an additional 10 species have a high likelihood of occurring in the study area. No conservation listed plants were assessed as having a high likelihood of occurrence in the study area

Widespread disturbance through human activities has impacted on the terrestrial ecology of the region, including through land clearance, industrial activities, and the introduction of animal pests (such as cane toads and feral pigs) and weeds.

The key impacts on terrestrial ecology from the project will arise through the clearance of vegetation on Curtis Island for the construction of the LNG plant.

The LNG site on Curtis Island is covered with varied tree shrub and ground cover layers. This vegetation will need to be cleared prior to construction of the plant, and the area extensively graded and modified. Approximately 250 ha of



vegetation will therefore be lost at the LNG plant site with resulting loss of habitat for animal species. Cleared areas can expose remaining vegetation to the risk of introduced pests and weeds and will break up the continuous cover of vegetation on this part of Curtis Island.

The areas to be cleared include approximately 26 ha of an endangered community of forest red gum woodland that grows along ephemeral streams flowing through the LNG plant site. This ecosystem is recognised generally as providing essential habitat for koala and coastal sheathtail bat, although neither of these species were found during field surveys for the project.

A small area of critically endangered vine thicket community on Hamilton Point will not be impacted and access to this area by project staff will be restricted.

Importantly, the construction camp will be located to avoid approximately half of a small area of semi-evergreen vine thicket at Boatshed Point that contains a potentially new species of the tuckeroo (*Cupaniopsis sp.* Indet) (Plate 9). The vine thicket not marked for removal will be fenced off to avoid direct disturbance to help protect a viable community.

The Queensland Herbarium initially identified this species as being closely related to the threatened flora species, wedge-leaved tuckeroo (*Cupaniopsis shirleyana*), which is currently listed as ‘Vulnerable’ under both the EPBC Act and Nature Conservation (Wildlife) Regulation. The area was revisited and assessed in detail during later field surveys and the previously identified specimens of Cupaniopsis displayed characteristics which were not entirely characteristic of *C. shirleyana*. The specimens were re-submitted to the Queensland Herbarium and initial assessment in August 2010 indicated that the sampled species (*Cupaniopsis sp.* indet.) is potentially a new species. The final identification results from the Queensland Herbarium are still awaited.

At the tunnel launch site across from Curtis Island, approximately 17 ha of tall eucalyptus woodland will need to be removed to allow the pipeline to be constructed and to provide access to the tunnel staging construction area. Approximately 30 ha of woodland will be cleared if the TWAF 8 is developed by the project.

Several species of birds use the Port Curtis area at various stages of their often extensive migrations, including wetland birds (such as waders, terns, and egrets).These birds feed on the intertidal areas around Port Curtis. Lighting, noise and the use of vehicles may disturb birds feeding and roosting near the tunnel site. The nearest major shorebird roost is over 1 km to the southeast of the tunnel site, whilst the mudflats themselves lie adjacent to a major shorebird feeding site. The site will be shielded to some extent from construction works by intervening mangroves, construction lighting will be designed to minimise impacts on birds (where practical), and workers will be prevented from accessing areas beyond the project area. Surveys are proposed at sites with potential for impacts to migratory shorebird habitat. The results of these surveys will guide the development of further management measures, if required.

Some impacts on terrestrial ecology are unavoidable, including the clearance of vegetation on Curtis Island (Plate 10). In such cases, biodiversity offsets provide a way of compensating for these impacts. Arrow Energy will consider biodiversity offsets and determine areas requiring to be offset in consultation with government stakeholders prior to commencement of construction. This is likely to include offsets for two areas of endangered forest red gum woodland community within the LNG plant site, and the area of semi-evergreen vine thicket community on Boatshed Point.

5.9 Freshwater Ecology

Habitat for freshwater plants and animals is limited within the project area and the majority of waterways are of low value, being generally sparse and fragmented. Streams are largely ephemeral and do not flow except after heavy rainfall. There are no permanent watercourses on Curtis Island near the LNG plant site. The nearest project infrastructure to a permanent freshwater stream is the tunnel launch site, located approximately 500 m to the south of Boat Creek.

No freshwater aquatic plants or animals listed under the EPBC Act or Nature Conservation Act were identified within the study area. Species, such as the water mouse and saltwater crocodile, are potentially present in the project area, and although linked to freshwater aquatic ecosystems, are not solely confined to these areas.

The project will not abstract freshwater and no effluent will be discharged directly to freshwater streams on either the mainland or Curtis Island. Streams may be crossed at TWAF 8 by service pipelines, security fences and access tracks, with limited associated works required. Some riparian vegetation may be lost at crossing sites along this stream, which is part of an important corridor through which wildlife travel. The area cleared at crossings will be limited and actions taken to reduce the potential for exposed soils and any contaminants to enter this waterway during construction.

On Curtis Island, the construction of the LNG plant will remove an ephemeral stream (and its associated side gullies) that currently passes though the site. The stream will be diverted east and west of LNG plant site. Works will take place when the stream is at no or low flow and limited, if any, impacts are expected on aquatic species.

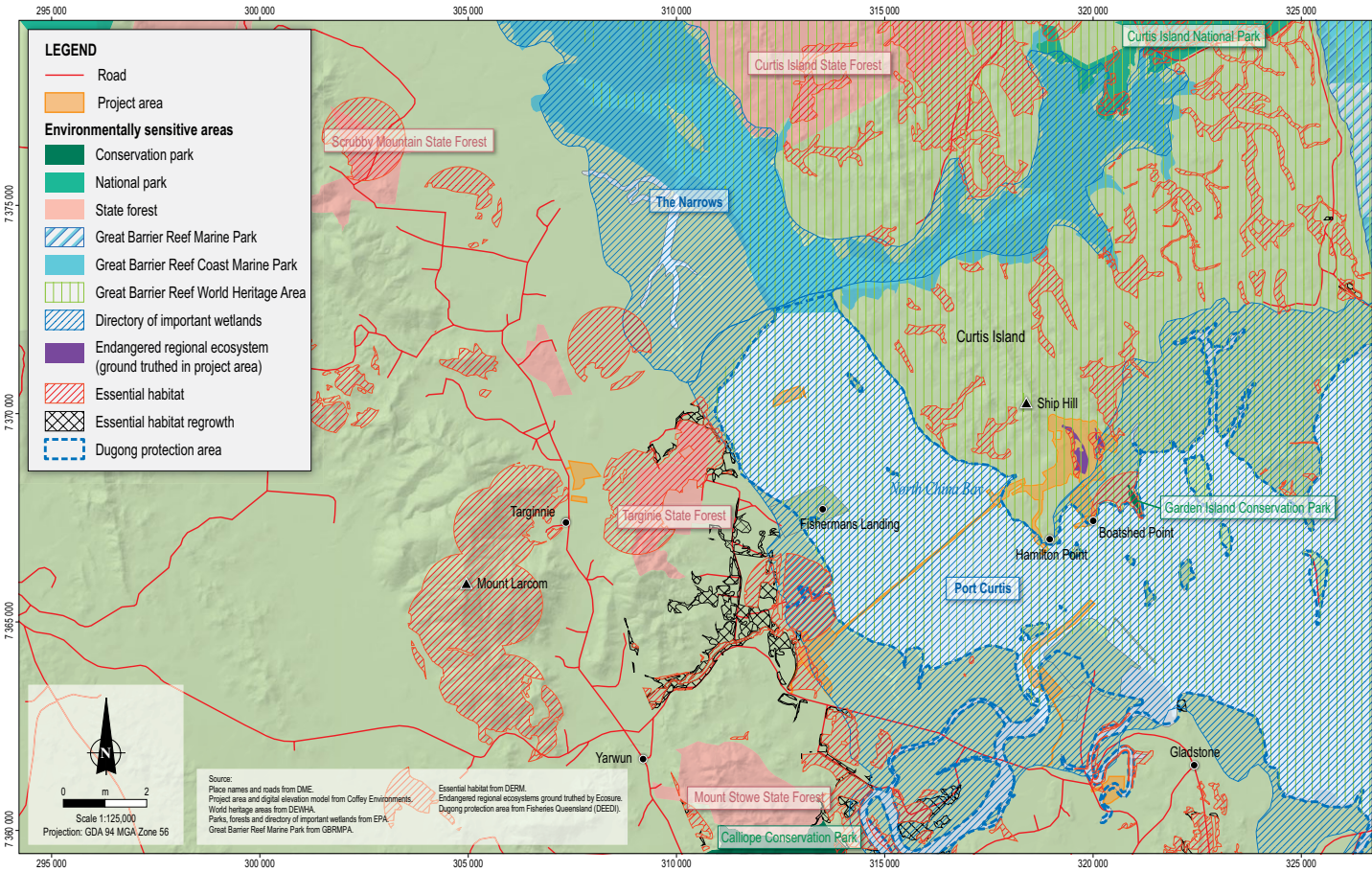


Figure 11 Environmentally sensitive areas within and adjacent to the study area



9



10



11

- 9 Cupaniopsis sp. indet leaves
- 10 Woodland at LNG plant site, Curtis Island
- 11 Gladstone city centre

5.10 Marine and Estuarine Ecology

The Arrow LNG Plant is located within the Great Barrier Reef World Heritage Area and adjacent to the Great Barrier Reef Marine Park and Great Barrier Reef Coast Marine Park (see Figure ES5). Port Curtis is included in the list of nationally important wetlands in Queensland. The areas of rocky reefs, mudflats, saltmarsh, mangroves and seagrass provide important habitat for a range of species, including a large marine fauna population. Many of these species are listed under the EPBC Act. Dugong, marine turtles, whales, dolphins and porpoises have known ranges that include the waters of Port Curtis. Other wildlife of note includes sea snakes, saltwater crocodiles, seahorses and pipefish.

The estuarine waters around Port Curtis also provide spawning, nursing and feeding areas for many recreationally and commercially important fish species.

Some of this marine habitat will be lost in Port Curtis during the construction of marine facilities, and through dredging activities. Dredging in the Calliope River and at other project sites will generate plumes of suspended sediment that will affect local water quality and settle to the sea floor, potentially smothering seabed habitats. Impacts will be greatest in the Calliope River, where ongoing maintenance dredging may also be required to keep the channel deep enough for shipping. A dredge management plan will be developed to manage these activities and will include requirements for water quality monitoring and actions to be taken should impacts not be as predicted.

Works at the tunnel launch site and associated construction area will disturb an estimated 58 ha of salt marsh. On Curtis Island, approximately 5 ha of intertidal habitat or mudflats and 6 ha of mangroves will be removed through construction of marine facilities. These impacts are unavoidable and a marine offsets strategy will aim to compensate for the loss of this habitat.

Loss of mangrove areas is likely to result in loss of habitat for the water mouse, although no individuals or important population of this species has been identified in the project area. Removal of this area of mangroves equates to a small (approximately 1%) proportion of habitat available to water mouse in Port Curtis. At the mainland tunnel launch shaft, the project has been designed to avoid mangrove areas altogether, as the tunnel will pass under the mangroves that grow between this site and Curtis Island.

Shipping traffic in the harbour will increase with construction and operation of the project including the use of fast ferries to transport personnel to and from Curtis Island. Other planned or approved projects in the Port Curtis region will significantly contribute to shipping numbers. Although combined numbers for all projects are not available, increases in the frequency of vessels using the port will increase the likelihood of dugongs, dolphins and turtles being injured or killed after being struck by a vessel. All project vessels will comply with applicable vessel speed limits set within the Port Curtis, which is located within the Port of Gladstone-Rodds Bay Zone B dugong protection area. A shipping activity management plan will be developed in consultation with port operators and other port users. Arrow Energy will also consider fitting propeller guards to high-speed vessels to reduce the seriousness of potential injury to wildlife in the event of a boat strike.

Construction of marine facilities and dredging will generate underwater noise as, for example, piles are driven into the seabed and the dredging buckets hit the sea floor. Soft-start procedures will be implemented for activities such as pile driving activities, and observers will look out for marine fauna in the area during pile-driving. Lighting will be designed to minimise impacts on wildlife and routine planned maintenance flaring at night will avoid sensitive turtle reproductive periods, where practical.

Ships (carriers) transporting LNG from the LNG plant to overseas markets will pass through Port Curtis, the Great Barrier Reef Marine Park, the Great Barrier Reef World Heritage Area and surrounding waters. All vessels are required to comply with applicable maritime and pollution laws and will traverse the marine park through designated navigation routes. Special protocols for the movement of LNG carriers within the port have been agreed and include strict pilotage requirements, speed limits and restrictions on the passing of vessels. These procedures all aim to reduce the risk of a collision or other incident to as low as possible.

5.11 Greenhouse Gas

Natural gas is an established energy source that presently meets 22% of the world’s energy needs and is set to play a central role in meeting the world’s energy needs for the next two-and-a-half decades.

The project will contribute to total greenhouse gas emissions in the region, Australia and the world. The maximum level of greenhouse gas emissions from operation was estimated to be 8.2 Mt CO₂-e/annum (excluding start-up flaring). This represents 2.01% of the Australian Government’s 2007 energy sector emissions.

Arrow Energy has committed to reducing the greenhouse intensity of its operations and measures to reduce the emissions from the plant have been incorporated in the design process. Arrow Energy will report on its greenhouse gas emissions and will continue to support the development of technologies and management practices that reduce greenhouse emissions.

5.12 Air Quality

The major emissions to air will be produced during operation of the LNG plant. Air emissions during construction are relatively low and short term. Dust, which can be a major nuisance during earthworks, will largely be restricted to the site. Some gas will be flared during start-up of the LNG plant.

The main emissions from the LNG plant will be nitrogen dioxide (NO₂) from the combustion of gas in the turbine generators and sulfur dioxide (SO₂) from the LNG carriers and tugs used to assist these vessels. Both of these gases can have negative health and ecological impacts particularly if recognised air quality criteria are exceeded at locations sensitive to air pollutants, such as residences and sensitive habitats. Gladstone is a maor industrial centre with numerous chemical and mineral processing facilities currently operating in the region, all of which emit pollutants to the atmosphere and influence the overall quality of air within the region. The wind conditions at the LNG plant site provide for relatively good conditions to disperse emissions. The prevailing southeasterly winds at the site will transport emission plumes away from Gladstone. Winds likely to carry emissions towards the city occur very infrequently.

The modelling of the dispersion of the main air quality pollutants (NO₂, SO₂ and carbon monoxide, as well as particulate matter) during routine operations predicts that levels will not exceed criteria within any sensitive receptor areas for the LNG plant. Expected ozone levels and odour concentrations are also not expected to exceed air quality criteria at any of the sensitive receptor areas.

The design of the LNG plant has incorporated several measures to limit emissions including the use of low-emission technology for equipment with high combustion rates (e.g., gas turbines), waste heat recovery, the use of low-sulfur fuel, and minimal flaring. All stacks will be fitted with equipment that will allow emissions to be continuously monitored.

5.13 Noise and Vibration

The existing noise environment of the Port Curtis area is dominated by marine traffic noise and the sounds of the natural environment including from waves, wind and wildlife. In the urbanised and industrialised areas of Gladstone, local road traffic and existing industry have a greater influence. Noise levels calculated for a range of locations both close to and further away from the LNG plant (Figure 12) ranged from 34 dB(A) during the day near Targinnie (furthest from the site) to 43 dB(A) at night on Tide and Witt Islands. Existing vibration levels at all locations measured were well below the threshold of human perception.

Sources of construction noise and vibration generally relate to the use of heavy construction vehicles and equipment for site preparation and earthmoving, and facilities and infrastructure installation of the LNG plant site, laydown areas and construction camps, marine facilities, feed gas pipeline and dredging activities.

The project has established noise criteria based on relevant guidelines and standards, and in consideration of existing background levels. The criteria are:

- Construction: 45 dB(A) at night. No limit is set for day time construction noise although all reasonable and practical measures will be taken to reduce noise levels.
- Operation of the LNG plant: 33 dB(A) at assessment site 1,6, and 3 and 28 dB(A) at assessment sites 2, 4 and 5.
- Operation of LNG carriers: 50 dB(A) day and even-ing, 45 dB(A) at night.Modelling of noise from the LNG plant shows that these criteria would be met at all of the sensitive locations assessed (see Figure ES15). The LNG plant will include specific design features that limit operational noise to ensure the criteria are met when the plant is operational.

Vibration levels will be well below the threshold of human detection, due to the large separation distances to all of the assessment locations from the LNG plant, LNG jetty, and the feed gas pipeline.

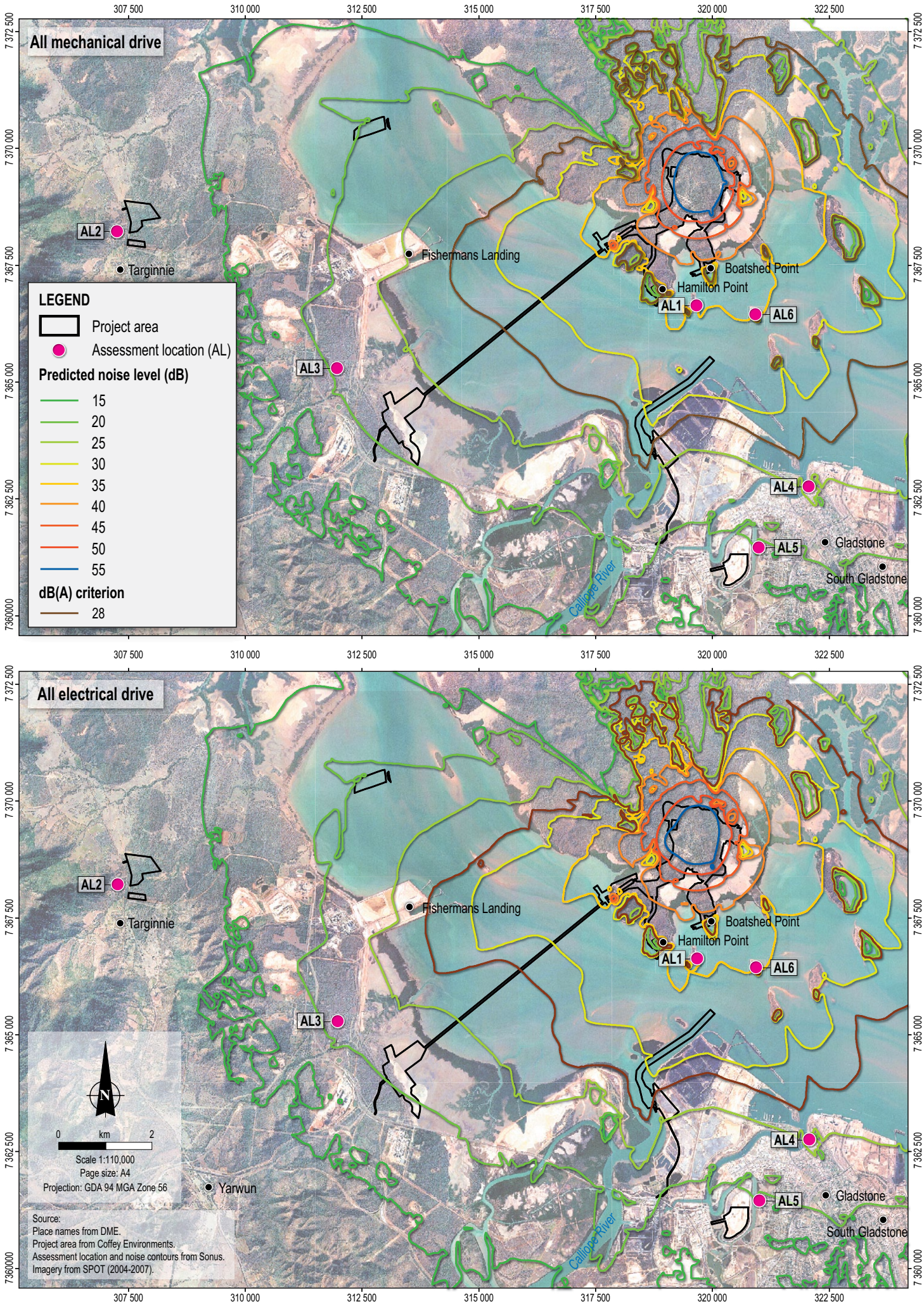


Figure 12 Noise Contours of the predicted noise levels with acoustic treatment

5.14 Landscape and Visual Amenity

The project is located in a variety of landscapes including natural areas on Curtis Island and a variety of mainland land uses such as open space, rural, strategic port and major industry, and infrastructure. Some landscapes or landscape elements within the Port Curtis area are valued and protected due to their character or quality and most significantly include the Great Barrier Reef World Heritage Area and Great Barrier Reef World Marine Park.

Most of the project area lies within the GSDA on Curtis Island where large scale industrial land use will occur and change remaining areas of rural or natural landscape characteristics to a landscape characterised by heavy and high impact industrial development.

Visual impacts of the project will be most prevalent on Curtis Island where significant clearance of vegetation and installation of project infrastructure, particularly at the LNG plant site, will alter the landscape and views to this area. Overall, the perception of Curtis Island as a natural landscape will diminish, including from viewpoints in Gladstone (Plate 7 and 8). Views from Southend towards the site will be marginally affected with the very top of the flare stack visible above the ridge line. Some glow in the night sky will be visible, although is not expected to be materially different from the current glow from development in Gladstone.

The design stage for the project offers the greatest opportunity to limit visual impacts and the design process for the LNG plant has adopted measures to limit impacts to the landscape and views. The tip of Boatshed Point will be protected from clearing and cutting to preserve areas of vegetation that help screen lower parts of the LNG plant and construction camp. Where practical, vegetation along the eastern boundary of the LNG plant site will also be retained to provide some screening to views from the east. The design of the LNG plant site will minimise cutting into the

high ground of the Curtis Island hogsback ridge system that will assist in maintaining a vegetated backdrop and visually absorbing the built form of the development.



5.15 Indigenous Cultural Heritage

Indigenous places previously recorded in the region are concentrated in the coastal development strip to the north of Gladstone and, given the extent of industrial development in the study area, are relatively low in number. Several cultural heritage places including a low-density artefact scatter, a single unmodified siltstone flake, stone artefacts, and a shell midden have been identified close to and within the project area. Eight sites were located within the project area on Curtis Island and the mainland.

The sites currently identified, when measured against registered sites and those recorded in other literature, are represented elsewhere, or are not described as outstanding examples of site-types the loss of which would be scientifically unacceptable. Central Queensland Cultural Heritage Management also noted that this observation does not diminish the significance of the identified sites to the Aboriginal parties. Arrow Energy is sensitive to the fact that contemporary Aboriginal people take seriously the responsibilities they have to their ancestors, spiritual entities and hero figures, and to the management and protection of Indigenous cultural heritage places and objects inherited from them.

Further Indigenous cultural heritage material may be identified during detailed investigations of the area of disturbance and again during construction. While no sites of ‘national significance’ have been identified, places or objects may hold significance to local Aboriginal parties.

Arrow Energy will seek to develop an approved cultural heritage management plan or a native title agreement that addresses Indigenous cultural heritage in consultation with the endorsed Aboriginal parties for the project. Compliance with the approved plan or native title agreement will constitute Arrow Energy’s compliance with the *Aboriginal Cultural Heritage Act 2003* (Qld) duty of care.

5.16 Non-Indigenous Cultural Heritage

Non-indigenous cultural heritage features of local significance have been identified within and close to the project area. The potential exists for further cultural heritage items to be uncovered during the course of the project.

The cultural heritage sites identified within and near the project area reflect the Gladstone region’s history of settlement and development, in particular pastoralism and livestock farming. No registered non-indigenous cultural heritage sites of Commonwealth, state or local significance

were identified within or near the project sites. Eleven known or likely unregistered sites have a local heritage significance or local historical interest.

Areas of high sensitivity for non-indigenous cultural heritage within the project area are located on Boatshed Point and the northern section of Hamilton Point including around the rendered brick building and the “Birkenhead” outstation sites. Areas of moderate sensitivity occur around these areas of high sensitivity, and at North China Bay around the China Bay yards. Curtis Island is the largest of the islands included in the internationally recognised Great Barrier Reef World Heritage Area. Cultural heritage values are recognised in this listing although it does not include reference to specific heritage locations.

Potential impacts to non-indigenous cultural heritage sites (including damage or destruction to a site) could occur through vegetation clearing and earthworks associated with the construction of the Arrow LNG Plant. Identified sites that cannot be avoided will be appropriately recorded and archived. Other unknown sites could be uncovered through chance find discoveries and accidentally impacted. A heritage management plan will be prepared prior to construction and will specify how known and unknown heritage sites are to be managed during construction.

5.17 Social

The project will stimulate economic activity at a regional, state and national level, both directly (via construction activities and the production and export of LNG) and indirectly (e.g., through increased household consumption and government fees and taxation revenues). A peak workforce of 3,715 is expected during stage 1 construction with the majority of workers to be sourced from outside Gladstone and accommodated in a construction camp on Curtis Island. A further 2,330 jobs will be created during stage 2 of construction and up to 600 long-term jobs during the project’s operational phase (Figure 13). Many positive impacts will also occur including opportunities for local employment and local businesses to provide goods and services. Between 5% and 20% of the construction

workforce may be sourced locally depending upon factors including how the timing of construction relates to other major projects under construction in the region. Approximately 30% of the operations staff and 40% of the contractors required during operation are anticipated to be sourced from the local region.

The increased demand for skilled labour generated by the project is likely to contribute to higher incomes both through the direct employment of local people and through demand driven escalating labour costs.

Businesses and industry in the Gladstone region and Queensland will be affected. Competition for, and draw of labour to the Arrow LNG Plant and its supply chain will exacerbate regional skills shortages and may increase labour costs for local businesses. Potential higher wages within the LNG industry may result in competition for, and a drain on, local workers. There may be a high staff turnover at some local businesses during project construction.

The project is likely to generate some adverse impacts on housing and accommodation. Increases in housing costs (due to demand generated by previous projects) could be sustained during the initial operation period, with housing less available and less affordable for local residents. Reduced

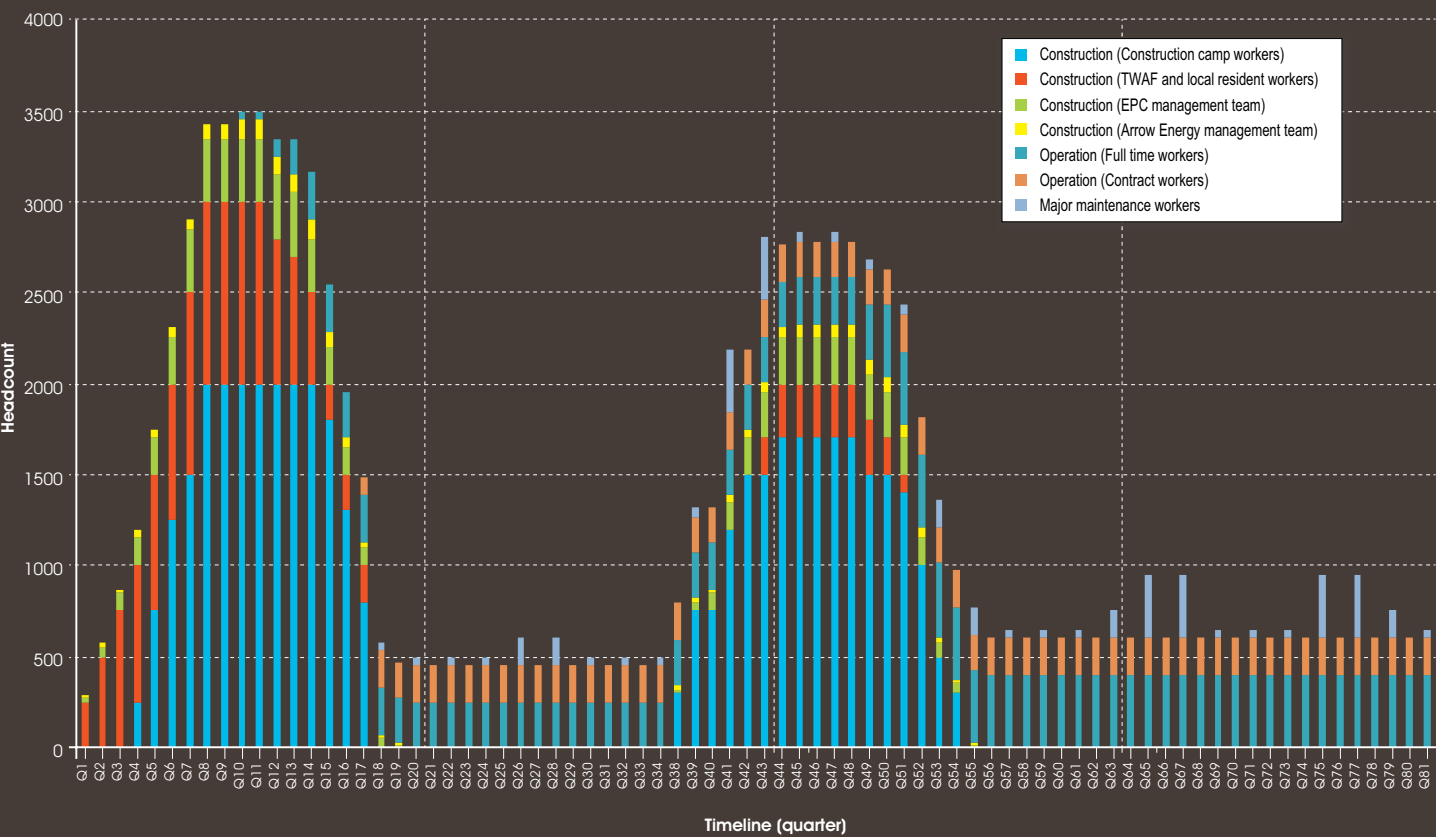


Figure 13 Arrow LNG Plant workforce

availability of temporary accommodation (hotels and motels) may occur, particularly during the initial construction phase (if temporary construction camps are not available). This may impact on the tourism industry, as well as other users of temporary accommodation.

Demand may also increase on local and regional infrastructure and services, including the airport, childcare and educational facilities, health care facilities, waste facilities, policing and emergency services, and water and electricity utilities.

Arrow Energy has committed to implementing a detailed series of actions to manage adverse impacts on the social values in the Gladstone region, as a result of the project. The measures have been developed in consultation with community organisations, government agencies and other stakeholders.

Arrow Energy will look to maximise local employment opportunities and develop a recruitment plan to identify what positions will be targeted without negatively impacting on the availability of local services. The company will engage and collaborate with Construction Skills Queensland and work to deliver work readiness and skills development training programs for vulnerable local people. Businesses will be kept informed of project goods and services requirements, and of opportunities and requirements for securing service provision and supply contracts. Opportunities for local businesses to benefit from the project will be pursued including developing a Local Industry Participation Plan in consultation with government agencies.

A detailed worker accommodation plan will be developed in consultation with housing providers and state and local government to address the housing needs of the project. This includes the provision of financial assistance towards social housing programmes and emergency rental accommodation and collaboration with other LNG proponents to identify opportunities to share temporary workforce accommodation.

Arrow Energy intends to expand the opportunities available for the region under its Brighter Future's program and its Social Investment Plan. The project will have a specific code of conduct which will cover workforce behaviour while on shift or on site. This code will be made available to the community on the project website. Fly-in/fly-out workers will be bound by the code while in transit to and from the project, as well as on shift.

5.18 Economic

The project is expected to provide major economic benefits at the regional, state and national levels including diversifying these economies and advancing Queensland and Australia as a global energy producer through substantial and sustained investment in the Gladstone and Queensland economies over the next 35 years or more.

Local, Queensland and Australian government taxation revenues will increase through a variety of taxes and duties. These additional revenues may then be used to provide additional infrastructure and services to support business and households throughout Australia.

The project will contribute to the growth in Gladstone's economy through increased employment opportunities, stimulation of other industry development, and support to small

businesses. There will be opportunities for these businesses to secure new contracts and increase sales to supply and service the needs of both the project and the workforce. Households will benefit from the project through increased job and income earning opportunities and through a moderate increase in real wages (i.e., above inflation).

Arrow Energy has committed to a range of measures to manage the potential economic impacts of the project in the Gladstone region. Many of these measures also address social issues and have been included in the Social Impact Management Plan for the project.

5.19 Traffic and Transport

The Gladstone region has an extensive road network that services major industry and allows heavy materials transport so as to minimise impacts to dense population areas. Other transport services include rail (which is currently not planned to be used) and air services. The Port of Gladstone is Queensland's largest multi-commodity port and comprises six wharf centres receiving bulk carriers, liquefied petroleum gas (LPG) tankers, chemical/oil products tankers and general cargo ships. Approximately 1,500 vessels enter the port each year. Gladstone marina services recreational and commercial fishing activities.

The movement of the project workforce and construction and operations materials and equipment will generate additional road, air and shipping traffic in the Gladstone region. Notable is the increased traffic on the road network, which, in parts of Gladstone is at capacity. Road traffic associated with the project, along with the cumulative impacts of other projects will affect existing road users and road infrastructure. Although the options for mainland launch sites concentrate traffic north of Gladstone (and so avoid central business district and residential areas), some connecting roads will become congested and some intersections will be significantly affected including the Hanson Road/Blain Drive/ Alf O'Rourke Drive, Gladstone-Mount Larcom Road/Landing Road and Gladstone-Mount Larcom/Red Rover Road intersections (Figure 14). Arrow Energy will develop a traffic management plan in consultation with the Department of Transport and Main Roads, Gladstone Regional Council and other LNG proponents to minimise cumulative impacts to the road network, and may contribute to intersection upgrades. The Gladstone Airport is located on Aerodrome Road, close to the Dawson Highway, approximately 7 km southwest of the Gladstone Central Business District (CBD). Arrow Energy has joined other LNG proponents and committed to provide \$10.5 million in funding to upgrade the airport's instrument landing system. During the peak phase of construction, 800 project personnel will fly in and out of Gladstone each week, increasing demand for air services. Additional flights will be required to accommodate these passengers and Arrow Energy may consider the option of managing personnel movements via charter flights.

5.20 Hazard and Risk

Major hazards and risks associated with the project relate to the potential exposure of people (including the general public and workforce) to hazards inherent in the project and the potential for property and environmental damage.

The Arrow LNG Plant is likely to be classified as a major hazard facility under the Dangerous Goods Safety Management Act 2001 as the stored quantities of LNG will exceed the prescribed quantity of 200 tonnes. As a major hazard facility, Arrow Energy will be required to implement a range of controls to reduce the likelihood and impacts of a major accident.

The Arrow LNG Plant will operate under the Arrow Health, Safety and Environmental Management System (HSEMS) which will provide the overarching framework to protect people, assets and the environment during the construction and operation of the project. Within this framework, the Shell Health, Safety, Security and Environment and Social Performance (HSSE and SP) control framework will apply to works associated with the design of the LNG plant. The standards incorporate the company's experience in delivering some of the world's largest and most complex LNG projects over the last 40 years.

Safety in design (or inherent safety principles) for the project will be determined using a phased approach, from concept design through to detailed (final) design, construction and commissioning, operation and lastly, decommissioning.

Increased shipping movements in Port Curtis due to construction and operation of the project may impact on existing commercial shipping, commercial fishing and recreational boat users. During construction, fast ferries will transport personnel to and from the island and other ferries and barges will transport materials to Curtis Island. During the operation of the plant, approximately 240 LNG carrier return trips are expected each year with four LNG trains operating. The increased frequency and number of shipping movements in the harbour will be managed safely and in ways that minimise impacts to the environment such as from accidental spills and boats striking marine mammals.

A shipping activity management plan will be developed and implemented in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Marine Safety Queensland and all contractors operating within the Port of Gladstone. LNG operating protocols have been agreed that will apply to all LNG carriers transiting to and from the Arrow LNG jetty. Operational performance and experience may lead to the refinement of rules or the introduction of further rules as required.

The indicative route for LNG carriers travelling from Gladstone to Asia uses the recommended outer shipping channel within the Great Barrier Reef Marine Park. The coastal passage to the shipping route from Port Curtis can be executed in all weather and visibility.

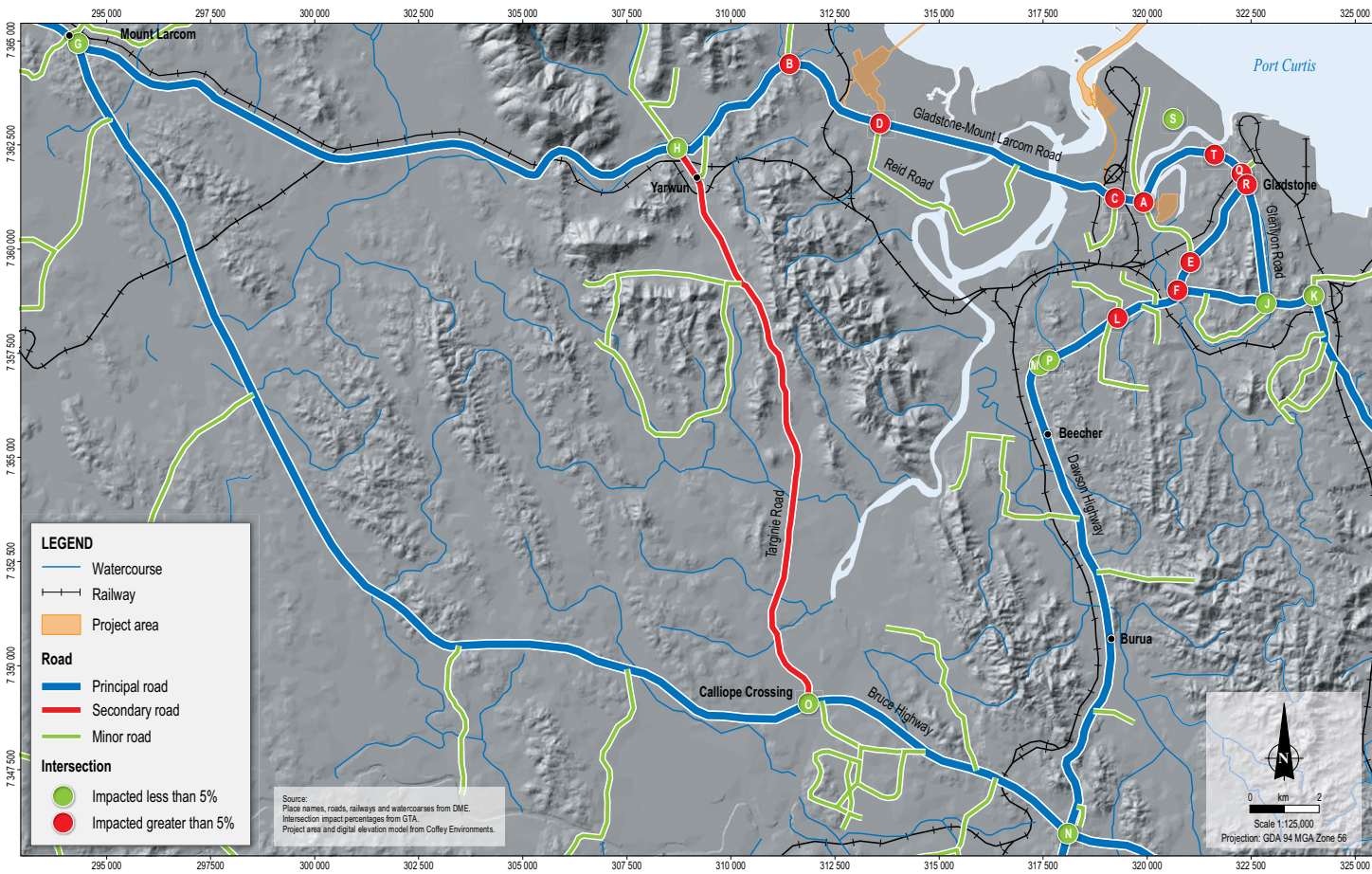


Figure 14 Intersections of relevance to the project

Phase 1 covered the project up to the end of the pre-front end engineering design or FEED phase. During this phase, health and safety issues for the project were identified at a concept level and a preliminary quantitative risk assessment (QRA) for the LNG plant was prepared. The second or FEED phase involves updating the various documents prepared in phase 1 as the design for the LNG plant is further refined. The emergency response plan, including medical emergency response, will also be developed in this phase. The third phase involves managing, during construction, non-routine tasks and hazardous activities by performing appropriate risk assessments and developing detailed procedures for carrying out various activities during construction and commissioning. The fourth (operational) phase includes implementation of the HSEMS management system, structured reviews of the performance of the system and other technical HSE reviews. The fifth (decommissioning) phase includes the preparation of detailed HSEMS plans for decommissioning.

The proponents of the four LNG projects on Curtis Island (Gladstone LNG, Queensland Curtis LNG, Australia Pacific LNG and Arrow LNG Plant) are in discussion with Maritime Safety Queensland, the Gladstone Regional Harbour Master, Gladstone Ports Corporation and Gladstone Regional Council regarding the development of a joint LNG maritime safety management plan. This plan will set out operational procedures, incident reporting, and crew requirements.

5.21 Land Use and Planning

The LNG plant will be constructed on land within the Curtis Island Industry Precinct as identified in the Development Scheme for the GSDA. Objectives of the scheme include the orderly development of the area in an ecologically sustainable manner. The Curtis Island Industry Precinct was established in 2008 to provide for the establishment of LNG facilities and for infrastructure associated with these facilities, including transport links to wharves.

The Arrow LNG Plant comprises gas transportation infrastructure and natural gas liquefaction and storage facilities. The plant will co-exist with other approved LNG facilities under construction or planned for the Curtis Island Industry Precinct. The workers’ accommodation facility proposed for Boatshed Point is ancillary to, and supports the development and operation of natural gas facilities.

The feed gas pipeline and tunnel shafts are located across several other precincts defined in the Development Scheme including the Boat Creek Sub-Precinct of the Materials Transportation and Services Corridor Precinct, Yarwun Precinct and the Curtis Island Corridor Sub-Precinct. The feed gas pipeline is highly consistent with specified uses of the Boat Creek Sub-Precinct and Curtis Island Corridor Sub-Precinct. Gas transportation infrastructure is not specifically listed as a use for the Yarwun Precinct although the route does not conflict with any current proposed developments. Given the linear nature of the infrastructure, substantial conflict is not expected. No private properties are traversed by the pipeline right of way.

Launch site 1 is located within the Clinton Precinct. As a facility providing for storage and facilitating materials transportation from the mainland to Curtis Island, the facility is a consistent use with the objectives for this area.

TWAF 8 is located outside both the GSDA and strategic port land. TWAF 8 (Class A agricultural land although currently in bushland), will be designed to be consistent with the planning scheme as a code assessable material change of use under the Calliope Shire Planning Scheme Rural Zone. Should TWAF 7 be used, facilities will be consistent with the planning scheme as an impact assessable material change of use under the Gladstone City Open Space Zone. Overall, the project will be designed, constructed and operated in accordance with relevant land use and planning legislation, policy, and statutory instruments. Compliance with design codes and standards of the project components during construction, operation and decommissioning will be assessed and determined through a range of post EIS applications for approvals and permits.

Restrictions to public access around the LNG plant and marine facilities are required for public safety. This includes a 250 m exclusion zone around the LNG jetty.

5.22 Waste Management

The amount of waste generated by the project will be minimised in accordance with the principles of the waste hierarchy - avoidance, reuse, recycling, and treatment and disposal activities.

The largest quantities of solid wastes generated by the project will be green, general and concrete wastes. The source locations of this waste will be at site preparation areas, offices and workshops, accommodation camps and canteens, and construction and infrastructure areas. The largest quantity of liquid waste generated will be approximately 80 tonnes per annum of used grease, lubricants and oils. The majority of these wastes will be generated during maintenance activities.

All solid waste that cannot be re-processed or recycled on project sites will be transported off site for disposal at a recycler, re-processor or other waste management facility such as a landfill by a licensed waste contractor. The majority of the solid waste will be disposed of at the Benaraby Regional Landfill following agreement of the Gladstone Regional Council.

All regulated wastes will be disposed of at licensed waste management sites within Queensland and will be transported by a waste transporter with an appropriate authority to collect and dispose of the waste.

The quantities and types of waters generated by the project will be recorded and reviewed against predicted waste streams and quantities, with a view to implementing improvements to waste management practices. Regular inspections will be carried out of waste storage, and containment areas, waste segregation bins and stockpiles, and levels of windblown litter.

5.23 Cumulative Impacts

Numerous large industrial projects are currently underway or planned for the Gladstone region including three other LNG projects on Curtis Island. Other significant projects in Port Curtis include the Wiggins Island Coal Terminal Project and the Western Basin Dredging and Disposal Project (Figure 15).

These projects bring considerable combined economic benefits to the local, regional and state economies through direct investment and ongoing operations including significant employment opportunities. During peak construction, all projects (if they proceed as planned) will cumulatively employ an estimated 14,000 workers although in practice this is unlikely to occur. Although a significant proportion of this workforce will be fly-in fly-out workers, during construction in particular, the population of the Gladstone area will increase.

Cumulative impacts may arise as increased (temporary and permanent) population puts pressure on accommodation, social infrastructure and recreational facilities. Impacts on community values and lifestyle may also arise. Significant cumulative impacts are also likely from increases in shipping in Port Curtis, road traffic, and land clearance as well as declines in visual amenity. Arrow Energy recognises that these impacts will need to be actively managed and has

worked with other proponents and government agencies to assess impacts where practicable and include the results in the EIS. For example, all four LNG proponents shared traffic data which the traffic impact assessment in this EIS reflects.

Most of the cumulative impacts from other significant projects in the Port Curtis area will occur prior to the construction stage of the Arrow LNG Plant, with the project making only a partial contribution. The execution schedules for planned projects considered in the cumulative impact assessment are not fixed and as such, there is a degree of uncertainty in estimating the potential cumulative impacts. A likely scenario is that the Arrow LNG Plant may extend impacts associated with other developments. Ongoing work and discussion with other proponents, regulators and the community is required to manage these impacts as construction schedules and likely project overlaps become clearer.

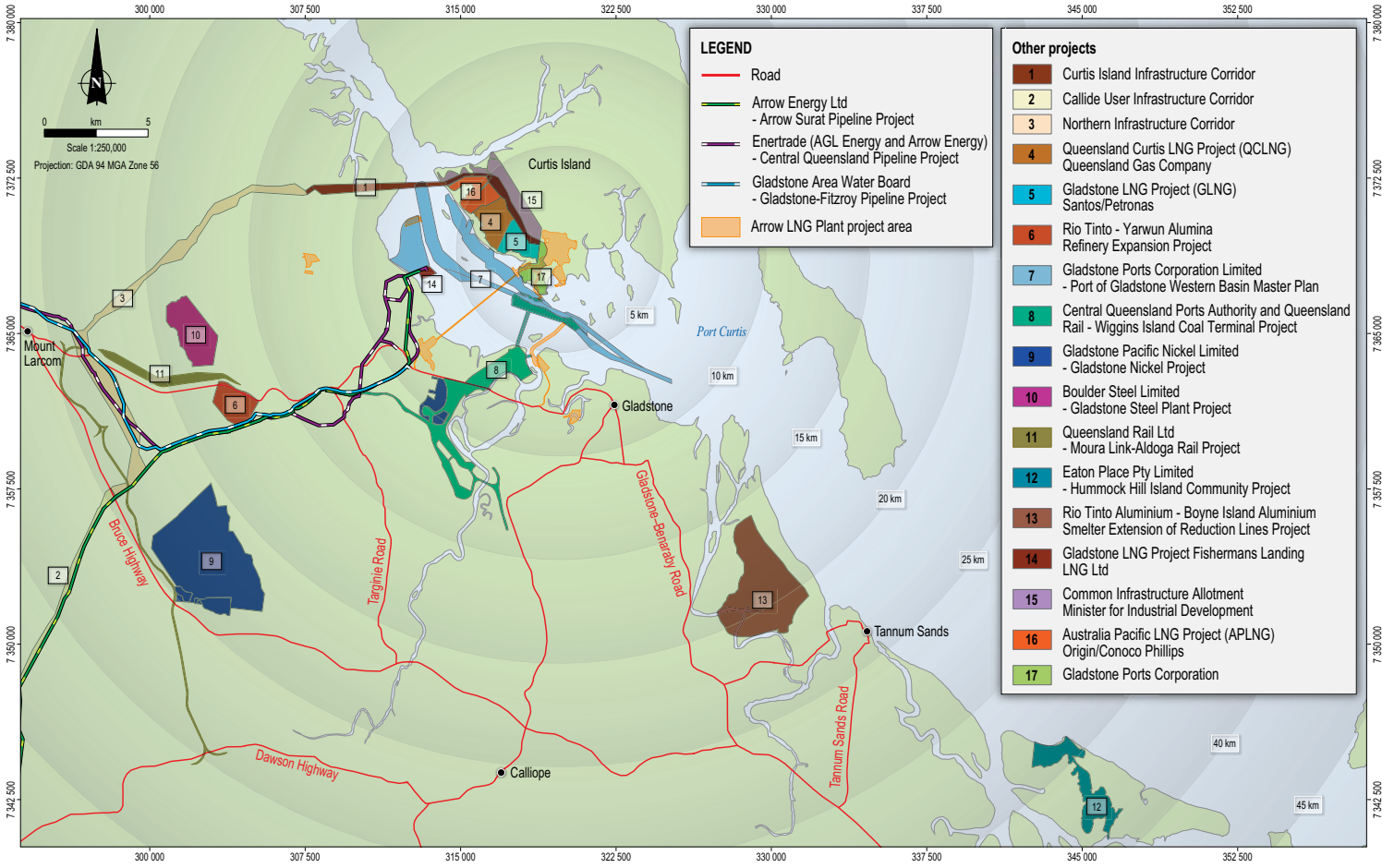


Figure 15 Arrow LNG Plant workforce

6 ENVIRONMENT MANAGEMENT

Arrow Energy is committed to the sound management of health, safety and the environmental issues and impacts throughout all its business activities. The company maintains a comprehensive system for managing these issues that is based on internationally recognised standards and has developed, as part of the requirements of the EIS, a detailed environmental management plan that will govern all aspects of the project.

6.1 Health, Safety and Environmental Management System

The Arrow Health, Safety and Environmental Management System (HSEMS) commits the company to conduct its operations in compliance with all relevant environmental legislation, regulations, standards and approvals, clearly allocate responsibilities for environmental matters at all levels of the company, seek to continually improve its health, safety and environmental performance, apply industry best practice in the management, supply and delivery of coal seam gas, and to maintain communications with its customers and the community (Figure 16).

Arrow reports its environmental performance in compliance reports, as required under various Queensland and Commonwealth government legislation and regulations.

Arrow is ultimately responsible for the ongoing environmental management of all project activities. This includes all its employees and contractors who must comply with all relevant Arrow Energy procedures and policies.

6.2 Environmental Management Plan

The EIS contains numerous actions that Arrow Energy will take to address the impacts of the project. These actions and measures have been consolidated into the environmental management plan (EMP) attached to the EIS. The aim of the EMP is to provide easily accessible information about the environmental values in the project area and vicinity, the issues and impacts associated with the project, and the management measures for Arrow Energy to implement during construction, operation and decommissioning.

The environmental protection commitments made by Arrow Energy, as documented in the EMP, are based on preferred project options, derived from research, environmental best practice and the technical studies carried out by specialists that support the EIS. Importantly, the plan sets specific objectives that Arrow Energy must meet to demonstrate an acceptable standard of environmental performance. Targets have also been set to measure Arrow Energy's performance which will be audited and reported on regularly throughout the project.

The EMP is seen as a 'living' document that is intended to be updated as the project proceeds through construction to operation and finally to decommissioning.

Numerous other management plans will be developed as part of the project and many are required before specific approvals and permits can be issued for different aspects of the project.

Importantly, environmental awareness training and inductions will be provided to all employees, contractors and visitors appropriate to the location and the type of work being performed.

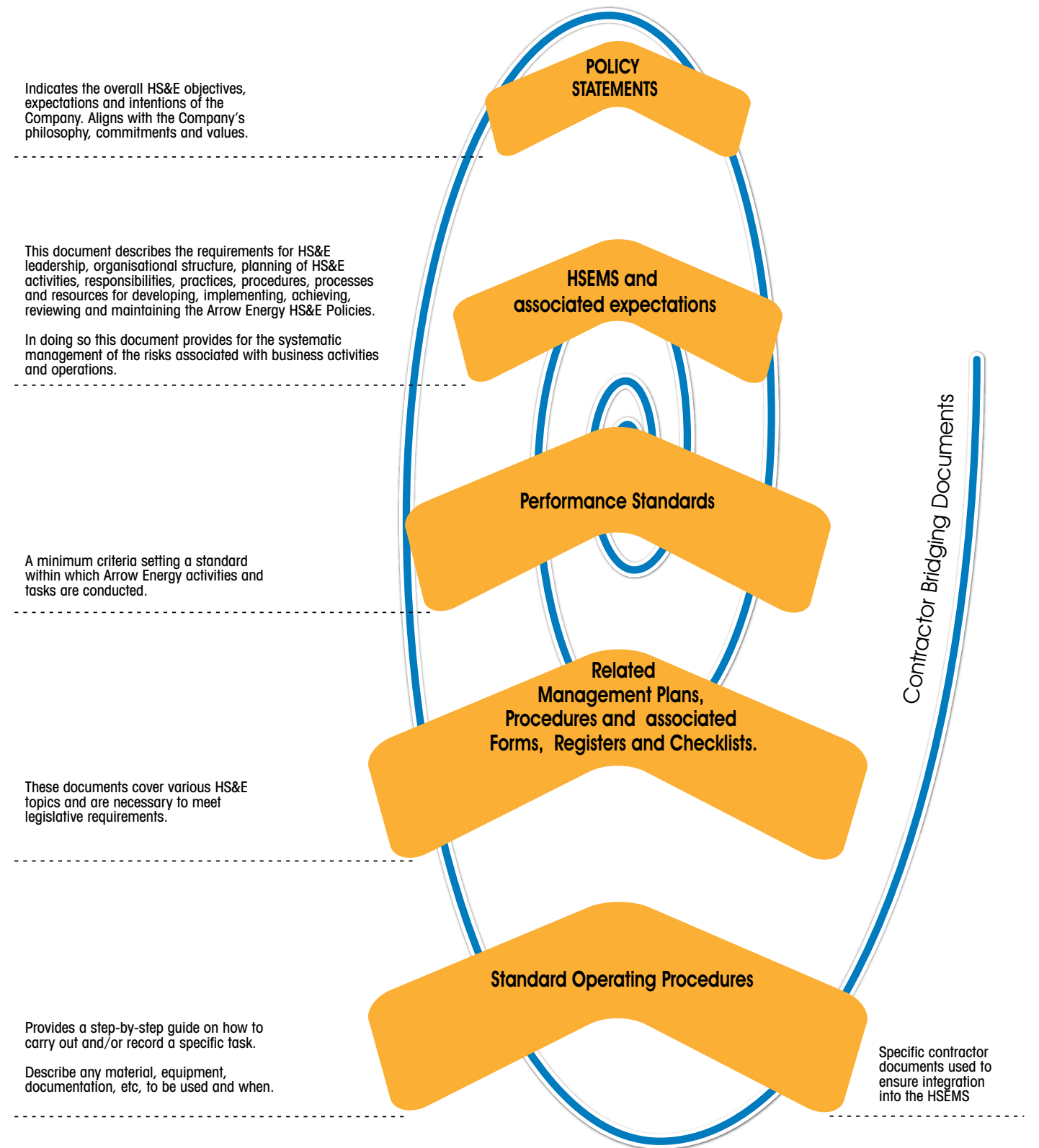


Figure 16 Arrow HSEMS framework

7

SUBMISSIONS

Submissions on the EIS may be made to the Coordinator-General during the period of public comment. The Coordinator-General will consider submissions when preparing the evaluation report for the EIS.

Submissions must be made within the submission period, either in written or electronic form and must be signed by each person making the submission. All submission must state the name and address for each signatory.



Submissions should be addressed to:

The Coordinator-General
Attn: Project Manager
Arrow LNG Project
Department of Employment, Economic Development and Innovation



By post:

PO Box 15517
City East, QLD 4002
Australia



By fax:

07 3225 8282



By email:

arrowlng@deedi.qld.gov.au

For further information about the EIS process for the Arrow LNG Plant, please contact the EIS Coordinator for the Coordinator-General on 07 3405 6205.

Arrow Energy welcomes comments and feedback on the EIS and will consider all submissions received on the EIS. The company is required to provide a response to the Coordinator-General on all the issues raised in submissions.

Guide to the EIS Volumes

EIS Section	Title	Author
Executive Summary		
Stand alone	Arrow LNG Plant EIS Executive Summary	Coffey Environments Australia Pty Ltd (Coffey Environments) and Arrow Energy
Volume One (Main Report)		
Chapter 1 to 19	Arrow LNG Plant EIS Main Report	Coffey Environments
Volume Two (Main Report)		
Chapter 19 to 37	Arrow LNG Plant EIS Main Report	Coffey Environments
Volume Three (Attachments)		
Attachment 1	Relevant Legislation, Policies and Approvals	Coffey Environments
Attachment 2	Terms of Reference	Coordinator General
Attachment 3	Terms of Reference Cross Reference	Coffey Environments
Attachment 4	Matters of National Environmental Significance	Coffey Environments
Attachment 5	Arrow Policies	Arrow Energy
Attachment 6	Environmental Management Plan	Coffey Environments
Attachment 7	Social Impact Management Plan	Sinclair Knight Merz Pty Ltd
Attachment 8	Commitments	Coffey Environments
Volume Four (Appendices)		
Appendix 1	Climate and Climate Change Adaptation	PAE Holmes
Appendix 2	Geology, Landform and Soils Impact Assessment	Coffey Geotechnics Pty Ltd
Appendix 3	Stage 1 Preliminary Site Investigation (Contaminated Land)	Coffey Environments Pty Ltd
Appendix 4	Acid Sulfate Soil Impact Assessment	Coffey Geotechnics Pty Ltd
Appendix 5	Surface Water Impact Assessment	Alluvium Consulting Pty Ltd
Appendix 6	Stormwater Quality Impact Assessment	Alluvium Consulting Pty Ltd
Volume Five (Appendices)		
Appendix 7	Groundwater Impact Assessment	Coffey Geotechnics Pty Ltd
Appendix 8	Coastal Processes, Marine Water Quality, Hydrodynamics and Legislation Assessment	BMT WMB Pty Ltd
Appendix 9	Terrestrial Ecology Impact Assessment	Ecosure Pty Ltd
Appendix 10	Pest Management Plan	Ecosure Pty Ltd
Volume Six (Appendices)		
Appendix 11	Freshwater Ecology and Water Quality Impact Assessment	Aquateco Consulting Pty Ltd
Appendix 12	Marine and Estuarine Ecology Impact Assessment	Coffey Environments
Appendix 13	Greenhouse Gas Impact Assessment	PAEHolmes
Appendix 14	Air Quality Impact Assessment	Katestone Environmental Pty Ltd
Appendix 15	Plume Rise Assessment	Katestone Environmental Pty Ltd
Volume Seven (Appendices)		
Appendix 16	Noise and Vibration Impact Assessment	Sonus Pty Ltd
Appendix 17	Landscape and Visual Impact Assessment	AECOM Australia Pty Ltd
Appendix 18	Indigenous Cultural Heritage Impact Assessment	Central Queensland Cultural Heritage Management Pty Ltd
Appendix 19	Non-Indigenous Cultural Heritage Impact Assessment	Heritage Consulting Australia Pty Ltd
Appendix 20	Social Impact Assessment	Sinclair Knight Merz Pty Ltd
Volume Eight (Appendices)		
Appendix 21	Economic Impact Assessment	AEC Group Limited
Appendix 22	Implications for the Domestic Gas Market	ACIL Tasman Pty Ltd
Appendix 23	Traffic and Transport Impact Assessment	GTA Consultants
Appendix 24	Confidential Information	
Appendix 25	Preliminary Safety Management Study	Planager Pty Ltd
Appendix 26	Bushfire Impact Assessment	Eco Logical Australia Pty Ltd
Volume Nine (Appendices)		
Appendix 27	Health Impact Assessment	Arup Pty Ltd
Appendix 28	Land Use and Planning Impact Assessment	Coffey Environments
Appendix 29	Waste Impact Assessment	Coffey Environments
Appendix 30	Consultation Report	JTA Australia Pty Ltd





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