Executive Summary

ES 1 Introduction

This executive summary provides an outline of the proposed Gladstone Liquefied Natural Gas Project (GLNG Project), its principal environmental impacts and the proposed management strategies and commitments.

The objective of this executive summary is to highlight the most important aspects of the project relating to its environmental performance and approval requirements. Its aim is to enable the reader to obtain a clear understanding of the project and its potential adverse and beneficial environmental, social and economic impacts and the management measures to be implemented to mitigate adverse impacts.

ES 2 The GLNG Project

Santos Limited (Santos) and its joint venture partner PETRONAS are proposing to develop their Queensland coal seam gas (CSG) resources in the Bowen and Surat Basins in the area between Roma and Emerald as feed gas for a liquefied natural gas (LNG) liquefaction and export facility on Curtis Island, near Gladstone, Queensland. The LNG facility will have an initial capacity of 3 - 4 million tonnes per annum (Mtpa) but will have the potential for later expansion to a nominal 10 Mtpa.

The GLNG Project has the following major components:

- Coal seam gas fields;
- Gas transmission pipeline; and
- LNG liquefaction and export facility (LNG facility).

Other components of the project include a potential bridge, road and service corridor to provide access to Curtis Island; and supporting marine infrastructure including a product loading facility, a materials offloading facility and channel dredging.

The CSG fields will be developed over a period of approximately 25 years to provide approximately 5,300 PJ of coal seam gas to the LNG facility.

The gas transmission pipeline will link the CSG fields to the LNG facility.

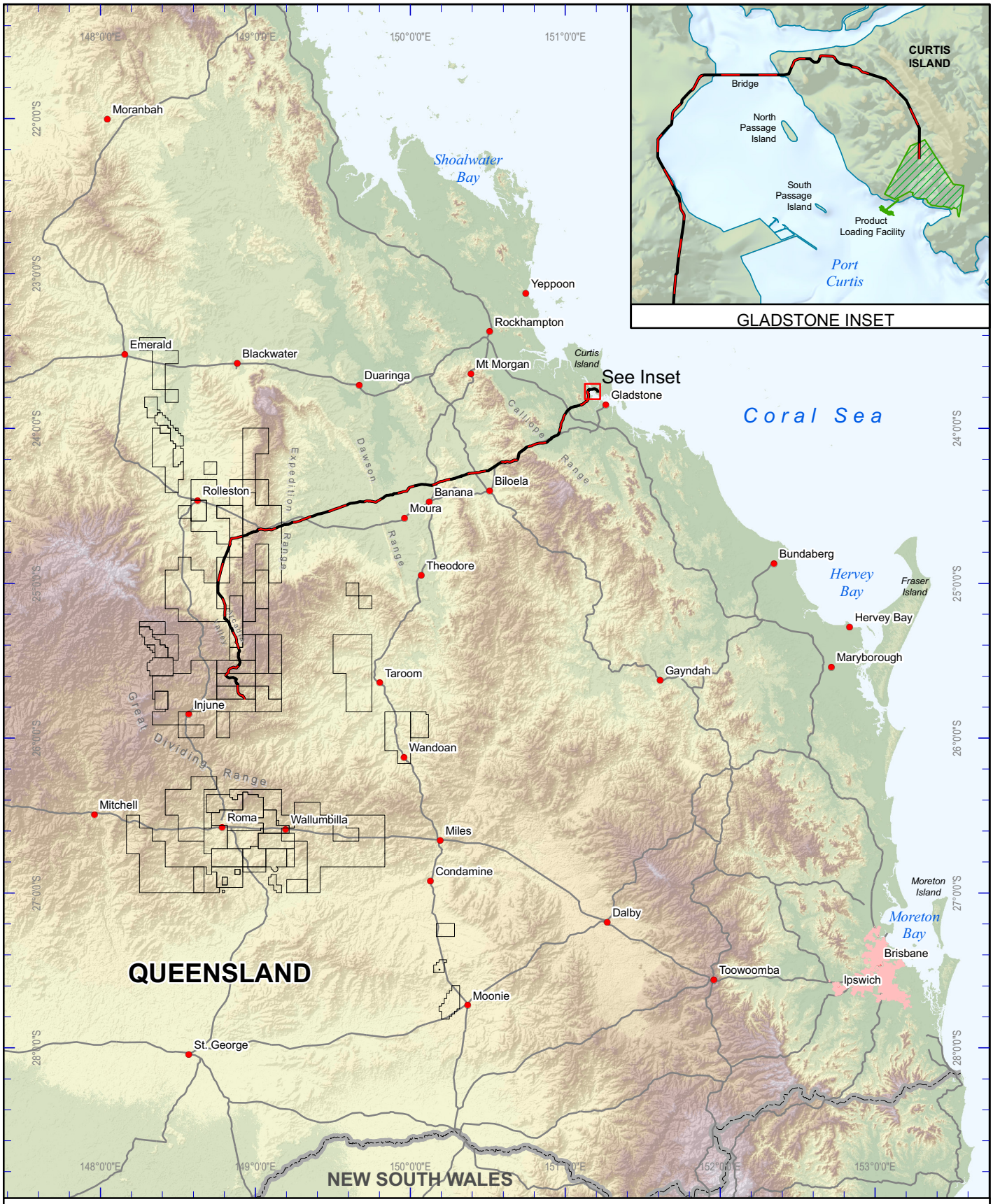
The LNG facility will be located in the south-west section of Curtis Island and will liquefy the gas to enable it to be transferred to ships for export.

Figure ES1 shows the location of the above project components.

ES 3 Project Objective and Benefits

The primary objective of the GLNG Project is to commercialise Santos' vast Queensland CSG resource in a sustainable manner. This includes continuing to protect environmental values; managing environmental, health and safety requirements; implementing best environmental practice; and providing employment opportunities in Queensland throughout all phases of the project. To meet this objective, Santos will adhere to its sustainability framework for the design and implementation of the project. This will be achieved through Santos' company-wide environment, health and safety management system (EHSMS) which provides a structured framework for effective environmental and safety practice across all of Santos activities and operations. The framework will also enable better business decisions through a deeper understanding of their impacts on people, communities, economics and the environment.

The economic benefits resulting from the project will have regional, state and national dimensions. It will contribute substantial, positive economic benefits to Queensland and Australia derived from the combination of: the export income the project produces; tax and royalty revenues paid by the upstream producers; businesses and individuals employed; the money spent in the local economy, and the incentive for accelerated exploration and reserve booking of the State's extensive CSG resources.



Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**REGIONAL LOCATION**

Drawn: MG	Approved: JB	Date: 17-02-2009	Figure: **ES1**	Rev. A
Job No.: **4262 6220**	File No.: 42626220-g-1031.mxd			A4

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The project will generate major net economic benefits for the Queensland economy and the wider Australian economy. In summary, the impact on the Queensland economy of the 10 Mtpa project is estimated to be:

- Over the period 2009 to 2033, Queensland's real gross state product (GSP) will on average be $4.1 billion or one percent higher each year than in the base case scenario. In the period after 2022, when the project has reached production of 10 Mtpa, real GSP will be almost $6.4 billion or 1.4 percent higher than in the base case scenario.
- This increase in Queensland's real GSP is distributed to households throughout Australia, although Queenslanders benefit proportionately more than other Australians. The project contributes to a net average annual increase in Queensland real private consumption spending over the period 2010 to 2033 of $540 million. This constitutes a 0.2 percent increase over the base case scenario, which is significantly higher than the gain for Australia as a whole (of 0.1 percent). In the period after 2022, the net average annual increase in real private consumption spending is almost $1 billion a year (0.4 percent) higher than it would be otherwise.
- The project delivers important employment benefits to the Queensland economy and the project regions. On average, additional employment in Queensland is 4,300 per year on a full-time equivalent basis. This exceeds the average annual employment of the project (the direct employment effect) across both the construction and operations phases of 3,196, demonstrating a significant employment multiplier effect. The employment effect is stronger after 2022, averaging almost 5,000 additional jobs per year.

The regional economies in which the project is located, on a per capita basis, are likely to benefit to a greater extent from the project than the wider Queensland and Australian economies. Regional residents can be expected to benefit from increased employment opportunities and opportunities to supply the project with goods and services. Given the relative size of the regional economies, project expenditures in the local region will be significant.

ES 4 The Proponent

The project proponent is an unincorporated joint venture between Santos and PETRONAS. At the time of submission of this EIS (March 2009), Santos and PETRONAS had a 60% and 40% respectively participating interest in the GLNG Project.

The proponent contact for the GLNG Project is:

Santos Limited
60 Edward Street
Brisbane 4000 Queensland
Attn: Mr. R. Wilkinson

Santos is a major Australian oil and gas exploration and production company with CSG interests in Queensland. Santos also has interests and operations in every major Australian petroleum province as well as interests in Indonesia, Papua New Guinea, Vietnam, India, Bangladesh, Kyrgyzstan and Egypt. Santos is one of Australia's largest onshore domestic gas producer, supplying sales gas to Queensland and all other mainland Australian states and territories, ethane to Sydney, and oil and other liquids to domestic and international customers. Santos' market capitalisation makes it one of Australia's top 20 companies. Significant development projects contributing to the growth of Santos include the following:

- CSG exploration and developments in Queensland;
- Bayu-Undan Liquids and Darwin LNG projects in the Timor/Bonaparte Basin area offshore Darwin;
- Mutineer-Exeter oil fields and John Brookes gas field developments in the Carnarvon Basin offshore Western Australia;
- Casino gas development in offshore Victoria; and
- Oyong oil and gas field and Maleo gas field in offshore East Java.

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PETRONAS is the acronym for Petroliam Nasional Berhad, a leading Malaysian based oil and gas multinational. Over the years, PETRONAS has grown to become a fully-integrated oil and gas corporation and is ranked among FORTUNE Global 500's largest corporations in the world. PETRONAS has four subsidiaries listed on the Bursa Malaysia (Kuala Lumpur Stock Exchange) and has projects and operations globally in more than 30 countries worldwide. On an equity basis, PETRONAS is the largest LNG producer in Asia and is the third largest in the world. The company operates the PETRONAS LNG Complex in Bintulu, Sarawak, which is the world's largest integrated LNG facility with a total capacity of approximately 23 Mtpa from 8 LNG trains. PETRONAS is also a partner in the ELNG Project in Egypt and in the Dragon LNG Project in Wales. It is the world's largest single owner - operator of LNG ships and has long standing relationships with an extensive base of high volume LNG customers in Asia.

ES 5 Commitment to Environmental Management

Santos has a long history of conducting its activities in a way that avoids or minimises potential impacts on the environment. This is based on a thorough understanding of the receiving environment, coupled with proven techniques tailored to specific ecosystems. Environmental performance is monitored by tracking against strategic company-wide and site-specific key performance indicators.

Santos has a company-wide environment, health and safety management system which will be applied to the GLNG Project. The EHSMS provides a structured framework for effective environmental and safety practice across all of Santos' activities and operations. The framework has been developed to ensure compliance with Australian Standard 4801:2000 *Occupational Health and Safety Management Systems – Specification* and AS/NZS ISO 14001:1996 *Environmental Management Systems – Specification*.

Management standards have been developed as part of the EHSMS and define the requirements necessary to ensure that environmental, health and safety risks are systematically managed. Hazard standards detail the controls required to manage the risks of specific hazards to acceptable levels. They contain specific requirements for planning and undertaking activities and include checklists and references to internal and external approvals and controls. Environment hazard standards have also been developed under the EHSMS.

In line with PETRONAS' commitment to continuous growth and sustainable development for the future, PETRONAS works in the best possible way to balance and integrate economic, environmental and social considerations into its business decisions. To this end PETRONAS is guided by a comprehensive HSE (Health, Safety and Environment) Management System which is implemented across the PETRONAS group of companies.

ES 6 Project Need

World energy demand continues to rise. Between 2008 and 2030, energy demand is expected to increase by 45%, an annual average rate of increase of 1.6% (International Energy Agency, 2008). Simultaneously, there is increased pressure to find less carbon-intensive energy solutions in an increasingly carbon-constrained world. The GLNG Project is a less carbon-intensive energy solution than other fossil fuel alternatives. As such, the GLNG Project can be a global contributor to energy needs with reduced greenhouse gas outputs.

In the calendar year 2007, Australia exported 15.2 million tonnes of LNG, valued at $5,368 million (ABARE, 2008). Exports of LNG have increased strongly over the past 20 years, and have risen particularly rapidly over the past five years. Exports of approximately 25 million tonnes are predicted for 2011-2012. ABARE (2008) predicts that this growth in exports will continue, with natural gas exports expected to grow by almost 8% per year until 2030.

The majority of the world's large importers of LNG are in the Asia Pacific region, giving Australia a natural advantage in terms of the relatively short distances to these key markets. ABARE (2008) predicts that the international demand from LNG importing countries will continue. This is expected to be 120 million tonnes in 2010 and increasing to over 150 million tonnes by 2015. There is a clear opportunity for the GLNG Project to fill some of this need.

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ES 7 The EIS Methodology

The methodology used to prepare the project's environmental impact statement (EIS) consisted of the following stages:

- **Project Description.** A description of the project was developed to enable the reader to gain an understanding of its construction and operation as well as its decommissioning. This description was separated into the three major project components of CSG fields, gas transmission pipeline and LNG facility (including associated marine facilities, bridge and access road).
- **Baseline Studies.** Relevant baseline environmental information was obtained for each of the three project components. Some baseline data were available from previous investigations and reports. They were supplemented by a field monitoring program to enable the existing environmental values of the project area to be identified.
- **Impact Assessment and Management.** The project description was analysed in relation to the identified environmental values to identify the project's potential environmental impacts during the construction, operational and decommissioning stages. These impacts were assessed according to their conformance with relevant state or national guidelines and standards. Based on this assessment, appropriate environmental management and impact mitigation measures were developed to ensure that the identified environmental objectives can be achieved.

Because of the large area of the CSG fields and the ongoing nature of exploration and gas production, the full extent and location of the wells and associated infrastructure is not yet known and will evolve gradually over the life of the project. Consequently, it is not feasible to undertake conventional baseline studies and impact assessment and so, for the CSG field component of the project, a two-phased approach has been adopted for its impact assessment. This two-phased approach has been recognised by the EIS terms of reference.

The first phase (Phase1) which has been reported in this EIS incorporates the following tasks:

- Desktop assessment of the CSG fields. This desktop assessment included literature reviews, database searches, interpretation of relevant mapping layers and liaison with local community groups.
- Reconnaissance field surveys of the reasonably foreseeable development areas in the potentially sensitive locations that were identified from the desktop assessment.
- Assessment of likely impacts from typical project elements (e.g. wells, pipelines, compressor stations, gas processing facilities, accommodation camps, produced water management and other related infrastructure). This was based on identified impacts and mitigation measures employed at the existing Santos CSG operations.
- Development of a protocol (based on Santos' existing CSG impact assessment process as described above) for the ongoing impact assessment of each project element to be undertaken as their nature and location becomes known over the life of the project.

The second phase (Phase 2) will be the implementation of the protocol for ongoing impact assessment of each project element once its nature and location becomes known over the life of the field development. This phase will be undertaken after the EIS process is completed and the GLNG Project is operational. It will be managed through the regulatory bodies and the existing internal Santos impact assessment process and will feed directly into their EHSMS.

ES 8 EIS Legal Framework

This EIS has been prepared in accordance with the requirements of the *State Development and Public Works Organisation Act 1971* (SDPWO Act). An Initial Advice Statement (IAS) for the project was lodged with the Coordinator-General (CG) on 10 July 2007. On 16 July 2007, the CG determined that the GLNG Project is a "Significant Project".

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A draft Terms of Reference (TOR) for the EIS was prepared and advertised for public comment on 24 May 2008 for a period of four weeks. The final TOR was released by the CG in August 2008. The EIS has been prepared in accordance with the TOR.

The impact assessment process under the SDPWO Act is also the subject of a bilateral agreement between the Queensland and Commonwealth Governments in relation to environmental assessment under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Santos referred the project to the Commonwealth Minister for the Environment, Heritage and the Arts under the EPBC Act as five EPBC Act referrals addressing the following:

- CSG Fields development (referral reference number 2008/4059);
- Gas Pipeline corridor (referral reference number 2008/4096);
- LNG Park (referral reference number 2008/4057);
- Bridge and Road (referral reference number 2008/4060); and
- Marine Facilities (referral reference number 2008/4058).

The Minister subsequently determined that each of the five components of the project was a controlled action. The following relevant controlling provisions were noted for some or all of the components:

- Listed threatened species and communities (ss 18 and 18A);
- Listed migratory species (ss 20 and 20A);
- World Heritage properties (ss 12 and 15A); and
- National Heritage places (ss 15B and 15C).

Consequently, an approval for the project is required under Part 9 of the EPBC Act following the conclusion of the Queensland assessment process.

A public notice has been placed in relevant newspapers advising the public where copies of the EIS are available for inspection or purchase; that submissions may be made to the CG about the EIS; and the timeframe for the submission period. During this advertising period, members of the public have the opportunity to make submissions about the EIS. Following the submission period, Santos may be required to prepare a supplementary report to address specific matters raised in submissions on the EIS.

At the completion of the assessment phase, the CG will consider the EIS, the submissions made on the EIS, and other material the CG considers relevant and will prepare an assessment report evaluating the EIS. In the assessment report the CG may:

- Evaluate the environmental effects of the project and any other related matters;
- State conditions that must attach to any approval; and
- Make recommendations.

At the conclusion of the Queensland Government process under the SDPWO Act, the Commonwealth Department of Environment, Water, Heritage and the Arts will receive a copy of the CG's report. The Commonwealth Minister will take the CG's report into account when making a decision on the project in accordance with the requirements of the EPBC Act.

In addition to the requirements under the SDPWO Act and EPBC Act, other Queensland Government approvals will be required including environmental authorities under the *Environmental Protection Act 1994*, petroleum authorities under the *Petroleum and Gas (Production and Safety) Act 2004* and *Petroleum (Submerged Lands) Act 1982*, development approvals under the Gladstone State Development Area (GSDA) Development Scheme made under the SDPWO Act, and development approvals under the *Integrated Planning Act 1997*.

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ES 9 Public Consultation

Extensive consultation with advisory agencies, members of the public and other stakeholders has formed an integral part of the EIS process and will continue to be an integral part of project development. The community consultation process aims to ensure clear, transparent, two-way communication between Santos and the interested and affected stakeholders through listening, recording and responding to issues relating to the project as these arise. The process provides an opportunity for Santos to impart information to the stakeholders regarding the project, to obtain valuable local knowledge from these groups, and to respond to concerns through appropriate action. It provides stakeholders with an opportunity to express their views and concerns, provide feedback, and be involved in the EIS process.

A comprehensive consultation program was successfully conducted throughout the EIS process and will continue during project implementation. A variety of communication tools and activities were used to inform and receive feedback including meetings, newsletters, presentations, a freecall number and a website. The issues identified and the resultant outcomes from the consultation program have been recorded and fed back into the EIS process.

The key objectives of the consultation program were to:

- Initiate and maintain open communication between stakeholders and Santos on all aspects of the project and the environmental impact assessment work;
- Inform interest groups about the project and encourage their involvement in the process;
- Seek an understanding of interest group concerns about the proposal;
- Explain the impact assessment research methodology and how public input might influence the final assessment of the project;
- Provide an understanding of the regulatory approval process;
- Seek local information and input into the project by providing a range of opportunities for stakeholders to identify key issues for consideration; and
- Proactively work with the community to propose strategies to maximise benefits and minimise any negative impacts.

ES 10 Assessment of Project Alternatives

ES 10.1 CSG Field

Location Alternatives

Demand for natural gas in Queensland is met from conventional gas and CSG. Both are natural gas - but there are significant differences in gas composition, the way the gas is extracted, and the location of the reserves in Queensland. Conventional gas is drawn from fields covering the Surat, Cooper and Eromanga Basins in the south and south-west of Queensland. CSG and conventional gas are drawn from the Bowen and Surat Basins in central west Queensland. Queensland has over 10,680 petajoules (PJ) of proven and probable reserves of CSG (DME, October 2008). Although there are conventional gas reserves in the Surat and Bowen Basins, conventional gas is not an alternative source for this project. Due to the composition differences between CSG and conventional gas, the LNG facility would require considerable pre-treatment equipment to accept any conventional gas.

Drilling Alternatives

Conventional drilling involves the development of vertical holes directly above the target resource. Most of the wells to be developed for the CSG fields will be vertically drilled in a conventional manner. However in environmentally sensitive areas, in areas of particular aesthetic significance, or in areas subject to conflicting land use, Santos will investigate the use of alternative drilling techniques designed to minimise the extent of disturbance to reduce the resultant environmental impact. Directional drilling techniques

(both vertical and horizontal) can have a number of advantages over conventional wells in that it is possible to drill multiple wells from the one lease, to access resources that are laterally displaced from the lease area, and to access multiple formations from the one well.

Field Alternatives

To ensure appropriate development of the state's petroleum resources, the governing legislation requires Santos to prepare a development plan providing an overview of activities proposed for each petroleum lease. The resources can be developed in a number of different ways. Santos is considering four different field development alternatives for its Fairview, Arcadia Valley and Roma fields in order to optimise the appropriate development of each field. Field development may include a mix of any of these alternatives.

The locations of these CSG fields are shown in Figure ES2.

All of the alternatives considered provide adequate gas supply for at least Train 1 of the GLNG Project The work has highlighted the value of developing the three fields together as a common feedstock. Further work is required to optimise the gas resource in line with commercial and LNG requirements before the preferred alternative is identified.

ES 10.2 Gas Transmission Pipeline

Route Alternatives

A route selection study for the gas transmission pipeline identified the following three alternative gas transmission pipeline routes:

- Route 1 Base route. Paralleling the existing Queensland Gas Pipeline (QGP) route from the northern end of the Arcadia Valley to Gladstone (see Figure ES3);
- Route 2 A more direct route to Gladstone, heading east from the Comet Ridge area in a large sweeping curve; and
- Route 3 Similar to Option 2 but in a more north-easterly direction.

Based on engineering, environmental, land use and cost criteria, Route 1 was selected.

Following adoption of Route 1 as the preferred option, the alignment was further refined and two alternative deviations for parts of the preferred route identified. Baseline environmental studies have not been undertaken along these alternatives as they had not been identified at the time of the Route 1 field investigations. However, desktop studies have been undertaken and prior to construction commencing field verification will be undertaken. The alternative deviations identified are as follows:

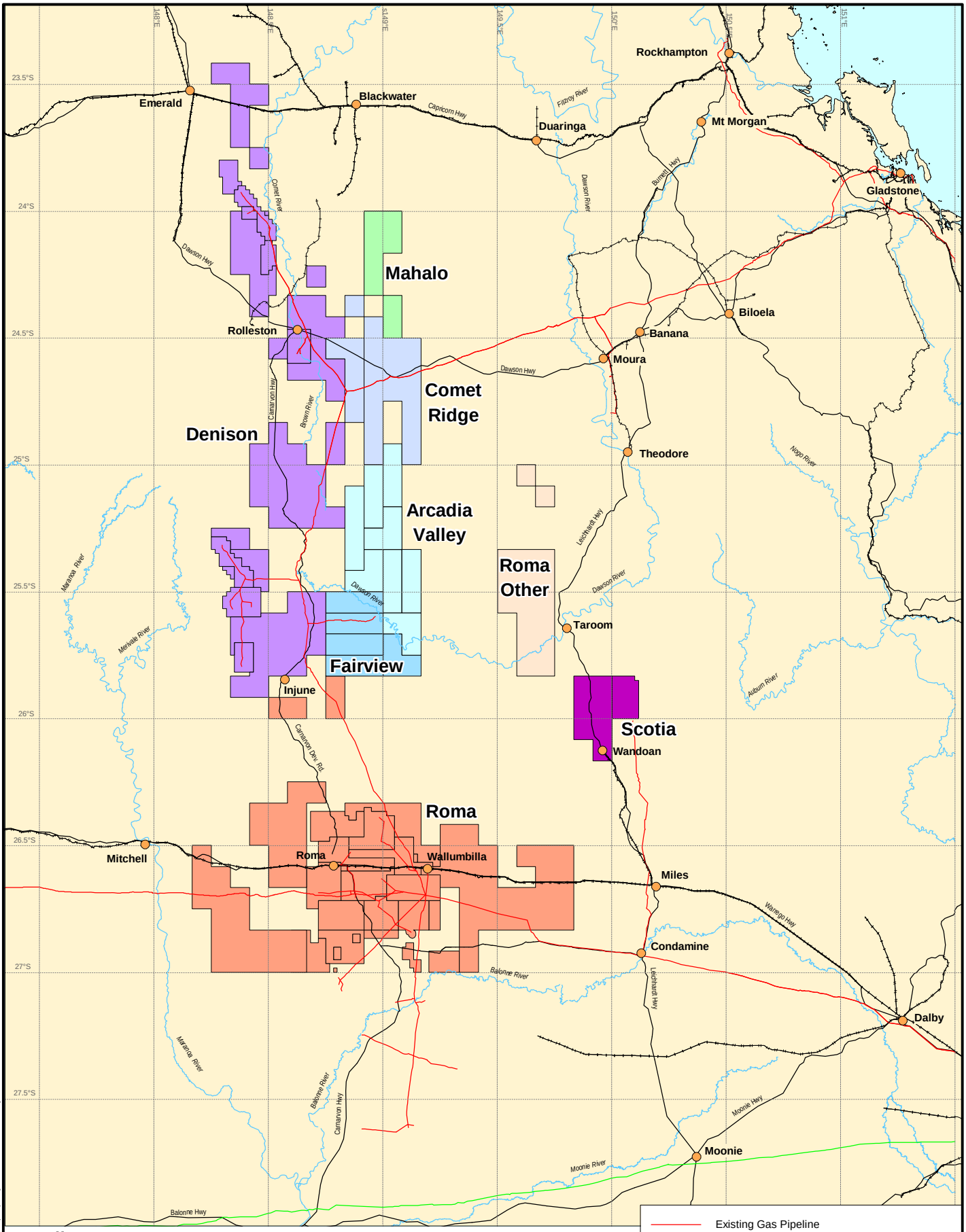
- Arcadia Valley West alternative; and
- Northern alternative within the GSDA.

Further route refinement studies will be undertaken during front end engineering design (FEED) to confirm whether either of the potential alternative deviations will be selected.

Watercourse Crossings

Three alternative methods will be used for watercourse crossings by the gas transmission pipeline. These alternatives are as follows:

- **Open Trench.** The majority of watercourse crossings are expected to be constructed using standard open trenching construction. This technique is most suited to the dry or low flow conditions which will be preferred for the construction phase.



Client

Project
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title
LOCATION OF CSG FIELDS

Drawn: LL	Approved: JB	Date: 19-03-2009
Job No: **4262 6220**	File No: 42626220-g-1032.wor	

Figure: **ES2**

Rev:B

A4

Client

URS

LNG

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

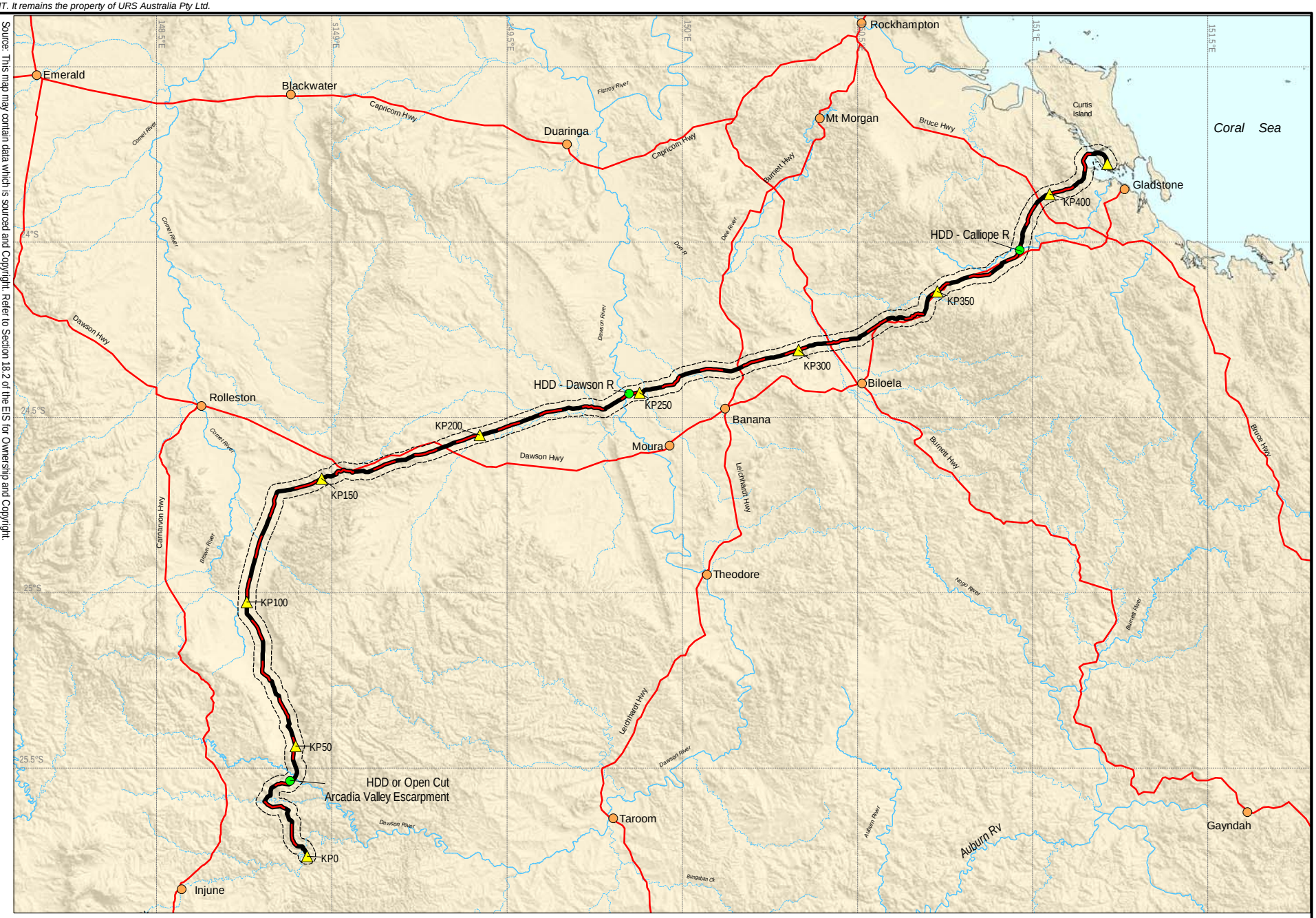
Drawn: CA | Approved: JB | Date: 12-03-2009

Job No: **4262 6220** | File No: 4262220-g-1033.wor

Title

GAS TRANSMISSION PIPELINE ALIGNMENT

Figure: **ES3** | Rev:A | **A4**



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Scale: 1:1 500 000 (A4)
Datum : GDA94

Gas Transmission Pipeline Corridor
Major Road
Major Drainage
Gas Transmission Pipeline
KP50 Kilometre Post Distance Marker (in Km)
Horizontal Directional Drilling Location

- **Open Trench with Flow Diversion.** Flow diversion is a modification to the standard open trench method employed where higher water volumes and flows are present (typically up to 1,000 litres per second). In this way the risk of erosion and interference with construction activities is reduced.
- **Horizontal Directional Drilling (HDD).** HDD is generally used to cross major watercourses where standard open cut methods are not feasible or to avoid environmentally sensitive features. The feasibility of using HDD is limited by site conditions such as soil stability, slope, access, available workspace and the nature of subsurface strata.

It is anticipated that the majority of the watercourse crossings will be constructed using standard open trench methods. Where possible, construction activities will be scheduled for dry or low flow periods to enable open trench methods to be used. However, an evaluation of site conditions will be made at the time of construction and the need to use flow diversion methods will be assessed based on actual site conditions. It is proposed to use HDD methods for the two major river crossings (Dawson and Calliope Rivers) and possibly for the crossing of the Arcadia Valley escarpment to avoid the potential for significant environmental impact.

Port Curtis Crossing

It is proposed that the gas transmission pipeline will cross Port Curtis between Friend Point (on the mainland) and Laird Point (on Curtis Island). This route is to the north of the potential Curtis Island bridge alignment and is at the southern end of the Great Barrier Reef Coast Marine Park (State Marine Park).The location north of the potential bridge alignment is preferred as a route south of the bridge would cause an increased risk of interference to port shipping and potential damage from ships' anchors.

The following four options were considered for constructing the gas transmission pipeline across Port Curtis:

- Laying the pipeline directly on the sea floor;
- Placing the pipeline within a trench and backfilling;
- Suspending the pipeline from the potential road bridge; and
- Horizontal directional drilling (HDD) beneath the sea floor.

The preferred pipeline crossing option is to trench below the seabed and to backfill with sand and rock. This will avoid the risk from boat anchors if the pipe was not trenched and it also avoids the risk of delay if the bridge option was selected but the bridge was not constructed in time or not constructed at all. While both the trenched and HDD options will avoid the risk from pipeline damage due to boat anchors, there remain significant technical issues associated with the HDD option due to the length of the crossing (1.5 km) and the diameter of the pipe (approximately 1 m). This crossing is considered to be at the extreme capability of the technology and carries significant technical risk.

Pipe Delivery

Pipe will be shipped to Gladstone and unloaded at the existing Auckland Point wharves. From there it will be delivered to various laydown areas along the pipeline route. Both truck and rail are being considered as optional means of delivery of the pipe from Gladstone to the laydown areas.

For the truck delivery option, trucks will be used to transport the pipe from Auckland Point to one of six or more laydown areas spaced roughly equidistant along the pipeline route. The laydown areas (approximately 5 ha each) will consist of a hardstand area for pipe storage and associated facilities. Pipes will then be reloaded onto trucks for delivery to the pipeline construction areas. Delivery will be at an approximate rate of 65 - 70 truck loads per day (i.e. up to 140 truck movements per day). This will last for approximately six months. The primary delivery route will be along the Dawson Highway.

As an option to trucking, the use of rail has been considered. In this case the pipe will be loaded onto a train at Auckland Point and railed to one of three laydown areas along the pipeline route. One laydown area will be at Moura and the other two at intermediate locations between Gladstone and Moura. A rail siding will be constructed at each laydown area and a hardstand and associated facilities developed for

the unloading of pipe off the trains and loading it onto trucks for delivery to the pipeline construction areas. Delivery will be at a rate of approximately one train per day for approximately six months (i.e. two train movements per day). Each train will consist of approximately 50 cars.

A decision as to which option will be used will be made during FEED and both options have been assessed in the EIS.

ES 10.3 LNG Facility

Port Location

Santos investigated six possible port locations between Townsville and Brisbane to site its LNG facility. Potential sites were assessed based on a number of key criteria including:

- Proximity to CSG fields;
- Available unencumbered land, with a minimum area of 200 ha, safe from flooding and storm surge, and capable of withstanding high foundation loads, suitable land ownership and proximity to utilities and road access;
- Sheltered and navigable water for the LNG export facility, within an economically viable dredging distance to deep water for LNG carriers;
- Available workforce - including proximity of nearby town(s) to house both construction and operations labour force;
- Controllable site safety and security, both landside and marine - including suitability in terms of proximity of LNG plant and ships to communities, other industries and planned wharves;
- Environmental impacts - including comparative advantages / disadvantages between the various sites and potential acceptance of an LNG export development in that location as well as land use and land tenure constraints; and
- Development cost - including the differential costs of land purchase, site preparation (including piling if required), road access, utilities supply, feed gas supply, LNG jetty and dredging.

Based on the above criteria, Gladstone was selected as the preferred location.

Alternative Sites

In 2007 the Department of Infrastructure and Planning (DIP) assessed 13 sites in the Gladstone region for their suitability to be developed for LNG projects. The DIP's two preferred sites were on Curtis Island.

In addition to the DIP study, Santos also investigated the following alternative potential sites within the area administered by the Gladstone Ports Corporation (GPC):

- GSDA (west of Fisherman's Landing);
- Fisherman's Landing;
- Wiggins Island;
- South Trees Point;
- Port Alma;
- Boatshed Point, Curtis Island;
- North China Bay, Curtis Island;
- Hamilton Point, Curtis Island; and
- Hamilton Point West, Curtis Island.

Port Alma (60 km north of Gladstone) was considered but has since been dismissed by the GPC as being unsuitable for the LNG industry. Fisherman's Landing, Wiggins Island, South Trees Point and Boatshed

Executive Summary

Point did not meet the key safety, environmental and technical criteria. At the GSDA (mainland) site, the availability of suitable land was limited due to existing mining leases in the area. However the Curtis Island sites of Hamilton Point, Hamilton Point West and North China Bay were shown to be feasible from a technical, environmental and safety standpoint.

No decision has yet been made by the Queensland Government to make the Hamilton Point site available for a gas liquefaction facility. Santos has an option to purchase Hamilton Point in the event it does become available. Santos understands that the North China Bay site has since been allocated to another LNG project. In these circumstances the currently proposed site is Hamilton Point West.

Construction Techniques

One construction option being considered is conventional construction whereby all the basic construction materials will be barged to Curtis Island and assembled on-site. This method is known as stick-built. It will require all of the construction workers to be located on-site. It is estimated that the peak on-site construction workforce for this option would be approximately 3,000.

An optional construction technique being considered to reduce the impact on local infrastructure is the pre-assembling of major items of equipment off-site (either interstate or overseas) and then shipping them to site for installation. This would result in ocean-going barges delivering large pre-assembled modules directly to the site where they will be unloaded at the proposed materials offloading facility (MOF) and transported along the haul road by multi-wheeled heavy movers to the construction site.

As a final decision on the construction technique to be used has not yet been made, both of the options have been assessed in this EIS.

Construction Workforce Accommodation Alternatives

A number of alternatives were considered for providing temporary accommodation for the LNG facility's construction workforce. The preferred option is for a Construction Accommodation Facility (CAF) and associated facilities on Curtis Island. The construction and operation of the CAF would ultimately be subject to the Coordinator General's approval of a principal material change of use (planning) application by Santos under the GSDA development scheme. The assessment of the application would involve a consideration as to whether the CAF and associated facilities fall within the definition of an ancillary use.

The alternatives considered included:

- CAF established at the facility site on Curtis Island to accommodate the majority of the construction workforce;
- CAF development (single or multiple CAFs) on the mainland to accommodate the majority of the construction workforce;
- Split between CAF on Curtis Island and CAF on mainland;
- Utilising existing housing on the mainland (through rental and/or purchase), hotels and developing additional accommodation as required; and
- Accommodating workforce on a former passenger liner within Port Curtis (Float-tel).

Santos considered the implications for each of these alternatives, with the preferred alternative being to develop a CAF on Curtis Island at the LNG facility site with the capacity to accommodate the entire construction workforce.

There are good town planning, environmental, transport, safety and security reasons to establish the CAF on Curtis Island as opposed to the other alternatives. Any other approvals needed for the CAF would be obtained prior to the occupation and use of the accommodation facility. Santos will adopt the goals, standards and guidelines for environmental management under the GSDA development scheme. The environmental management strategies to be implemented for the LNG facility component of the project are outlined in environmental management plan.

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Several factors were considered in the decision to locate the CAF on Curtis Island including logistics, workers safety, costs and the potential for negative social impacts.

The CAF on Curtis Island can offer workers increased benefits and opportunities while reducing certain hazards and risks associated with the other CAF alternative accommodation options. The advantages associated with having a majority construction workforce accommodated on Curtis Island include:

- Specific health and safety benefits of CAF style accommodation;
- Security considerations for the local community;
- Mitigation of social impacts to Gladstone communities;
- Economic benefits for the project; and
- Reduced environmental impacts.

The proposed CAF would be completely self contained and would only be required for LNG facility construction activities. At the end of construction activities the CAF would be demobilised.

During the operations phase, temporary short term accommodation would be provided on site for up to approximately 30 days on an as needs basis for major plant upgrades, maintenance and shut down programs (e.g. major turbine refurbishment is required approximately every three years) and statutory plant vessel inspections. In accordance with standard LNG industry practices, this work would be conducted on a continuous 12 hour roster basis. At completion of these maintenance programs, these temporary facilities will be demobilised.

Also in the operations phase, in the event that adverse whether conditions temporarily prevent transfers from Curtis Island, limited emergency accommodation would be provided for a reduced operations workforce, located within the facility administration complex, and in the form of portable roll-out bedding.

The CAF will be located within the fenced perimeter of the LNG facility site. Workers would be limited to the facility site during their rostered work period, with access prohibited to surrounding areas such as South End. To address community concerns, Santos will actively monitor social issues through its local community engagement team presence in Gladstone, and continue to proactively communicate with Curtis Island residents in regard to their concerns. Santos will also liaise with the construction contractor to ensure appropriate behavioural provisions and access restrictions are built into worker contracts. Breaches of these conditions will result in disciplinary action or dismissal.

Technology Alternatives

Santos considered two alternative LNG technology providers during the Pre-FEED stage of the project: one was the Propane Pre-cooled Mixed Refrigerant (C3MR) process and the other the Optimized Cascade LNG Process (OCP). Both processes utilise upstream gas treatment and purification unit operations and downstream LNG storage and ship loading facilities. The main difference between the two alternatives is the technology licensor package used to liquefy the purified CSG.

The OCP technology uses three refrigerants - in cascaded propane, ethylene and methane circuits. Each circuit uses two 50% compressor strings with common brazed aluminium heat exchange equipment. The C3MR process uses a two refrigerant system: propane and mixed refrigerant. The mixed refrigerant used is composed of nitrogen, methane, ethane and propane. The refrigeration circuit typically uses a single compressor string with common spiral-wound heat exchange equipment.

After a detailed assessment of performance, reliability, environmental and cost criteria, Santos selected the OCP process for the GLNG Project.

Dredge Material Placement Facility

The Queensland Government and the GPC are presently reviewing the dredge material management plan for Port Curtis to plan for the long term dredging and dredge material disposal that may be required to provide safe and efficient access to existing and proposed port facilities in the harbour for the

foreseeable future. The plan considers dredging and dredge material disposal required for industrial and port related projects currently proposed for Gladstone. As part of the plan, the GPC is considering a single dredge material disposal area which will be large enough to accommodate the combined dredged material from all of these projects in a manner which is consistent with GPC's long term port development objectives.

The GPC and the Queensland Government propose to undertake an environmental assessment of the overall plan and to obtain the necessary approvals before adopting and implementing the plan. If the plan is approved, the dredging and the associated dredge material placement for the GLNG Project will be undertaken in accordance with the plan provided the timing of the approval is consistent with the GLNG Project requirements.

If for some reason the GPC's strategic dredging and disposal project is delayed or does not proceed, a plan specific to the GLNG Project has been prepared to manage the project's dredged material. This plan is to develop a dredge material placement facility south of Laird Point on Curtis Island.

Santos considered a number of options prior to the selection of this site. Three locations on Curtis Island were originally identified via desktop studies, including the area to the south of Laird Point; an area adjacent to Boatshed Point and part of the valley directly to the north of the LNG facility site and to the east of the proposed gas transmission pipeline corridor. Two of these options (Boatshed Point and the valley area) were dismissed by Santos prior to conducting field investigations, due to the perceived environmental sensitivity. An additional option at Fisherman's Landing was dismissed because of timing uncertainties.

The GPC's strategic plan indicates future port developments at both Laird Point and Boatshed Point and reclamation of either of these sites using dredged material could be undertaken in such a way as to facilitate the development of future industrial uses. The impacts on visual amenity and ecology were considered less for the Laird Point option than that for Boatshed Point. Accordingly, Laird Point was selected as the preferred location for the GLNG Project.

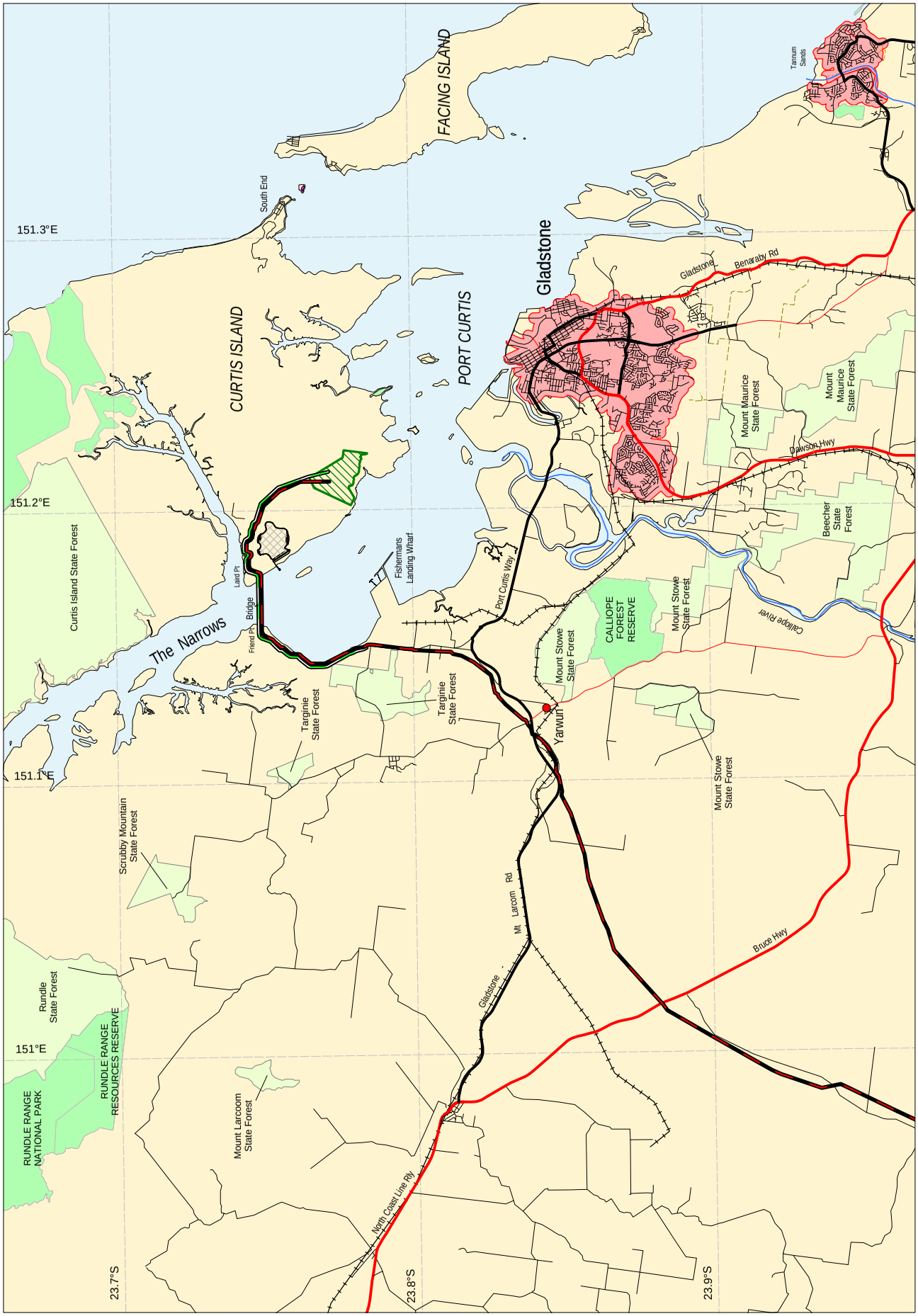
Santos recognises that use of Laird Point as a dredge material placement facility would require approval by the Queensland Coordinator General for a material change of use of the site to allow for dredge material disposal. At the time of this EIS submission, Laird Point, while declared for LNG industry use, had not been formally acquired by a specific proponent for LNG industry use.

Offshore disposal was dismissed by Santos due to the impacts to water quality and benthic ecology in the Great Barrier Marine Park, the timeframe for obtaining approvals may not be consistent with the GLNG Project schedule, and because the National Ocean Disposal Guidelines for Dredge Material require that all alternatives should be considered before offshore disposal is selected (i.e. it is an option of last resort).

ES 11 Project Description

The GLNG Project consists of the following components:

- Production of approximately 5,300 petajoules (PJ) (140 billion m^3) from the CSG fields to supply the first stage of the LNG facility. This will involve the development of approximately 2,650 exploration and production wells. It is anticipated that up to 1,200 wells will be established prior to 2015, with potential for up to 1,450 or more additional wells over a 20 year period after 2015. Additional supporting infrastructure including field gathering lines, nodal compressor stations, centralised gas compression and water treatment facilities, accommodation facilities, power generation and water management facilities will also be installed.
- A 435 km long gas transmission pipeline for the delivery of the gas from the CSG fields to the LNG facility. The pipeline alignment is shown on Figure ES3.
- An LNG facility of approximately 10 million tonnes per annum (Mtpa) capacity on Curtis Island (see Figures ES4 and ES5). The LNG facility is proposed to be developed in three stages (called trains), the first of which will have a capacity of approximately 3 - 4 Mtpa. The LNG facility will consist of the following key elements:



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Client	Project	Title
	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**GLADSTONE REGION**
	Drawn: CA | Approved: JB | Date: 12-03-2009	Figure: **ES4** | Rev:A
	Job No: **4262 6220** | File No: 42626220-g-1034.wor	**A4**

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Gas Transmission Pipeline

Potential LNG Facility Access Road

Site Boundary

Client: LNG	Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT		Title: **LNG FACILITY SITE**
URS	Drawn: CA	Approved: JB	Date: 18-03-2009
	Job No: **4262 6220**	File No: 42626220-g-1035.wor	Figure: **ES5**
			Rev:B
			A4

  - A liquefaction facility which includes the on-shore gas liquefaction and storage facilities;
  - Marine facilities which will include a product loading facility (PLF) for loading LNG into ships for export, and a MOF and haul road for the delivery of workers, equipment, plant and materials to the LNG facility site;
  - A swing basin and an access channel from the existing Targinie Chanel in Port Curtis;
  - A dredge material placement facility at Laird Point; and
  - A 2,000 person capacity accommodation facility on Curtis Island for construction workers.
- Access to the LNG facility from the mainland will occur by either of the following options:
  - The provision of road access to Curtis Island by way of a potential access road and bridge from the mainland crossing Port Curtis between Friend Point and Laird Point. Construction phase access to the site for at least Train 1 will be by barge and ferry as the access road and bridge will not be constructed by that time; or
  - Access to the site by barge and ferry for the life of the GLNG Project (for both construction and operation) if the access road and bridge is not constructed.

CSG in quantities beyond 5,300 PJ required for the second and third trains of the LNG facility is likely to be supplied from a combination of the wells referred to above, further development of the Santos operated CSG fields, by utilising Santos' share of gas from fields in which Santos has an interest but is not the operator, and/or from third parties.

The timing and selection of the source of gas for the subsequent stages of the LNG facility cannot be fully determined at present as it will depend on future exploration activities and development plans. A desktop assessment of the existing environment of the Santos related fields for the second and third stages of the LNG facility has been included in this EIS. It is expected that further environmental assessment and approval processes beyond those given in this EIS may be required for the extraction of the additional CSG depending on the arrangements made for sourcing of the gas.

The major project parameters are summarised in Table ES12.1.

ES 12 Project Schedule

Construction of the first train (Train 1) including the marine facilities and capital dredging is proposed to commence in 2010 with construction taking approximately four years. During this period the gas transmission pipeline will also be constructed. This will take approximately two years.

The LNG facility operations are planned to commence in 2014. Depending on demand, it is possible that construction of Train 2 could commence in 2014 and Train 3 in 2018, which will bring the LNG facility up to its ultimate capacity of 10 Mtpa by 2022. However the timing of these trains is dependant on market conditions, gas availability, labour availability and the economic climate and may be earlier or otherwise vary from what is described in the EIS. It is possible that construction of Trains 1 and 2 and/or Trains 2 and 3 may overlap.

For the GLNG Project a reasonably foreseeable development (RFD) scenario has been established to assess the degree of CSG development that can be reasonably expected to occur over a given period of time. CSG field development to support Train 1 is proposed to be located in the RFD area. The RFD area comprises tenements in the Roma (part), Fairview, Arcadia Valley and Comet Ridge (part) CSG fields.

Development of the RFD area will be ongoing to reach the required production of 5,300 PJ. As each production well will have an approximate life of 5 to 15 years, it will be necessary to replace depleted wells with new ones. New wells will be developed at a rate that is sufficient to provide enough CSG for the annual LNG production. To supply Trains 2 and 3, further development of the RFD area and/or the future development areas of the Santos CSG fields may also occur. The nominal life of the project is 25 years. However the project may remain in operation beyond this period.

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Table ES 12.1 Major Project Parameters

Coal Seam Gas Fields	
Reasonably Foreseeable Development (RFD) Area	Expected to produce at least the 5,300 petajoules of gas required for Train 1. Includes: • Roma (part), Fairview, Arcadia Valley and Comet Ridge (part) CSG fields (6,800 km^2); • Approximately 2,650 exploration and production wells; • Approximately 2,000 km of gas and water gathering pipelines; • Approximately 6,800 km of access roads; • Approximately 150 nodal compressor stations; and • 12 centralised gas compression and water treatment facilities Up to 90 ML/day of associated water to be managed by a variety of beneficial reuse and disposal options. Peak workforce of approximately 1,500 based on two fly-in/fly-out rosters of 14 days on/14 days off. On-site accommodation facilities provided for fly-in/fly-out workforce
Future Development (FD) Areas	May supplement RFD area to supply CSG for Trains 2 and 3. Includes Denison, Mahalo, Comet Ridge, Scotia, Eastern Surat Basin and Roma Other fields (12,100 km^2).
Gas Transmission Pipeline	
Pipe Characteristics	Buried high pressure steel pipeline. 435 km long and up to 1,070 mm diameter.
Right of Way (easement)	30 m wide.
Compression	Gas compression at CSG fields. No intermediate compression.
Above Ground Facilities	Nine mainline valve stations (each in 20 m x 50 m fenced compound). Four scraper stations along route (each in 80 m x 100 m fenced compound). Warning signs placed so that at least one is visible at any location along pipeline.
Workforce	Up to 1,000 construction workers to be accommodated in a number of main and satellite self-contained accommodation facilities along the pipeline route. 15 - 20 operational and maintenance personnel.
Schedule	Construction over 21 months (starts Q2 2011 and finishes Q1 2013).
LNG Facility	
Location	Hamilton Point West, Curtis Island. Site area - 190 ha. Footprint (Trains 1, 2 & 3) - 100 ha.
Capacity (approx.)	Train 1 : 3 - 4 Mtpa. Trains 1 & 2 : 6 - 7 Mtpa. Trains 1, 2 & 3 : 10 Mtpa.
LNG Technology	Optimised Cascade Process (OCP).
LNG Storage	Liquid kept at -161^{o}C at atmospheric pressure. Low temperature is maintained by insulation (not refrigeration). At 10 Mtpa production capacity will be stored in three tanks each of 125,000 – 200,000 m^3 capacity.

LNG Facility (continued)	
LNG Shipping	50 LNG tankers per year for Train 1. 160 LNG tankers per year at full production rate.
Construction Workforce	Peak of 3,000 over 4 years for Train 1 using stick-built. Could reduce to 2,000 if pre-assembled modules used. Peak of 1,800 over 4 years for subsequent trains (stick-built). Rosters will be 10 days on and 4 days off. Non-local workers will return to their places of residence during time off under a fly-in/fly-out arrangement. Self-contained accommodation facility to be provided on Curtis Island (capacity of 2,000).
Estimated Construction Schedule	Train 1 : 2010 – 2014. Train 2 : 2014 – 1017. Train 3 : 2018 – 2021.
Operational Workforce	Up to 140 for Train 1 increasing to 250 at full production rate. 20% will work 12 hour shifts, 7 days per week on a 4-day on/4-day off roster. The balance will work 9 hour days, 5 days per week. Accommodated in Gladstone with daily commuting to Curtis Island.
Site Access	Either: • Bridge between Friend Point (mainland) and Laird Point (Curtis Island) plus access road. Train 1 construction to use ferries (for workers) and barges (for materials and equipment) as bridge will not be built in time; or • Ferries used for both construction and operational workforce and barges for materials and equipment for the life of the project in the event the bridge and access road are not built.
Dredging	Capital dredging of 8 million m^3 for shipping channel and swing basin, and 100,000 m^3 for access channel to the MOF. Dredge material to be placed in a placement facility located south of Laird Point on Curtis Island of approximately 120 ha.

ES 13 Environmental Impacts and Management Strategies – Coal Seam Gas Fields

ES 13.1 Climate

The CSG field study area is characterised by an inland sub-tropical climate with cool winters and hot summers. The majority of the annual rainfall occurs during the summer months. In general, the year round climate is dry, with winter months being more arid than summer months.

Climatic conditions across the CSG fields include periodic, high intensity rainfall events (which can lead to flooding in lower areas) as well as periods of extended drought and increased fire risks. The CSG field development will be managed to ensure that any consequences of climatic hazards can be managed. The risk of natural hazards is part of the business risk management process, with appropriate controls and monitoring details in the emergency management plan being a fundamental part of the risk management process.

Executive Summary

ES 13.2 Land, Terrain and Soils

Soils and Geomorphology

A terrain analysis was carried out as a basis for the description of the physical environment to identify existing environmental values and to assess potential engineering and environmental impacts that may result from the development of the CSG fields. The main potential impacts identified included:

- Changes to agricultural land capability;
- Increased erosion potential of development areas when subject to clearing and earthworks;
- The occurrence (and subsequent effective management of) problem soil areas, including saline, sodic and/or dispersive soils;
- Excavation conditions for pipelines and/or buried services; and
- Terrain suitability for construction of water storage facilities.

These potential impacts have been addressed and management strategies developed to mitigate the potential environmental impacts identified. In places where potentially high environmental impacts have been identified, more detailed field investigations, including site specific investigations (comprising soil sampling and testing) will be undertaken as part of the Phase 2 assessment to define the extent of potential problem areas, to identify the specific locations for the field development sites, and to determine the appropriate level of mitigation or management required.

Contaminated Land

An indicative assessment was undertaken to identify land uses within the CSG fields with the potential for land contamination. These land uses included existing Santos CSG operations, conventional gas operations, as well as grazing and cropping land uses.

The contaminated land study concluded that none of proposed CSG field development activities presented a high risk of land contamination, and can be appropriately managed by implementing a range of mitigation measures including construction techniques, engineering controls, operational procedures and planning tools.

In accordance with the protocols developed for Phase 2 impact assessment of the CSG field development, consideration of site specific land contamination investigations will be undertaken as future development plans are developed.

ES 13.3 Nature Conservation

Terrestrial Ecology

The terrestrial ecology investigation included a literature review of known data sources for both the RFD area and the future development (FD) area, and field surveys in the RFD area (Roma, Fairview and Arcadia Valley fields).

The literature and database review of all of the Santos CSG fields (RFD area and FD area) indicated that the study area potentially supports a number of conservation significant ecological values including:

- 130 significant flora species identified by searches with 21 of these species potentially occurring in the CSG area based upon knowledge of likely habitat usage;
- 51 significant fauna species identified by searches with 28 of these species potentially occurring in the CSG area based upon resources and habitat;
- 4 regional ecosystems (REs) that are listed as 'Endangered' communities and one RE listed as 'Critically Endangered' under the *Environment Protection and Biodiversity Conservation Act 1999*; and

- 49 REs listed as 'Of Concern' and 45 REs listed as 'Endangered' as mapped by the Queensland Government mapping under the *Vegetation Management Act, 1999* (VM Act).

The field survey of the northern CSG fields identified the presence of 156 taxa representing 52 families and 102 genera. Four of the vegetation communities listed under the *Vegetation Management Act* were identified during the survey. There was a relatively moderate diversity of weed species found with 11 species identified.

The field survey of the southern CSG fields identified the presence of 92 taxa representing 35 families and 62 genera. Three of the vegetation communities listed under the *Vegetation Management Act* were identified during the survey. There was a relatively low diversity of weed species found with five species identified.

Forty-nine significant fauna species potentially present in the CSG fields were identified from database searches. These included 2 frogs, 14 reptiles, 23 birds and 10 mammals. An analysis of habitat requirements and distribution determined that 27 of these species may utilise habitat within the CSG fields.

For each CSG field, an analysis of fauna habitat and corridor linkage values was undertaken and the ecologically significant values were summarised. This includes mapped REs, mapped significant REs and potentially present Endangered, Vulnerable and Rare (EVR) fauna and flora species and vegetation communities to provide an overall understanding of the nature conservation values in each CSG field.

The protocols for ongoing field development as part of the Phase 2 assessment will include consideration of the identified conservation values when locating wells and associated infrastructure. Every effort will be made to avoid areas of high conservation value. A range of mitigation and management measures as identified in the environmental management plan for the CSG fields will be implemented to minimise any environmental effects.

Aquatic Ecology

The environmental values of watercourses within the CSG field study area are relatively low and consistent with those of the wider catchments. Environmental values are dictated primarily by the ephemeral nature of many of the region's waterways, although agricultural development (particularly grazing) within the region has significantly influenced water quality and the physical characteristics of aquatic habitat. Water quality is generally poor and is characterised by high turbidity and low or variable dissolved oxygen levels.

The biodiversity of smaller watercourses is relatively low. Nevertheless, these creeks do offer some habitat to the native fish species, and may provide habitat for breeding and dispersal during periods of high flow. In contrast, the larger waterways in the CSG field study area support more permanent water, and offer more stable habitat for aquatic organisms.

The condition of artesian springs in the Upper Dawson Catchment varies considerably between the springs surveyed, with the state of each spring largely dependent on; the presence of water, the ability of stock to gain access to the spring, and the presence and abundance of terrestrial weeds. The endangered macrophyte salt pipewart has been recorded at springs on Hutton Creek in the Upper Dawson Catchment. No other rare or threatened aquatic flora or fauna have been recorded from the watercourses or artesian springs in the CSG field study area. Cattle damage and weeds were common and have degraded the condition of many springs.

Development of the CSG fields has the potential to impact the following threatened aquatic species and ecological communities (as listed under the *Environment Protection and Biodiversity Conservation Act 1999*); Fitzroy River turtle (*Rheodytes leukops*), Murray cod (*Maccullochella peeli peeli*), and Mound spring communities that are dependent on the natural discharge of water from the Great Artesian Basin.

Any disturbance to aquatic habitats will be managed to minimised potential impacts. Impacts from physical disturbance such as creek crossings or vegetation clearance will be subject to the mitigation measures outlined in the environmental management plan and in accordance with the necessary

approvals that will be sought under the *Water Act 2000* and/or the *Fisheries Act 1994*. Any discharge of associated water will only be permitted after treatment to ensure compliance with approved discharge criteria and after full consideration of alternative re-use options.

ES 13.4 Surface Water

The CSG field study area is located within three river catchments; Upper Balonne River, Upper Dawson River and Comet River. The wet season for the area is October to April. The majority of streams are ephemeral or intermittent and are dominated by periods of low to zero flow.

The existing water quality of surface streams across the catchments is variable. Surface waters frequently do not meet the water quality guidelines specified for the protection of aquatic ecosystems for a number of indicators. The results suggest a considerable influence of regional land clearing and stock access on water quality (particularly nutrients).

A qualitative risk assessment approach was used to determine the potential impacts and identify mitigation measures through the different stages of construction, operation and decommissioning. These impacts will be minimised using a range of construction techniques, operational procedures and planning tools including a stormwater management strategy, waste management and disposal plan, and erosion and sediment control measures.

ES 13.5 Groundwater

Shallow Groundwater

A desktop review and field assessment of the shallow (near surface) formations indicated that there are both non-aquifers and minor shallow groundwater aquifers in the area. The majority of shallow formations have negligible permeability and are generally regarded as not containing groundwater in exploitable quantities. Although these aquifers seldom produce large quantities of water, they are important for local stock watering supplies. To protect the shallow groundwater from impacts associated with the CSG field development, all potential sources of contamination such as fuel storage areas, refueling points, and waste management facilities will be designed and managed to ensure that the potential for groundwater contamination is avoided.

Deep Groundwater Aquifers

The coal seams from which the gas is obtained are filled with both water and the gas which is adsorbed in the coal matrix. To remove the gas, the water must be pumped from the coal seams to reduce pressure and enable the release of the gas. Removing the water (known as associated water) results in a reduction in groundwater pressures. Surrounding aquifers that could be affected include the Precipice Sandstone aquifer at Fairview and Arcadia Valley, and the Mooga, Gubberamunda and Hutton Sandstone aquifers at Roma.

Groundwater flow models capable of simulating existing conditions and predicting the potential groundwater impacts of CSG production were developed. The models' results which enabled the likely reductions in groundwater pressures to be predicted are summarised below:

- Reduction in groundwater pressure in the coal seam aquifers within the Fairview field may in some circumstances result in inter-aquifer transfer from the overlying Precipice Sandstone aquifer. A drop in the water table within the Precipice Sandstone was predicted under worse case conditions to reach up to 15 m at the end of 2013. This is likely to impact four registered bores within the area.
- Reduction in groundwater pressure within the Precipice Sandstone as a result of extraction of CSG at Fairview is not expected to alter the base flow contributions to the perennial portion of the Dawson River and groundwater discharge volumes to springs located in the vicinity.
- In the Roma field, reduction in groundwater pressure in the coal seam is expected to result in minor inter-aquifer transfer from the underlying Hutton Sandstone aquifer. Groundwater head loss within the Hutton Sandstone is predicted to decline by approximately 3 m at the edge of the CSG field. No

impacts on the Mooga or Gubberamunda Sandstone aquifers are predicted within the Roma field. No landholder bores are expected to be impacted as a result of groundwater withdrawal from the Roma field.

- No town water supply bores are likely to be impacted as a result of groundwater withdrawal in the Roma, Fairview or Arcadia Valley fields.

To minimise these impacts, Santos is investing in one of the most significant water monitoring programs of its kind in Australia. It will involve establishing a bore inventory of some 350 bores in the Roma, Fairview and Arcadia Valley fields, with an extensive program of monitoring groundwater drawdown and extraction rates. This information will be openly available to landholders and any other interested community stakeholder. The water monitoring program will be part of a larger integrated water management strategy that will consist of a range of mitigation measures to address any impacts, should they begin to be realised.

ES 13.6 Associated Water

An associated water management strategy has been developed to consider a range of water management options which will be adapted according to the variations in quality and quantity of associated water produced from CSG wells. Separate strategies have been developed for the Roma, Fairview and Arcadia Valley fields with the preferred scenarios including:

- Potable, industrial re-use and treated irrigation for the Roma field;
- Treated irrigation and untreated irrigation for the Fairview field; and
- Treated irrigation for the Arcadia Valley field.

The selection of the preferred scenarios considered risk to the wider environment, practicality, cost effectiveness and site specific constraints.

The strategy will be reviewed, monitored and continually improved on a regular basis. It is envisaged that the strategy will be developed to allow informed decisions to be made throughout the life of the CSG field development program and help meet the needs for regulatory approvals, negotiations and compliance with EPA requirements.

ES 13.7 Air Quality

Potential air emission sources during construction include airborne particulates and exhaust fumes associated with the clearing of vegetation and topsoil, transport of material, loading and unloading of trucks, and wind erosion from unsealed roads. Potential emission sources associated with the operational phase include emissions from field compressor stations and other associated facilities. The only emissions modelled were those from the field compressor stations, as other field operations such as drilling and well construction are short-term activities spread over a large area, with only minor emissions to air.

Modelled pollutants were nitrogen dioxide (NO_2) only, as sulfur dioxide (SO_2), carbon monoxide (CO) and inhalable particulate matter (PM_{10}) have low emission rates from the compressor stations. The modelled NO_2 concentrations were predicted to comply with the Queensland air quality guidelines for both human health and ecosystem health at the modelled distances (600 m, 1 km and 2 km) from the compressor stations.

The coal seam gas and gas process facilities in the CSG fields will not release strong odorous compounds. Minor odour associated with oxides of nitrogen (primarily due to NO) is not of concern. Furthermore, the odour related to volatile organic compound releases is not of concern as their emissions from the CSG fields will be low.

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ES 13.8 Greenhouse Gas Emissions

There is increased world-wide pressure to find less carbon-intensive energy solutions in an increasingly carbon-constrained world. The GLNG Project is a less carbon-intensive energy solution than other fossil fuel alternatives. As such, the GLNG Project can be a global contributor to energy needs with reduced greenhouse gas (GHG) outputs.

According to accepted GHG accounting standards, impacts resulting from GHG should be assessed on the total amount resulting from an entire project rather than individual sections or components. Therefore the following discusses emissions from the CSG field activities, the LNG facility and the gas transmission pipeline combined. All values presented are for the entire GLNG Project unless otherwise stated.

Direct (Scope 1) GHG emissions were estimated as both an annual average and a total amount over an assumed 25 year project lifetime for both the 3 Mtpa and 10 Mtpa cases. Indirect (Scope 2) emissions were assumed to be immaterial as the majority of the project will use CSG to produce any necessary electrical power and hence are included in Scope 1 emissions. Indicative values for Scope 3 emissions from end use of the LNG were calculated based on transportation of the LNG to Japan for combustion in a power station. The Scope 1 emissions (CO_2-e) are summarised below for the project options and include the ferrying/barging option to Curtis Island.

CSG well development figures for the 10 Mtpa case are highly uncertain. Consequently, GHG emissions from the field for the 10 Mtpa case as range assuming that between 2,650 and 6,625 wells will be required to supply all three trains. The maximum of 6,625 wells is an extremely conservative figure intended to represent the worst case development that is highly unlikely to occur. It has been assumed only for the purposes of making an assessment of GHG emissions from the 10 Mtpa case and does not represent an estimate of the actual number of wells planned for the GLNG Project.

Table ES 13.1 Greenhouse Gas Emissions

Stage	Scope 1 Emissions (million tonnes)		Percentage of Queensland's Total Emissions	Percentage of Australia's Total Emissions
	Annual	Total		
3 Mtpa	2.6	66.4	1.55%	0.46%
10 Mtpa	5.0 - 7.2	110.4 - 166.0	2.90 – 4.21%	0.86% - 1.25%

Santos will reduce GHG emissions to the extent practicable. This is reflected in the benchmarking results which place the emissions from the GLNG Project (0.347 tonnes of CO_2-e per tonne of LNG) in the ranks of the most GHG efficient LNG facilities in the world. Additionally, LNG is a low-emissions fuel, producing roughly half the GHG of coal when used to produce energy. Consequently the GLNG Project represents a potential significant reduction in GHG emissions should its product be used in place of other fossil fuels such as coal or oil.

ES 13.9 Noise and Vibration

The noise and vibration impact assessment identified that compliance with the applicable noise and vibration criteria is achievable with the adoption of off-set buffer distances between construction and operational plant items and noise sensitive receptors. Noise generating equipment (e.g. compressors and well heads) to be used as part of the CSG field development will be located so that adequate buffers can be achieved from adjacent noise sensitive land uses. Where such equipment cannot be located beyond the buffer zone due to operational constraints, noise mitigation measures will be adopted to provide sufficient attenuation to meet noise criteria.

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ES 13.10 Land Use and Infrastructure

The predominant land use within the RFD area is cattle grazing. Cropping, including irrigated and dryland cropping, occurs around more fertile areas. In addition there are approximately 140 homesteads in the area (excluding town areas). Other land uses include forestry, conservation and recreation, ecotourism, mining/petroleum, and extractive resources.

CSG field development will include construction of wells (up to 2,650), laying of gas and water pipeline gathering systems (up to 2,000 km) and the use of access roads (both new and existing – up to 6,800 km). Initially the well sites may vary in area from about 0.5 to 1 ha. However once they are developed as production wells the area of disturbance will be reduced to about 0.1 ha with the balance areas rehabilitated.

Strategies to be implemented to minimise the impacts to existing land uses include:

- Avoiding (where practicable) good agricultural land;
- Avoiding (where practicable) smaller land parcels where the relative impact will be greater;
- Locating (where practicable) gathering pipelines and access roads along fence lines and property boundaries;
- Locating (where practicable) development activities away from the more intensively used areas of the property;
- Liaising with each relevant landholder regarding their site-specific land use practices and ways to minimise interference from project activities;
- Minimising the lease area required for well development; and
- Rehabilitating as quickly as possible the areas no longer required following drilling and well development.

ES 13.11 Visual Amenity

CSG field development activities will create both temporary and longer term changes to the visual landscape character of the areas in which they are located. These changes will result primarily from the removal of vegetation and earthworks that will be carried out at the gas well sites and to create trenches for the in-field gas pipeline network. The most visible components of the CSG field development will be exposed soil, new access roads and the movement of vehicles and equipment associated with the establishment of the gas wells and installation of pipelines. In situations where these components are visible from public roads, towns or homesteads the visual impact is likely to be moderate, although generally short term. In situations where the CSG field development activities are not visible from public roads, towns or homesteads then the visual impact is predicted to be negligible.

The long term components of the production wells will be relatively small in scale and will not form visually prominent elements in the rural landscape. In situations where these components are not visible from public roads or homesteads, the longer term visual impact will be negligible.

Other components of the CSG field development such as compressor stations, accommodation facilities, and water management dams will generally be located in areas that will not be visible from public roads or homesteads and therefore the visual impact will be negligible. In those situations where they are visible from public roads or homesteads, the visual impact will generally be low.

When viewed from the air, the visual impact will be greater as a greater extent of the developed will be visible compared to ground-based views.

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ES 13.12 Cultural Heritage

Indigenous

Santos has adopted an avoidance or harm minimisation approach to cultural heritage, and has established an Aboriginal Engagement Policy (AEP) as one of the tools through which the company can build sustainable relationships and support Aboriginal people and communities. The AEP commits Santos to greater than minimal legal compliance in the company's relations with Aboriginal persons and enables the company to manage risk in engagement with Aboriginal peoples in terms of cost, delay and legal action. Importantly, the AEP provides a sustainable platform for the aspirations of Aboriginal people in their dealings with the company.

Santos has sent or will send formal notifications of its intention to develop cultural heritage management plans (CHMPs) with all relevant Aboriginal Parties in the CSG fields. The philosophy behind the CHMPs is to avoid harm to cultural heritage in the first instance and if that cannot be achieved then a harm minimisation approach will be adopted.

The CHMP process allows for cultural heritage surveys to be carried out on an "as required" basis, throughout the duration of the project. Protection, management and mitigation measures will be agreed once the cultural heritage surveys are finalised and incorporated into Santos' cultural heritage management system.

Non Indigenous

Twenty five sites of historic cultural heritage significance as well as six precincts and ten sites of historical interest have been identified within the RFD area. Sites located as part of this assessment relate to pastoral and settlement activities, such as roads, telegraph and railway lines and homesteads.

Of the sites identified in the desktop review, 15 were considered to be of state significance based on the criteria of the *Queensland Heritage Act*, with 12 already listed on state registers.

General mitigation measures to be adopted in the CSG field development include avoiding items of state and local significance and the adoption of appropriate offset distances to avoid indirect impacts to items of heritage significance.

ES 13.13 Socio-Economics

Table ES 13.2 presents an estimate of the total construction and operation workforce in the RFD area and Roma Centre from 2010 to 2034.

Table ES 13.2 RFD Area Workforce

Area	2010	2011	2012	2013	2014	2019	2024	2029	2034
Construction									
Compressor construction.	20	50	60	20	15	0	0	0	0
Drilling.	266	180	200	80	130	153	153	153	153
General field construction.	500	700	700	700	600	31	31	31	31
Operations									
Roma centre.	29	39	45	53	57	59	60	62	62
Roma CSG field.	62	123	185	245	245	252	260	266	270
Fairview CSG field.	137	198	258	320	320	335	344	339	339
Arcadia Valley CSG field.	20	27	19	62	62	82	99	99	99
Total	1,034	1,317	1,467	1,480	1,429	912	947	950	954

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The above workforce estimates are based on two rosters working 14 days on 14 days off for 11 hours per day. Note that the numbers in the table do not equate to the total workforce in the area at any given time. This will be significantly less as the workers will be on different schedules and work rotations.

The non-local field operational workers will live in a number of on-site accommodation facilities located at sites convenient to the various work areas and generally the same accommodation facilities will be used by the exploration, drilling and construction workforce. At the end of their two-week rosters the field employees will fly-out to their places of origin (unless locally based). It is expected that the Roma Centre employees will live permanently in Roma or the surrounding area.

The workforce for the CSG fields constitutes a moderate increase in regional labour demand relative to the size of the regional labour market. The nature of the skills available in the region compared to the nature of the skills required dictate that the vast majority of the workforce will be brought in from outside the region. Given that most of the workforce is likely to be on fly-in/fly-out rosters there will be limited demand from the workers on existing housing and community facilities.

The extent to which the project competes with local businesses for local labour is likely to be mitigated by the general downturn in economic activity resulting in a slowing in regional employment growth which may contribute to rising unemployment in the region over the next two years. Increased availability of local labour with project relevant skills may increase the opportunity for local sourcing of both construction and operational labour. The project would therefore assist in providing employment opportunities in a time of lower employment growth in the region.

ES 13.14 Rehabilitation and Decommissioning

The rehabilitation and decommissioning of the CSG fields will be undertaken progressively over the life of the project and in accordance with relevant regulatory requirements and industry standards (e.g. *Petroleum and Gas (Production and Safety) Act 2004, Petroleum Act 1923, Environmental Protection Act 1994, Environmental Protection (Waste Management) Policy 2000* and the *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland 1998.* The *Petroleum and Gas (Production and Safety) Act 2004* and the *Petroleum Act 1923* requires petroleum infrastructure to be removed from active service and left in a manner that is safe. This process is known as final relinquishment and results in the tenement being surrendered to the Queensland Government.

Upon decommissioning, all plant and equipment (with the exception of underground pipelines) will be removed, sites will be tested for any potential contamination, and remediation of any contamination will occur as soon as practical. Rehabilitation will occur in consultation with the relevant landholder and will generally involve surface contouring, respreading topsoil, respreading vegetation and reseeding. The determination of any site specific rehabilitation criteria will be influenced by the original land use and the requirements of the landholder or other relevant third parties.

All landholders within the tenement proposed for relinquishment will be requested by Santos to sign a rehabilitation form indicating the landholder's satisfaction with the standard of rehabilitation before the tenement is relinquished. In addition, the administrating authority must be satisfied with the standard of rehabilitation before Santos can relinquish any tenement.

ES 13.15 Traffic and Transport

Traffic impacts to the road network by the proposed CSG field development are not expected to be significant because of the relatively low levels of traffic generated over a relatively large area. Additionally, the existing traffic volumes on most roads in the vicinity of the CSG fields are at such low levels that the roads operate with significant spare capacity and the proposed GLNG Project traffic will not trigger capacity upgrades.

In combination with the traffic generated by the construction of the gas transmission pipeline, the CSG field development traffic will "bring forward" the need for pavement rehabilitation on two road sections of the Carnarvon Highway, one road section of the Dawson Highway, and one section of the Warrego

Highway. These road sections will require pavement rehabilitation works one or more years earlier with the GLNG Project than they would with background traffic only.

ES 13.16 Hazard and Risk

A hazard analysis of the CSG field activities was undertaken to minimise the risks from the CSG field construction and operations. The hazards assessed included pipe ruptures, blow-out of gas at well heads, fires and gas leaks. An extensive range of mitigation measures were identified and will be implemented to ensure that health and safety as well as environmental risks are minimised.

ES 13.17 Cumulative Impacts

Other CSG projects are planned for the region surrounding the GLNG Project field development, however their location and extent are not yet known. This will mean that there could be more CSG development in the future in the areas surrounding the Santos tenements. As these areas develop, the number of wells will increase but the spacing of wells will not intensify.

Each CSG project could potentially produce large volumes of associated water significantly increasing the total volume of associated water produced in the region beyond that to be generated by Santos alone. However, it is expected that the other CSG projects would involve the management of associated water in accordance with current Queensland Government policies, as well as include mitigation measures to minimise any cumulative impacts on the receiving environment. Furthermore, these project will be spread out over a large area and many catchments.

The other development projects may also rely on the infrastructure, housing and community facilities of the existing towns in the region. Existing roads could also be used by multiple projects. The cumulative impacts on these facilities may be greater than those described in this EIS which are from the GLNG Project only. Until more detailed information is known about the location and extent of the other projects in the region, no quantitative impact assessment can be undertaken.

ES 14 Environmental Impacts and Management Strategies - Gas Transmission Pipeline

ES 14.1 Climate

The climate of the gas transmission pipeline corridor ranges from an inland sub-tropical climate along the western section (within the CSG fields), with cold winters and hot summers; to the wet-dry regime characterised by high summer rainfall and dry winter conditions at the eastern extent on Curtis Island.

Due to the relatively short timeframe for the pipeline's construction, climatic hazards are not considered a major risk for this component of the project. The risk of natural hazards is part of the business risk management process, with appropriate controls and monitoring details in the emergency management plan being a fundamental part of the risk management process.

ES 14.2 Land, Terrain and Soils

Soils and Geomorphology

The terrain of the gas transmission pipeline corridor has been assessed in terms of geological regimes, landform types and associated soils. Terrain mapping has been carried out with reference to existing geological, topographic and soils information.

Descriptions of the terrain units, together with an assessment of engineering and environmental constraints and by association, potential environmental impacts for pipeline construction relate primarily to the following:

- Topographic constraints;

- Excavation conditions - relates to the ease or difficulty of excavation within the typical trench depth;
- Erosion potential - where the land is subject to clearing or disturbance associated with construction;
- Drainage status - relating to surface drainage conditions and susceptibility to flooding or tidal inundation;
- Problem soils - the occurrence of reactive soils, sodic, dispersive and/or saline soils, acid sulfate soils; and
- Agricultural land classes - changes to agricultural land capability.

The potential impacts relating to the above issues have been addressed and management strategies will be implemented to mitigate the potential environmental impacts identified. Targets to achieve acceptable levels for land rehabilitation in areas disturbed by construction and development activities will be incorporated in the project's environmental management plan. Monitoring of the success of the impact management strategies and the progress of land rehabilitation of disturbed areas will be carried out following completion of construction and periodically throughout the operating life of the pipeline.

Contaminated Land

A Preliminary Site Investigation (PSI) undertaken along the pipeline corridor identified six sites as areas of potential concern with respect to soil contamination. Of these, only one site (an industrial plant) is listed on the Environmental Management Register as maintained by the Environmental Protection Agency (EPA). These six sites are considered to have a low contamination risk for the project given the flexibility of the pipeline's alignment to deviate around them. Following final agreement on pipeline alignment a protocol will be developed to further assess (and manage as required) these sites. The protocol will include site inspections as deemed necessary and possible soil testing where required.

Acid Sulfate Soils

Actual Acid Sulfate Soils (ASS) (AASS) and Potential ASS (PASS) was found within the upper levels of the estuarine sediments along the pipeline corridor. These estuarine sediments occur along the coastal fringe of The Narrows, both on the mainland coast south of Friend Point and along the western coastline of Curtis Island between Graham Creek and Laird Point. This is only a very small percentage of the total pipeline route. The AASS is generally at a low level but is widely present. Management and mitigation strategies will be implemented including more detailed sampling and analysis to further delineate the extent of ASS followed by treatment of excavated soils as required.

ES 14.3 Nature Conservation

Terrestrial Flora

A desktop assessment identified 68 significant flora species as potentially present within the gas transmission pipeline corridor. Of these identified taxa, two species (*Cycas megacarpa* and *Acacia pedleyi*) were located during the field surveys.

The field survey identified the presence of 47 REs including 18 listed as 'Endangered' or 'Of Concern' under the VM Act and/or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The field survey also identified 302 taxa of plants, representing 210 genera from 74 families. Forty exotic plant species were also recorded. Of these, 10 are listed as declared weed species under the Queensland *Land Protection (Pest and Stock Route Management) Act,* 2002.

The clearing of remnant vegetation within the right-of-way (ROW) will provide the greatest impacts to flora. This clearing will result in the loss of a small area of some REs listed as 'Endangered' and 'Of Concern' under the VM Act and EPBC Act. This vegetation clearing may also potentially impact upon the two significant flora species recorded. A number of mitigation measures will be implemented during pipeline construction including in-field alignment variations to avoid (or minimise the impacts on) sensitive areas, weed control, rehabilitation and biodiversity offsetting.

Terrestrial Fauna

A desktop assessment identified fauna potentially present along the gas transmission pipeline corridor, including significant species listed under the *Nature Conservation Act* and the EPBC Act. Forty-six significant species were identified as potentially present. Of these, only the powerful owl (*Ninox strenua*), squatter pigeon (southern form) (*Geophaps scripta scripta*) and glossy black cockatoo (*Calyptorhynchus lathami lathami*) were located during field surveys.

A total of 122 native and 13 introduced terrestrial vertebrate species were recorded during the field surveys along the pipeline corridor. Native species included 7 reptile, 101 bird and 12 mammal species including 4 species of microbat with another 5 tentatively identified.

The clearing of remnant vegetation within the pipeline ROW will result in the removal of some habitat features such as arboreal hollows, dense vegetation and fallen timber. The construction of the pipeline will not present long-term impacts to fauna as rehabilitation will allow for fauna habitation and usage following the completion of works.

ES 14.4 Surface Water

The gas transmission pipeline will cross a large number of minor watercourses and a number of larger rivers including the Dawson and Calliope Rivers. Specific construction techniques will be implemented at each crossing to minimise the risk of contamination to downstream waters. The following techniques will be used as appropriate:

- **Open Trench.** The majority of watercourse crossings are expected to be constructed using standard open trenching construction. This technique is most suited to the dry or low flow conditions which will be preferred for the construction phase.
- **Open Trench with Flow Diversion.** Flow diversion is a modification to the standard open trench method employed where higher water volumes and flows are present (typically up to 1,000 litres per second). In this way the risk of erosion and interference with construction activities is reduced.
- **Horizontal Directional Drilling (HDD).** HDD is generally used to cross major watercourses where standard open cut methods are not feasible or to avoid environmentally sensitive features.

It is anticipated that the majority of the watercourse crossings will be constructed using standard open trench methods. Where possible, construction activities will be scheduled for dry or low flow periods to enable open trench methods to be used. However, an evaluation of site conditions will be made at the time of construction and the need to use flow diversion methods will be assessed based on actual site conditions. It is proposed to use HDD methods for the Dawson and Calliope River crossings.

ES 14.5 Groundwater

Along the gas transmission pipeline corridor shallow groundwater is utilised for domestic and stock watering purposes. Small scale irrigation using groundwater also occurs from the various shallow aquifers within the vicinity of the corridor.

The impact on the shallow groundwater from the gas transmission pipeline's construction is assessed to be negligible due to the shallow and short term nature of the trench excavation.

ES 14.6 Air Quality

There will be minimal air quality impacts from the construction and operation of the gas transmission pipeline. Dust emissions during the construction phase will be managed through implementing best practice dust control procedures such as minimising clearance areas, revegetation, and watering exposed areas. During the operational phase of the pipeline, gas venting for scheduled maintenance and emergencies will release only small volumes of gas infrequently.

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ES 14.7 Greenhouse Gas Emissions

Refer to Section ES.13.8 for details.

ES 14.8 Noise and Vibration

The noise and vibration assessment of activities associated with the pipeline's construction identified that compliance with the applicable criteria is achievable with the adoption of appropriate off-set buffer distances between construction plant items and noise sensitive receptors. These off-sets will be applied wherever possible and no significant noise impacts are expected. Furthermore, construction activity will continually move along the gas transmission pipeline route and will remain at any one location for only a few weeks.

Noise sources associated with the operation of the gas transmission pipeline are limited to the operation of the main line valves (MLVs) during intermittent gas venting for planned maintenance and upset situations. The MLVs will be positioned outside of the required off-set buffer distance from noise sensitive uses and hence no unacceptable noise impacts are expected.

ES 14.9 Land Use and Infrastructure

The predominant land uses along the gas transmission pipeline corridor includes cattle grazing, cropping and forestry. Other land uses include industry, conservation and recreation, residential use (homesteads) and mining.

The main potential impact of the gas transmission pipeline on agricultural land uses will occur during construction when agricultural and grazing activities will be temporarily restricted over the ROW. Land use can generally recommence following construction, with landholders retaining full access and use of the surface area above the pipeline subject to some minor restrictions to preclude activities that would threaten pipeline integrity or significantly impede future access to the pipeline (e.g. construction above the pipeline, planting trees or invasive crops in close proximity to the pipeline, or installation of subsurface infrastructure).

The area affected will generally be limited to within the 30 m wide ROW during construction. However, as pipeline construction will advance at an average rate of approximately 1 km per day, the period that any one location is affected by the peak of construction activities will be limited to several weeks. Santos and/or the construction contractor will consult with all landholders prior to construction commencing to minimise any land use interferences.

Care will be taken to avoid disturbance to any pre-existing soil conservation measures (e.g. levee/contour banks) as far as possible. Where disturbance is required, the banks/levees will be reinstated as soon as practicable, in consultation with the relevant landholder.

The gas transmission pipeline trench will be left open for a minimum amount of time and should not pose a long-term hazard or barrier to stock. Temporary provisions such as fencing or access to water will be discussed with the landholder and any fences that are crossed will be repaired to at least the original condition. While the trench is open, ramps will be placed at strategic locations to ensure that any stock or native animals trapped in the trench can escape.

Additional tracks may be required in some areas to provide access to the construction ROW. The location and rehabilitation of the access tracks will be conducted in consultation with the landholder.

ES 14.10 Visual Amenity

During operations, visual effects will be limited to warning signs and mainline valves. There will be approximately nine mainline valves located approximately equidistant along the pipeline and each will be within a small compound of approximately 20 m x 50 m. The visual impacts of these facilities will be negligible.

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ES 14.11 Cultural Heritage

Indigenous

Santos has adopted an avoidance or harm minimisation approach to cultural heritage, and has established an Aboriginal Engagement Policy (AEP) as one of the tools through which the company can build sustainable relationships and support Aboriginal people and communities. The AEP commits Santos to greater than minimal legal compliance in the company's relations with Aboriginal persons and enables the company to manage risk in engagement with Aboriginal peoples in terms of cost, delay and legal action. Importantly, the AEP provides a sustainable platform for the aspirations of Aboriginal people in their dealings with the company.

Santos has sent or will send formal notifications of its intention to develop cultural heritage management plans (CHMPs) with all relevant Aboriginal Parties along the pipeline route. The philosophy behind the CHMPs is to avoid harm to cultural heritage in the first instance and if that cannot be achieved then a harm minimisation approach will be adopted.

The CHMP process allows for cultural heritage surveys to be carried out along the pipeline route prior to construction. Protection, management and mitigation measures will be agreed once the cultural heritage surveys are finalised and incorporated into Santos' cultural heritage management system.

Non Indigenous

Eight sites of historic cultural heritage significance as well as two sites of historical interest were identified within the gas transmission pipeline corridor. The sites relate to pastoral and settlement activities such as roads, survey trees and homesteads.

Of the 8 sites, 4 were assessed to be of state significance based on the criteria of the *Queensland Heritage Act* including the Kilbirnie Homestead site which is listed on the Queensland Heritage Register. In these instances, the project will investigate options which avoid these sites where feasible, especially with regard to those sites of state significance.

General mitigation measures to be adopted include avoiding items of state and local significance and the adoption of appropriate offset distances to avoid ant indirect impacts to items of heritage significance.

ES 14.12 Socio-Economics

A construction workforce of up to approximately 1,000 is anticipated during the construction of the gas transmission pipeline. They are expected to work 10 hours per day, 7 days per week with no night-time construction activity. Crews will typically work for four weeks followed by four weeks off on a rostered system.

Due to the mainly rural nature of the region and the limited number of townships along the proposed gas transmission pipeline route, existing accommodation is not readily available. Hence dedicated workers' accommodation facilities will be provided.

The workforce will be accommodated in a series of main and satellite accommodation facilities. There will be three main accommodation facilities located roughly equidistant along the pipeline. Facilities 1 and 2 will operate for half of the time and then facilities 2 and 3 will operate for the other half. There will be up to 500 workers accommodated in the two main accommodation facilities. In addition, two smaller satellite accommodation facilities will be located between the main facilities. They will operate one at a time and will accommodate up to 100 workers.

The exact locations of the accommodation facilities will be determined during the detailed construction planning phase.

The workforce for the pipeline construction constitutes a moderate increase in regional labour demand relative to the size of the regional labour market. The nature of the skills available in the region compared to the nature of the skills required dictate that the majority of the workforce will be brought in from outside

the region. Given the temporary nature of the work and that most of the workforce are likely to be on fly-in/fly-out rosters there will be limited demand from the workers on existing housing and community facilities in the region.

The extent to which the project competes with local businesses for local labour is likely to be mitigated by the general downturn in economic activity resulting in a slowing in regional employment growth which may contribute to rising unemployment in the region over the next two years. Increased availability of local labour with project relevant skills may increase the opportunity for local sourcing of workers. The project would therefore assist in providing employment opportunities in a time of lower employment growth in the region.

There will be 15 - 20 personnel required for operational and routine maintenance/surveillance activities. This will consist of 6 - 8 field-based maintenance and surveillance personnel, 4 panel operators, and the remainder being supervisors, engineers and managers. Most personnel will be located in Gladstone although there may be up to six located in towns along the pipeline route.

ES 14.13 Rehabilitation and Decommissioning

The rehabilitation and decommissioning of the gas transmission pipeline will be undertaken in accordance with relevant regulatory requirements, Australian Standards and industry guidelines including the *Petroleum and Gas (Production and Safety) Act 2004, Environmental Protection Act 1994,* Australian Pipeline Industry Association *Code of Environmental Compliance - onshore pipelines 1995*; and the Australian Petroleum Production and Exploration Association *Code of Environmental Practice 2008.*

The pipeline ROW will be rehabilitated as soon as possible after completion of the pipeline installation. It will occur in consultation with the relevant landholders and will generally involve the removal of all construction materials and waste, surface contouring, respreading topsoil, respreading vegetation and reseeding. Typically the landscape will be rehabilitated to pre-existing contours and natural drainage lines restored and protected (if required).

In the future when the pipeline is no longer required, the pipeline and associated infrastructure will be decommissioned. A decommissioning plan will be prepared in accordance with these requirements and after consultation with relevant landholders and regulatory agencies.

ES 14.14 Waste

Pipeline construction activities will generate relatively small amounts of waste. All waste material that is generated will be removed from the gas transmission pipeline ROW on a regular basis and disposed of at an authorised facility as agreed to by the local authority and in accordance with EPA waste management guidelines.

Sewage wastes will be treated in mobile package sewage treatment plants. Treated plant effluent will be disposed of by irrigation in accordance with the relevant environmental authority requirements.

ES 14.15 Traffic and Transport

The traffic impacts of the gas transmission pipeline construction will be seen on the road network for approximately a two year period only, during late 2010 through late 2012. During this time, traffic will be travelling to and from the accommodation facilities and between the accommodation facilities and the work sites along the pipeline route. The road impacts will be seen in the form of additional construction related traffic and minor disruptions to roads due to the construction of the pipeline across or under roads. Roadway capacity and pavement impacts specifically attributed this component of the pipeline's construction are expected to be very low.

In addition there will be traffic associated with the transport of the pipe. Both truck and rail are being considered as optional means of delivering the pipe from Gladstone to the laydown areas along the gas transmission pipeline. The truck option will generate approximately 140 truck movements per day through

Gladstone. This will last for approximately six months. With the rail option, truck traffic through Gladstone will be minimal.

Compared to the rail option, the truck option will increase noise levels along the truck route through Gladstone (from Auckland Point along the Dawson Highway) as well as increase traffic safety risks. It will also contribute in the "bring forward" of some of the intersection and road upgrades required for the LNG facility (Section ES15.15).

The construction of the western sections of the pipeline will also add heavy vehicle traffic to the road network partially contributing to the "bring forward" need for pavement rehabilitation on the Carnarvon Highway and Dawson Highway as described for the CSG field development (Section ES 13.15).

In order to mitigate the effects of the construction traffic on the existing road network, Santos will prepare and implement a traffic management plan as part of the project's environmental management plan. The plan will be prepared in accordance with the requirements of the Department of Main Roads and the relevant regional councils.

ES 14.16 Hazard and Risk

The semi-quantitative hazard assessment found that in the event of a full bore rupture of the gas transmission pipeline there would be off-site impacts. However, further analysis of the safety risk determined that the risk contours for such an event would be within the societal tolerance limits set out in the New South Wales Department of Planning, Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning.

ES 14.17 Cumulative Impacts

There are proposals for other CSG and other pipelines to be developed in the general region of the GLNG gas transmission pipeline. However details on the locations and timing of such proposals are limited. During the consultation undertaken as part of the EIS preparation, some landholders expressed concern about having multiple easements within their property and suggested that this may have implications on their ability to subdivide their property into smaller lots or to use their property effectively. Having adjoining easements will reduce constraints to subsequent land use.

For some areas, Santos may be able to negotiate the shared use of land with the owner of the QGP. The land where Santos has permission from either the landholder or the Minister for Mines and Energy to construct the pipeline will in most places be 30 m wide and in some areas will be in close proximity to the QGP easement area. Without the consent of the QGP easement holder, the two easement areas cannot overlap and this consent has not yet been obtained.

The currently proposed route for the pipeline through the Gladstone State Development Area (GSDA) is through the Materials Transportation and Services Corridor Precinct which is relatively narrow and already contains a number of pipelines and other services. Addition of the GLNG Project pipeline and possibly pipelines from other CSG projects will constrain this area. The Queensland Government has advised that its preference is for the gas transmission pipelines for all LNG facilities proposed for Curtis Island to be located in another common pipeline corridor across the GSDA. Santos will work with the Queensland Government to achieve an acceptable solution.

ES 15 Environmental Impact and Mitigation Strategies - LNG Facility

ES 15.1 Climate

The LNG facility site has a sub-tropical coastal climate, characterised by increased rainfall and hot humid conditions in the summer months (November to March). Climatic conditions are prone to periodic high intensity rainfall events associated with cyclones and other storm events.

Natural hazards are not considered a major risk for the site. However, both floods and cyclone associated storm surges are possible. The facility will be design in accordance with the relevant cyclone building

codes and the design ground level will be 13 m AHD well above any predicted storm surge level. This level also allows for potential sea level rises due to climate change.

An emergency management plan will be prepared which will address all foreseeable site specific risks, such as fire, cyclones and flooding. The risk of natural hazards is part of the business risk management process, with appropriate controls and monitoring details in the emergency management plan being a fundamental part of the risk management process.

ES 15.2 Land, Terrain and Soils

Soils and Geomorphology

A terrain analysis was carried out as a basis for the description of the physical environment to identify existing environmental values and to assess potential engineering and environmental impacts that may result from the development of the LNG facility site.

The main potential impacts identified included:

- Changes to agricultural land capability;
- Increased erosion potential of development areas when subject to clearing and earthworks;
- The occurrence (and subsequent effective management of) problem soil areas, including saline, sodic and/or dispersive soils; and
- Excavation conditions for pipelines and/or buried services.

These potential impacts have been addressed in the EIS and management strategies developed to mitigate the potential environmental impacts identified.

Contaminated Land

No land parcels on the site are listed on the Environmental Management Register or the Contaminated Land Register which are maintained by the EPA. During a site survey, five areas of potential concern with respect to soil contamination were identified and investigated. Evidence of a notifiable activity (cattle dip) was identified with arsenic contamination (Fishermans Hut site) but this is outside of the LNG facility footprint and will not be disturbed by the project. No other sites investigated indicated the presence of notifiable activities or land contamination.

Potential sources of land contamination associated with the construction, operation and decommissioning of the LNG facility include putrescible waste, fuel, oil and lubricant storage, sewage waste, stormwater originating from operational areas and brine waste from water treatment activities. These potential sources of contamination will be managed in accordance with the facility's environmental management plan (EMP) to ensure that soil or water contamination does not occur.

Acid Sulfate Soils

An ASS assessment of the site was undertaken using a geomorphological modelling approach. The distribution of AASS and PASS is limited to the coastal fringe of the site and does not extend to the area proposed for the facility. While the AASS is generally at a low level, it is widely present along the coastal fringe. Management and mitigation strategies will be implemented including more detailed sampling and analysis to further delineate the extent of ASS followed by treatment of excavated soils as required.

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ES 15.3 Nature Conservation

Terrestrial Flora

The terrestrial flora survey of the LNG facility site identified the presence of 191 taxa representing 60 families and 150 genera of plants. This result represents a moderate floral diversity typical of the ecosystems found within the region.

The desktop literature review identified eight flora species of conservation significance as potentially present in the study area. Despite extensive targeted surveys, no significant flora species were identified from the surveys as being present within the LNG facility study area.

Construction of the LNG facility will result in the clearing of approximately 100 ha. This will include 40 ha of the 'Endangered' RE *Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains. This disturbance represents 0.14% of this community found within the sub-region. A relatively small (0.4 ha) of the vegetation community of *Microphyll / Notophyll* vine forest on beach ridges will also be cleared. This community is listed as 'Endangered' under state legislation and 'Critically Endangered' under commonwealth legislation. Its clearing will represent 0.03% of its extent within the sub-region.

Other REs to be cleared include 63.5 ha of *Corymbia citriodora* and *Eucalyptus crebra* open forest to woodland (Not of Concern), and 19.5 ha of *Eucalyptus crebra, E. tereticornis* grassy woodland (Of Concern).

The site's EMP contains a number of mitigation measures which will be implemented to minimise the effect of the project on terrestrial flora.

The vegetation communities in the vicinity of the dredge material placement facility include mangrove and saltmarsh communities in the intertidal areas. Above the high tide mark, the communities include grassland dominated by exotic pasture species merging into terrestrial woodland. Construction of the facility will result in the loss of 120 ha of these communities. Further assessment of these areas and development of appropriate mitigation measures will be undertaken as part of the proposed dredge management plan.

Terrestrial Fauna

Twenty significant fauna species were identified as potentially present as an outcome of the desktop database searches. Of these, two species; the beach stone curlew (*Esacus neglectus*) and sooty oystercatcher (*Haematopus fuliginosus*) were recorded during site surveys at or near the LNG facility study area.

EPA mapping shows habitat mapped for the koala within a regional ecosystem within and around the LNG facility site. The koala is listed as 'Vulnerable' under the *Nature Conservation Act*. No evidence of koalas was observed during the field survey. Anecdotal information from local informants on Curtis Island indicated that koalas had not been seen for many years in the vicinity of the proposed LNG facility site.

A protected matters report for the study site notes 19 terrestrial, wetland and marine migratory birds that may occur within the area. The list includes eight terrestrial migratory species. The LNG facility study area does not act as core habitat for any of these species and similar vegetation communities and topography is found elsewhere in the region.

An EPBC listed threatened species search of the area identified the water mouse as potentially being present in the survey area. This species is listed as vulnerable, with suitable habitat identified as present in the vicinity of the proposed dredge material placement facility. A subsequent targeted investigation was undertaken, with no definite evidence found. Construction of the facility may remove available habitat for any local populations of water mouse. Where suitable habitat for the water mouse could be disturbed, targeted trapping surveys will be conducted to confirm the presence/absence of the species. Low numbers of wader/shorebird species were observed in the area and habitat values appear to be low for many species due to low foraging potential.

Executive Summary

The primary impact on fauna from construction of the LNG facility site will be the direct loss of habitat. The construction will also reduce opportunities for fauna movement in this part of the island. However, habitat values on the site are degraded due to previous activities on the site including grazing, clearing, cropping, weed infestations, selected timber felling and other human activities.

The site's EMP contains a number of mitigation measures which will be implemented to minimise the effect of the project on terrestrial fauna.

ES 15.4 Surface Water

Drainage features within the LNG facility site only contain water during and immediately after rainfall events. During flood events, runoff is predicted to contain high sediment loads, as flows erode the upper catchment alluvials. The relatively short drainage features discharge into the intertidal flats of China Bay.

During construction, the major potential surface water impacts will be from the movement of sediment and potential erosion from earthworks and construction activities. These impacts will be minimised by using erosion and sediment control techniques.

During operations, as the LNG process is essentially a dry process there will be only minor quantities of wastewater generated. The waste water streams in the LNG facility will be managed to minimise environmental risks and impacts on receiving waters. The following are key management strategies will be implemented to achieve this objective:

- Treating potentially contaminated water;
- Minimisation of the potential for contaminants to be mobilised in off-site runoff; and
- Directing naturally occurring runoff around the site and away from process or utility areas.

The site's EMP contains a number of mitigation measures and monitoring programs which will be implemented to minimise the effect of the project on surface water.

At the dredge material placement facility, the dredge material will be pumped into a series of internal ponds separated by bunds with strategically located weirs to allow the overflowing seawater to flow from one pond to the next. The dredge material will pass slowly through the ponds allowing the solid material (sand, silt etc) to settle out of the seawater. Following a period of controlled settlement and monitoring, the seawater will be discharged back into marine environment. The facility will be designed and managed to ensure that the quality of discharge water complies with the relevant environmental authority approval conditions.

ES 15.5 Groundwater

Groundwater in and adjacent to the proposed LNG facility site is unsuitable for drinking purposes, has limited potential use in terms of irrigation, and is an unsustainable groundwater resource for industrial uses.

The potential impacts to groundwater during construction and operation include dewatering of excavations, hydrocarbon spills, waste management and waste water and sanitation. All potential impacts will be minimised with the use of mitigation measures including constructing all process facilities on concrete hardstand areas, storing and handling all hydrocarbons and chemicals in accordance with the relevant Australian Standards, and managing waste streams to ensure contamination of groundwater cannot occur.

The groundwater resources in the area of the dredge material placement facility are of poor ambient quality, have little or no current usage, and have restricted future development potential. Based on the evaluation of the groundwater resources it is recognised that only limited to low levels of groundwater protection are required. The inclusion of groundwater protection measures in the final design of the facility will allow for an acceptable reduction of the risk to groundwater resources.

Executive Summary

ES 15.6 Coastal Environment

The Great Barrier Reef World Heritage Area covers approximately 348,000 km^2, extending from the low water mark of the mainland and stretching for over 2,000 km along the north-eastern coast of Australia. Port Curtis and Curtis Island (above the mean low water mark) are within the World Heritage Area but are outside of the Great Barrier Reef Marine Park. The potential bridge and the pipeline crossing for Port Curtis are in the Great Barrier Reef Coast Marine Park (a state marine park).

To satisfy the objectives of the Great Barrier Reef Coast Marine Park, a permitted use must not interfere with the protection and management of sensitive habitats and must be for a reasonable use. The habitats to be disturbed by the proposed pipeline and bridge are not specially significant particularly when compared with the more extensive seagrass and mangrove areas further north in The Narrows. Furthermore it is considered that the provision of vital infrastructure to a major LNG precinct on Curtis Island that is consistent with the strategic planning intent of the Queensland Government (as expressed in the GSDA development plan) is a reasonable use. On this basis it can be concluded that the proposed pipeline and bridge will be consistent with the objectives of the Great Barrier Reef Coast Marine Park. Furthermore, the pipeline and bridge are not expected to significantly impact on the area's World Heritage values.

The coastal fringes of the LNG facility site and the dredge material placement facility site south of Laird Point contain a mixture of saltpans, saltmarsh, seagrass, mangroves and intertidal habitats.

The major impacts on the marine environment from the project are likely to be a result of dredging and dredge material placement as well as clearing for the construction of the PLF and the MOF. Direct disturbance to habitat from these activities will occur from the following activities:

- The PLF, berthing pockets, MOF, swing basins will result in removal of subtidal soft bottom communities in China Bay. Disturbance to rocky slope habitat and associated subtidal communities will also occur in China Bay and at Hamilton Point. Some disturbance to mangroves, saltmarsh and intertidal communities will also result from the shore crossings to the PLF and the MOF.
- Construction of the potential bridge and trenching of the pipeline will result in disturbance to the subtidal soft bottom communities at the crossing between Friend Point and Laird Point as well as saltpan, saltmarsh, seagrass, mangrove and intertidal habitats at Friend Point and Laird Point.
- Construction of the road along the mainland to the potential bridge at Friend Point will be on tidal land and result in direct disturbance to saltpan, saltmarsh, mangrove and intertidal habitat.
- Construction of the dredge material placement facility will result in the loss of 37 ha of saltpan, saltmarsh, and mangrove habitat.

The short-term disturbance to these habitats would also result in the displacement of those species directly dependant on these areas. However, the rates of re-colonisation of the dredged areas are expected to be high. Construction activities will result in the modification of several habitats, increasing the available space for a number of sessile species, and also provide habitats and food sources for mobile species (e.g. fish, crabs) which would use these new habitats for shelter and/or food.

It is expected that dugongs, whales, dolphins and turtles will not be affected from turbidity or sedimentation; however there is the potential for direct impacts from boat strike, entanglement in lines or being captured by suction pressure associated with the dredge head. Some impacts to commercial and recreational fishing activities are expected. With the exception of the dredge material placement facility, these impacts are considered to be short term and only during the construction phase of the potential bridge, pipeline and marine facilities.

Dredging will result in the direct disturbance to marine sediments. Indirect impacts can be expected from increased turbidity, sedimentation and smothering resulting in mortality of some benthic flora and fauna. Impacts to seagrass meadows from increased turbidity and sedimentation may impact foraging behaviour of turtles and dugong. Negligible changes to the existing hydrodynamic and sediment transport processes are expected. Impacts from light and noise to marine fauna are also considered to be negligible.

Executive Summary

Modelling of turbidity effects from the dredging indicated that during neap tides with low tidal velocities, there would be an immediate impact zone of the order of several hundred metres. Outside this area maximum additional total suspended sediment concentrations of approximately 25 mg/L were predicted (over ambient). These values are in the order of the natural variability of concentrations across the site. Concentration increases during spring tides were generally less than during neap tides.

There is potential for localised impacts to water quality resulting from surface water discharges from the dredge material placement facility into the surrounding water column. However, this facility will be managed to ensure that the quality of the discharged water will comply with agreed discharge standards.

A dredge management plan will be developed collaboratively by Santos, together with relevant contractors, the EPA, the Department of Primary Industries and Fisheries and the GPC. This plan will be designed to manage potential impacts to the marine environment resulting from the dredging and dredge material placement facility. A range of mitigation measures will be specified and a detailed monitoring program will be prepared to confirm that the impacts are kept to within acceptable levels. If monitoring shows that acceptable levels are not being met, the necessary corrective actions will be implemented.

ES 15.7 Air Quality

Emissions to air during construction of the LNG facility will be primarily dust, with some minor sources of combustion pollutants due to diesel and petrol vehicles operating on site. Management of these emissions will be implemented through the EMP that will be prepared for the site. This will include strategies to prevent or minimise dust and exhaust emissions during construction activities and documentation of procedures that will be implemented to correct any adverse off-site impacts.

Emission sources associated with the operational phase include the following:

- Refrigeration compressor gas turbines;
- Power generators (gas turbines);
- Flare pilots;
- Nitrogen vent;
- Regeneration gas heater;
- Hot oil heater;
- CO_2 vent, and
- Fugitive emission sources such as valves, flanges, pump seals, connectors, compressors and vents.

The major emissions from these sources are oxides of nitrogen, carbon monoxide and methane. The emissions from these sources were modelled and the results showed that there would be no exceedances of the relevant guidelines at any sensitive receptors, with cumulative impacts from the LNG facility and other existing and proposed major industrial sources included. The predicted impacts of sulfur dioxide due to the LNG facility are extremely low because of the negligible amount of trace sulfur content in the coal seam gas. Impacts on ambient concentrations of suspended particulates, particulate matter and carbon monoxide due to the LNG facility are low, with no predicted cumulative impacts above guidelines.

ES 15.8 Greenhouse Gas Emissions

Refer to Section ES 13.8.

ES 15.9 Noise and Vibration

The potential construction noise and vibration associated with the LNG facility is predicted to meet noise criteria at all assessment locations.

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Modelling of noise from the operation of the LNG facility has indicated that there could be non-compliance with overall noise criteria if appropriate noise mitigation measures are not implemented. In addition, the low frequency noise predictions showed that there are low frequency components in the overall noise levels predicted at nearby sensitive receptors.

The facility's design will include a range of noise mitigation measures which may include lagging, silencers, acoustic shielding and other 'quiet design' measures. The details of such noise mitigation measures will be determined during the detailed design phase, when more information relating to the specific plant items to be installed is available.

There are no major vibration sources associated with the operational phase of the project likely to generate vibrations at sensitive receptors.

ES 15.10 Land Use and Infrastructure

The proposed LNG facility site and surrounds are currently used for grazing cattle purposes.

The small settlement of South End is located at the south-east end of Curtis Island, approximately 8.5 km from the proposed LNG facility site. There are approximately 50 dwellings at South End, with approximately 20 permanent residents and 90 seasonal residents. Other small islands in Port Curtis contain permanent or seasonal residents including She Oak Island, Tide Island and Compigne Island.

Gladstone is a regional industrial centre with a population of approximately 30,000. The administrative and commercial centre of Gladstone is on the southern side of Port Curtis, within 6 km of the LNG facility site. Gladstone is also a significant industrial centre within Queensland, containing a number of major international manufacturing industries.

The LNG facility site is located in the Curtis Island Industry Precinct of the GSDA development scheme. The preferred land use for this precinct is for natural gas (liquefaction and storage) use. On this basis, the LNG facility is compatible with the planning intent of the development scheme.

The development of the CAF and associated facilities on Curtis Island are considered by Santos to be an ancillary use to the development of the LNG facility. The construction and operation of the CAF will ultimately be subject to approval of Santos' principal material change of use (planning) application by the Coordinator-General under the GSDA development scheme with the CAF and associated facilities falling within the definition of an ancillary use. Such a use would be included in and would form part of the planning application to be made to the Coordinator-General. Any other approvals needed for the CAF will be obtained prior to its occupation and use.

The proposed dredge material placement facility site at Laird Point is surrounded by the Curtis Island Industry Precinct of the GSDA development scheme and is designated for future port development in the GPC's 50 year strategic plan. Once the dredged material has been placed in the facility it has the potential to be re-used for uses consistent with the intent of these plans.

ES 15.11 Visual Amenity

The visual amenity assessment concluded that the LNG facility will result in a change to the existing landscape character of the site on Curtis Island. This change will result from the removal of existing woodland vegetation, implementation of earthworks and construction of the LNG facility structures. However, most components of the LNG facility will only be visible from a limited number of view situations that are accessible to the general public. Potential views of the LNG facility will generally be blocked by the system of hills and ridges that define the valley in which the LNG facility is to be located. At present the forested hill slopes of Hamilton Point provide a visual 'buffer' to the facility site when viewed from the Gladstone town area. The result will be a low to moderate visual impact for most view situations, with the exception of The Narrows waterway, where the visual impact is predicted to be high due to availability of direct views into the site. The most visually significant structures will be the LNG storage tanks.

The visual impact from the vertical flare stack when lit will be significantly greater than other components of the LNG facility. While flaring is predicted to occur irregularly and for limited periods of time, it will be

highly visible due to its height and the visual contrast with the natural landscape setting of Curtis Island against which it will be seen. The visual impact will be greatly increased when flaring occurs at night. Adopting a ground level flare option will reduce such visual impacts, and the practicality of this design option will be considered as part of the FEED process.

The aspect of the dredge material placement facility, being low lying within a valley, will reduce its visual impact although the 18 m high embankment containing the structure will be clearly visible from vessels in Port Curtis and from the opposite mainland shore (north of Fisherman's Landing). Longer term impacts will be minimised through rehabilitation of the facility that is likely to include contouring and revegetation and/or future industrial or port development.

ES 15.12 Cultural Heritage

Indigenous

The CHMP process allows for cultural heritage surveys to be carried out on an "as required" basis, prior to construction commencing. Protection, management and mitigation measures will be agreed once the cultural heritage surveys are finalised and incorporated into Santos' cultural heritage management system.

Non Indigenous

The non-indigenous cultural heritage assessment identified three sites of historic cultural heritage significance and three sites of historical interest within the LNG facility study area. Sites located as part of this assessment relate to transient pastoral activities including the transfer of goods between the mainland and Curtis Island.

None of the three sites was assessed to be of state significance based on the criteria of the Queensland *Heritage Act* or listed on heritage registers. Two of these sites will be directly impacted by the construction of the MOF and haul road.

General mitigation measures include avoiding sites of local significance and the adoption of appropriate buffer distances to avoid construction and operational impacts to heritage sites. Where additional heritage sites are identified, assessments shall be undertaken as part of the requirements of the EMP.

ES 15.13 Socio-Economics

Construction Phase

Construction of the LNG facility (Train 1) will take approximately four years. The construction workforce for the stick-built option will peak at up to 3,000 people and for the pre-assembled module option it will peak at up to 2,000.

The construction workforce will be accommodated in a construction workforce accommodation facility to be established on Curtis Island. This will include both local and non-local workers so as to avoid the significant time delay that will otherwise be incurred if workers had to travel by ferry to and from the site each day. All workers will be transported to and from Curtis Island by ferry. During their rostered time off, the non-local workers will return to their places of residence under a fly-in/fly-out arrangement. As not all workers will be on site at the same time, the capacity of the accommodation facility will be 2,000 for the stick-built option.

If construction of Train 1 commenced in mid 2010, it is expected to be completed by mid 2014. At this time it is possible that, depending on market conditions, construction of Train 2 could commence. The maximum construction workforce for this second stage will be approximately 1,800 as many of the facilities required for Train 2 will have already been built for Train 1. Once this construction is completed, and depending on market conditions, construction of Train 3 could commence. The Train 3 construction worker profile will be similar to that for Train 2.

Executive Summary

It is possible that, given favourable market conditions, construction of Train 2 could commence before the completion of the Train 1 construction. Similarly, construction of Train 3 could start before the completion of Train 2 construction. In this event the total construction workforce may exceed the maxima given above.

The accommodation facility on Curtis Island will be completely self-contained and will provide the housing, dining, logistics and recreation facilities for the residents. Worker access to areas on Curtis Island outside of the designated construction site will be restricted.

Given the temporary nature of the work and that most of the workforce will be on fly-in/fly-out rosters, there will be limited demand from the construction workers on existing housing and community facilities in the region.

Operational Phase

The LNG facility will operate 24 hours per day 7 days per week. This will require four 20-person operation shifts for train 1. These shifts are likely to be 12 hour shifts, and may be on a 4 days on, 4 days off rotation. Should the potential bridge option not proceed, these workers may be shifted to a two week on, two week off rotation. Rotation lengths are yet to be determined and may be altered to meet changing project needs and parameters. It is expected that maintenance and administration will work week days for eight hours with weekends off.

The 3 - 4 Mtpa facility (Train 1) will have an operational on-site workforce of about 80 increasing to 130 for the 10 Mtpa facility (Trains 1-3). Due to the shift arrangements this will mean a total workforce of 140 for Train 1 increasing to 250 for Train 3.

It is assumed that all of the operational workforce will reside in Gladstone and surrounding areas and will be transported daily by ferry from Auckland Point to Curtis Island and back again.

It is assumed that approximately 40% of the operational workforce will come from existing local residents and the balance will be come from elsewhere. In addition to the direct workforce, there will also be a multiplier effect which will generate additional employment in the area. Based on an assumed demographic profile of the non-local workers coming into the area as a result of the GLNG Project, the estimated population increase during Train 1 is 160 increasing to 280 for Train 3. These demographic effects are summarised in Table ES 15.1.

Table ES 15.1 Operations Phase Demographic Effects

Stage	Direct Employment	Flow-on Employment (Indirect)	Total Employment	Recruitment (Direct and Indirect)		Population Increase (approx)
				Local	Non-local	
Train 1	140	77	217	130	87	160
Train 2	195	107	302	181	121	220
Train 3	250	138	388	233	155	280

It is anticipated that the local workers will already have accommodation arrangements and will not affect housing availability and demand. The relatively small number of non-local direct and indirect workers moving into the area and requiring accommodation (87 accommodation units for Train 1) should not significantly affect housing availability and affordability in the Gladstone area. Based on development trends and movement patterns, Gladstone and coastal locations such as Boyne Island and Tannum Sands are expected to have adequate capacity to meet the demand. The demands for an additional accommodation units for Train 2 (34 units) and Train 3 (34 units) will not occur until approximately 2018 and 2022 respectively.

Executive Summary

Due to the relatively small increase in population associated with the project, the demand for additional educational, recreational and community services is not expected to cause any significant impacts to existing resources.

An assessment of the impact of the GLNG Project on the regional labour market and on the regional, Queensland and Australian economies was undertaken. The estimated project benefits in terms of gross domestic product and household consumption spending (a measure of household welfare) are substantial, particularly in the case of the 10 Mtpa LNG facility.

If all projects planned for the Gladstone region were to proceed, the construction of the GLNG facility would coincide with a period of extremely tight labour market conditions in the Gladstone region. The project would need to import most of its construction workforce from outside the region, adding to the demands placed on regional infrastructure and services. However, the economic outlook suggests that there will be a slowdown in economic activity in Gladstone and that a number of planned projects will either slow down or even be abandoned. If this were to be the case, construction of the GLNG facility will coincide with a period of reduced labour demand. The project's labour demands could therefore be met, to a greater extent, from local labour supply.

ES 15.14 Rehabilitation and Decommissioning

The LNG facility has a nominal project life of 20 years but may continue operations for a longer period. Rehabilitation and decommissioning plans will be developed in conjunction with regulatory agencies at least five years prior to closure. At that time there will be a greater understanding of the relevant decommissioning standards and alternative land uses available for the site.

Prior to site closure and the removal of any buildings or other infrastructure from the site, a series of stakeholder discussions will be held to determine the agreed end land use and fate of the LNG facility site and associated infrastructure. This will guide decisions about whether any buildings, equipment or facilities should remain on-site for future use, or if they should be decommissioned and removed. Once it has been determined which components of the facility will be decommissioned, a site decommissioning and closure plan will be developed in conjunction with the regulatory authorities. All decommissioning works will be conducted in accordance with relevant regulatory requirements and standard industry practices applicable at the time including the requirements of the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) as amended or superseded from time to time and any requirements as stipulated under the site's environmental authority.

ES 15.15 Waste

The construction of the LNG facility will generate waste from all stages of the construction. An EMP will be developed by Santos and implemented to establish a series of environmental controls (administrative, engineering, and monitoring and auditing procedures) to manage waste appropriately and to minimise the risk of environmental impacts.

During operations, sources of wastes will include administration areas, plant area, amine and dehydration units, sewage treatment plant, reverse osmosis plant, hot-oil system and mercury removal catalyst units. The site's EMP will incorporate a waste management strategy which will aim to:

- Manage all wastes in accordance with the waste management hierarchy;
- Continually maintain high standards of due diligence;
- Maintain proper housekeeping activities for every component of the project;
- Keep detailed records to ensure all wastes are properly handled, stored, treated, and disposed of from each site effectively; and
- Continually improve waste management policies, procedures, and practices.

The plan will address all relevant aspects of waste management including waste minimisation, recycling and reporting for waste streams generated directly and indirectly from facility. The plan will also ensure

that all waste management practices comply with policy, license/authority and other relevant legislative conditions.

ES 15.16 Traffic and Transport

Road Traffic

Construction and operation of the LNG facility on Curtis Island will result in additional traffic on the local road network in Gladstone. For the option that assumes the potential bridge to Curtis Island is built (bridge option), the main traffic impacts will be in the vicinity of Hanson Road (Gladstone-Mt Larcom Road) and Fisherman's Landing Road. For the no-bridge option, the main traffic impacts will be centred around the barge and ferry terminal at Auckland Point.

Analysis of the increased traffic for the bridge option has shown the following:

- **Intersection Capacity.** Traffic generated as a result of the GLNG Project will require a "bring forward" of, or a contribution to, the upgrading of two intersections on the Dawson Highway and two on Hanson Road.
- **Road Link Capacity.** Traffic generated as a result of the GLNG Project will require a "bring forward" of the upgrading of two sections of Hanson Road between Red Rover Road and Reid Road from two to four lanes (6 km).

Under the "no bridge" option, the analysis has shown the following:

- **Intersection Capacity.** Traffic generated as a result of the GLNG Project will require a "bring forward" of, or a contribution to, the upgrading of three intersections on the Dawson Highway and one on Hanson Road.
- **Road Link Capacity.** Traffic generated as a result of the GLNG Project will require a "bring forward" of the upgrading of two sections of the Dawson Highway (2.2 km) and one section of Glenlyon Road/Hanson Road (1.4 km).

In order to mitigate the effects of the construction traffic on the existing road network, Santos will prepare and implement a traffic management plan as part of the project's EMP. The plan will be prepared in accordance with the requirements of the Department of Main Roads and the regional council.

Ferry Operations

Ferries will be used to transfer construction workers from the mainland to Port Curtis during the construction of Train 1. In the event that the potential access road and bridge option does not proceed, the ferry operation will continue for the life of the GLNG Project. Should the access road and bridge be built at some later stage, it will then be used and the ferrying operation will cease.

A number of options exist to provide a ferry service for the project. These include:

- Use of the existing Curtis Ferry Service which operates two 150 passenger capacity ferries from the Gladstone Marina. These ferries have an operating speed of 10 knots.
- Use of a high speed "fast-cat" service using ferries with a passenger capacity of 300 - 400 and speeds of 15 - 25 knots. This will require the use of ferries not currently available in Gladstone.
- Placing the buses directly onto barges which will also be used for the transfer of construction equipment. The buses could then be used to transfer the workers directly to the construction workers accommodation facility.
- A combination of the above.

It is estimated that Train 1 construction will require 21 ferry trips per 14-day work cycle. This equates to one to two ferry trips per day. The construction of Trains 2 and 3 will require approximately one ferry trip per day.

Executive Summary

The above estimates of ferry movements have been based on the stick-built construction option. Should pre-assembled modules be used, there is unlikely to be any significant reduction in ferry movements although the capacity of the ferries could be reduced.

During the operations phase, the workforce will be accommodated on the mainland and will travel to Curtis Island on a daily basis. Due to the proposed shift arrangements there could be up to four ferry trips per day depending on the final roster selection. Due to the smaller workforce, the capacity of the ferries used during operations will be much less than that proposed for the construction phase.

The preferred site for the ferry terminal on the mainland is Auckland Point. It is proposed that some upgrades will be undertaken to provide adequate ferry docking and vehicle parking facilities. On Curtis Island, the ferry terminal will be at the MOF.

Barging Operations

During construction, barges will be used to transport construction materials from the mainland to Curtis Island. This will include aggregate, cement, piping, structural steel, electrical and instrumentation equipment, and machinery. The barges will be loaded at Auckland Point and offloaded at the MOF.

Stick-Built

For the stick-built option, there will be approximately 2,500 barge trips for Train 1 construction. The barges will carry trucks loaded with construction materials and a capacity of four trucks per barge has been assumed. Most of the barge traffic will occur during the peak 24 month period of the construction phase. If it was evenly spread over that time it will result in three to four barge trips per day. However there will be periods of peak construction activity when the daily barge traffic will be greater than this.

For the construction of Trains 2 and 3, approximately 1,200 barge movements will be required for each train. This is because the construction of subsequent trains will required less material than the initial construction. The daily barge movements for the construction of Trains 2 and 3 could be approximately half that for Train 1.

Pre-Assembled Modules

For the pre-assembled module option, there will be a significant reduction in the amount of construction materials and equipment that will need to be barged from the mainland. The actual reduction cannot be estimated until the extent of modular construction is determined during detailed design, however it can be assumed that the barge traffic between Auckland Point and the MOF will reduce by one third to one half of that required for the stick-built option.

The local barge traffic will be replaced by barges and heavy lift vessels coming from overseas or interstate delivering the pre-assembled modules. The modules will be offloaded at the MOF onto self-propelled motorised transporters which will be designed to carry the heavy loads along the haul road to the construction site.

Under Australia's quarantine regulations, the GLNG Project will undertake cleaning of any imported equipment. To avoid the possibility of re-exporting due to contamination, offshore inspection by an appropriate AQIS or equivalent officer may be undertaken at the module construction site prior to shipment.

Shipping

The ships to be used to export the LNG will have a laden draught of up to 12.0 m, be up to 300 m in length, and could contain from 130,000 m^3 to 180,000 m^3 of LNG.

LNG tankers will enter Port Curtis and proceed along the main shipping channel to the loading berth. Turnaround time for vessels to enter and exit the port will be about 32 hours, of which product loading will take approximately 15 - 16 hours. For Train 1 there will be approximately 50 ship loads exported each

year, or about one ship per week. This rate will increase to 160 ships per year or about one ship every 2 days for Train 3.

In the 2007/08 financial year (the latest year for which data are available), there were 1,368 ship visits to the port and the tonnage handled at Port of Gladstone was approximately 76 Mt. The GPC's projections of trade volumes for the 2011/12 financial year show the tonnage handled at the port increasing to approximately 104 Mt. This represents an increase of 28 Mt (37%) over a 4 year period. Assuming a proportional increase in the number of ship movements, the ship movements generated by the initial LNG facility (Train 1) will represent an approximate 3.6% increase in ship movements in the port. Ship movements from Train 3 operations will be approximately 11.7% of 2007/08 ship movements in the port.

ES 15.17 Hazard and Risk

LNG Facility

As a liquid, the risk of LNG exploding or burning is extremely low. It is colourless, odourless, and non-toxic. It does not mix with water. If LNG liquid escapes from its storage containment to the environment, it begins warming immediately and begins turning into a vapour cloud. As the gas warms up to -107ºC from -161ºC (the temperature at which it is liquid at atmospheric pressure) the vapors become lighter than air and will rise into the atmosphere. Methane vapour is only flammable if it is within the concentration range of 5 - 15% gas in air. If spilt on water or land, LNG evaporates and dissipates into the air as it warms to ambient temperature without leaving any residue. The gas is liquefied but is not under pressure either in the on-site storage tanks or while being transported in the LNG ships.

The safety, efficiency and stability of the proposed LNG facility operations will be achieved through the use of high level detection and safety systems and regular preventative maintenance. Security measures will include security patrols, protective enclosures, lighting and monitoring equipment. The site and plant layout will ensure that any site operational issues are contained within the site boundaries.

As part of the risk assessment for the LNG facility, the following hazards and potential scenarios were modelled to determine the 'hazard end point'[1]:

- Loss of containment of natural gas or liquid natural gas in the process from various points of release, including the PLF;
- Loss of containment of refrigerant gas or liquid from various points of release;
- Fire within the facility involving process or refrigerant liquids in storage; and
- Explosion of an unpurged vessel during decommissioning.

It was found that most of the hazards did not result in an off-site impact with the design parameters that are already set. However the parameters required for modelling of the refrigerant circuit are not all yet known (i.e. pipe sizes), so that the modelling undertaken was based on an assumed pipe size. Depending on the pipe size, it is possible to have an off-site impact for a scenario involving the refrigerant circuit. The modelling reported in this EIS assumed the maximum pipe size before an off-site impact could occur and this risk will be managed through detailed engineering. With regard to a loss of containment on the PLF, the modelling shows that the hazard end point is 186 m and hence the proposed safety zone of at least 200 m radius will be adequate.

[1] The hazard end point is defined as the distance from the source of a hazard to the point at which the impact from the potential consequences is at a level that is considered not to be a threat to human safety. The criteria for hazard end points are set by the relevant design standards as well as the New South Wales Department of Planning, Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning.

Shipping

LNG ships are double-hulled ships and are specially designed to prevent leakage or rupture in an accident. Transportation of LNG by marine carriers has a long record of safe operation. In LNG's 40-plus year history of over 40,000 voyages, LNG carriers have travelled more than 100 million miles without a major incident. There have been no collisions, fires, explosions or hull failures resulting in a loss of containment for LNG ships in ports or at sea. Over this period only eight marine incidents worldwide have resulted in accidental spillage of LNG and not one of the spills has been as a result of a failure or breach of a containment system. In the cases of the accidental spillages, no fires occurred and only minor structural damage was noted. Seven additional marine-related incidents have occurred with none resulting in release of cargo. No explosions or fatalities from a cargo spill have ever occurred aboard an LNG carrier.

Lloyd's Register North America Inc carried out a risk assessment specifically for an LNG ship transiting Gladstone Port to/from the proposed LNG facility on Curtis Island. The quantitative assessment of the potential for an incident to occur during the transit showed that the likelihood was extremely low, being less than 2.2 per 1,000 per ship visit. The assessment concluded that the societal risk from the transit of LNG ships through Gladstone Port will be negligible.

ES 15.18 Cumulative Impacts

Apart from the GLNG Project there are a number of other LNG projects proposed for Curtis Island. There is limited information available as to the planned development of these proposed projects or the scale and timing of their development.

Should all of the proposed projects be developed, the south-west corner of the island will change from a rural use to a major industrial and port area supporting LNG plants and associated infrastructure and services. Concentrating this development in the one location will facilitate the provision of public infrastructure such as access roads, shipping access, power etc. This development is consistent with the intent of the GSDA Development Plan and of the GPC's 50 Year Strategic Plan.

The LNG facility development is not expected to lead to future non-industrial development on Curtis Island. The development of non-industrial projects is contrary to the objectives of the GSDA Development Plan. It is proposed that the bridge will have no public access and will provide access to only the industrial and port developments in the GSDA's Curtis Island Industry Precinct. Any associated infrastructure will also be limited to that precinct. Public road access to other parts of the island is not envisaged.

Cumulative airshed modelling has been conducted using the Gladstone Airshed Model for NO_x and SO_2 emissions from the GLNG LNG facility as well as from other approved and potential industrial developments in Gladstone. The results of the air quality modelling have shown that the proposed LNG facility will result in low incremental impacts to the Gladstone airshed and in acceptable cumulative impacts. These impacts are below the air quality guidelines and operation of the GLNG facility will not restrict the development of other potential industries in the Gladstone region.

The cumulative effect of noise emission from the LNG facility and any other proposed industrial developments (including any other proposed LNG facilities) is not expected to exceed the recommended ambient noise levels, on the basis that any other proposed industrial developments will be required to achieve the same noise criteria which are applicable for the GLNG Project. In some case where the existing ambient noise level is already above the recommended noise levels, noise generated by the LNG facility will be maintained at approximately 8 or 10 dBA below the existing ambient noise level. This should ensure that the cumulative noise impacts of the project will be negligible.

The provision of a project-specific accommodation facility on Curtis Island for the construction workforce will ensure that there will be no significant demand on existing accommodation facilities in Gladstone due to the construction of the GLNG facility. In this way the GLNG Project will not constrain the availability of existing accommodation facilities for other potential projects in Gladstone. During operations, the population increase generated by the GLNG Project is relatively small (280 for Train 3), will build up over an approximately eight year period, and is within the anticipated growth projections for Gladstone. The

cumulative effect of this growth together with that of other potential projects in the area will lead to the ongoing growth and development of Gladstone.

ES 16 Sustainability

In the course of preparing the EIS, Santos examined the potential environmental, social, cultural and economic impacts of the GLNG Project. In so doing, Santos developed and implemented a clear, transparent and repeatable framework to identify the possible impacts, benefits and risks associated with the GLNG Project. In this way the five key concepts inherent in the principle of ecologically sustainable development have been incorporated as follows:

- **Long term and short term economic, environmental, social and equitable considerations.** The potential long term impacts of the GLNG Project have been assessed by specialist studies on all relevant aspects including land, terrain and soils, terrestrial flora and fauna, aquatic flora and fauna, surface water, groundwater, the marine environment, air quality, GHG emissions, noise and vibration, visual amenity, indigenous and non-indigenous cultural heritage, and the social environment and the community. The outcomes of each of these studies are summarised in the chapters of the EIS which deal with these issues.
- **The precautionary principle**. The EIS risk assessment procedures implemented for the GLNG Project have evaluated the potential for serious or irreversible harm to the environment arising out of the project's development. Where potential for harm to the environment has been identified and to minimise the uncertainty as to the nature and scope of the threat of environmental damage, Santos has undertaken detailed studies to identify the risks of environmental harm. Mitigation measures have been developed to be implemented, where practicable, to minimise the anticipated threat of environmental damage.
- **Inter-generational equity**. The concept of inter-generational equity has been addressed in the design and planning phase of the project, and will continue to be implemented during its construction and operational phases.
- **Conservation of biological diversity and ecological integrity.** The GLNG Project addresses the conservation of biodiversity and ecological integrity by proposing a comprehensive environmental management framework designed to conserve ecological values and long term species diversity as far as practicable throughout the project's design and implementation of appropriate mitigation measures.
- **Improved valuation, pricing and incentive mechanisms**. Inherent in the project's design is consideration of economic efficiency, with improved valuation of the environment and carbon emissions, aimed to overcome the underpricing of natural resources and integration of economic and environmental considerations in the project's decision making.

ES 17 Environmental Management Plans

Five preliminary EMPs have been developed for the following project components;

- CSG fields;
- Gas transmission pipeline;
- LNG facility;
- Marine facilities; and
- Access road and bridge.

The purpose of these preliminary EMPs is to propose environmental protection commitments to protect the environmental values that may be affected by the development of the project and to assist the administering authorities to decide the appropriate regulatory conditions for the project.