5. ASSESSMENT OF ALTERNATIVES

Development of the Arrow LNG Plant has involved an iterative process of identifying and evaluating alternatives. Some alternatives still remain under investigation, as the front end engineering and design (FEED) study for the proposed LNG plant and ancillary infrastructure reviews the basis of design and commences detailed design of the facilities, including construction methods, and operation and maintenance programs and procedures.

This chapter describes the alternatives investigated, and reasons for particular options being assessed in this EIS (Table 5.1) and taken forward into FEED.

Specifically, this chapter describes:

- The identification and evaluation of potential sites for the proposed LNG plant.
- Alternative sites considered for ancillary infrastructure, including the LNG jetty, materials offloading and personnel transfer facility, mainland launch facility, construction camp and temporary workers accommodation facility.
- Routes investigated for the feed gas pipeline and potential construction methods for crossing Port Curtis.
- The sites being considered for disposal of dredge spoil.
- The opportunities investigated for co-location of infrastructure and those options still being pursued.

This chapter concludes with a discussion of the economic, environmental and social impacts of the project not proceeding.

Table 5.1 Summary of alternatives

Site or Infrastructure	Alternatives Discussed in this Chapter	Option/s Assessed in this EIS
LNG Plant		
LNG plant site	• South Townsville (Port of Townsville). • Dudgeon Point (Port of Hay Point). • Curtis Island (Port of Gladstone). • Rubyanna (Port of Bundaberg). • Fisherman Islands (Port of Brisbane).	Curtis Island.
Ancillary Infrastructure		
LNG jetty	• North China Bay: Northern. • North China Bay: Central. • North China Bay: Southern.	North China Bay: Southern.
Materials offloading facility (MOF) site	• Hamilton Point (GLNG). • Hamilton Point South. • Boatshed Point.	• Boatshed Point (Arrow Energy preferred). • Hamilton Point South. • Hamilton Point (GLNG)*.
Mainland launch site	• Launch site 1. • Launch site 2. • Launch site 3. • Launch site 4S. • Launch site 4N.	• Launch site 1 (Arrow Energy preferred). • Launch site 4N.

Table 5.1 Summary of alternatives (cont'd)

Site or Infrastructure	Alternatives Discussed in this Chapter	Option/s Assessed in this EIS
Construction camp site	Boatshed Point.	Boatshed Point.
Temporary workers accommodation facility (TWAF) site	• TWAF 1. • TWAF 2. • TWAF 3. • TWAF 4. • TWAF 5. • TWAF 6. • TWAF 7. • TWAF 8.	• TWAF 8. • TWAF 7.
Pipeline Route		
Feed gas pipeline route and construction method	• Indirect (The Narrows) feed gas pipeline route (conventional and bundled). • Direct (Port Curtis) feed gas pipeline route (tunnel, multi-stage horizontal directional drilling (HDD), direct-pipe micro-tunnelling and HDD, HDD and post-lay, and HDD, open-cut trenching and pre-lay).	Direct feed gas pipeline route via a tunnel under Port Curtis.
Dredge Spoil Disposal		
Dredge spoil disposal site	• Western Basin Reclamation Area. • East Banks Sea Disposal site. • New offshore disposal site. • New onshore reclamation area.	Western Basin Reclamation Area (impacts of this option have been assessed in the Western Basin Dredging and Disposal Project EIS).

*Assessed as part of the GLNG Project EIS and included in this EIS as a possible option.

Arrow Energy is investigating options for powering the proposed LNG plant, including all electrical (grid) power, all mechanical power using gas turbine generators, and combinations of these options. These options, along with the implications for the liquefaction process, are described in Chapter 6, Project Description: LNG Plant.

5.1 LNG Plant Site

In 2008, Shell CSG (Australia) Pty Ltd (Shell Australia) commenced investigations into the development of an LNG plant on Curtis Island (at Gladstone on the east coast of Queensland) using gas supplied from coal seam gas developments in the Surat and Bowen basins. The company was granted exclusive rights to investigate a site at the southern end of the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA). The allocated site was one of four sites being investigated for development of LNG facilities by oil and gas companies. As part of its investigations, Shell Australia undertook a site selection study to determine whether a more feasible alternative to the Curtis Island site existed.

5.1.1 Alternative Sites

The area of interest for the site selection study was defined as the Queensland coast between Brisbane and Townsville, and all land within 5 km of the coast. The northern and southern limits were considered the feasible distance an LNG plant could be located from the Surat and Bowen basins coal seam gas resources. The onshore distance defined the nominal limit for cost effective operation of the cryogenic pipeline required to transport LNG from the plant to carriers. Proximity

of the site to the Surat or Bowen basins was a consideration but not a material constraint. The area considered in the investigation is shown in Figure 5.1.

The investigation was carried out in three phases: a screening exercise, followed by primary and secondary constraints analyses. The screening exercise identified areas that might offer potential LNG plant sites. The primary and secondary constraints analyses used available GIS data to identify sites of least constraint within the identified areas. During each phase, comparison of sites also necessitated semi-qualitative assessment to identify strategic environmental and social issues and constraints. Table 5.2 summarises the criteria used in each stage of the study.

Table 5.2 Criteria used for site selection study

Stage	Criterion	Description
Screening exercise	Area	Queensland coast between Brisbane and Townsville. Minimum area of land required for the LNG plant is 80 ha.
	Proximity to coast	LNG jetty will not be more than 5 km from the LNG plant. This is the nominal limit for cost effective operation of the cryogenic pipeline.
	Marine facilities and access	Either adjacent to an existing port facility or has access to the Queensland coast.
	Biodiversity conservation	Not within a national, state or conservation park.
	Land use	Not within or adjacent to a defence area, i.e., army, navy or air force training areas. Not in close proximity to residential areas.
	Tourism	Not within or adjacent to premier tourism facilities, features or landmarks.
	Pipeline routes	Feasible pipeline routes exist from the Surat and Bowen basins to the site.
Primary constraints analysis	***Engineering***	
	Onshore facilities	Minimum area of land required for the LNG plant is 80 ha.
	Marine facilities	LNG jetty will not be more than 5 km from the LNG plant. This is the nominal limit for cost effective operation of the cryogenic pipeline. The cryogenic pipeline and LNG carriers have direct access to the LNG jetty.
	Environmental	
	Biodiversity conservation	World heritage areas other than the Great Barrier Reef World Heritage Area were excluded.* National parks and marine parks were excluded. State parks, state forests and conservation parks were excluded. Nature, forest and water supply reserves were excluded. Wetlands and major waterbodies were excluded.
	Socioeconomic	
	Land use	Water supply reservoirs, domestic and industrial slurry, tailings and effluent storages and treatment facilities were excluded. Mines, quarries and petroleum production facilities were excluded. Land within 1 km of an airport or registered airfield was excluded. Land within 1 km of a military base or training area was excluded.
	Heritage	Sites listed in the Queensland Heritage Database were excluded. Sites listed in the Register of the National Estate were excluded.

Table 5.2 Criteria used for site selection study (cont'd)

Stage	Criterion	Description
Primary constraints analysis (cont'd)	***Socioeconomic (cont'd)***	
	Public safety	The minimum separation distance between the LNG plant and: • Hospitals, nursing homes and schools is 2 km. • Residential and rural residential areas is 500 m. The minimum separation distance between the LNG jetty and residential and rural areas is 250 m.
Secondary constraints analysis	***Engineering***	
	Onshore facilities	Elevation of the LNG plant is to be no less than 5 m Australian Height Datum (AHD) to protect the facility from storm surge and flooding. Unconsolidated sediments and acid sulfate soils are to be avoided where possible, as they could significantly increase project cost.
	Marine facilities	Minimum water depth for shipping channels and berths needs to be 14 m at the lowest astronomical tide (LAT) (including identifying dredging requirements). The width of shipping channels is 160 m to 200 m. The minimum diameter for a swing basin is 600 m, twice the overall length of the largest anticipated LNG carrier. The LNG jetty should be located in sheltered water.
	Environmental	
	Terrestrial ecology	Endangered and 'of concern' regional ecosystems (vegetation communities) were considered a high constraint.
	Marine ecology	Endangered and 'of concern' regional ecosystems (intertidal vegetation communities) were considered a high constraint.
	Socioeconomic	
	Land use	Compatibility with surrounding land uses, including landscape, visual and lighting issues, was to be considered. Impact on existing services and infrastructure, and future infrastructure requirements, was to be considered.
	Land tenure	Freehold or leasehold land is required. Crown or public land was considered highly constrained.

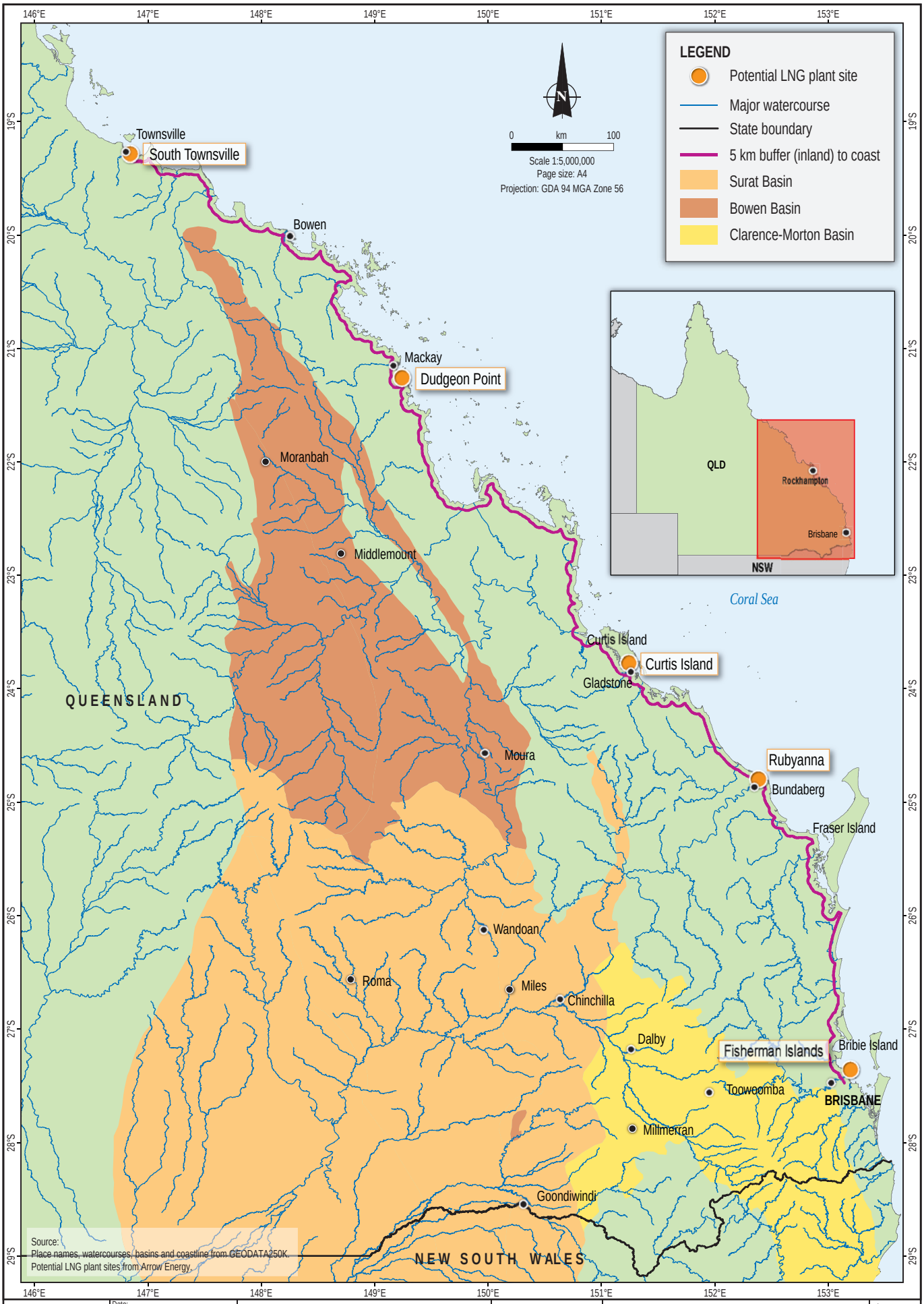
*Note: The Great Barrier Reef World Heritage Area was not excluded from consideration as port facilities and heavy industrial developments along the Queensland coast are included within its boundary and development at or adjacent to those sites may not be inconsistent with existing land use and zoning plans.

5.1.2 Short Listed Sites

The investigation short listed four sites as potentially feasible alternative sites to Curtis Island for establishing an LNG plant (see Figure 5.1). These were:

- Fisherman Islands at the Port of Brisbane.
- Rubyanna adjacent to the Port of Bundaberg.
- Dudgeon Point adjacent to the Port of Hay Point.
- South Townsville adjacent to the Port of Townsville.

Primary and secondary constraints criteria were used as the basis for comparison of the short listed sites against the Curtis Island site. Table 5.3 details the results of the comparison of short listed potential LNG plant sites.



coffey environments	Date: 25.11.2011 MXT: 7033CA_07_GIS259_v1_4 File Name: 7033_07_F5.01_GIS_GL	Arrow Energy Arrow LNG Plant	arrow energy go further	Potential LNG plant sites	Figure No: 5.1

Table 5.3 Constraints analysis of potential LNG plant sites

Site	Suitability
Engineering Onshore Facilities	
Fisherman Islands, Port of Brisbane	There is opportunity for expansion at the site, which is located at the eastern extremity of the reclamation area that is being progressively reclaimed using dredged materials from the mouth of the Brisbane River and Moreton Bay. The current relief varies from sea level to 9 m AHD, with the final surface level unknown. The time required to reclaim the site could impact the project schedule.
Rubyanna, Port of Bundaberg	There is opportunity for expansion at this site, located in farmland east of the Burnett River and south of the Port of Bundaberg. The site relief is 5 to 10 m AHD. Soils are expected to be stable, and there are no mapped acid sulfate soils.
Dudgeon Point, Port of Hay Point	Located on the headland behind Dudgeon Point, the site relief varies from 9 to 20 m AHD. There is some opportunity for expansion at the site, mainly to the south. The site geology is mixed volcanic and sedimentary rock. There are no acid sulfate soils mapped on the site.
South Townsville, Port of Townsville	There is some opportunity for expansion at the site, which has a low relief of 2 to 6 m AHD, although it would possibly involve reclamation of intertidal areas. Located south of the Ross River adjacent to the Stuart Bypass, the site comprises unconsolidated sediments, which may require stabilisation. No acid sulfate soils are mapped at the site.
Curtis Island, Port of Gladstone	There is opportunity for expansion at the site through acquisition of the adjacent allotments. Site relief varies from sea level to 40 m AHD, with the majority of the site above 10 m AHD. The site geology comprises late Carboniferous Shoalwater Formation sediments of the Curtis Island Group. Acid sulfate soils may occur in the low-lying intertidal areas adjacent to the site.
Engineering Marine Facilities	
Fisherman Islands, Port of Brisbane	The site is located 300 m from the existing shipping channel, which has a depth of 14 m LAT. Dredging in the Moreton Bay Marine Park will be required to provide an access channel and swing basin for the LNG jetty. The site is exposed to northeasterly winds and swells. Moreton and North Stradbroke islands may offer some protection for vessels approaching and mooring at the facility.
Rubyanna, Port of Bundaberg	The existing marina would need to be relocated to facilitate construction of the LNG jetty. The marina embayment would have to be widened and deepened, as would the existing shipping channel, which would have to be extended some 8.5 km. The seawall at the Burnett River entrance would offer reasonable protection for LNG carriers once they were in the river and at the LNG jetty.
Dudgeon Point, Port of Hay Point	This site is approximately 3 km from the existing shipping channel, which has a depth of 14.7 m LAT. Dredging would be required to establish an access channel and swing basin for the LNG jetty. Hay Point may provide some protection against southeasterly winds and associated swells.
South Townsville, Port of Townsville	The existing Port of Townsville shipping channel (11.7 m LAT) is located north of the site. An access channel and swing basin would need to be dredged to provide access to the LNG jetty, to be built adjacent to the mouth of the Ross River. Deepening, widening and extension of the existing channel to some 15 km offshore would be required for LNG carriers to access the jetty. This would involve dredging inside the Great Barrier Reef Marine Park. Magnetic Island and Cape Cleveland may offer some shelter to LNG carriers approaching and mooring at the LNG jetty.
Curtis Island, Port of Gladstone	An access channel and swing basin would need to be dredged to connect the existing shipping channel to the LNG jetty site at Hamilton Point. Deepening and widening of the existing channels, and dredging of the access channel and swing basin would be undertaken as part of Gladstone Ports Corporation's Western Basin Dredging and Disposal (WBDD) Project, which will be jointly funded by LNG facility proponents. There is no dredging in the Great Barrier Reef Marine Park, which extends up to the east coast of Curtis Island. The waters of Port Curtis are sheltered by Facing and Curtis islands.

Table 5.3 Constraints analysis of potential LNG plant sites (cont'd)

Site	Suitability
Environmental: Biodiversity Conservation Assets	
Fisherman Islands, Port of Brisbane	The site lies outside the Great Barrier Reef and Fraser Island world heritage areas. The marine facilities could extend into Moreton Bay Marine Park.
Rubyanna, Port of Bundaberg	The site lies outside the Great Barrier Reef and Fraser Island world heritage areas, and the Great Sandy Marine Park. The marine facilities could extend into the Great Sandy Marine Park, particularly dredging activities.
Dudgeon Point, Port of Hay Point	The site lies outside the Great Barrier Reef World Heritage Area and the Great Barrier Reef Marine Park. The marine facilities would be located in the Great Barrier Reef World Heritage Area.
South Townsville, Port of Townsville	The site lies outside the Great Barrier Reef World Heritage Area and the Great Barrier Reef Marine Park. The marine facilities would lie outside the Great Barrier Reef Marine Park but inside the Great Barrier Reef World Heritage Area.
Curtis Island, Port of Gladstone	The site and the marine facilities would lie inside the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park.
Environmental: Terrestrial Ecology	
Fisherman Islands, Port of Brisbane	There are no terrestrial ecology issues at the site because it is reclaimed land.
Rubyanna, Port of Bundaberg	This site is located in sugar cane fields. 'Not of concern' remnant vegetation is located adjacent to the site along the Burnett River. Patches of 'not of concern' regional ecosystems adjacent to the Port of Bundaberg would be avoided.
Dudgeon Point, Port of Hay Point	The site is located on cleared land. Patches of 'not of concern' regional ecosystems flank the site. 'Of concern' remnant vegetation along the shore of Dalrymple Bay constrains access to the coast south of Dudgeon Point.
South Townsville, Port of Townsville	This site comprises degraded land with patches of remnant 'not of concern' vegetation. Previous activities, including access tracks and laydown areas, have disturbed the coastal area.
Curtis Island, Port of Gladstone	The site is part of a former grazing property and, despite evidence of grazing pressures and improvements, is largely undisturbed. The site contains endangered and 'of concern' regional ecosystems, particularly along the ephemeral watercourses and slopes of Ship Hill.
Environmental: Marine Ecology	
Fisherman Islands, Port of Brisbane	Habitat for threatened species (sea grasses) might be affected by laying of subsea gas pipelines in Moreton Bay, as there are limited options for pipeline access to the site.
Rubyanna, Port of Bundaberg	Barubbra Island Conservation Park (a fish habitat reserve) is located at the mouth of the Burnett River in proximity to the possible swing basin and dredging to deepen and widen the existing shipping channel.
Dudgeon Point, Port of Hay Point	Estuarine ecosystems of Sandringham Bay, which is located north of Dudgeon Point, are listed as a nationally important wetland.
South Townsville, Port of Townsville	Flatback and loggerhead turtle habitat is located nearby, as is seagrass that provides habitat for dugong and green turtles.
Curtis Island, Port of Gladstone	Seagrasses that provide habitat for dugong and green turtle are located in the western basin of Port Curtis, northwest of the site. Turtle nesting grounds are located on Facing Island and the east coast of Curtis Island, which are remote from the site.
Socioeconomic: Land Use	
Fisherman Islands, Port of Brisbane	The site is located within an existing port precinct, which supports large industrial activities. The locality has no airshed issues. Visual and lighting issues would require investigation for potential impacts on marine fauna.

Table 5.3 Constraints analysis of potential LNG plant sites (cont'd)

Site	Suitability
Socioeconomic: Land Use (cont'd)	
Rubyanna, Port of Bundaberg	A LNG plant would contrast with the existing agricultural use and may have additional infrastructure requirements. The current land use zoning is not compatible with the proposed development. Visual and lighting impacts are expected to be manageable.
Dudgeon Point, Port of Hay Point	The site is located northwest of the Hay Point coal export terminal on the opposite side of Dalrymple Bay. Located close to Mackay, the site and facility would have access to goods and services. The location is remote from settlements, and visual and lighting impacts are expected to be manageable.
South Townsville, Port of Townsville	The site is located on land used for municipal and industrial purposes, close to the Port of Townsville. A LNG plant would not be inconsistent with the surrounding land use. Services are available and would involve short extensions to mains and pipelines. Visual and lighting impacts are expected to be manageable.
Curtis Island, Port of Gladstone	The site is located within the Curtis Island Industry Precinct of the Gladstone State Development Area, in close proximity to the Port of Gladstone. It is remote from existing services. The site might be influenced by Gladstone airshed issues. Visual and lighting impacts are expected to be manageable.
Socioeconomic: Land Tenure	
Fisherman Islands, Port of Brisbane	The availability of land at the site for a LNG facility is unknown. Land tenure is expected to be a perpetual lease from Brisbane Ports Corporation.
Rubyanna, Port of Bundaberg	Development of a LNG facility at the site would involve the acquisition of private properties. The availability of land for purchase is not known.
Dudgeon Point, Port of Hay Point	Development of a LNG facility at the site would involve the acquisition of private properties. The availability of land for purchase is not known.
South Townsville, Port of Townsville	Land identified for a LNG facility is freehold, set aside as strategic land for the Port of Townsville. The availability of the land for the proposed purpose is not known.
Curtis Island, Port of Gladstone	The site and adjacent land is freehold. Shell Australia was granted the right to investigate the development of a LNG facility on the site.
Socioeconomic: Heritage Assets	
Fisherman Islands, Port of Brisbane	There are no heritage listings for the site. The reclaimed land is not expected to have any Indigenous cultural heritage values.
Rubyanna, Port of Bundaberg	There are no heritage listings for the site. Located in sugar cane farms and on Port of Bundaberg land, the site is not expected to have any Indigenous cultural heritage values.
Dudgeon Point, Port of Hay Point	The site is not listed on any heritage register. The marine facility would lie within the Great Barrier Reef Region, a registered place on the Register of the National Estate. Mount Hector Environmental Park, a registered place on the Register of the National Estate, is located east of the site at the mouth of Louisa Creek. It is possible that Indigenous cultural heritage values might exist along the coast and in the adjacent land.
South Townsville, Port of Townsville	The site is located within the Ross River Alligator Creek Coastal Area, an indicative place on the Register of the National Estate. The marine facilities would lie within the Great Barrier Reef Region, a registered place on the Register of the National Estate. It is possible that Indigenous cultural heritage values might exist along the coast and in the adjacent land.
Curtis Island, Port of Gladstone	The LNG plant and marine facilities would lie within the Great Barrier Reef Region, a registered place on the Register of the National Estate. The site has potential Indigenous cultural heritage values.
Socioeconomic: Public Safety	
Fisherman Islands, Port of Brisbane	The site at the seaward end of the reclamation area is remote from sensitive areas, including hospitals, schools and residences.

Table 5.3 Constraints analysis of potential LNG plant sites (cont'd)

Site	Suitability
Socioeconomic: Public Safety (cont'd)	
Rubyanna, Port of Bundaberg	The site is remote from sensitive areas, including hospitals, schools and residential areas, but close to sugar cane farm residences.
Dudgeon Point, Port of Hay Point	The site is remote from sensitive areas, including hospitals, schools and residences.
South Townsville, Port of Townsville	Located south of the Ross River, the site is less than 3 km from residential areas of South Townsville, which are located along the northern banks of the river.
Curtis Island, Port of Gladstone	The site at the southwestern corner of Curtis Island is remote from the communities of Southend and Gladstone, but closer to residences on the Port Curtis islands.
Pipeline Access	
Fisherman Islands, Port of Brisbane	There are limited opportunities for pipelines to the site due to urbanisation and the protection of surrounding ecological values. The most feasible routes involve subsea gas pipelines from the north. A 500 km long pipeline from the Surat Basin and a 700 km long pipeline from the Bowen Basin would be required to deliver gas to the site.
Rubyanna, Port of Bundaberg	There are no significant limitations on feasible pipeline routes to the site. Up to 500 km long pipelines would be required to connect the site to the Surat and Bowen basins.
Dudgeon Point, Port of Hay Point	There are no significant limitations on feasible pipeline routes to the site. Approximately 500 km long pipelines would be required to connect the site to the Surat and Bowen basins.
South Townsville, Port of Townsville	The existing North Queensland Pipeline (Stuart Lateral) extends almost to the site. The pipeline could be extended or duplicated to provide the required capacity. A 500 km long pipeline would be required to deliver gas from the Bowen Basin, and a 900 km long pipeline from the Surat Basin.
Curtis Island, Port of Gladstone	Existing and proposed 500 km long gas pipelines (licences) extend from the Bowen and Surat basins to the Gladstone City Gate and Fishermans Landing respectively.

While all four short listed sites had merits, each site presented significant technical, environmental and commercial challenges that required further investigation to determine their feasibility. On the basis of the high level evaluation of potential sites, none of the short listed sites were considered distinctly better than the Curtis Island site, which had a number of technical and commercial advantages for the development of a LNG plant, including:

- Stable geology and an elevation that ensured the proposed LNG plant could be constructed to avoid predicted sea level rises and storm surges.
- Access to shipping channels within a sheltered harbour, where the cost of dredging to deepen and widen the channels would be shared with other proponents.
- Although in the Great Barrier Reef World Heritage Area, the site was within the Port of Gladstone and remote from the Great Barrier Reef Marine Park. Dredging would not extend into the marine park.
- The limited dredging required to access the site would avoid or significantly reduce potential impacts on marine ecosystems and threatened species and their habitat, including dugong and turtles.
- The site is located in an industry precinct declared to facilitate the development of LNG plants.

- An exclusive right to investigate the site for development of a LNG plant overcomes potential issues with the acquisition of private freehold or perpetual leases of strategic port land.
- The site is remote from existing settlements at Southend and Gladstone, although it is closer to residences on the Port Curtis islands.
- Existing and proposed pipelines (licences) overcome the need to identify gas pipeline routes and secure interests in the land.

5.2 Ancillary Infrastructure

Ancillary infrastructure is required to facilitate construction and operation of the proposed LNG plant on Curtis Island. Ancillary infrastructure includes the LNG jetty, MOF and integrated personnel transfer jetty, mainland launch facility, construction camp and TWAF. Several options were identified and evaluated in short listing or nominating preferred sites for the infrastructure. The sites assessed and preferred options are described in this section. Potential sites for the MOF and integrated personnel transfer jetty, mainland launch facility and TWAF are shown in Figure 5.2.

5.2.1 LNG Jetty

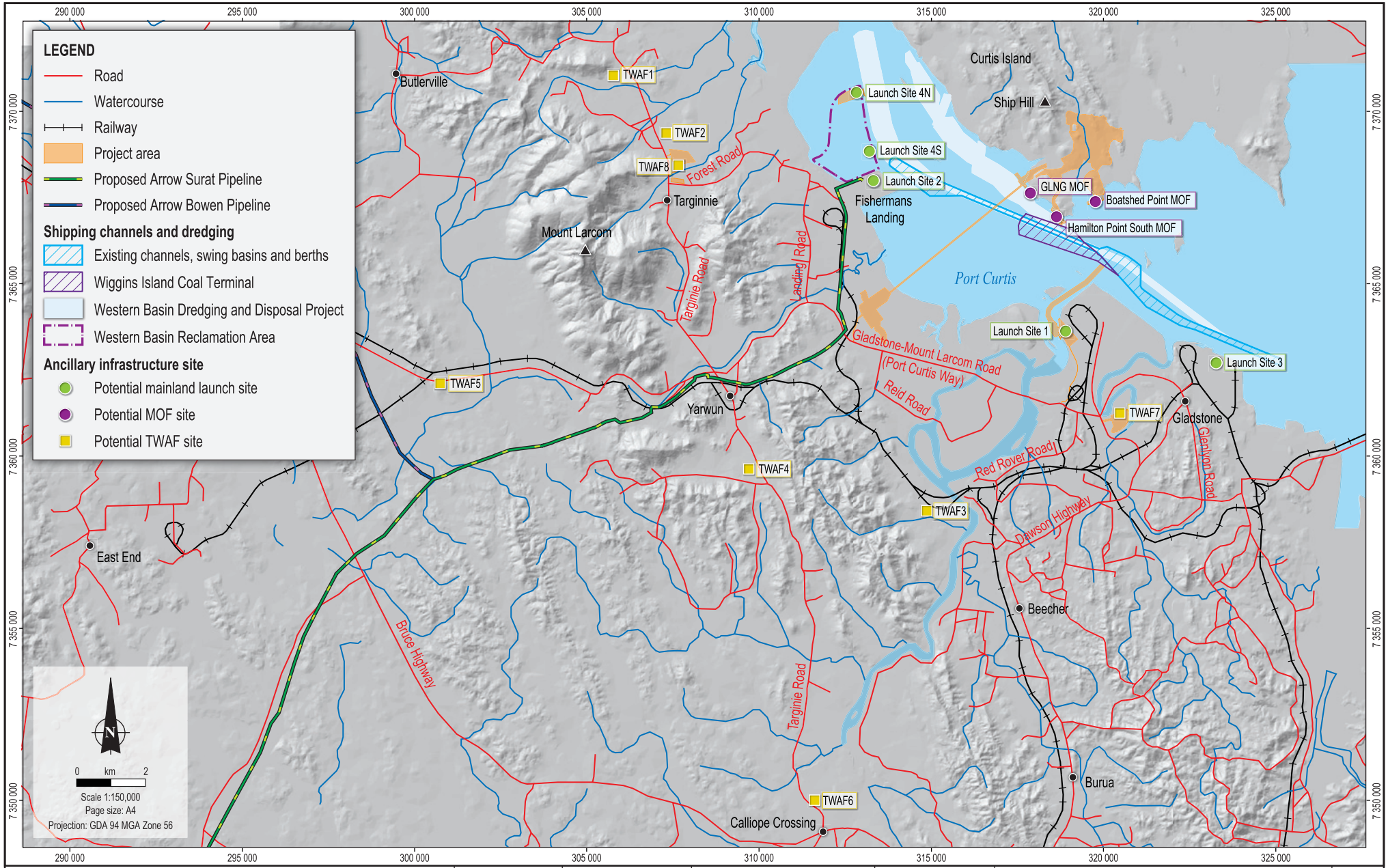
The topography of Curtis Island and the relationship of the LNG plant site to adjacent LNG developments limit feasible sites for the LNG jetty. Key requirements for selecting a site for the LNG jetty were proximity to shipping channels and the length of the LNG loading lines (cryogenic pipelines) that transfer LNG from the storage tanks to LNG carriers. It was desirable to reduce the length of the jetty and the distance from the LNG plant to the jetty.

Two areas satisfy the strategic constraints of topography, distance and proximity. They are North China Bay and the embayment west of Boatshed Point. A third area along the west coast of Hamilton Point was discounted from consideration because of potential conflicts with future port development.

Sites in the embayment west of Boatshed Point, while closer to the proposed LNG plant site than those in North China Bay, were discounted due to the proximity of the access channel and swing basin to Witt and Tide islands, the strong currents that run through Compigne Channel and around the islands and the additional dredging required over that proposed as part of the WBDD Project. The Western Basin Master Plan (DIP, 2010a), prepared by the Coordinator-General, stated:

> The Coordinator General will recommend to LNG proponents establishing plants in Boatshed Point to locate their berth(s) at Hamilton Point West, instead of at Boatshed Point. This will enable the LNG proponents to take advantage of the proposed development of shared facilities, reduce the total quantity of dredge material, and minimise the impacts of dredging activities.
>
> The Coordinator General as part of the Hamilton Point Land Use Plan, in consultation with LNG proponents and Gladstone Ports Corporation, will determine the extent and location of a common-user infrastructure corridor on Hamilton Point to service North China Bay, Boatshed Point and Hamilton Point West.

Three jetty sites have been identified in North China Bay: northern, central and southern. The Gladstone LNG (GLNG) Project proposes to use the northern site due to its close proximity to its proposed LNG plant site. The southern site off the northwest corner of Hamilton Point is available to Arrow Energy, and the central site has been reserved for future expansion of either



Source:
Place names, roads, railways and watercourses from DME.
Proposed pipelines, ancillary facilities and marine infrastructure from Arrow Energy.
Proposed feed gas pipeline, project area and digital elevation model from Coffey Environments.
Western Basin Dredging Master Plan and Disposal Project from Gladstone Ports Corporation.

coffey environments

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Arrow Energy

Arrow LNG Plant

arrow energy go further

Potential ancillary infrastructure sites

Figure No: 5.2

development. Shipping access to the sites will be enabled through dredging of an access channel and swing basin, as part of the WBDD Project. The LNG loading lines will be located in the Curtis Island Corridor Sub-precinct, which extends east from Hamilton Point to the Arrow Energy LNG plant site, then north and west behind the other LNG plant sites.

5.2.2 Materials Offloading Facility

Arrow Energy proposes to develop a MOF and integrated personnel transfer jetty on Curtis Island to enable the transport of materials and workers to and from the island. The Coordinator-General stated in the Western Basin Master Plan (DIP, 2010a) that:

> Hamilton Point is the nominated location for a possible common-user material offloading facility to service projects located at North China Bay, Hamilton Point West and Boatshed Point.

The GLNG Project is developing a MOF at Hamilton Point to service its proposed development on the north side of North China Bay. The MOF is one of three sites identified and investigated by Arrow Energy. The other sites are at Hamilton Point South and Boatshed Point (see Figure 5.2).

Located at the northwest corner of Hamilton Point, the GLNG MOF connects to the GLNG LNG plant site via a haul road constructed along the northern flanks of Hamilton Point around the intertidal mudflats of North China Bay. A haul road would need to be constructed from the GLNG haul road up the valley extending east from North China Bay to the proposed LNG plant site. This would result in an overall distance from the MOF to the LNG plant site of approximately 2 km. GLNG proposes to establish a quarantine area adjacent to the MOF.

The Hamilton Point South site is located adjacent to the southwest corner of Hamilton Point where deep water extends almost to the coast. A 2 km long haul road would connect the MOF to the proposed LNG plant site. The haul road would pass between the two low hills forming the spine of Hamilton Point before connecting to and following the GLNG Project haul road to west of the proposed LNG plant site, where it would leave the GLNG Project haul road to run up the valley to the LNG plant site. This alignment would involve steeper gradients as the haul road climbs over the saddle between the low hills. The quarantine area would be located adjacent to the LNG storage tanks and western boundary of the proposed LNG plant site.

The Boatshed Point site is located on the southwest corner of the headland at the interface between deep water and the shallow waters of the embayment to the west of the point. A 1.4 km long haul road would be constructed along the west coast of the point to the proposed LNG plant site. The quarantine area would be located adjacent to the southern boundary of the LNG plant site.

The advantages and disadvantages of each site are summarised in Table 5.4.

Table 5.4 Advantages and disadvantages of potential MOF sites

Advantages	Disadvantages
Hamilton Point (GLNG MOF)	
• An existing facility with access to the proposed LNG plant site provided by the haul road connecting the GLNG MOF to the GLNG LNG plant site. • Reduces need for dredging to establish a MOF at another site.	• The limited capacity of MOF to handle the requirements (personnel and materials transfer) of two projects simultaneously. • Potential misalignment of construction schedules leading to use conflicts and congestion.

Table 5.4 Advantages and disadvantages of potential MOF sites (cont'd)

Advantages	Disadvantages
Hamilton Point South	
• Separation from GLNG MOF will reduce shipping congestion and overcome use conflicts. • Only minor dredging is required to establish the MOF due to its proximity to deep water.	• Dredging is required to establish the MOF. • A haul road would need to be constructed across the spine of Hamilton Point creating potential future land use conflicts. • Steeper gradients might be encountered along the haul road alignment. • Topography limits opportunities for locating the quarantine area adjacent to the MOF site. • The site may conflict with future port-related development.
Boatshed Point	
• Closest site to the proposed LNG plant. • Only minor dredging is required to establish the MOF due to its proximity to relatively deep water off the point. • Shortest haul road distance; 1.4 km compared with 2 km for other options. Gentle gradients. • No conflict with GLNG MOF; potential shipping congestion at Hamilton Point reduced.	• Dredging is required to establish the MOF. • Topography limits opportunities for locating the quarantine area adjacent to the MOF site. • Proximity to seagrass beds off Garden Island Conservation Park that are located 600 to 800 m to the east of the point.

Table 5.4 demonstrates that each site has its advantages and disadvantages. Boatshed Point is currently Arrow Energy's preferred site for the MOF and integrated personnel jetty because it reduces the risks associated with the scheduling conflicts, congestion and commercial negotiations associated with the Hamilton Point site (GLNG MOF). Boatshed Point does not have the same topographical or land use constraints as the Hamilton Point South site. The final design of the proposed LNG plant and ancillary facilities on Curtis Island is not yet complete, and all options remain under investigation. The GLNG MOF option is not considered in this EIS because it has already been assessed in the EIS for that project. The other two MOF options have been assessed in this EIS. During the initial development phase of the project, Arrow Energy will investigate sites for a temporary MOF while the permanent facilities are constructed.

5.2.3 Mainland Launch Facility

A mainland launch facility is required to facilitate the transport of materials and workers to and from Curtis Island via barges and ferries. While it is possible to establish temporary facilities for construction and separate permanent facilities for operation, Arrow Energy desires to develop a permanent facility that will cater for construction and operation. Consequently, the following criteria were nominated for the site selection study:

- A freehold site is preferred. If leasehold is necessary, the lease must be for a 25 year minimum term.
- The land parcel must be at least 10 ha in size, be regularly shaped, and relatively flat.
- The land parcel should have direct access to the harbour or access via a waterway.
- Vessels with up to 5 m draught must be accommodated at lowest astronomical tide (via dredging if required).
- The site must be accessible in all weather conditions.

- Services (e.g., power, sewerage, water) should be available or able to be provided through extension of existing services.

Five potential mainland launch sites were identified (see Figure 5.2). The locations of the sites, and the advantages and disadvantages of each, are summarised in Table 5.5.

Table 5.5 Advantages and disadvantages of potential mainland launch sites

Launch Site	Discussion	Outcome
Launch site 1: Calliope River adjacent to RG Tanna Coal Terminal	*Advantages:* • The land parcel is greater than 10 ha, which allows for future expansion. The topography is relatively flat. • The land is highly disturbed with no biodiversity conservation assets. • The site is located within the Clinton Precinct of the Gladstone State Development Area, and the proposed use is compatible with the purpose of the land use designation. • Services are available at Port Curtis Way and Alf O'Rouke Drive. • It is the closest site to the preferred MOF site at Boatshed Point. *Disadvantages:* • Stabilisation and capping of the former fly ash ponds may be required. Any contamination will have to be remediated, as required. • Dredging of the Calliope River channel and bar will be required to achieve 5 m draught at low tide. Ongoing maintenance dredging may also be required. • Patches of mangroves are present at the proposed barge landing site. • An access road will need to be constructed to access the site. Existing haul roads may need to be upgraded to provide access.	A feasible option that is assessed in this EIS.
Launch site 2: Gladstone LNG Project – Fishermans Landing site	*Advantages:* • The location is an existing reclamation area with no biodiversity conservation issues. • The site abuts an existing deep water shipping channel and has good proximity to Curtis Island. • Barges and ferries travelling to and from Curtis Island will not have to cross shipping channels used by coal carriers and general cargo ships. • The site is located within the Major Industry Zone of the Calliope Planning Scheme. *Disadvantages:* • The site is currently leased to a third party and may not be available. • Vehicle and shipping traffic congestion associated with the WBDD Project and other LNG projects may be experienced. • Upgrade of Serrant Road will be required to provide access in the event Forest Road is unavailable due to WBDD Project activities.	Site discounted due to land access constraints.
Launch site 3: between Auckland Point wharves and Barney Point export coal terminal	*Advantages:* • The land is predominately vacant. • Onsite vegetation is mapped as non-remnant. • The site is located within land zoned Strategic Port Land in the Gladstone City Planning Scheme. • The site has no additional dredging requirements. • The site was nominated by Gladstone Ports Corporation as a possible mainland consolidated operations facility for all LNG projects.	Site discounted due to land availability and potential traffic impacts on the Gladstone central business district.

Table 5.5 Advantages and disadvantages of potential mainland launch sites (cont'd)

Launch Site	Discussion	Outcome
Launch site 3: between Auckland Point wharves and Barney Point export coal terminal (con't)	*Disadvantages:* • Available land is limited through development of the site by GLNG Project and Queensland Curtis LNG (QCLNG) Project. • Access to the site is through the Gladstone central business district via Hanson and Glenlyon roads, or Dawson Road to Port Access Road. • Multiple port users may lead to vehicle and marine traffic congestion. • This site is a considerable distance from the preferred MOF site at Boatshed Point.	
Launch site 4N: northeast corner of proposed Western Basin Reclamation Area	*Advantages:* • The site is located on and adjacent to the bund wall of the Western Basin Reclamation Area and has no biodiversity conservation assets. • The site will abut an existing deep water shipping channel and has good proximity to Curtis Island. • Barges and ferries travelling to and from Curtis Island will not have to cross shipping channels used by coal carriers and general cargo ships. • The site is under consideration by Gladstone Ports Corporation as a possible mainland consolidated operations facility for all LNG projects. *Disadvantages:* • The availability of the site will be dependent on the timing of completion of dredge spoil disposal to that part of the Western Basin Reclamation Area. • Spoil material settlement timeframes will necessitate ground stabilisation works to prepare the site for the intended purpose. • This site is a considerable distance from the preferred MOF site at Boatshed Point.	A feasible option that is assessed in this EIS.
Launch site 4S: southeast corner of proposed Western Basin Reclamation Area	*Advantages:* • The site is located on and adjacent to the bund wall of the Western Basin Reclamation Area and has no biodiversity conservation assets. • The site will abut an existing deep water shipping channel and has good proximity to Curtis Island. • Barges and ferries travelling to and from Curtis Island will not have to cross shipping channels used by coal carriers and general cargo ships. *Disadvantages:* • The site is adjacent to Australia Pacific LNG (APLNG) Project's proposed mainland launch site. Vehicle and marine traffic congestion is possible due to the close proximity of the sites and access. • The availability of the site will be dependent on the timing of completion of dredge spoil disposal to that part of the Western Basin Reclamation Area. • Spoil material settlement timeframes will necessitate ground stabilisation works to prepare the site for the intended purpose. • This site is a considerable distance from the preferred MOF site at Boatshed Point.	Site discounted due to potential conflicts with APLNG mainland launch site.

Arrow Energy's desire to establish a permanent facility for construction and operation favours launch site 1, as development of the site is not contingent on completion of dredge spoil disposal and stabilisation in the Western Basin Reclamation Area. However, launch site 4N remains a feasible option and, consequently, both sites have been assessed in this EIS. During the initial

development phase of the project, Arrow Energy will investigate sites for temporary mainland launch facilities while the permanent facilities are constructed.

5.2.4 Construction Camp

Safety and logistics are key requirements for the location of the construction camp required to accommodate the fly-in, fly-out workforce. Vehicle accidents are a key risk in major projects and, consequently, a camp site as close as possible to the proposed LNG plant site is preferred over more remote sites. Close sites also improve transportation logistics, particularly where the site is within walking or short transit distance of the LNG plant site.

Limited options exist for locating the required 2,500 person construction camp on Curtis Island, the preferred location to reduce travel time and improve transportation logistics. Separation distances from hazardous facilities (flare, operating LNG train and LNG and refrigerant storage tanks) limit options on the Arrow Energy allotment. Possible sites include Boatshed Point and the headlands east of the proposed LNG plant. Insufficient land is available on the headlands to accommodate the construction camp, which has a nominal requirement of 25 ha.

Boatshed Point is more remote from the hazardous facilities and, with approximately 18 ha of land available for development of the construction camp, it is the only feasible site. A separate site is required to accommodate the recreation facilities. The headland immediately to the north of Boatshed Point has about 7 ha of usable land, sufficient area to establish recreation facilities within walking distance of the construction camp.

The proximity of the proposed construction camp site to the proposed MOF and integrated personnel transfer jetty has advantages, as separate pedestrian access can be provided to the camp via the eastern shore of Boatshed Point. Buses, delivery vans and light trucks will convey personnel, goods and services to and from the camp via the haul road, which will be designed to carry light and heavy vehicles.

5.2.5 Temporary Workers Accommodation Facility

A TWAF may be required to provide accommodation for fly-in, fly-out workers once the construction camp on Curtis Island has reached full capacity. The TWAF will have a nominal capacity of 1,000 workers and additional land for lay down and storage of construction materials. Criteria for the identification of potential sites were:

- A freehold site with services (e.g., power, water, sewage) is preferred.
- The site should be relatively flat but not flood prone.
- The land parcel must be at least 20 ha, and up to 25 ha if onsite water and sewage treatment is required.
- The site should be as close as possible to the mainland launch site to minimise travel time.
- The use of the land as a TWAF must be compatible with local planning scheme zoning, or a material change of use for the land must be able to be obtained.
- The route between the TWAF and mainland launch site must be accessible in all weather conditions.

Eight potential sites, on public and private land, within and outside the GSDA were identified (see Figure 5.2). The locations of these sites, and the advantages and disadvantages of each, are summarised in Table 5.6.

Table 5.6 Advantages and disadvantages of potential TWAF sites

TWAF site	Discussion	Outcome
TWAF 1 Calliope–Targinie Road, Targinnie	TWAF 1 is a 50-ha grazing property at Targinnie accessed from the Calliope–Targinie Road. *Advantages*: • The site is located in proximity to launch site 4N with access via Calliope–Targinie Road and Forest Road. • Located in gently undulating land, the predominantly cleared site has adequate space for the TWAF and laydown areas. *Disadvantages*: • No services are available at the site. • Forest Road and parts of Calliope–Targinie Road will require upgrading to provide all weather access. • The site is located in the Targinie Precinct of the GSDA. TWAFs are currently prohibited land uses within the GSDA.	This site was discounted as it is in the GSDA and more remote from the mainland launch sites than other potential sites.
TWAF 2 Calliope–Targinie Road, Targinnie	This is a 35-ha site located south of TWAF 1 on Calliope–Targinie Road. The current land use is cattle grazing. *Advantages*: • The site is located in proximity to launch site 4N with access obtained via Calliope–Targinie Road and Forest Road. • The site lies outside the GSDA. • The site is relatively flat and predominantly cleared. • There is adequate space for the TWAF and laydown areas. *Disadvantages:* • No water and sewerage services are available; therefore, onsite package water and sewage treatment facilities will be required. A power line traverses the allotment. • Forest Road and parts of Calliope–Targinie Road will require upgrading to provide all weather access to the site. • The establishment of a TWAF on the property is not compatible with the rural zoning, and planning approval will be required for the proposed use and possible reconfiguration of the allotment. • The site is partly encumbered by Queensland Energy Resources' (QER's) mining licence application for its Stuart Oil Shale Project.	This site was discounted as it was encumbered by a mining tenement that would have resulted in incompatible land use.
TWAF 3 Port Curtis Way, Gladstone	Located adjacent to Calliope River, on a dead end road, the 197-ha cattle grazing and horticultural property provides adequate space for the TWAF and laydown areas. *Advantages*: • Moderate distance (approximately 12 to 13 km) to mainland launch sites 1 and 4N. • The allotment has adequate space for the TWAF and laydown areas. • The location is quiet and there are no neighbours. *Disadvantages*: • The topography is undulating and benching would be required to establish the TWAF. • Endangered regional ecosystems are present on the property, but avoidable. • The access road will require upgrading to an all weather surface, and additional signage may be required at the railway crossing. Water and sewerage services are not available; therefore, onsite package water and sewage treatment facilities will be required. Power is available at the site; however, it may need to be upgraded.	Land availability and competing land use were the reasons for this site being rejected.

Table 5.6 Advantages and disadvantages of potential TWAF sites (cont'd)

TWAF site	Discussion	Outcome
TWAF 3 Port Curtis Way, Gladstone (cont'd)	• The property has been acquired by Queensland Rail for development of railway infrastructure associated with the proposed Wiggins Island coal export terminal.	
TWAF 4 Calliope–Targinie Road, Yarwun	Located approximately 2 km south of Yarwun on the Calliope–Targinie Road, the site is a 50 ha rural property currently used for cattle grazing. Scattered trees cover part of the allotment. *Advantages*: • The site is centrally located to mainland launch sites 1 and 4N. It is approximately 12 km from launch site 4N and 16 km from launch site 1. • The site has all weather access via the Calliope–Targinie Road. • The site is located outside the GSDA. *Disadvantages*: • Patches of 'of concern' vegetation are present on the property. • The establishment of a TWAF is not compatible with the rural zoning and planning approval will be required to permit the proposed use and potentially reconfigure the allotment. • Water and sewerage services are not available; therefore, onsite package water and sewage treatment facilities will be required. A high voltage power line traverses the property. • Amenity issues may arise from its close proximity to rural residential developments along Calliope–Targinie Road.	This site was discounted as other more feasible sites closer to the mainland launch sites existed.
TWAF 5 Euroa Homestead, Gladstone–Mount Larcom Road, Aldoga	Located in the Aldoga Precinct of the GSDA, this 52 ha site is the home paddock of the historic Euroa Homestead. The historic homestead is set among remnant native vegetation mapped as 'of concern'. Land to the east of the homestead is predominantly cleared and gently undulating, and is the preferred site for the TWAF. This area is approximately 20 ha, which is adequate for the facility, as sewage would be pumped to and treated at the nearby sewage treatment plant. *Advantages*: • The site is a moderate distance to launch sites 1 (22 km) and 4N (18 km). • The site is close to a sewage treatment plant, negating the need for onsite treatment. • Located adjacent to Gladstone–Mount Larcom Road, there is all weather access to the site, and arterial road access to the mainland launch sites without the need to traverse Gladstone. • The site is close to the Northern Infrastructure Corridor Sub-precinct and future industrial development in the Aldoga Precinct, creating the potential for future third party use. *Disadvantages*: • Accommodation facilities are currently a prohibited land use in the GSDA. • Proximity of the facility to the historic Euroa Homestead may lead to conflicting land uses. • Access to the property is currently prohibited due to a giant rat's tail grass infestation. • Mapping indicates 'of concern' regrowth vegetation may be present.	This site was discounted from further consideration due to its distance from the mainland launch sites, proximity to historic Euroa Homestead and prohibited access (land use zoning and giant rat's tail grass infestation).

Table 5.6 Advantages and disadvantages of potential TWAF sites (cont'd)

TWAF site	Discussion	Outcome
TWAF 6 Calliope–Targinie Road, Calliope Crossing	This site is located approximately 1 km north of Calliope Crossing off the Calliope–Targinie Road. The 47-ha site extends from the road to the Calliope River. There are scattered trees on this relatively flat site. The site is understood to be subject to a material change of use application for a construction camp. *Advantages*: • The site is potentially subject to a material change of use application for a construction camp. • The site is close to the Bruce Highway, the major transport route from Brisbane to Townsville. • All weather access to the site is available from the Calliope–Targinie Road. *Disadvantages*: • The establishment of a TWAF is not compatible with the site's current rural zoning and planning approval would be required for the proposed use and potentially to reconfigure the allotment. • The site is distant from the mainland launch sites. The site is 27 km from launch site 1 at Calliope River and 24 km from launch site 4N at Fishermans Landing.	The distance to the mainland launch sites was the reason this site was discounted, despite the potential for a rezoning application expediting planning approval and access to the site.
TWAF 7 Former Gladstone Power Station Ash Pond 7, Blain Drive, Gladstone	The former Gladstone Power Station Ash Pond 7, located off Blain Drive, has been decommissioned and capped with approximately 200 mm of clay fill. Gladstone Regional Council has nominated the 72-ha site as a potential site for recreation facilities or temporary workers accommodation. Council is pursuing the purchase of the land from the Queensland Government and proposes to prepare a material change of use application for the proposed future land use. *Advantages*: • The site is close to mainland launch site 1 (3.5 km) and readily accessible from mainland launch site 4N via Blain Drive, Port Curtis Way and Landing Road (approximately 16 km). • The site is close to Gladstone Airport. • Power, water and sewerage services are available in Blain Drive and easily connected to the site. • The Gladstone Regional Council supports the use of the site for a TWAF. • The site is highly disturbed with no biodiversity conservation assets. *Disadvantages*: • The site is the former fly ash landfill of the Gladstone Power Station. Further capping or specific building controls will need to be considered in developing the site. • A large part of the site is subject to king tides and a 100 year annual recurrence interval (ARI) flood event; and accommodation would have to be placed on an elevated bench or raised foundations. • The causeway that provides access to the site will require upgrading to provide all weather access, and a second access route will need to be established for safety reasons, potentially involving the construction of a bridge over Auckland Creek or its anabranch. • Gladstone Power Station Agreement Act allows for only industrial and open space use of the site and a legislative change may be required to facilitate use of this site as a TWAF.	The proximity of this site to mainland launch site 1, arterial roads and Gladstone Airport resulted in it being put forward for further investigation as a potential TWAF.

Table 5.6 Advantages and disadvantages of potential TWAF sites (cont'd)

TWAF site	Discussion	Outcome
TWAF 8 Calliope–Targinie Road, Targinnie	TWAF 8 is a 51 ha parcel of land at the corner of Forest Road and Calliope–Targinie Road, Targinnie. It is located outside the GSDA and QER's mining lease for the proposed Stuart Oil Shale Project. Targinie Creek flows through the site, which is relatively flat and covered in 'of concern' and 'not of concern' native vegetation. A power line traverses the allotment, which is a partially developed grazing property. Arrow Energy has acquired the property. *Advantages*: • The property is outside the GSDA and is not encumbered by QER's mining lease. • Arrow Energy owns the property. • The site is close to mainland launch site 4N (7 km) with access to that site via Forest Road. It is 19 km from mainland launch site 1 via Forest Road, Landing Road and Port Curtis Way. • Power is available, but onsite package sewage and water treatment plants would be required. *Disadvantages*: • Targinie Creek is an important wildlife corridor and the site will need to be developed in a way that protects the corridor from disturbance. • Native vegetation along the creek and elsewhere is relatively intact, with weeds more prevalent away from the creek. • Forest Road and possibly part of Calliope–Targinie Road (depending on access to the site) will need to be upgraded to provide all weather access to the TWAF.	Notwithstanding the native vegetation, there is sufficient space to develop a TWAF and protect the wildlife corridor along Targinie Creek. The proximity of this site to mainland launch site 4N makes it attractive and, consequently, it was considered a feasible option worthy of further investigation.

The relationship of the TWAF to the mainland launch site is a consideration in the selection of the preferred site or sites. The TWAF should be as close as possible to the mainland launch site to minimise travel time, and ideally located on the same side of Gladstone to avoid the need for travel through residential and commercial areas.

TWAF 7 and TWAF 8 are the closest feasible sites to the proposed mainland launch sites at Western Basin Reclamation Area (launch site 4N) and the Calliope River (launch site 1). These sites could be used with either mainland launch site; however, greater efficiencies would exist if the sites were adjacent. Consequently, TWAF 7 and TWAF 8 remain under investigation and are assessed in the EIS.

During the development of the project, Arrow Energy will consider alternative mainland TWAF sites and alternative opportunities for temporary workers accommodation on the mainland, such as established third party provided accommodation facilities.

5.3 Feed Gas Pipeline Routes

Arrow Energy has coal seam gas assets in the Surat and Bowen basins from which gas transmission pipelines will be constructed to deliver gas to the proposed LNG plant on Curtis Island. This section describes how the gas transmission pipelines from the Surat and Bowen basins influenced the identification of feed gas pipeline routes and proposed Port Curtis crossing methods.

5.3.1 Proposed Gas Transmission Pipelines

The proposed gas transmission pipelines that would transport coal seam gas from the Surat and Bowen basins to the proposed LNG plant are described in this section.

Proposed Arrow Surat Pipeline

In 2009, Surat Gladstone Pipeline Pty Ltd, a wholly owned subsidiary of Arrow Energy Pty Ltd (Arrow), prepared an EIS under the *Environmental Protection Act 1994* (Qld) for the Surat–Gladstone Pipeline Project (now the Arrow Surat Pipeline). The pipeline was originally proposed to deliver gas from Arrow's Surat Basin coal seam gas fields to the proposed LNG Limited, Gladstone LNG Project at Fishermans Landing.

The 470-km-long pipeline begins near Kogan North and runs in an arc around the Barakula State Forest to Gladstone. The pipeline terminates at Fishermans Landing with a potential lateral connection to the Gladstone City Gate adjacent to the Yarwun alumina refinery. Petroleum Pipeline Licence (PPL) 144 and environmental authority have been issued for this pipeline. The Arrow Surat Pipeline enters and runs in the Western Corridor Sub-precinct then Boat Creek Sub-precinct of the GSDA, from the Bruce Highway to Fishermans Landing.

Proposed Central Queensland Pipeline

A joint venture between Arrow and AGL owns the Central Queensland Pipeline, which has been approved and licensed (PPL 121). The Central Queensland Pipeline runs from Moranbah to the Gladstone City Gate and, consequently, was a potential asset for delivery of gas from Arrow's Bowen Basin coal seam gas fields to Gladstone. However, the geographically diverse coal seam gas fields of the Bowen Basin and constraints imposed by black coal mine developments have resulted in Arrow investigating a separate pipeline route.

Proposed Arrow Bowen Pipeline

The proposed Arrow Bowen Pipeline and associated lateral pipelines will connect Arrow's tenements in the Bowen Basin with Gladstone. The proposed pipeline route extends from north of Moranbah to Gladstone. It enters the Stanwell–Gladstone Infrastructure Corridor south of Midgee near Rockhampton and runs in that corridor to Mount Larcom, where it enters and runs in the Northern Infrastructure Corridor Sub-precinct, Western Corridor Sub-precinct and Boat Creek Sub-precinct of the GSDA to the Gladstone City Gate.

5.3.2 Northern Infrastructure Corridor Sub-precinct

The proposed LNG plants on Curtis Island will result in four feed gas pipelines from the Surat Basin and one from the Bowen Basin. To avoid land use conflicts in the GSDA, particularly in the vicinity of Yarwun where the materials transportation and services corridors are constrained by topography, road and rail infrastructure and existing industrial developments, the Queensland Government declared the Northern Infrastructure Corridor Sub-precinct. This corridor starts at the Bruce Highway at the end of the Callide Infrastructure Corridor and generally runs around the western and northern perimeter of the GSDA. From the Bruce Highway, it runs north to near Mount Larcom, where it turns northeast, then east to traverse the foothills of the Mount Larcom Range and Targinie State Forest before crossing The Narrows between Friend and Laird points to Curtis Island.

5.3.3 Proposed Feed Gas Pipeline Routes

Arrow Energy's proposed gas transmission pipelines traverse or adjoin the Northern Infrastructure Corridor Sub-precinct; hence, there are two possible routes (Figure 5.3) to the proposed LNG plant on Curtis Island. They are:

- An indirect feed gas pipeline route in the Northern Infrastructure Corridor Sub-precinct, across The Narrows and in the Curtis Island Corridor Sub-precinct, which abuts the proposed LNG plant site.

- The Arrow Surat Pipeline to near Fishermans Landing and a direct route across Port Curtis to the Curtis Island Corridor Sub-Precinct at Hamilton Point then via that corridor to the proposed LNG plant site.

The methods for crossing The Narrows and Port Curtis were factors in the assessment of the direct and indirect routes. The crossing methods investigated are described in the following sections.

Indirect Feed Gas Pipeline Route Construction Methods

The construction methods investigated for The Narrows crossing include:

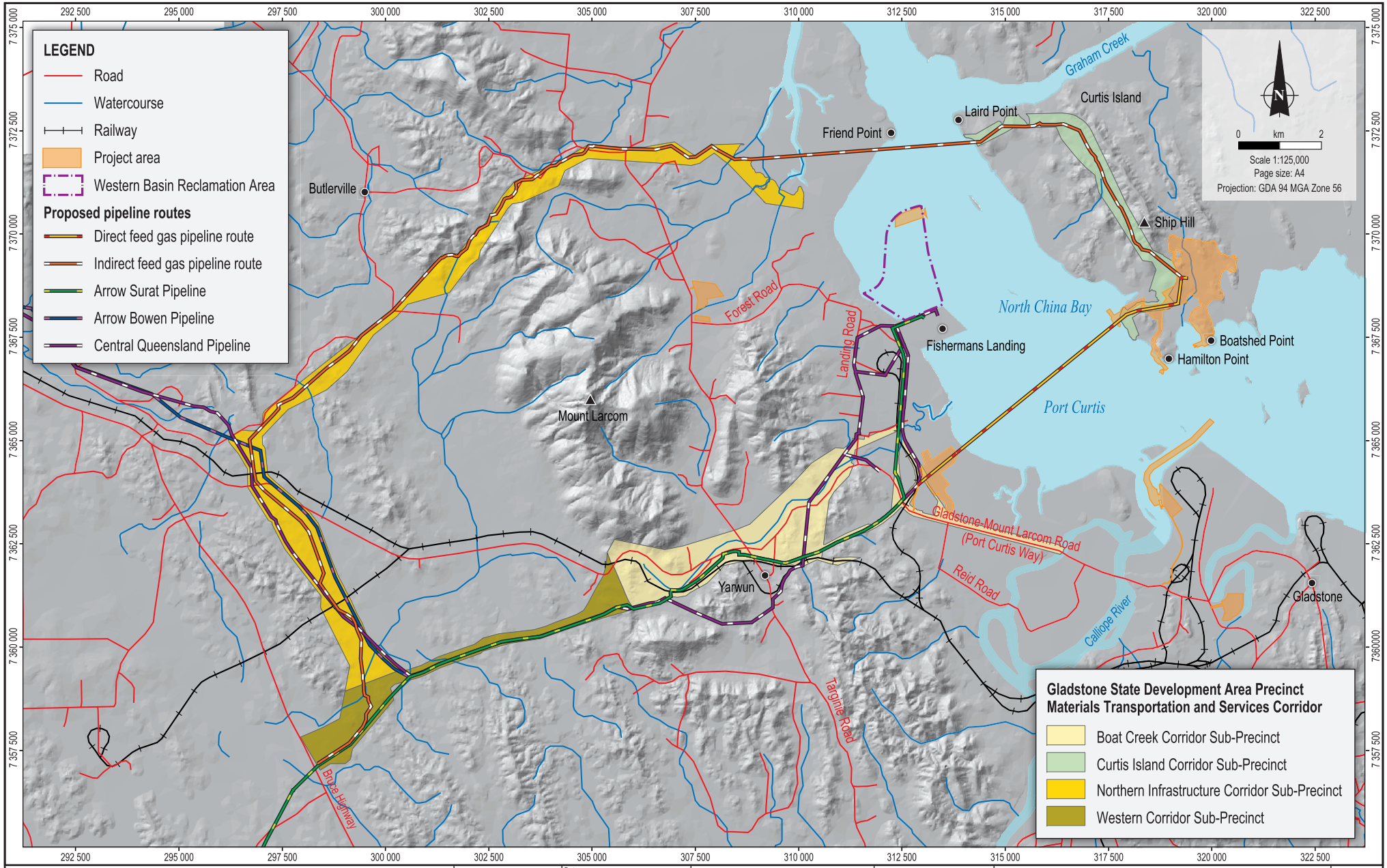
- Construction of separate pipeline crossings using conventional pipe laying methods modified to permit work on the unconsolidated sediments of the wetlands. Installation of the pipelines across The Narrows by construction of cofferdams from each point and dredging of a channel in the deeper waters. The buried pipelines would be protected by rock armouring. Alternatively, the pipelines would be installed under The Narrows using horizontal directional drilling (HDD).
- A bundled crossing where all pipelines would be laid in a single trench in a single construction campaign. The bundled crossing would involve excavation of a trench across the wetland from an elevated work platform constructed using conventional and sheet piles. Targinie and Humpy creeks would be crossed using HDD with one borehole for each pipeline. A trench would be dredged across The Narrows between cofferdams constructed from Friend and Laird points. The pipe bundle would be fabricated on the mainland and pulled into the trench and across The Narrows by winches installed on Laird Point, Curtis Island. The pipe bundle across The Narrows would be protected by rock armouring.

Direct Feed Gas Pipeline Route Construction Methods

Construction methods investigated for the direct crossing include:

- A tunnel bored from the mainland near Boat Creek to Hamilton Point in which the feed gas pipeline would be installed.
- A multi-stage HDD and installation of the feed gas pipeline in the boreholes. It is anticipated a three-stage drill would be required for the crossing. One borehole would be drilled from the mainland to an offshore cofferdam located near or beyond the edge of the seagrass beds. A second borehole would be drilled from Curtis Island to an offshore cofferdam west of the shipping channels. The final borehole would be drilled between the offshore cofferdams.
- A combination of direct-pipe micro-tunnelling and HDD. Direct-pipe micro-tunnelling involves attaching a boring or micro-tunnelling head to the end of a pipe and installing the pipe as the borehole is excavated. Pipe thrusters are used to assist with feeding the pipe into the borehole. The direct-pipe micro-tunnel would extend from the mainland for approximately 4.5 km, with offshore cofferdams each 1.5 km. The HDD would extend from Curtis Island for approximately 1.5 km to an offshore cofferdam where the pipeline installed in the HDD borehole would connect with the pipeline installed by direct-pipe micro-tunnelling.
- A combination of HDD and post-lay trenching. HDD would be used for the mainland and Curtis Island shore crossings, which would extend to offshore cofferdams. The mainland HDD would extend near or beyond the edge of the seagrass beds depending on the reach of the HDD.

  The Curtis Island HDD would extend west of the shipping channels. The pipeline would be installed in the HDD boreholes. Concrete-coated pipeline would be layed on the seabed



Source:
Place names, roads, railways and watercourses from DME.
Proposed pipelines from Arrow Energy.
Proposed feed gas pipeline, project area and digital elevation model from Coffey Environments.
Western Basin Dredging Master Plan and Disposal Project from Gladstone Ports Corporation.
Gladstone State Development Area Precincts from DIP.

coffey environments

Date: 18.11.2011
MXD: 7033CA_07_GIS261_v1_4
File Name: 7033_07_F05.03_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Proposed feed gas pipeline routes

Figure No: **5.3**

between the offshore cofferdams and buried by post-lay trenching using a plough or hydro-jetting machine.

- A combination of HDD, pre-lay and open-cut trenching. A HDD would be used for the Curtis Island shore crossing, which would extend west of the shipping channels to an offshore cofferdam. Open-cut trenching would be used for the mainland shore crossing and extend to sufficient water depth to enable the excavation of a trench using pre-lay methods. Pre-lay trenching methods include ploughing and excavation by barge-mounted excavators or submersible trenching machines. The concrete-coated pipeline would be installed in the open trench, which would be backfilled with the excavated material that would typically be side-cast.

5.3.4 Preferred Feed Gas Pipeline Route and Construction Method

Arrow Energy has investigated the pipeline routes and proposed construction methods, and worked with the other LNG proponents and the Queensland Government on the evaluation of the bundled crossing of The Narrows to explore co-location opportunities and the associated efficiencies and cost benefits. The investigations resulted in Arrow Energy pursuing a direct crossing of Port Curtis and installation of the feed gas pipeline in a tunnel to be bored under Port Curtis between shafts established on the mainland and Curtis Island. The reasons for this decision are set out below.

Alignment with Arrow Energy Project Timeframes

Environmental and engineering constraints associated with laying separate pipelines across The Narrows would make it desirable for Arrow Energy to participate in the proposed bundled crossing and single construction campaign. Arrow Energy's schedule is presently 24 to 36 months behind the other LNG projects that have received approval. Construction has commenced on the three other LNG projects on Curtis Island. These differing project timelines (including the absence of approval for Arrow Energy to use The Narrows crossing) meant that this indirect route was a less favoured option.

Avoidance of Significant Environmental and Cultural Issues

The indirect route involves construction of the pipeline in difficult terrain involving steep slopes, narrow valleys and wetlands. HDD will be required to avoid steep side slopes and watercourses in the foothills of the Mount Larcom Range.

The Narrows crossing presents significant environmental management issues, including the management of potential and actual acid sulfate soils along the length of the pipeline route where it crosses the wetland adjacent to Targinie Creek and Kangaroo Island. Migratory bird roosting and foraging sites have been identified on the wetland and in the fringing mangroves. The Narrows crossing between Friend and Laird points is immediately south of the habitat protection zone of the Great Barrier Reef Coast Marine Park, which extends up Graham Creek and to the mouth of Targinie Creek. Kangaroo Island and Graham Creek are significant cultural sites for the Indigenous community.

In contrast, the tunnel is less invasive and would be undertaken in less environmentally sensitive areas. Consequently, the direct crossing was preferred over the indirect route with a crossing of The Narrows.

Shortest Distance

Depending on the starting point for the feed gas pipeline, the indirect route involves construction of between 28 km (start near Mount Larcom) and 38 km (start at Bruce Highway) of pipeline. The direct route involves the construction of 9 km of pipeline (up to 6 km in a tunnel) from the Arrow

Surat Pipeline near Fishermans Landing to the proposed LNG plant site. The significantly shorter direct route was preferred over the longer indirect route.

Avoidance of Future Infrastructure Conflict

The Western Basin Master Plan (DIP, 2010a) notes that an infrastructure corridor from the mainland to Curtis Island has been investigated and involved provision for road and rail infrastructure, including a possible bridge over The Narrows. The Coordinator-General states:

> In the absence of demonstrated demand or willingness to pay by potential users, the development of road and rail infrastructure to connect the mainland section of the Gladstone State Development Area to Curtis Island will not be viewed at this stage as a priority by the Department of Infrastructure and Planning.
>
> The capacity to accommodate future linear infrastructure such as road and rail infrastructure will be maintained to ensure all infrastructure planning options are available to the Government in the future.

The indirect route, although located south of the possible future infrastructure corridor, would involve crossings of the corridor on the mainland and Curtis Island. The corridor is highly constrained at Laird Point where it traverses undulating terrain between the Curtis Island Industry Precinct and the Great Barrier Reef Coast Marine Park. The direct route avoids potential conflicts with the possible future infrastructure corridor on the mainland, at The Narrows and on Curtis Island.

5.4 Dredge Spoil Disposal Sites

In addition to dredging undertaken as part of the WBDD Project, up to five additional sites may require dredging to facilitate construction and operation of the LNG plant marine infrastructure. The sites are:

- Mainland launch site 1: Dredging of approximately 900,000 m^3 (maximum amount of dredging which will be minimised where possible) of material from the Calliope River to connect the launch site to the Clinton Channel.
- Mainland launch site 4N: Dredging of approximately 2,500 m^3 of material to connect the launch site to the Targinie Channel.
- MOF (Boatshed Point): Dredging of up to 50,000 m^3 of material to facilitate construction and operation of the facility.
- MOF (Hamilton Point South): Dredging of up to 50,000 m^3 of material to construct and operate a facility at this site.
- LNG jetty (Hamilton Point): Dredging of approximately 120,000 m^3 of material to create a workspace for construction of the jetty using barge mounted cranes and equipment.

The volume of dredge spoil to be disposed of ranges from 172,500 m^3 to 1,070,000 m^3 depending on the mainland launch and MOFs adopted. Arrow Energy's preference for disposal of dredge spoil is an existing or approved spoil disposal area, as this would avoid establishing a new onshore or offshore disposal area. The relatively small volume of dredge spoil compared with the volumes to be dredged as part of the WBDD Project (Table 5.7) enable existing and proposed disposal sites to be considered.

Table 5.7 Western Basin Dredging and Disposal Project dredge volumes

Stage	Description	In Situ Volume (million m^3)
1A	Curtis Island channels, berth pockets and swing basins	24.2
1B	Targinie Channel (deepening to Fishermans Landing)	5.6
2 and 3	Laird Point and Fishermans Landing	10.0
4	Hamilton Point	5.5
	Total volume of material to be dredged	**45.3**

Source: GHD (2010a).

The Gladstone Ports Corporation is responsible for providing and maintaining shipping facilities and navigable channels within the port. The Gladstone Ports Corporation undertook an assessment of potential spoil disposal options as part of the WBDD Project, which was approved by the Queensland and Commonwealth governments in July 2010. The spoil options investigated were described in the WBDD Project EIS (GHD, 2010a) and included:

- The proposed Western Basin Reclamation Area, an approximately 300 ha site abutting the Fishermans Landing reclamation area.
- East Banks Sea Disposal Site, which is located east of Gatcombe Head, Facing Island. This existing site has been used for disposal of capital and maintenance dredging spoil.
- Commercial re-use of spoil material that was deemed unviable due to the material comprising mixed, difficult-to-separate soil types.
- Unconfined disposal in subtidal locations within Port Curtis that were deemed unviable because deposited material was likely to be transported into shipping channels, swing basins and berth pockets, resulting in the need for more frequent maintenance dredging with the potential for greater adverse environmental impacts.
- Alternative reclamation areas within the port, which had similar environmental values to the Western Basin Reclamation Area; however, construction of substantial bund walls to contain the dredged material would be required.
- Onshore disposal at Hamilton Point, Boatshed Point and Laird Point, which had the potential to prevent sites being used for LNG development.

Gladstone Ports Corporation undertook further investigations into the feasibility of the East Banks Sea Disposal Site to determine its capacity to accept dredge spoil. At the time the EIS was prepared, the site had a licensed limit of 1 million m^3. Bathymetric surveys determined that it has an additional net capacity of approximately 9 million m^3.

On 22 October 2010, the Commonwealth Government approved the WBDD Project with conditions. The conditions restricted the Western Basin Reclamation Area to 300 ha, with spoil mounds not to exceed 27 m above lowest astronomical tide. This area was less than originally proposed by the Gladstone Ports Corporation and, consequently, the Commonwealth Government approved disposal of up to 11 million m^3 (in situ) at the East Banks Sea Disposal Site. The approval also permitted disposal to new sites including in the Great Barrier Reef Marine Park, subject to the preparation and approval of a long-term sediment disposal plan. This was particularly relevant to material dredged as part of stages 2, 3 and 4 of the WBDD Project.

Arrow Energy has considered four options for spoil disposal (Figure 5.4). All options involve taking a coordinated approach with the Gladstone Ports Corporation. The options are:

Western Basin Reclamation Area

The Western Basin Reclamation Area is Arrow Energy's preferred disposal site due to its proximity to the dredge sites. The revised layout of the reclamation area has a nominal capacity of 29 million m^3. The Gladstone Ports Corporation Western Basin Dredging and Disposal (Onshore and Offshore) Dredge Management Plan (Aurecon, 2011) indicates that approximately 19 million m^3 will be disposed of in the reclamation area, including up to an additional 8 million m^3 if that material is not disposed of in the East Banks Sea Disposal Site.

The timing of Arrow Energy's dredging program in relation to the progress of reclamation may preclude this option, particularly if acid sulfate soils are present in the dredged material, because the Coordinator-General (DIP, 2010a) has imposed a condition (Condition 24) on the placement of untreated potential acid sulfate soil. Disposal to the reclamation area, which has capacity, is consistent with the Port of Gladstone Western Basin Master Plan, which promotes a coordinated approach to disposal of spoil material.

East Banks Sea Disposal Site

In his report for the WBDD Project EIS, the Coordinator-General (DIP, 2010b) noted:

> The advantages of offshore disposal of 8-10 million cubic meters of material at sea are that it would potentially reduce the quantity of [potential acid sulfate soil] PASS requiring storage in the [Western Basin] reclamation area; reduce the overall height of the reclamation mound by approximately 10 m and the batter slope to a maximum of 1-in-10; and avoid or significantly reduce the necessity for rehandling of dredged material extracted by trailing suction hopper dredge thereby significantly reducing the incidence of turbid plumes and the area of impact on nearby seagrasses.

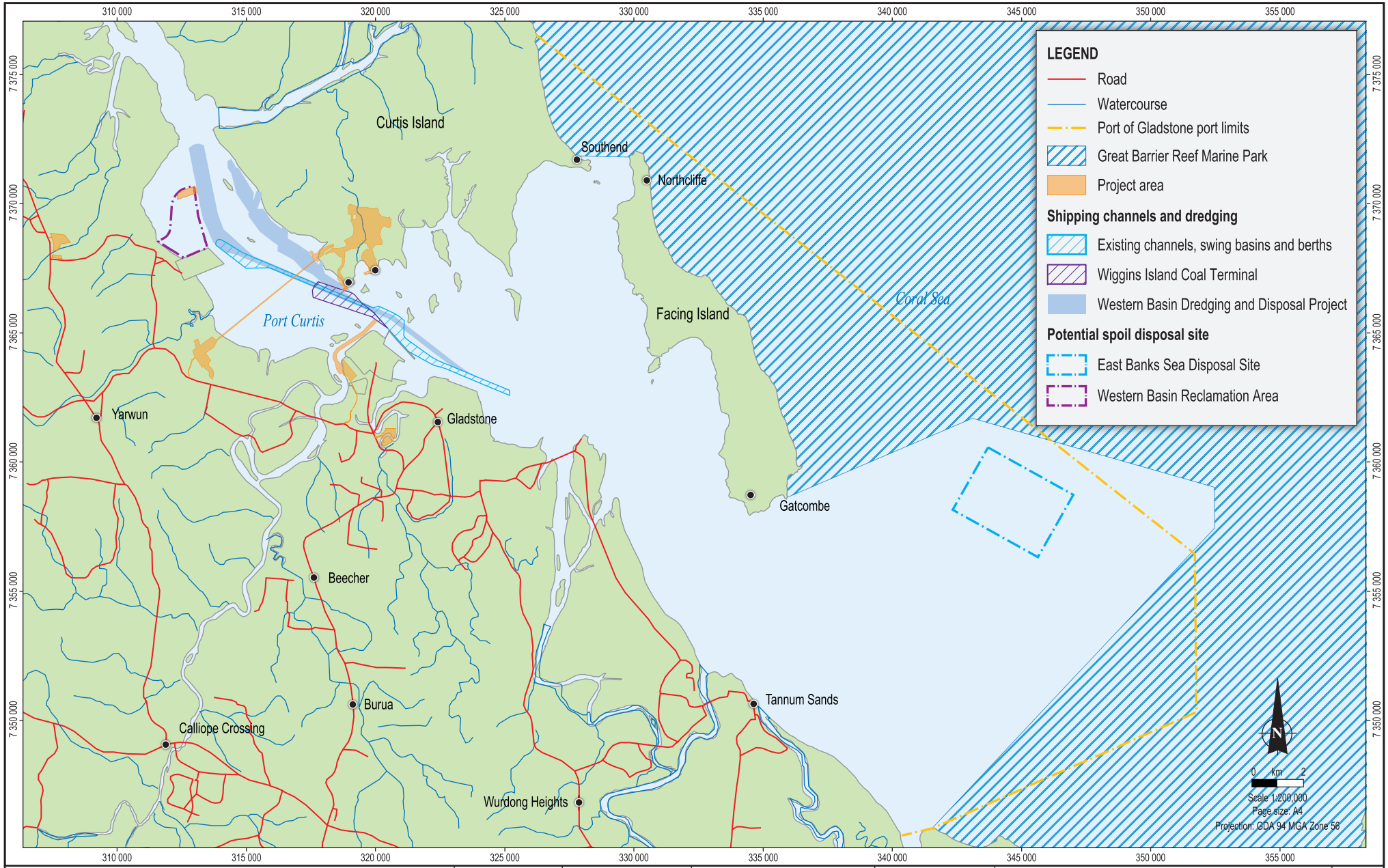
There is capacity in the East Banks Sea Disposal Site, which will be utilised where it is prudent to dispose of dredge spoil containing acid sulfate soils. The feasibility of using this site will be determined in consultation with Gladstone Ports Corporation once the total volume and composition of dredge material are known. Being an approved site, it is preferred over new disposal sites.

New Offshore Disposal Site

Gladstone Ports Corporation has been approved to investigate and seek approval for new offshore disposal sites in the event that capacity in the Western Basin Reclamation Area and East Banks Sea Disposal Site is exhausted. The approval relates principally to dredging conducted as part of stages 2, 3 and 4 of the WBDD Project. Arrow Energy will liaise with Gladstone Ports Corporation on access to any new offshore disposal area before pursuing the identification and approval of an offshore disposal site for its purposes.

A new offshore disposal site, if sought, would likely lie within the Great Barrier Reef Marine Park. Requirements for offshore disposal of spoil in the Great Barrier Reef Marine Park include:

- A permit under the *Environment Protection (Sea Dumping) Act 1981* (Cwlth). Permit application requirements are described in the national assessment guidelines for dredging (DEWHA, 2009a). The guidelines require evaluation of all alternatives to ocean dumping before a permit application is lodged. The applicant must then undertake an extensive environmental data collection program before a decision will be made.
- A permit under the *Great Barrier Reef Marine Park Act 1975* (Cwlth). The Great Barrier Reef Marine Park Authority, which administers the act, requires dredging and spoil disposal within the marine park to be assessed in accordance with the authority's policy for environmental impact management.



Source:
Place names, roads and watercourses from DME. Great Barrier Reef Marine Park from GBRMPA.
Project area and potential soil disposal sites from Coffey Environments.
Western Basin Dredging Master Plan from Gladstone Ports Corporation.
Port of Gladstone port limits and East Banks Sea Disposal Site digitised by Coffey from GPC figure (accuracy may be compromised).

coffey environments

Date: 17.11.2011
MXD: 7033CA_07_GIS262_v1_1
File Name: 7033_07_F05.04_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Potential spoil disposal sites

Figure No: 5.4

- Referral and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). Referral must be made due to the activity's potential to have a significant impact on a matter of national environmental significance, particularly the Great Barrier Reef World Heritage Area. The approval process will need to demonstrate that all prudent and feasible alternatives have been identified, assessed and discounted.

Offshore disposal in a new sea disposal site is not preferred by Arrow Energy. A decision on whether to pursue this option would be made in consultation with the Gladstone Ports Corporation and Queensland and Commonwealth governments. Key issues in deciding whether to pursue this option include:

- Arrow Energy's preference to avoid project activities in the Great Barrier Reef Marine Park.
- The logistics and costs associated with transporting spoil significant distances offshore.
- The lengthy approval times under the relevant legislation, which might be inconsistent with the project schedule.

New Onshore Reclamation Area

Onshore disposal of dredge spoil is an option, as discussions with the Queensland Government indicate that future development of the Gladstone State Development Area might include reclamation of intertidal and coastal areas of Port Curtis. Potential sites might include the intertidal areas adjacent to the proposed tunnel launch site on the mainland where it is proposed to dispose of the tunnel spoil. Use of such sites for dredge spoil disposal would require separate planning and approval processes. Onshore disposal is not preferred by Arrow Energy, and would only be considered when options to use existing and proposed disposal sites were exhausted.

5.5 Co-location Opportunities

Arrow Energy has participated in discussions with the Queensland Government and other LNG proponents about opportunities to rationalise and co-locate infrastructure. Co-location opportunities considered by Arrow Energy include:

- Feed gas pipeline route (Northern Infrastructure Corridor Sub-precinct, The Narrows and Curtis Island Corridor Sub-precinct). Arrow Energy participated in discussions on the consolidation of all feed gas pipelines in the Northern Infrastructure Corridor Sub-precinct and design and construction of a bundled crossing of The Narrows. Disparate project schedules and the need for a substantial pre-investment were key reasons for Arrow Energy withdrawing from the discussions and pursuing a direct crossing of Port Curtis.
- Facilities at Hamilton Point, Curtis Island. Arrow Energy continues to discuss options for use of Gladstone LNG Project's Hamilton Point MOF because this facility and the associated haul road provide ready access to the proposed LNG plant site. Differences in project schedules and access arrangements are key reasons for Arrow Energy pursuing alternative sites at Hamilton Point South and the preferred site at Boatshed Point.
- Mainland launch sites. Gladstone Ports Corporation has promoted the consolidation of mainland launch facilities for the operations phases of the proposed LNG projects on Curtis Island. The Commonwealth Government approval for the WBDD Project proposes an LNG operations area at the northeast corner of the Western Basin Reclamation Area at proposed launch site 4N. Arrow Energy has investigated sharing of mainland launch facilities with the other LNG proponents; however, different project schedules and facility access arrangements remain key reasons for Arrow Energy pursing separate facilities. Arrow Energy also seeks to

consolidate its construction and operations needs in a permanent facility in order to reduce the impact on available land.

- Common infrastructure. Arrow Energy is participating in the Gladstone Infrastructure Working Group, which is considering opportunities for the provision of electricity, water and sewerage services to Curtis Island to overcome the need for each project to construct and operate onsite power generation and water and sewage treatment facilities. At the time of preparation of this EIS, the Gladstone Area Water Board was investigating the construction of a water supply pipeline and sewerage main to the island. Arrow Energy is considering participation in the project to supply water and sewerage connections to the island.

Arrow Energy will continue to participate in such forums to realise any efficiencies achieved through sharing of common infrastructure.

5.6 Economic, Environmental and Social Impacts of Not Proceeding

The direct consequences of not proceeding with the Arrow LNG Plant comprise negative and positive environmental, economic and social impacts. Potential positive impacts of not proceeding include:

- Potential environmental and social impacts of the project will be avoided. The impacts on land, water and air (and associated physical, biological, social and cultural impacts) arising from the development of the project will not occur.
- Potential impact on the domestic gas market will be reduced. The Arrow LNG Plant is expected to have only a minor effect on eastern Australian gas consumption and prices. The Arrow LNG Plant, when considered in conjunction with other LNG project proposals, is likely to have a major impact on gas consumption and prices, particularly in Queensland, in the period after 2020. The magnitude of this impact will ultimately depend on the scale and pace of LNG industry expansion.
- Potential loss of skilled workers from local and regional businesses to the LNG industry will be reduced. Employment opportunities and potential higher wages within the LNG industry may result in competition for, and a demand for, local workers. There is a risk that businesses competing for skilled and unskilled workers and supplies could face a potential rise in wages and operating costs. This is particularly the case given the labour market will already be under pressure from other LNG projects in the Gladstone region. Timing of construction of the Arrow LNG Plant will determine whether there is further pressure on the local workforce or whether it is reduced by the migration of workers from the QCLNG and GLNG project, as they near completion.
- Potential housing impacts may not be as significant or sustained as predicted. Demand for housing and short-term rental accommodation in the Gladstone region is expected to drive up property and rental prices, leading to reduced availability and less affordable accommodation for local residents. This may lead to the temporary and possibly permanent relocation of residents to other towns as they seek respite from a lack of housing or higher house and rental prices. Low-income households and the predominately retired 55 to 75 year olds are the most vulnerable in this respect. Construction of the QCLNG and GLNG projects is already affecting property and rental accommodation availability and affordability. The timing of the Arrow LNG Plant in relation to these projects will determine whether the project exacerbates or prolongs

this situation, and whether social impact mitigation measures implemented by those proponents have reduced stresses in housing and rental accommodation.

- Potential pressure generated by the project on local and regional infrastructure and services will be reduced. The project may stimulate demand for services including the Gladstone airport, childcare and educational facilities, health care facilities, waste facilities, policing and emergency services, and water and electricity utilities. By not proceeding, the additional demand on these services will be avoided.

Potential negative impacts of not proceeding include:

- Economic benefits will not be realised. These benefits include an estimated investment of A$15 billion and estimated annual operating costs of A$750 million. Local, regional and state economies would not realise the direct benefits and flow-on effects of these investments. Opportunities for local businesses to increase sales through new contracts for the supply of goods and services to the project would be diminished.
- Job opportunities will be lost. The direct creation of approximately 3,715 jobs during stage 1 of project construction, a further 2,330 jobs during stage 2 of project construction and up to 600 long-term jobs created during the project's operational phase will not be realised. This will include both general positions and those that require training for highly skilled roles.
- Revenue to the Queensland and Australian governments from taxes and duties would be forfeited. Potential downward pressure on the cost of foreign goods and services from a strong Australian dollar, as a result of the production and export of LNG, a high value product, would not be as pronounced.
- An opportunity to reinforce Australia’s position as a global energy producer will be compromised. This would be as a consequence of industry and investment community confusion about Australian and Queensland government commitment to the LNG industry, particularly as Australian and Queensland government policy supports the development of Australia's LNG industry and the country's potential as a global energy producer of less carbon-intensive energy resources