WorleyParsons

resources & energy

EcoNomics™

LANDCORP

Ashburton North Strategic Industrial Area

Economic and Market Analysis

301012-02069 – MP-REP-0001

19 March 2015

Level 7, QV1 Building,
250 St Georges Terrace Perth WA 6000
Australia
Telephone: +61 8 9278 8111
Facsimile: +61 8 9278 8110
www.worleyparsons.com
ABN 61 001 279 812

SYNOPSIS

This report has been prepared for LandCorp by WorleyParsons for an economic and market analysis of the Ashburton Strategic Industrial Area (ANSIA). The purpose of this study is to inform the future studies required to plan the remaining areas (Stage 1D, Stage 2 and land further to the east) within the ANSIA.

In doing this, a review of market data and literature has been undertaken to consider the potential for iron ore, LNG, petrochemicals, salt and renewables industries to potentially locate within the ANSIA. A number of potential projects have been outlined in short, medium and long term scenarios along with the key inputs and outputs for each of these industries. Finally, an analysis has been undertaken of other similar strategic industrial estates and regions to compare these to ANSIA.

PROJECT 301012-02069 - ASHBURTON NORTH STRATEGIC INDUSTRIAL AREA

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for review	M Wegg	J Schepis	N/A	25-Nov-14	N/A	
0	Issued to client	M Wegg	J Schepis	M Wegg	23-Dec-14		N/A
1	Reissued to client	M Wegg	D Foster	D Foster	19-Mar-15	D Collins	31-Mar-15

CONTENTS

Appendices

1 INTRODUCTION

This report has been prepared for LandCorp by WorleyParsons for an economic and market analysis of the Ashburton Strategic Industrial Area (ANSIA).

In 2009, the Western Australian State Government announced its support for the establishment of the ANSIA as a hydrocarbon precinct that would allow for the development of natural gas projects, associated industry and downstream processing. Since this time, a number of milestones have been achieved including the following:

- In 2010, establishing the ANSIA Special Control Area as a planning framework for the area;
- In 2011, the ANSIA ANSIA Structure Plan approved establishing the planning framework and staging of the ANSIA in more detail;
- In 2012, leasing land to Chevron for the Wheatsone LNG Project and BHP Billiton for the Macedon Domestic Gas Plant;
- In 2013, zoning of LandCorp's General Industrial Area (Stage 1C) as 'Industry' under the Shire of Ashburton's Town Planning Scheme No. 7; and
- In 2013, rezoning the 'Future Industry Area' (Stage 1B) to 'Strategic Industry' under the Town Planning Scheme.

In general, the majority of the work to bring the original 'Stage 1' of the ANSIA to a project ready status has been completed from 2011 to 2014. The purpose of this study is to inform the future studies required to plan the remaining areas (Stage 1D, Stage 2 and land further to the east) within the ANSIA.

This study has been prepared based on a review of background reports and from consultation with Apache, Norwest Energy, North West Shelf Gas for gas processing matters, Horizon Power for power and Wesfarmers CSBP for potential ammonia/urea developments.

2 BACKGROUND

2.1 The Pilbara

The Ashburton North Strategic Industrial Area is located just south of Onslow on the Pilbara coast in the Shire of Ashburton.

The Shire, at about half the size of Victoria, boasts some of the world's largest open cut mines, pastoral leases and cattle stations, and a strong fishing industry. Employment includes oil and gas, mining, cattle, fishing and tourism. There is an established salt recovery project at Onslow. The majority of the area of the Shire is divided into pastoral properties.

Spread amongst these large pastoral stations is the towns of Onslow, Pannawonica, Paraburdoo and Tom Price. The majority of the population lives in these four towns with a number of Aboriginal communities in more remote locations.

The Pilbara region comprises the Local Government Areas of Ashburton, East Pilbara, Port Hedland and Karratha. The region has experienced a boom in the last decade with the jump in world commodity prices and the demand for minerals and oil and gas. Between the 2006 and 2011 Census, employment in the region almost doubled with the greatest growth being in the East Pilbara (+136%) and Karratha (+111%) Shires/Cities.

Although its residents represent only 0.2% of Australia's total population, the Pilbara region accounts for 13%of Western Australia's Gross State Product, driven mainly by the mining and oil and gas sectors. Not surprisingly, the Pilbara has been dubbed "the engine room of the Australian economy".

Rising demand for minerals and oil and gas has helped put many large-scale projects into the development pipeline over the last decade. In WA, the more significant projects include the $56 billion Gorgon and $30 billion Wheatstone oil and gas projects. As at March 2014, Western Australia had an estimated $149 billion worth of resource projects under construction or in the committed stage of development. A further $112 billion has been identified as planned or possible projects[1].

The 2011 Census data shows that the mining industry was the largest employment sector, accounting for 41% of employment followed by the Construction industry with 19% (Table 1).

[1] http://www.dmp.wa.gov.au/pdf/12410.pdf

Table 1 Pilbara Region Employment by Industry and Local Government Area

Local Government Area	Mining	Construction	Transport, Postal and Warehousing	Accommodation and Food Services	Education and Training	Manufacturing	Healthcare and Social Assistance	Other	Total
Ashburton	5,429	1,855	631	431	231	120	182	1,398	10,277
East Pilbara	7,472	935	598	163	241	207	174	1,490	11,280
Port Hedland	2,170	1,547	520	732	432	472	554	2,143	8,570
Karratha	3,429	4,067	718	1,028	623	646	514	3,804	14,829
Pilbara Region - total	**18,500**	**8,404**	**2,467**	**2,354**	**1,527**	**1,445**	**1,424**	**8,835**	**44,956**

Source: ABS 2011 Census

The Pilbara is such a vast area that statistics on the region as a whole can be misleading in terms of the impact of local industry. The Shire of Ashburton has experienced rapid growth over the last 50 years from a very small population of an around 500 in 1961 to nearly 11,000 in June 2013 (Figure 1).

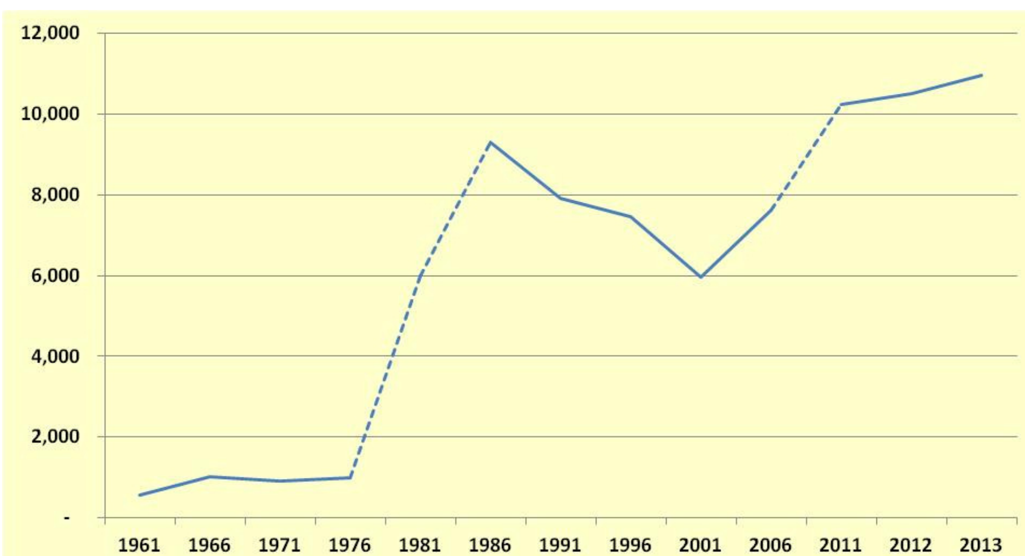

Figure 1 Shire of Ashburton Population

*Source: ABS database *some missing years mean the data needs to be viewed with caution*

The Shire had 22% of the jobs in the Pilbara at the 2011 census. The 10,230 jobs counted in 2011 are estimated to have increased to 17,820 by June 2013 as a consequence of the construction of the gas plants at Onslow and expansions in iron ore mining. Reflecting the construction phase of the projects only half of the jobs are held by residents of the Shire. The resource boom in the Shire means that the estimated unemployment rate in mid-2013 was only 1.46%[2].

Within the Shire the overwhelming majority of the jobs are associated with the mining operations and the associated towns. In the 2011 Census the top three employment sectors were mining (53%), construction (18%) and hospitality services (6%).

The Shire's economy is dominated by the mining sector. This was reflected in both economic output and wages and salaries.

Mining contributes 85% of the economic output while construction contributes 8% making a combined total of 93% (Figure 2). Much of the construction work is linked to the mining and oil and gas sectors and hence the domination of these sectors is clear.

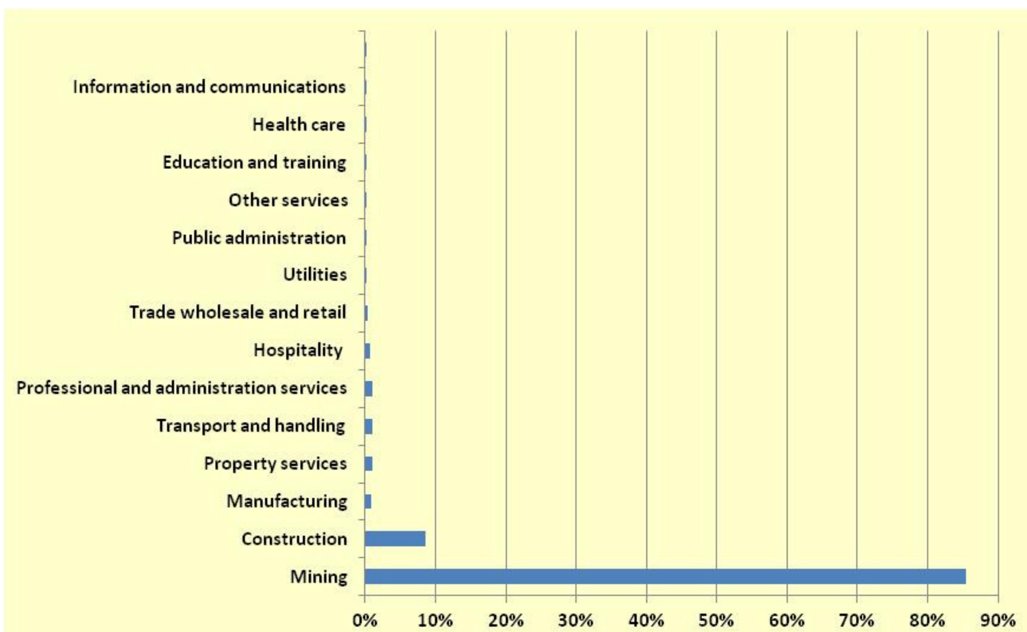

Figure 2 Shire of Ashburton Economic Output

Wages and salaries are among the highest in Australia with an average of around $120,000 per employed person in 2013. Payments were dominated by the mining sector (65%) and the construction sector (18%) together making up 83% of the total (Figure 3).

[2] Id.com.au Ashburton database

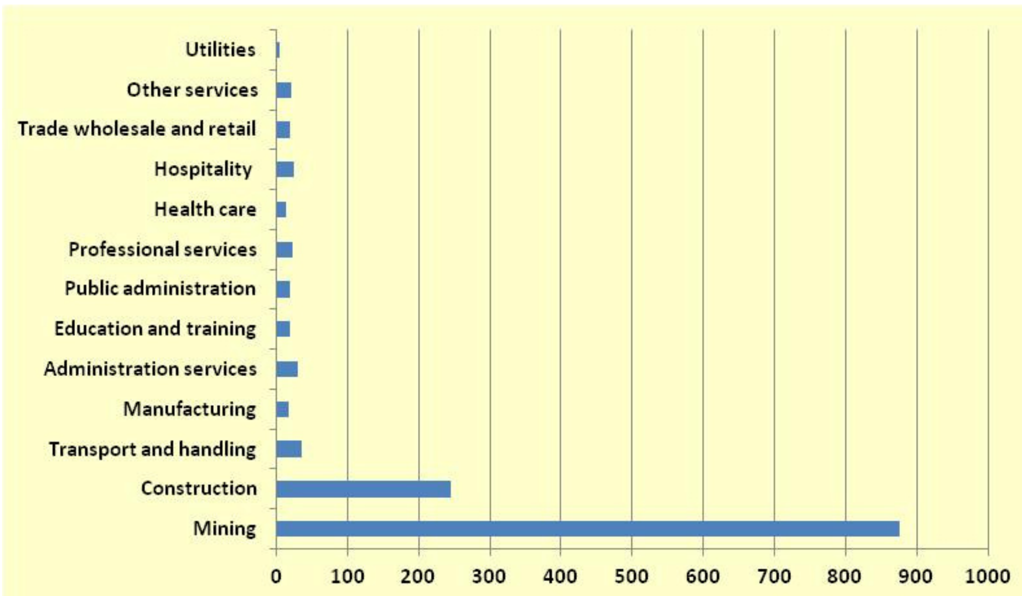

Figure 3 Shire of Ashburton Wages and Salaries

2.2 Ashburton North Strategic Industrial Area

The Ashburton North Project is located 11km southwest of Onslow and approximately 300km west of Karratha. It was announced in 2009 to cater for the LNG and domestic gas processing industries as well as related downstream processing industries.

The project comprises a port area (Ashburton North Port) and an 8,000ha Strategic Industrial Area (SIA) with the potential to accommodate up to two LNG processing facilities, at least two domestic gas processing facilities and multiple downstream processing industries.

The current proponents in the Ashburton North SIA are:

- BHP Billiton – Macedeon Domestic Gas Project
- Chevron – Wheatstone LNG Project

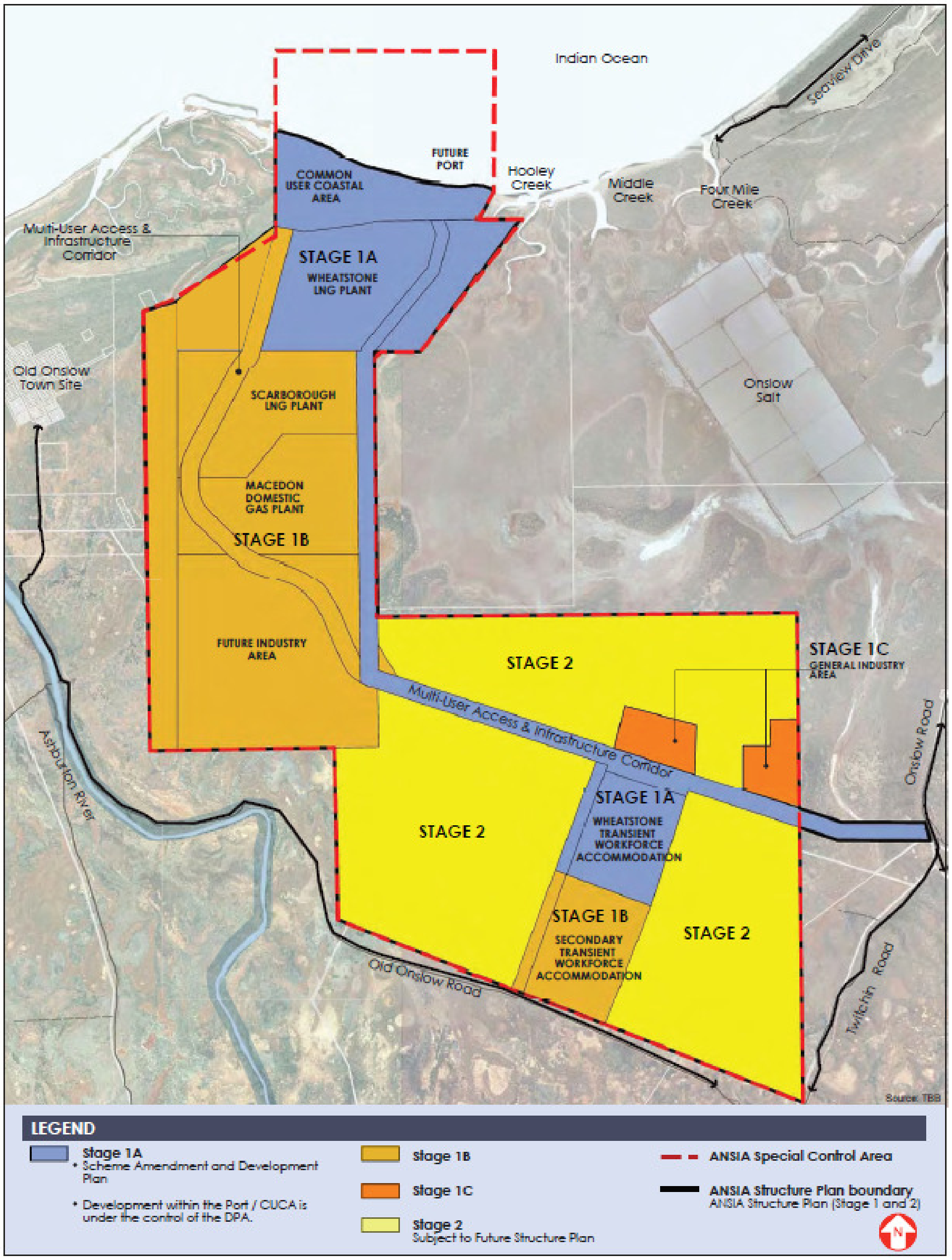

Figure 4 ANSIA Staging Plan

(source: tpg Ashburton North Strategic Industrial Area Development Plan Report)

The ‘general industry area’ occupies 200ha (two 100ha portions) and is a multi-user estate for general industrial uses that support the key industries of the ANSIA.

3 IRON ORE INDUSTRY

3.1 Iron Ore in the Pilbara

Iron ore production is the foundation of the Pilbara economy. It involves a large workforce in construction and operations, dominates trade through the ports, involves a high level of investment and has a promising future.

More than 98% of Western Australian iron ore comes from the Pilbara with small volumes from the Mid West, Kimberley and Yilgarn regions.

Almost 93% of identified resources in Australia (64 billion tonnes) are located in Western Australia, with more than 98% of this from the Pilbara, one of the world's major iron ore regions. Western Australia provides 97% of Australian production with small volumes from South Australia and Tasmania (Figure 5).

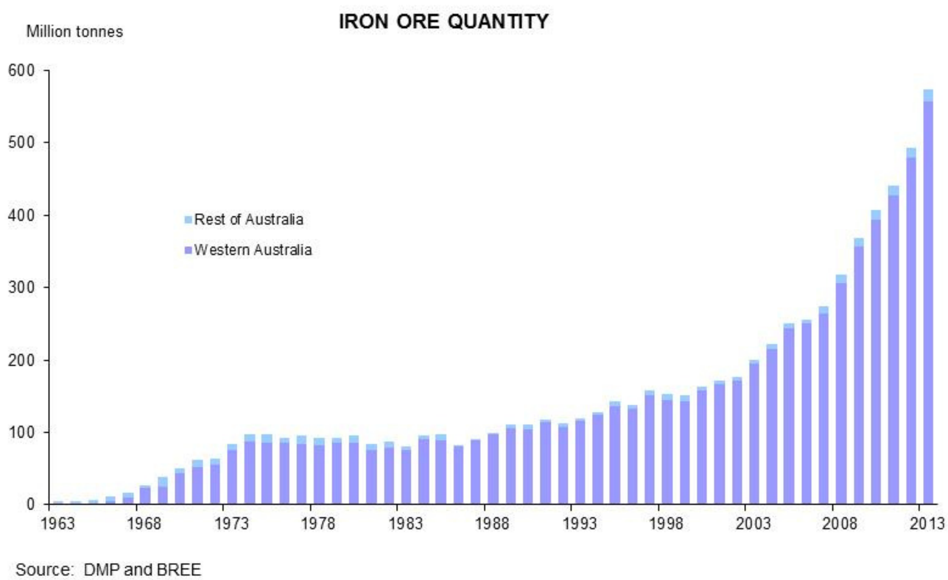

Figure 5 Australian Iron Ore Production

Iron ore export and processing are highly unlikely to take place at the ANSIA given the location of present infrastructure. Hence, while the industry has a promising future in the Pilbara it is not considered further in this report.

4 LNG INDUSTRY

The world liquid natural gas (LNG) industry is the most rapidly expanding component of the energy sector, driven by increases in economic growth in Asia and fuel switching from nuclear and coal sources. In addition, the LNG part of the gas industry is anticipated to grow twice as fast as the total natural gas market over the next 30 years. The LNG industry has strong prospects for growth over the long term.

There are sufficient gas reserves around the world to meet current demand for the next 70 years. While the reserves of unconventional gas (shale gas, tight gas, and coal bed methane) are not well defined, their inclusion is likely to add a further 100 years to the life of existing reserves at the current rate of gas use.

Australia contributes only 1.5% of world LNG production. However, Australian exports are currently at 24Mtpa and make up 9% of world trade. Asian markets – China, Japan and Chinese Taipei – are the most rapidly expanding. Australia has been spending much more than the total of the rest of the world on export infrastructure and is set to become the leading world LNG export nation with a number of additional facilities due to come on-stream over the next four years.

4.1 Production

The Pilbara contributes 85% of current Australian LNG production, with the North West Shelf and Pluto projects producing this supply.

The Carnarvon Basin off the Pilbara coast is Australia's largest reserve and currently provides 30% of domestic gas needs and virtually all the exported gas. Three new projects are under construction in WA[3]:

- Gorgon LNG (Barrow Island) will be online by 2015-16 producing 15.6Mtpa
- Wheatstone LNG (Onslow) will be online in 2016 with an initial capacity of 8.9Mtpa
- Prelude Floating LNG under construction with a planned production of 3.6Mtpa and an additional 1.7Mtpa of associated liquids from 2017

The Gorgon and Wheatstone projects will include pipeline connections to the Dampier to Bunbury Natural Gas Pipeline (DBNGP) and will supply domestic customers in the South West of the State. There is no domestic gas component to the Prelude project at this stage.

These new projects will increase Western Australian exports from 21Mtpa to 49Mtpa. Adding the projects currently awaiting a final investment decision would take Western Australian to 70Mtpa.

Even when production from Western Australia reaches the anticipated 70Mtpa, the proven and probable reserves identified to date will be sufficient to sustain production at that rate for more than

[3] Excludes the Ichthys field which is offshore Western Australia but with the gas being processed in Darwin

30 years. History suggests that in that period of time there will be further discoveries which will again extend the life of the resource.

4.2 Gas products

The alternative market for gas is in the domestic natural, or piped, gas market. Natural gas use in Western Australia represents 55% of all energy consumed in the State.

Natural gas requires considerable treatment before it can be a safe and reliable source of energy for consumers. The natural gas used by consumers is composed almost entirely of methane. However, natural gas at the wellhead, although still composed primarily of methane, can be found in association with oil or condensates, or simply gases alone.

Whatever form the gas reserve takes, it commonly exists in mixtures with other hydrocarbons; principally ethane, propane, butane, and pentanes. In addition, raw natural gas contains water vapour, hydrogen sulphide, carbon dioxide, helium, nitrogen, and other compounds.

Natural gas processing consists of separating all of the various hydrocarbons and fluids from the pure natural gas, to produce what is known as 'pipeline quality' dry natural gas. While the ethane, propane, butane, and pentanes must be removed from natural gas, they are not waste products and can in fact be very valuable by-products as “natural gas liquids”.

Before the gas reaches the processing plant it is passed through scrubbers to remove sand and other large particulate impurities. Often it needs to be heated to prevent the formation of ice-like crystals which occur at colder temperatures with the interaction between water and natural gases to form hydrates. These hydrates are solid or semi-solid and can impede the passage of natural gas through valves and gathering systems.

If natural gas has to be transported long distances to a market it becomes economic to first liquefy it into LNG. The process for production of LNG is, in its first steps, the same as for production of natural gas. The gas is treated to remove impurities. It is important for example to remove substances like water and carbon dioxide which freeze at temperatures well above those required to liquefy methane. The gas is then liquefied by reducing the temperature to about minus 160 degrees Celsius. The liquid gas does not need to be pressurised at this temperature, which makes it safer to transport. Natural gas in the liquid form takes up about 1/600th its volume as a gas.

LNG is returned to a gaseous state at LNG import and re-gasification terminals, which are designed and constructed according to stringent national codes and international standards.

4.3 Unconventional Gas

The decision to develop a gas field also depends on its characteristics. They include its size, location and distance from markets and infrastructure; its depth (in the case of offshore fields); and the quality of the gas, such as CO_2 content and presence of natural gas liquids.

Resource characteristics influencing the development of unconventional gas resources partly diverge from those relevant to conventional gas fields. Location and size of accumulation remain important but there are no associated hydrocarbon liquids with coal seam gas (CSG). As all current identified unconventional resources in Australia are onshore, distance to market and infrastructure are key location factors.

The geological factors which influence CSG resource quality include tectonic and structural setting, depositional environment, coal rank and gas generation, gas content, permeability and hydrogeology. For shale gas, resource quality is dependent on gas yield which is controlled by organic matter content, maturity and permeability, particularly that provided by natural fracture networks. Reservoir performance (porosity and permeability) is the primary determinant of the quality of all gas resources and the point of difference between conventional gas and tight gas.

Australia's identified and potential gas resources occur within a large number of sedimentary basins that stretch across the continent and its vast marine jurisdiction. Identified conventional gas resources are predominantly located in offshore basins along the north-west margin. Much of the undeveloped resource and the undiscovered potential is in deep water.

Western Australia has large reserves of unconventional gas in the Canning Basin in the onshore areas to the South and East of Broome. The reserves in this basin are said to equate to half the known reserves in WA's offshore natural gas fields.

4.4 International Markets

LNG contracts generally have a price component linked to world energy prices (generally crude oil) and also include the cost of processing and transport. Typically, LNG must travel large distances to markets. LNG transport costs are distance and time sensitive and, as such, can account for a significant proportion of overall LNG costs.

Across the world, there have been three reasonably distinct markets for LNG, each with its own pricing structure. In the United States, pipeline natural gas prices have been used as the basis for setting the price of LNG. The benchmark price is either a specified market in long-term contracts or the Henry Hub (Louisiana) price for short-term sales. In Europe, LNG prices are related to competing fuel prices, such as low residual sulphur fuel oil, although LNG is now starting to be linked to natural gas spot and futures market prices. In the Asia Pacific region, Japanese crude oil prices have historically been used as the basis for setting the price of LNG under long term contracts. Asian prices are generally higher than prices elsewhere in the world. While still distinct, the markets are becoming more interconnected, not least because of the rapid growth in Middle East LNG supply to both regions.

In the short term, LNG prices are assumed to continue following a similar trajectory to oil prices, reflecting an assumed continuation of the established relationship between oil prices and long-term LNG supply contracts. However, the opening up of gas exports from the USA due to a spike in domestic supplies from unconventional gas flags a likely relaxation of this relationship in the medium term as significant new gas supplies come on line, placing downward pressure on LNG prices.

Henry Hub prices for piped gas are currently at about the equivalent of $3.80/GJ, having been lower than $2.00/GJ for part of the 2012 calendar year. There would appear to be a large opportunity for US producers to sell into the Asian market where prices are currently at about $12 – 16/GJ. This opportunity is enhanced by the prospect for relatively low cost conversions of existing US LNG import installations into export terminals as the USA moves from a net importer to a net exporter.

Gas prices are quoted on different bases across the globe – by volumetric measure, by calorific value and by weight. In this analysis all prices have been converted to price in terms of calorific value as measured in Australian Dollars per gigajoule (GJ).

While export opportunities look attractive from the US, exports from that country need a Federal approval and must be assessed as not being contrary to the national interest – which means the interests of consumers as well as producers. To date, some LNG export approvals have been given but they have largely been restricted to exports to those countries that are signatories to free trade agreements with the USA, which does not include Asian countries such as China Japan and India.

Figure 6 provides a comparison of gas prices at different points around the world and illustrates the apparent attractiveness of gas at Henry Hub market prices.

The costs of refrigeration and transport from the Gulf ports of the USA to Japan is not publicly available but is of the order of $5 to $8 a GJ. If natural gas can be sourced for around $4 a GJ, this would give a landed price in Japan of $9.00 to $12 a GJ, which leaves a considerable gap for arbitrage against the early 2014 price of around $17 a GJ. US supply sources could widen with the opening of extensions to the Panama Canal which will give LNG tankers direct access from the Gulf ports to Asian markets. On the other hand, once the capacity of existing import terminals is exhausted, exports will require construction of greenfields installations and this could add about $3 a GJ to the total supply cost out of the USA.

The impact of US exports on prices in Asia will depend on how all these forces play out. The general consensus seems to be that prices for internationally traded LNG will remain related to the price of alternative energy sources, notably oil. The long term outlook for the price of oil seems to be for a price of around $100 a barrel. Setting an LNG price per Gigajoule at 14% of the oil price per barrel (the standard rule of thumb) gives a price in Japan of $US14.00 a gigajoule.

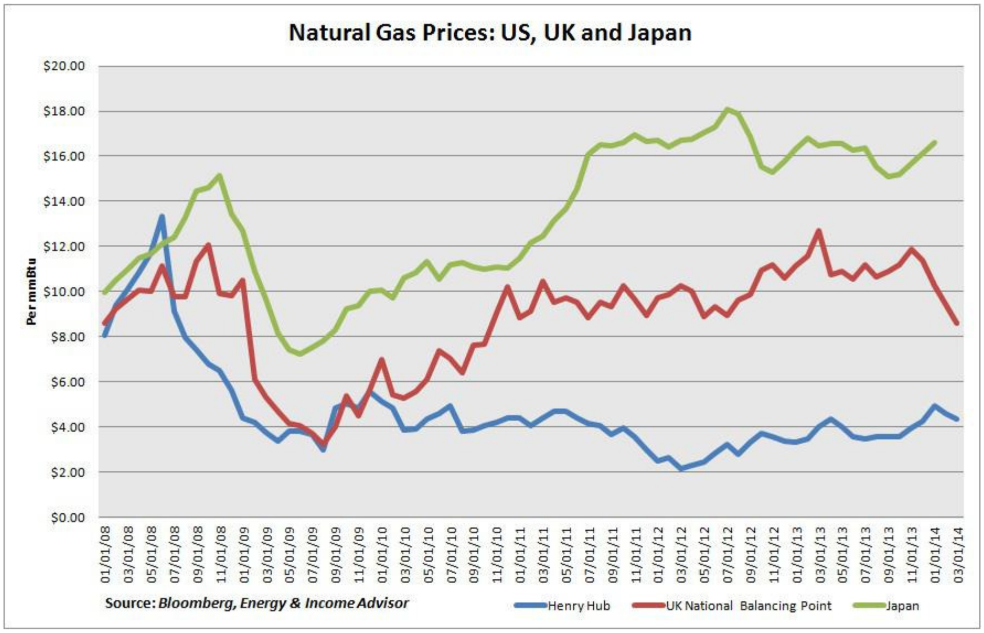

Figure 6 Natural Gas Prices USA, UK and Japan

The most significant factor determining the price that WA producers might receive for LNG will be the price at which USA can land LNG into Japan and China. Taking the likely supply costs out of the USA and delivery costs to Japan, and then netting this back to an Australian price, could give an FOB (Free on Board) price out of Australia as low as $10/GJ.

At the current Henry Hub quote and after the widening of the Panama Canal (expected to be completed at the end of 2015), seaborne LNG imports from the US Gulf Coast could give Japan and South Korea a modicum of price relief-depending on the contract terms.

However, the belief that US LNG exports will provide Asian LNG buyers with a massive discount to prevailing prices appears misguided. In our assessment, growing supplies of LNG are expected to shrink the premium that the commodity commands in Asia to $2/GJ from about $4/GJ (after liquefaction and transportation costs) toward the end of the decade.

4.5 Western Australian Natural Gas Market

The future price of gas is one of the main factors affecting both exploration and development of the resource. Australian gas producers have typically faced different prices for domestic and export gas. Domestic prices have historically been much lower than international prices, although domestic gas prices have been rising in recent years.

For the domestic market, Australia has historically provided some of the lowest cost gas in the world. These low gas prices were generally the result of mature long term contracts out of the Cooper and

Gippsland basins and the North West Shelf fields. The North West Shelf field domestic contract expires in 2020.

Australian gas prices have historically been relatively stable because of provisions in long term contracts that include a defined base price that is periodically adjusted to reflect changes in an index such as the CPI. In addition, prices have been capped by the price of coal (a major competitor for use in electricity generation).

In Australia, except for Victoria, there is currently no formal exchange for trading natural gas. In all jurisdictions except Victoria, wholesale gas trading occurs through private negotiations between buyers and sellers. The terms, quantities and prices are confidential and can vary significantly across contracts. Typically these contracts contain take-or-pay components where shippers agree to pay for a specified quantity of gas, regardless of whether they are able to on-sell it.

Unless there is a fundamental shift in government policy, it is likely that domestic gas prices will be determined by export parity prices.

Woodside reported in August 2012 that its cost of producing gas was $5.18 per barrel of oil equivalent. This is equivalent to a production cost of $0.84/GJ. This is understood to be the “lifting cost” to which must be added the “finding cost” and the processing costs. Finding costs are the costs of exploration and testing of new fields. Processing costs are about $1/GJ.

Based on production and price data for 2014, North West Shelf LNG is achieving an export price of US$12/GJ and an average domestic price of around $5/GJ.

4.6 Cost competitiveness

The cost of new developments has increased rapidly, with the average cost worldwide more than doubling between 2004 and 2008. Over the same period, development costs in Australia have also increased and are likely to increase further as a result of development of projects in deeper water that are typically more expensive than onshore and shallow water projects.

The capital costs of LNG liquefaction plants fell from approximately US$600 per tonne per year of installed capacity in the 1980s to US$200 in the 1990s, but in 2008 rose to around US$1,000 or more for some new plants. A tight engineering and construction market has contributed to delays in LNG projects as well as cost increases. Material costs have increased sharply, particularly for steel, cement and other raw materials. Limited human resources – in terms both of the number of capable engineering companies and of engineers, as well as skilled labour for construction, has also been a factor. The construction of four new LNG projects in waters offshore Western Australia has placed great pressure on the specialist construction sector leading to significant cost increases. Unless some of the cost increases can be reduced, the potential for further LNG plants onshore Western Australia is limited. Floating ship liquefaction has the potential for significantly lower capital costs with manufacture of the vessels and equipment in Asian countries and vessel servicing in the same region.

Generally, CSG can be produced using similar technologies to those used for the development of conventional gas. Compared with the conventional gas, CSG projects can generally be developed at a lower capital cost because the reserves are typically located at a shallow depth and hence require smaller drilling rigs. The production of CSG can also be increased incrementally given the shallow production wells. Although hundreds of wells are needed to produce a field as opposed to a few dozen at most in a giant conventional gas field, they are hundreds of metres rather than kilometres deep, and take a few days as opposed to weeks to drill. Nonetheless, they have their own particular engineering requirements.

4.7 Technology developments

Advances in technology can increase access to reservoirs; increase recovery rates; reduce exploration, development and production costs; and reduce technological and economic risks.

Technological improvement has had a significant influence on exploration activity by increasing the accessibility of resources. In the 1990s and early 2000s, technological advances (mainly 3D seismic) were the principal driver of new discoveries and rising success rates in offshore Australian exploration. More recent engineering innovations, particularly deep water subsea production facilities, extreme length underwater pipelines and Floating LNG, will ensure most discovered gas in North West waters can brought to market economically, with timing dependent on market conditions.

Onshore, unconventional gas in the Canning Basin is in the early stages of discovery. In the longer term, successful delineation of gas resources and proving up of economic production rates could see a major new gas province searching for both domestic and export customers for gas and LNG.

4.8 Possibilities for ANSIA

There are large natural gas resources offshore Western Australia that remain to be developed. While floating LNG appears more likely for processing, the circumstances facing producers vary widely and some may opt for onshore processing. The Wheatstone LNG project with future capacity for up to 25 Mtpa of LNG export provides possible synergies in terms of shared infrastructure that may swing the economic balance towards onshore processing for undeveloped offshore gas fields in the southern Carnarvon Basin.

There is also potential for an onshore LNG plant to process gas from onshore fields when the commercial extraction of unconventional gas is proven.

The following projects may be viable within ANSIA in the future:

1. Domestic gas facility - The Wheatstone project will incorporate a 200 TJ/d gas plant with deliveries starting in 2018. With the market demand for piped gas into the domestic market growing strongly and some long term contracts reaching their end date, there is a possibility of additional domestic gas processing being established within ANSIA in the medium term. Additional domestic gas produced at ANSIA could be connected via the pipeline established for Wheatstone-sourced domestic gas to the DBNGP or via a new parallel pipeline. A potential

new source of demand could be as a replacement fuel for diesel engines at mine sites and for heavy transport.

ANSIA may also play a role as a gas swap hub through which gas sold to LNG plants near Karratha is first processed to pipeline quality. In that case, commercial arrangements may allow for pipeline gas 'backflow' from ANSIA to Karratha although physical movement of gas molecules from ANSIA and into the DBNGP would remain southward towards the domestic markets in the SW.

2. Domestic LNG/CNG/GTL - A variation on domestic gas is the possibility of a plant to produce LNG or compressed natural gas (CNG) for the Pilbara mining companies. An alternative might be a gas to liquids (GTL) plant to replace diesel in mobile vehicles.

3. Electricity generation - there is a growing demand for electricity generation in the region associated with population growth and industrial development. A further possibility is supplying electricity to DBNGP compressors currently running on gas, to minimise own use of gas along the pipeline route and increase the pipeline's effective gas carrying capacity. This could be particularly beneficial if the power station fuel was gas that failed to meet the DBNGP specification. A power station could be co-located with a domestic gas plant.

4. LNG – The North West could be swamped with pipeline gas if onshore shale gas fulfils its potential. In that case, ANSIA could serve as a location for LNG liquefaction trains and export facilities dedicated to processing shale gas sourced from the Merlinleigh – Southern Carnarvon Basin. A number of large discovered offshore gas fields remain to be developed. With the planned LNG-related infrastructure at ANSIA it may be economic to pipe some or all of the gas from these offshore fields to shore for processing into LNG.

5 PETROCHEMICALS INDUSTRY

Key ingredients at the starting point of an integrated petrochemicals industry are ethane (for ethylene production, then downstream plastics) and chlorine.

5.1 Ethane / Ethylene

Ethane is a component of most natural gas, next most common hydrocarbon component to methane. The gas fields feeding the Wheatstone project contain varying amounts of ethane in the gas mix and this can be extracted from mix during gas processing and liquefaction. The best option is to integrate ethane extraction into the design and construction of a new or expansion phase LNG project. This has two key advantages: extra refrigeration, fractional distillation and power requirements needed for ethane separation can be added at relatively low cost into the design of an LNG plant; and gas sales contracts can incorporate the leaner gas specification at the outset.

An opportunity exists to investigate the possibility of any new LNG trains built for the Wheatstone project at ANSIA to incorporate ethane extraction. An ethane pipeline could then run from the LNG plant into the front end of a petrochemicals plant or could be made available for export.

Another possibility is that new Floating LNG projects have ethane extraction and an ethane pipeline to shore in partial satisfaction of their domestic gas reservation obligation. This could apply to the Scarborough Floating LNG project. Although relatively lean in ethane, the large volumes of Scarborough gas available for development may allow a pipeline to shore to be viable if a petrochemical feedstock market existed locally.

5.2 Chlor-alkali

The two primary inputs for a chlor-alkali plant are salt and electricity. The primary high-value product is chlorine gas which is feedstock into plastics manufacture in combination with ethylene, or as feedstock in pigment manufacture from mineral sands. Due to chlorine's high toxicity the chlor-alkali plant is usually located close to downstream users of chlorine. Secondary products from chlor-alkali, such as caustic soda, hypochlorite solution and hydrochloric acid can be transported to markets. Caustic soda is primarily used in production of alumina from bauxite.

Proximity to the Onslow Salt facility would also assist a chlor-alkali plant located at ANSIA. It is possible that brine from the evaporation ponds could be piped directly to the chlor-alkali plant saving in harvesting, storage and salt transportation costs.

5.3 Plastics

Ethylene can be converted to polyethylene which, in various forms, is one of the world's most common plastics. Combined with chlorine, ethylene can be converted to EDC (ethylene dichloride), a precursor to VCM used for making PVC plastic.

If an ethylene plant were to be set up at ANSIA there would be a strong case for also establishing a chlor-alkali plant there, with chlorine output from the chlor-alkali plant matched to the demand profile for plastics manufacture.

5.4 Ammonia/urea

Price and availability of natural gas would be the driver for construction of an ammonia plant at ANSIA. Methane, the dominant molecule in natural or pipeline gas, is the source of hydrogen and air is the source of nitrogen for the catalytic conversion of nitrogen and hydrogen to ammonia. Nitrogen could be supplied from an air separation plant which would also produce oxygen for export in liquid form or piped to the Wheatstone LNG plant to allow efficient CO2 capture from gas turbines.

A world-scale ammonia plant has a production capability of approximately 800,000 tonnes annually. Liquid ammonia is a vital raw material in the manufacture of fertiliser. Output from the plant could be sold in the Australian domestic market as well as exported into SE Asian markets. At ANSIA, some of the ammonia could be dedicated to manufacture of ammonium nitrate (fertiliser / mining explosive). Combined with carbon dioxide, ammonia can be transformed into urea. This has the added advantage of synergy with LNG production at the Wheatstone LNG plant where carbon dioxide from turbine exhausts or removed from the gas stream is currently vented.

5.5 Possibilities for ANSIA

The following industry is therefore considered potentially feasible for establishment at ANSIA:

1. Ethane stripping plant or storage and export from a dedicated pipeline
2. Ethane cracking plant to produce ethylene for plastics
3. Chlor-alkali plant using local salt / brine tied to producing chlorine for plastics
4. Plastics manufacture from upstream petrochemical plant
5. Ammonium sulphate or urea fertiliser plant using piped ammonia and possibly using carbon dioxide waste product from LNG plants.
6. Cyanide plant to supply Pilbara projects.

6 SALT INDUSTRY

Salt is another significant mining activity in the Pilbara. In 2013, WA production of salt totalled 12.9 million tonnes and this represented a value of $415 million, and about 95% of all Australian production. Pilbara production is a major component of State production, making up about half of WA production. The Rio Tinto operations at Dampier, Port Hedland and Lake MacLeod account for just over 75% of the total with projects at Onslow, Koolyanobbing and Esperance making up the rest.

Australian production of salt represents only about 4.8% of world production which, in 2013, is estimated to have reached 286Mt, in response to a recovery in demand from the de-icing market. This follows a decline of 4.6% between 2011 and 2012, to 277Mt, owing to weak demand from de-icing and chlor-alkali markets.

Over 110 countries produce salt, but the majority of production originates from just seven. China, the USA and India together accounted for 46% of total world supply in 2013. Despite a slowdown in Chinese salt output in 2012, regional growth was still led by Asia, which was sustained by growing Indian production.

Globally, solar evaporation of seawater or inland brines accounts for around 40% of salt production. The balance is divided between mined rock salt (26%) and brine extracted by solution mining (34%).

During the last 10 years both the North American and European markets have seen a decline in domestic production. Regional outputs fluctuate annually however, dependent upon winter weather conditions influencing the demand for de-icing salt, which accounts for up to 43% of consumption in the USA and up to 30% in Europe.

The use of salt in chemicals production accounts for 60% of the world market, while road de-icing and food/food processing represent the two other significant market sectors. Asia accounted for approximately 42% of world salt consumption, with China alone consuming 24%. European consumption overtook North America in 2010 and now accounts for 25% of world salt consumption, whilst North America represents 22%.

Future demand for salt is forecast to rise, growing at around 3% a year. Asia, especially China and India, will continue to lead growth driven largely by chemical production. The region is forecast to account for almost half of world salt demand by 2018. It is estimated that around 70% of growth demand over the next decade will originate from the chemical sector, including the chlor-alkali and soda ash industries.

Global demand for salt is anticipated to rise steadily over the next five years with most of the growth in demand being fuelled by growth in chemical production, especially in China. Lower US domestic gas prices linked to shale gas development will boost chlorine demand in the USA and Canada as the petrochemical sector takes advantage of lower costs and PVC production ramps up.

A large proportion of the salt produced in Australia is exported to chemical product manufacturing plants in Asia. While Australia produced less than 5% of the world's salt production, it is the world's largest exporter of salt. Unlike most other salt-producing countries, Australia exports the bulk of its salt production.

As stated earlier, 60% of salt production is sold into chemicals production. Soda ash, or sodium carbonate, can be produced either by mining natural sources or manufactured synthetically using salt and limestone.

6.1 Soda Ash

About half of the soda ash produced in the world is used in the glass industry for the production of flat glass, container glass, fibreglass and other products. High exposure to glass markets means that soda ash demand is significantly influenced by the fortunes of the construction and automotive industries.

China is the world's largest producer of soda ash with an output of about 23Mt in 2011. Production in China has expanded rapidly since 2000 driven by surging domestic demand. While most of China's output is consumed in domestic markets, producers there have become increasingly established in export markets.

The world's second largest producer, the US, is also the largest global exporter, but has been hit hard by the global economic downturn in 2008-2012. The US soda ash industry is centred at the Green River Basin in north-western US state of Wyoming, where it is mined from natural soda ash, or trona.

6.2 Possibilities for ANSIA

The following industry is therefore considered potentially feasible for establishment at ANSIA:

1. Soda ash production. Possibility of establishing a soda ash production facility based on the salt harvesting operations adjacent to ANSIA.
2. Chlor-alkali plant based on harvested salt or concentrated brine directly sourced from salt pans adjacent to ANSIA.

7 RENEWABLES INDUSTRY

7.1 Algae

The algae industry is still in its early stages, with a number of companies still exploring potential locations and technologies in the pursuit of large scale development. The algae produced is then used in three distinctly different markets, namely the biofuels, health foods and pharmaceuticals, and feedstock markets. Two basic concepts have emerged over the years for the commercial production of algae, namely closed system bioreactors and open ponds.

Closed system bioreactors have high production and high growth rates and provide a highly controlled and contaminant free environment, however they have been shown to only work on a small scale. They have yet to demonstrate real progress in terms of overall economic viability compared to open pond systems.

Open pond systems typically consist of raceways in which algae is circulated (usually using paddles or other such devices) in water which is exposed to the atmosphere. The critical issues affecting unstirred ponds are cross contamination and low photosynthetic efficiency.

The ideal characteristics for an algae industry can be found in the Pilbara region and include:

- Ideal weather conditions
  - light intensity: >5kWh/m^2/day
  - +/- 37 degrees to the equator
- Proximity to abundant CO_2 source
  - As close as possible, with desirable distance in the order of 20km
- Proximity to sea water
  - As close as possible, with desirable distance less than 20km
- Topography
  - Flat land for sale (<1% slope)
  - Relatively flat land for infrastructure corridors
- Area of land
  - 5,000ha considered suitable for world scale production, although smaller areas can be adopted for smaller scale facilities
- Accessible and low cost land, with low population density

A previous investigation undertaken by WorleyParsons concluded that the optimal location for algae farming in Western Australia is along a coastal strip between Karratha and Port Hedland, with south Onslow also being identified as a suitable location.

Large-scale algae farming requires flat land that is not suitable for traditional agriculture, is close to sea water, sunshine, and waste CO_2 stream. These conditions are likely to be met in the vicinity of the ANSIA. A study undertaken in 2012 showed the optimal location for algae farming in Western Australia occurs further north in a coastal strip between Karratha and Port Hedland, with a smaller zone of suitable land to the south of Onslow that was also considered suitable. Aurora Algae have developed a pilot plant near Karratha and were looking to expand this facility near Maitland, however they have abandoned these plans due to the cost of labour and the high temperatures of the region. Aurora later looked at developing a production facility near Geraldton although have again abandoned these plans, this time to focus on what it plans to be its initial production facility in Texas.

Extraction and conversion of harvested, de-watered algae into high grade food products, pharmaceuticals and biodiesel may possibly occur at ANSIA if an algae farm is located nearby. Algae farming is currently driven by the value of food and pharmaceutical products rather than biodiesel and to date, the industry is yet to develop sufficiently to promote its development at ANSIA. In the longer term the value of liquid fuel produced renewably could justify large scale algae farming on the basis of bio-diesel alone but currently this is not commercially viable.

7.2 Solar

It is not considered likely that a solar project could be developed at ANSIA. At present, the cost of solar electricity is greater than the cost of gas a source of power generation. However as the cost to generate solar electricity falls, it can be expected that at some time in the future it will be lower than the current cost of gas. There are no unique conditions at ANSIA that aren't replicable at other locations and therefore the use of solar technology at ANSIA could be applied on a large scale elsewhere at a similar cost.

However this only considers one side of the coin. If solar power can be produced for a lower cost than LNG, then the price of LNG will move downwards in response. The reason for this is that the primary use of LNG is for power generation and that any sizeable shift in demand will have a large impact on price. Ultimately, the price for LNG would continue to sit lower than the price of solar generation. A downward shift in LNG pricing would place greater pressure on the LNG industry to cut costs and further implement new technologies that drive efficiency.

The possibility of solar power replacing gas-fired power generation at the ANSIA or adjacent LNG plants has therefore not been included.

8 INDUSTRY SUMMARY

There are several opportunities for ANSIA. The current stage of the economic cycle does not favour many industries in the short term but the medium term has reasonable possibilities and the longer term is very promising. The opportunities are ranked here in three categories. The longer term industries are considered more speculative at this stage and would need to be re-examined at a later date following development of foundation proponents and other industries within the SIA.

8.1 Short to medium term (less than 5-7 years)

- Domestic gas
- Electricity generation

8.2 Medium to longer term (less than 10 years)

- Domestic LNG/CNG/GTL
- Air fractionation/liquefaction (utility gases)
- Ammonia or urea fertiliser plant
- Ethane storage and export from Wheatstone LNG expansion trains
- Ethane cracking plant

8.3 Longer term (from 10 to 20 years)

- Soda ash
- Chlor-alkali and plastics plant
- Bio-fuels based on algae

8.4 Proposed project descriptions

The following describes the potential project that have been considered for development with the ANSIA and a series of enablers that will promote their development.

8.4.1 Domgas

A domestic gas processing plant is envisaged with an output of around 200 TJ/day. This matches the adjacent BHP Billiton Macedon gas plant and the planned size of the Apache operated plant at Devil Creek. The ANSIA domestic gas plant would strip liquid hydrocarbons and impurities from gas sourced from offshore or onshore fields and pipe it via interconnecting pipeline to customers via the Dampier to Bunbury Natural Gas Pipeline.

The Devil Creek plant is a staged development with the first 100 TJ / day of processing currently in operation. Staged development of gas is assumed for ANSIA. Macedon feed gas has particularly low liquid hydrocarbon content. Feed gas to Devil Creek has a higher liquids content which could be more representative of gas from onshore fields and offshore fields similar in gas composition to Wheatstone.

Enablers: Access to gas from an off-shore or on-shore project, suitable land area, connection to the DBNGP, increased demand for domestic gas.

8.4.2 Power station

A 250MW power station is envisaged using around 50 TJ/day of natural gas. The plant is assumed to be a high efficiency combined cycle gas turbine design and would occupy a site of around 50 hectares and employ around 75 people when operating. It is assumed that some pre-investment in infrastructure (site works, grid connections and supply pipeline) is made to allow up-scaling as demand grows. Low pressure / low temperature steam could be exported to adjacent industries for pre-heating applications.

Enablers: pre-investment infrastructure, availability of gas, interconnected distribution grid in the Pilbara.

8.4.3 Desalination Water Facility

A seawater desalination plant would produce high quality / low impurity water which may be required for some adjacent industries. A mid-scale desal plant would sit on 65 ha, consume 20 MW and produce around 40 GL of high quality water a year. Alternatively, a lower cost water treatment plant could be fed by groundwater or water discharge from adjacent industries for less demanding applications.

Enablers: demand for water from industry, access to source water.

8.4.4 Air Separation/Liquefaction Plant

Nitrogen and oxygen from the air would be separated either through membrane technology or via liquefaction and re-vaporisation. The purified nitrogen gas stream would be input to an ammonia synthesis plant. Purified oxygen gas could be piped to the power plant or to LNG power turbines. Using oxygen in place of air for combustion allows efficient capture and re-use of almost pure carbon dioxide from the exhaust stream of the gas turbine. The carbon dioxide could then be used as feedstock to a urea plant.

Enablers: Demand from power plant and urea plant.

8.4.5 Ammonia/urea plant

Ammonia is synthesised from hydrogen (from re-formed natural gas) and nitrogen (extracted from the air). Urea is made from ammonia and carbon dioxide. The carbon dioxide can be captured from the exhaust stream of a power plant or from a domestic gas or LNG plant.

Enablers: Carbon dioxide source, suitable export facility.

8.4.6 Domestic LNG/CNG/GTL

A domestic scale gas to liquids or LNG plant would be scaled to supply Pilbara minesite vehicles and power generation facilities currently running on diesel. A 500,000 t/a liquids plant could replace approximately 700 Ml a year of diesel and consume 36,500 TJ a year (100 TJ/d) of feed gas for LNG production. Compression power and process heat for the plant would be sourced from input gas with control room power either generated internally or sourced from an adjacent power plant.

Enablers: Availability of feed gas supply.

8.4.7 Ethane storage and extraction

Ethane is the raw material for ethylene production and downstream synthesis of plastics. The feedstock gas from offshore fields such as Wheatstone is relatively lean in ethane so obtaining economic quantities of ethane depends on a large throughput of source gas, ideally situated as an integral part of an LNG plant.

Assuming Wheatstone LNG is expanded at some stage, some 250 ktpa of ethane is contained in the raw gas feeding a 5 Mtpa LNG train (assuming 5% by weight ethane content in the raw gas). Assuming 60% ethane extraction, approximately 165 ktpa ethane would be extracted. It is assumed that any small increments to land or utilities for integrated ethane extraction, above those already needed to support Wheatstone LNG, are not considered material to planning at ANSIA. However, ethane export would require storage tanks that require incremental land allocation and 10 ha is allowed for that purpose.

In the event that a portion of Scarborough gas is piped ashore for domestic use it could be economically advantageous to source this gas from an ethane-rich gas stream within the FLNG process. Assuming a 100 TJ/day domestic gas stream with 20% ethane by weight, around 400 t/day of ethane may come ashore. Another 200 t/day of ethane could be contained within a further 100 TJ/day of gas sourced from onshore unconventional gas fields heading for processing at a domestic gas plant located at ANSIA. While 100% extraction is not economically optimal or possible within existing gas specifications, at 40% extraction approximately 85 ktpa of ethane could be extracted. The only significant input is gas to power the compression / turbo-expander extraction cycle and additional gas to replace the energy content of the extracted ethane. An 85 ktpa plant would require around 15 TJ/d or 5,500 TJ a year for fuel and make-up gas.

Enablers: Input gas, changes to specification of domestic gas, makeup gas.

8.4.8 Ethane cracker

Ethane can be converted to ethylene which is the precursor to plastics manufacture. A mid-scale 250 ktpa ethane cracker could use ethane extracted from LNG (165 ktpa) and from domestic gas processed at ANSIA (85 ktpa). The plant would produce approximately 230 ktpa of ethylene.

Enablers: Ethylene source, government requirement for new projects to make ethylene available into the local market.

8.4.9 Soda ash

A soda ash plant occupying an area of 25ha has been considered a long term prospect for ANSIA, utilizing local supplies of ammonia and salt to produce 300,000 tonnes p.a. of soda ash. At this size, it would be a mid-scale operating plant in the soda ash market. One of the factors which has influenced it being considered as a long term prospect is that the current economics for mid-scale soda ash plants are difficult. Such plants compete against suppliers which mine natural deposits of soda which is currently undertaken at a lower cost.

Although it has been recently mothballed, Penrice operated a similar scale plant in South Australia and which produced approximately 0.8% of world demand. The majority of their product was exported, however approximately 30% (100,000 tonnes) was further processed into sodium bicarbonate and used by the local market. There could be a similar opportunity for a soda ash plant at ANSIA.

Enablers: Ammonia source and pipeline, salt source.

8.4.10 Chlor-alkali and plastics plant

A chlor-alkali and plastics plant occupying 120ha is considered a long term prospect for ANSIA. This would occupy a combined area of 120ha and be a replacement for the 20ha already accounted for in the earlier developed ethane cracker.

The chlorine output from the chlor-alkali plant is wholly used as feedstock to the petrochemical plant which manufactures ethylene dichloride (EDC) vinyl chloride monomer (VCM). EDC is further processed into more VCM which is either exported or used on site as the raw material for making PVC plastic. Due to the chlorine 'link', it makes sense to consider chlor-alkali and petrochemical plants as a single complex comprising two components.

For ANSIA, it has been assumed that around 250,000 tonnes p.a. of ethane could be extracted from both LNG and domestic gas streams to produce 100,000 tonnes p.a. of plastics. The land area of 120 hectares takes into account the large assumed base load feed of ethane and the scope for expansion of feedstock supply at ANSIA.

Enablers: Salt, electricity

8.4.11 Bio-fuels based on algae

Production of bio-fuels based on algae is considered to have long term potential, as it is acknowledged that the industry is still in its infancy. Development within ANSIA would utilise adjacent piped sources of CO_2 (likely from a power plant) and water for a site occupiny 10ha and producing 800,000 tonnes p.a. of bio-fuels. The bio fuels produced could be used for mining operations in the region.

The size of this potential market greatly exceeds the potential supply that would be created from within ANSIA, however the current limitation is that bio-fuels based on algae cannot be produced at such a point to make them competitive against diesel. In time and with further developments in the industry, there is the potential for this position to change.

Enablers: CO_2 and water pipeline access, CO_2 and water supply

8.5 Summary of Key Assumptions

Table 2 summarises the key assumptions made for each industry in relation to land requirements, operating workforce size, energy requirements, and key inputs and outputs. Producers for each of these industries who could consider ANSIA are identified in Table 3. These are identified for the short and medium term only as this is considered the only relevant timeframe for comparative purposes. Long term (10 to 20 years) industries are likely to have significant changes before they are realised at ANSIA. Furthermore, these are dependent upon earlier development of other short and medium term industries and therefore their suitability would be heavily factored on the scale of the preceding development.

Table 2 ANSIA Industry Key Assumptions

Project	Area (ha)	Operating Workforce	Energy requirement	Key Inputs	Key Outputs	Infrastructure Requirements
Domgas	60	25	20TJ/day gas	220 TJ/day raw gas	200TJ/day pipeline gas 150 ML condensate	Critical • Pipeline Access (import/export) • Close proximity to pipeline is preferred Important • Road • Utilities
Power Station	50	75	50 TJ/day gas		250 MW power Waste Heat 2800t/day CO_2	Critical • Connection to the grid/demand source • Proximity to demand important • Connection to gas pipeline • Cooling water (significant volume required) Important • Road • Utilities
Desalination	65	15	22MW electricity	Seawater	40GL/yr high grade water Brine effluent	Critical • Seawater Pipelines (intake/outfall) • Coastal site preferred • Power • Pipeline to distribution network/demand source Important • Road • Utilities

Project	Area (ha)	Operating Workforce	Energy requirement	Key Inputs	Key Outputs	Infrastructure Requirements
Air Separation	5	25	40MW electricity	Air	180t/day oxygen 600t/day nitrogen 10t/day argon	Critical • Power Important • Road • Utilities
Ammonia/Urea	65	250	2MW electricity 60 TJ/day gas	Pipeline gas for reforming 600t/day nitrogen gas 800t/day CO_2	250ktpa ammonia 400kmtpa urea	Critical • Pipeline Access (Import) • Export facility • Will require access to port Important • Road • Utilities
GTL or Domestic LNG	50	100	100 TJ/day gas	Pipeline gas	500 ktpa LNG/synthetic diesel	Critical • Pipeline Access (import) • Export facility (either port or road transport terminal) • Power Important • Road • Utilities

Project	Area (ha)	Operating Workforce	Energy requirement	Key Inputs	Key Outputs	Infrastructure Requirements
Ethane Storage	10	-	-	[Integral to LNG trains]	165ktpa ethane	Critical • Pipeline Access (import) • Export facility (either port or road transport terminal) • Power Important • Road • Utilities
Ethane Stripping from Domgas	15	25	15 TJ/day gas	Access to 200TJ/day pipeline gas	85 ktpa ethane	Critical • Pipeline Access (import) Important • Road • Utilities
Ethane Cracker	20	250	10 MW	250ktpa ethane	230ktpa ethylene	Critical • Pipeline Access (import) • Export Facility (either port or toad transport terminal) • Power Important • Road • Utilities
Soda Ash	25	60	8 MW electricity	Salt Ammonia	300 ktpa soda ash	Critical • Power • Pipeline access Important • Road • Utilities

Project	Area (ha)	Operating Workforce	Energy requirement	Key Inputs	Key Outputs	Infrastructure Requirements
Chlor Alkali & Plastics Plant	120	800	170 MW electricity	230 ktpa ethylene	100ktpa plastics	Critical • Power • Pipeline access Important • Road • Utilities
Bio-fuels Based on Algae	10	30	2 MW electricity	3000 tpa CO_2 200 ktpa water	800tpa bio-fuels	Critical • Pipeline Access – CO_2 • Pipeline intake and outfall - water • Power Important • Road • Utilities

Table 3 Typical Producers for Potential Short and Medium Term ANSIA Industries

Project	Typical Producers
Domgas	Petroleum companies listed as 'Operator' for offshore petroleum permits within ~150km of Onslow or ~250km onshore from Onslow. This includes: Apache Chevron BHP Billiton Woodside
Power Station	Contract Power Australia KPS Power Generation GE Energy Horizon Power ATCO
Desalination	Veolia Water Degremont Australia Suez Water Corporation
Air Separation	BOC Gases Air Liquide Universal Industrial Gases Air Products Linde Group Siemens
Ammonia/Urea	CSBP – Wesfarmers Yara Pilbara Fertilisers Latrobe Fertilisers Impact Fertilisers

Project	Typical Producers
GTL or Domestic LNG	EDL Wesfarmers Kleenheat Mobile LNG ELGAS LNG Chevron Woodside Inpex
Ethane Storage	Wesfarmers Kleenheat Cryoquip Australia Cryeng Group Pty Ltd
Ethane Stripping from Domgas	BHP Apache Chevron
Ethane Cracker	Qenos ExxonMobil Formosa Petrochemical Corp Nova Chemicals Chevron Phillips Chemical Co. Dow Chemical Co.

Further information on each of these project types and their producers is contained in Appendix 1.

9 COMPETING STRATEGIC INDUSTRIAL ESTATES

This section provides an analysis of other competing strategic industrial estates within Western Australia as well as competing regions within Australia and internationally and the factors that influence industry location.

9.1 Factors Influencing Industry Location

It is important to consider that a number of factors will influence industry to choose a particular location. The level of influence that each of these factors has will vary between industry types and developers. In all cases, industry will seek to achieve a competitive advantage through the achievement of one or more of these factors.

Feedstock – The availability of feedstock includes not just the availability of the raw material/s required by industry for their manufacturing process but also its price and the volume of material/s available and the ease at which it can be transported to site.

Infrastructure – This includes the availability and price of utilities such as power, water and gas. It can also include access to transportation infrastructure including roads, railways and ports. The cost of accessing this infrastructure, its capacity and availability are all factors that industry will consider in identifying a preferred location.

Labour – Access to suitable workforce for the construction and ongoing operation of a project is an important consideration for industry. They will consider the cost, skill level, availability and stability of labour as part of a location decision.

Land – The availability of a suitably sized lot is fundamental to the location decision. In addition to the land area available, industry will also consider the lots shape, prevailing topography (earthworks requirements), risk factors (storm surge, flooding, geohazards) and cost to purchase/lease.

Proximity to Market – For some commodities (typically those of high value) proximity to final markets is not a significant driver of the location decision. For lower value, bulk commodities or commodities with complex transport requirements proximity to market can play be a significant influence.

Business/Regulatory Climate – The prevailing business climate in a given country/location will also play an important role influencing location decision of industry. Countries with a climate more conducive to business (tax regimes, labour laws, environmental regulations, political stability, etc.) will be more attractive to industry.

It should also be noted that governments can sometimes offer significant incentives to attract or retain industry in a particular location. This may include subsidised utilities, reduced taxation, reduced land cost or investment in supporting infrastructure.

These factors above are critical elements in industry determining where it can locate to achieve a competitive advantage. Developing ANSIA will not necessarily ensure that proponents will be drawn to locating there if there are other locations which are able to offer greater conditions. Therefore, a comparative exercise focussed on local industrial estates within the control of LandCorp is useful in determining the most suitable location within Western Australia for a particular industry, however it also must be balanced with an understanding of regional market conditions.

9.2 Local Competing Industrial Estates

The analysis undertaken so far focuses on the potential development of ANSIA. This industrial estate represents one of the potential locations for supporting industry development, however there are a number of other similar areas which are proposed to be developed and which may be competitors to these industries. Each of these sites falls under the management of LandCorp and include the following:

- Boodarie Strategic Industrial Area
- Burrup Strategic Industrial Area
- Maitland Industrial Estate
- Mt Anketell Strategic Industrial Area
- Oakajee Industrial Estate

A description of each of these industrial estates follows, along with the relative strengths and weaknesses of these sites in comparison to Maitland.

9.2.1 Boodarie Strategic Industrial Area

The Boodarie Industrial Estate is located 5km west of Port Hedland and is planned to support the growth of downstream processing in the Port Hedland area.

The area covers a total of approximately 3,500ha with current plans for the Boodarie SIA including the following land use types:

- Downstream iron ore processing
- Port dependent land uses
- Resource processing
- Non-ferrous processing
- By-product storage area
- Utilities and resource recovery
- General industries

These industries are considered to be non-compatible with the proposed development at ANSIA and therefore it is not considered to be a competing site for potential developers.

Port access is currently proposed via two berths at South West Creek with the potential to also connect to the Multi-User Outer Harbour should this be developed in the future.

The area has the potential to utilise local iron ore, manganese and salt resources as well as the Dampier Bunbury Natural Gas Pipeline which runs through the estate to deliver gas from Dampier to the Alinta power station within the estate and to mining operations in the East Pilbara.

The cost to develop the Boodarie SIA will be high due to the low lying land and the need to use large volumes of fill to raise the site to a suitable level or to implement other solutions to protect infrastructure components from inundation.

Planning for the SIA has long been underway and appropriate zoning and infrastructure plans are in place to allow for its development subject to proponent interest. The area has ready access to roads, water, natural gas, power and port facilities and is therefore considered one of the more advanced options of the currently undeveloped sites.

9.2.2 Burrup Strategic Industrial Area

The Burrup Strategic Industrial Area is a well-established strategic industrial estate located on the Burrup Peninsula, approximately 10km from Dampier, 20km north west of Karratha and 30km north east of Maitland. The SIA occupies 350 hectares and is located near to gas, port and other infrastructure in the Pilbara region and was created to take advantage of the region's natural gas resources.

The Burrup SIA currently contains the following developments:

- North West Shelf Venture project – a joint venture between Woodside (operator), Shell, BHP Billiton, BP, Chevron and Japan Australia LNG;
- Woodside's Pluto LNG plant;
- Yara Pilbara Fertilisers plant; and
- Yara Pilbara Nitrates technical ammonium nitrates plant, which is currently under development.

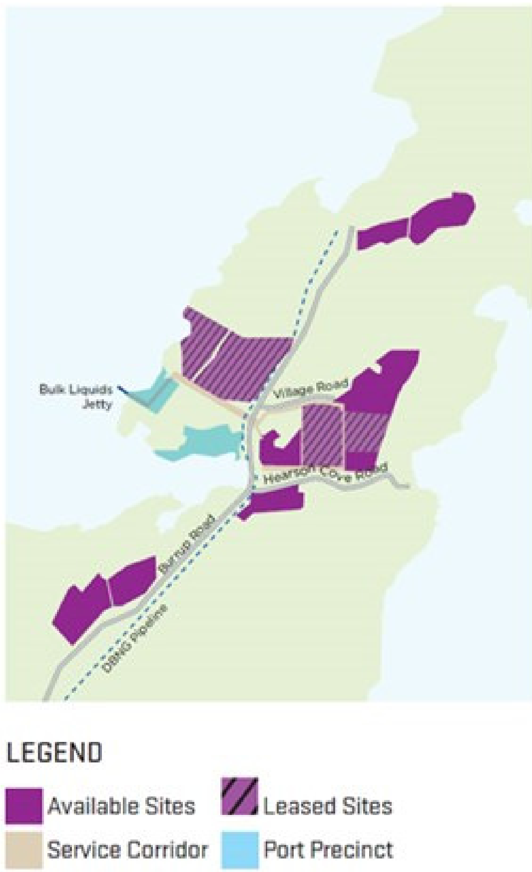

Figure 7 Burrup SIA Development Sites

(source: LandCorp)

The available sites within the Burrup SIA present a number of issues for their future development, including heritage and constructability issues, connectivity to port facilities, potential impact on the sensitive environment of Hearson Cove. Locations along the coast are within a coastal inundation area due to storm surge during cyclonic events.

A study into the future optimum use of sites has recently been undertaken to allow a strategy to be developed to connect future development with port access. From his study it was recommended that urea, ammonia, ammonium nitrate (export) and gas (export) were the most suitable uses for this location. These uses correspond with the suitable land uses identified for ANSIA and therefore this site could be seen to be a competitor for future development.

9.2.3 Maitland Industrial Estate

The Maitland Industrial Estate is located 15km west of Karratha and occupies an area of approximately 3,000ha. The site has been planned for the downstream processing of resources within the Pilbara which may include natural gas, iron ore or salt.

The site is located along the North West Coastal Highway with DBNGP running through the site. It is also in close proximity to major infrastructure such as Dampier Port and gas processing facilities on the Burrup Peninsula. The proximity of Maitland to vacant land at the nearby Burrup SIA can be seen as potentially either a positive or negative from a competitive standpoint. There are potential industries which may look to locate at either facility, likely to be related to the hydrocarbons industry, which may then create a competitive position. Alternatively these two SIAs could be viewed as complementary to each other through a strategic planning process. If Maitland is instead progressed as a downstream minerals processing SIA then it is unlikely to compete with the Burrup SIA in the short to medium term at least as it is expected it would continue to be a hydrocarbons based area.

Previous studies into the potential development of Maitland have not led to any significant development due to a range of concerns over heritage issues and commerciality. However, with the changing market landscape and the limited land available for development, this is shifting. As such, Maitland is considered a site with reasonable potential for development, particularly around the domestic gas, power and downstream processing. Given this, Maitland is considered a reasonable competitor with similar land uses to that which have potential for development at ANSIA.

9.2.4 Mt Anketell Strategic Industrial Area

Mt Anketell, 30km east of Karratha and 10km west of Rio Tinto's Port Walcott facility, has been selected as the location of the next major deepwater port in Western Australia. The Anketell Port Master Plan was released in June 2014 and states that the area will be developed for a multi-user, multi-commodity port and associated industrial area. The port is planned as an iron ore export facility with an ultimate capacity of not less than 350 Mtpa, with provision for heavy industry exports, general cargo trade and fuel imports.

Anketell Port consists of three specific land-use areas, including the following:

- 1,701 ha port precinct (excluding marine areas)
- 1,761 ha infrastructure corridor
- 838 ha industrial areas including a Strategic Industrial Area.

The purpose of the SIA is for the establishment of industry to support the port and any future mining operations. Given that development of Mt Anketell would support iron ore development, then industry supporting this or other types of mineral processing would be considered the most likely within the SIA. Hydrocarbons related industries would be considered to be less likely at this location due to their desire to be located away from iron ore stockpiling areas and therefore this location is not considered to be a competitor to ANSIA.

9.2.5 Oakajee Industrial Estate

Oakajee, located 20km north of Geraldton, was selected as a location for a future deep water port and heavy industrial processing area to support the Mid West region. After being considered for the past 30 years as a potential port location, the most recent WA Government approval for this site was in 2008 for Oakajee Port & Rail, a joint venture between Murchison Metals and Mitsubishi.

This was to see construction commence in 2011 with possible completion in 2014, but was eventually cancelled in 2012. Future development of the port remains a potential although there are no proposals at this time.

The Oakajee Industrial Estate (OIE) occupies approximately 6,400 hectares, comprising the following:

- 1,000 ha port area for export of mineral resources such as magnetite iron ore
- 1,100 ha heavy industrial area core for ammonium nitrate or other heavy industry processing
- 196 ha general industrial area
- 4,000 ha buffer

The *Oakajee Industrial Estate Structure Plan* was prepared in 2012 to support of the development of the major industrial development area and deep water port. This document identified a range of generic land uses likely to be located within the OIE, in particular the 'Strategic Industry Area', 'Coastal Area', 'General Industry Areas', and 'Buffer – Compatible Use Area'. The Structure Plan identified the following potential land uses for the OIE Strategic Industrial Area:

- Ferrous mineral processing
- Large non-ferrous mineral processing / manufacturing
- Medium size non-ferrous mineral processing / manufacturing
- Large scale mineral processing / manufacturing
- Non-ferrous mineral processing / manufacturing
- Heavy construction
- Energy supply
- Agricultural industrial processing
- Solid waste industrial processing

The OIE will not be developed until such time that the Oakajee Port is developed and at this stage there is no timeframe for this. Furthermore, the types of industries proposed for development at Oakajee are not seen as competitors to development at ANSIA. For these reasons, the two locations are not seen to be competitors to one another.

9.2.6 Local Competing Industrial Estates Summary

Site	Port Access	Distance to Population Centre	Infrastructure Developed	Existing Tenants	Targeted Industry
Boodarie	Proposed	Port Hedland 10km	No	Alinta, Sub 161 CNG	Downstream gas industries
Burrup	Yes	Karratha 20km	Yes	NWSV, Woodside, Yara	Downstream gas industries
Maitland	Proposed	Karratha 15km	No	None	Downstream minerals and gas processing
Mt Anketell	Proposed	Karratha 30km	No	None	Iron ore
Oakajee	Proposed	Geraldton 23km	No	None	Downstream minerals and gas processing
Ashburton	*Under development*	*Onslow 11km*	*Under development*	*Chevron* *BHP Billiton*	*Downstream gas industries*

9.3 Other Competing Industrial Areas

Further competing regions have also been considered for comparative purposes including the following:

- Gladstone, Queensland
- Northern Territory
- Asia

9.3.1 Gladstone State Development Area, Queensland

The Gladstone State Development Area covers an area of approximately 29,000ha on the central Queensland coast and is made up of a number of major precincts including Aldoga and Yarwun. These two precincts are of high relevance to the ANSIA as they are planned for large scale heavy industry.

The region is one of the leading development sites for the conversion of coal seam gas into LNG, with the Santos GLNG (Santos, Petronas, total and Kogas) currently developing an LNG plant on Curtis Island, near Gladstone. This plant will have an initial production of 3-4 million tonnes of LNG per annum scheduled for 2015, ramping up to 7.8 million tonnes per annum.

Both precincts are in close proximity to the population centre of Gladstone, have access to a heavy rail network, the national highway network and port access. Access to the port is provided via a materials transportation and services corridor which connects the Gladstone State Development Area to the Port of Gladstone.

There are a number of existing industries already established in these precincts including:

- Queensland Alumina refinery;
- Rio Tinto Alumina Refinery;
- Boyne Smelters, which is Australia's largest aluminium smelter;
- Cement Australia Gladstone, which is Australia's largest cement plant;
- Orica Australia chlor-alkali plant (9,000t/yr), technical grade ammonium nitrate plant (590,000t/yr) and sodium cyanide plant (80,000t/yr); and
- NRG Gladstone power generation (1,680MW).

According to the Queensland Government's Department of State Development, Infrastructure and Planning, the following land uses are considered to be suitable for the Gladstone State Development Area:

- Large-scale, large-footprint industrial development;
- Industrial development requiring access to strategic port logistics and maritime facilities;
- Port-related activities and industries necessary to support major industrial development;
- Liquefied natural gas processing, storage and export facilities;
- Materials transportation infrastructure and utility and service infrastructure; and
- Gas transportation infrastructure and other compatible infrastructure.

The Queensland Government's decision to define an area as a 'State Development Area' is made with the aim of promoting economic development in the State. While there are no investor incentives offered, the following benefits of State Development Area are reported:

- Proximity to railways, ports and major road networks
- Greater planning and development certainty for project proponents
- Efficient processing of applications and requests
- Best practice land-use planning and management - ensuring land and infrastructure assets in SDAs are, and remain, attractive to existing occupants and potential investors
- More efficient use of land, most notably through the creation of multi-user infrastructure corridors
- Process for compulsorily acquiring land within an SDA if necessary, including on behalf of proponents
- Concentration of industrial development in selected areas, thereby minimising or avoiding:
  - Environmental impacts
  - Loss of amenity
  - Infrastructure duplications
  - Transport conflicts.

9.3.2 Northern Territory

Heavy industry in the Northern Territory is currently focussed on the Darwin Port and in particular East Arm/Wickham Point. This precinct is the focus of two LNG projects (ConocoPhillips and Inpex) and includes supporting infrastructure. Middle Arm Peninsula has been identified for future strategic development. This precinct is already served by high quality infrastructure and includes access to the Darwin/Adelaide Railway. From a supply of LNG and availability of infrastructure perspective, Northern Territory is considered a key competitor to ANSIA.

Outside of Darwin, Glyde Point has been selected as the preferred site for the future development of a major gas based industrial precinct. This location is approximately 90km from Darwin and is not presently serviced by infrastructure. There are also significant environmental and heritage concerns associated with the development of this precinct. The precinct will provide 4,212,ha of industrial land.

9.3.3 Asia

There are numerous industrial precincts located throughout Asia with the potential to attract petrochemical (ethane crackers) and ammonia/urea producers. Whilst Asia is currently a significant user of Ammonia it is also a significant producer. Currently production is greater than consumption in this region, therefore limiting the potential to export to Asia unless it can be produced and transported more cost effectively.

The dynamics of the ethylene market are changing at present. An increased volume of ethane is currently available on the global market as result of the ‘Shale Gas Revolution’ in the US. With the chemical industry in the US unable to process the volume of ethane being produced domestically it is now being exported to Europe and Asia.

Significant increases in ethylene production capacity are planned throughout Asia at present. Nine projects are planned in China (Ningbo, Taixing, Heze, Jiangyin, Yangzhou, Jiaxing and Yinchuan) alone with a further three planned in South Korea (Daesan and two in Ulsan).

The sites amongst these are summarised as follows:

- Ulsan Metropolitan City includes a large industrial precinct with multiple large scale industry including petrochemicals, fertilisers and automobile manufacturing and ship building.
- Ningbo industrial City on China's southern coast close to Shanghai and Hangzhou. Includes a large petrochemical complex.
- Cilegon is a large industrial city in Indonesia. Sometimes referred to as Steel City as it is the largest steel producer in South East Asia however it also includes a number of petrochemical plants.

All of these precincts are potential competitors to ANSIA, however they must be considered in the context of the various factors which influence industry site selection outlined in Section 9.1.

Table 4 Interstate / International Competing Estates

Site	Port Access	Distance to Population Centre	Infrastructure Developed	Existing Tenants	Targeted Industry
Gladstone	Yes	15km (Gladstone)	Highways, Rail, Gladstone Port	Rio Tinto Alumina Refinery Orica Chemicals Transpacific Industries Waste Management	Large scale, large footprint Industry requiring access to port/marine facilities Port related industry and activities LNG processing Gas transportation and related industry

Site	Port Access	Distance to Population Centre	Infrastructure Developed	Existing Tenants	Targeted Industry
Darwin East Arm/Wickham	Yes	16km (Darwin)	Highways, Darwin/Adelaide Railway, Darwin Port	100+ existing tenants	Darwin LNG, Offshore support, Misc Light Industry
Darwin Glyde Point	Yes	90km (Darwin)	No	Nil	Heavy Industry
Ulsan Metro City	Yes	N/A (integrated)	Highways, Rail, Ulsan Port	SK Energy Oil Refinery Fertilisers	Heavy industry including automobile manufacture, shop building, oil refining and fertilisers
Ningbo Industrial City	Yes	27km	Highways, Rail, Ningbo Port	Dow Chemical Ningbo Steel Esso Chemical Linde Gas Industries	Energy, Chemicals, Bio-Tech, Pharmaceuticals, Raw Materials Processing
Cilegon industrial City	Yes	Nil	Highway, Light Rail, Cilegon Port	Krakatau Steel Asahimas Chemical Company	Heavy Industry Steel Chemicals

10 BIBLIOGRAPHY

- Apache Energy, Devil Creek Gas Development Project Report and Recommendations of the Environmental Protection Authority, January 2009
- Climate Change Response, *Ashburton North Strategic Industrial Area Industrial Ecology Strategy – Concept Plan*, January 2012
- Dow Chemicals, Australia's Energy Opportunity, In the National Interest, Fact Sheet, December 2012
- Independent Market Operator, Gas Statement of Opportunities, January 2014
- Qenos Rising energy prices and the challenges, Ai Group National Environment & Energy Forum, May 2012
- Taylor Burrell Barnett, *Ashburton North Strategic Industrial Area Structure Plan*, August 2011
- TPG, *Ashburton North Strategic Industrial area Stage 1B & 1C Development Plan Report*, May 2012

Appendix 1 Project and Company Information

PROJECT	COMPANY	PROJECT NAMES	LOCATIONS	SIZE	CONSTRUCTION VALUE
Domgas	Apache	Devil Creek Gas Plant	45km south west of Dampier	220TJ/day	$1.1B
	Chevron	North West Shelf JV Gorgon Wheatstone	Burrup Peninsula Barrow Island Near Onslow	600TJ/day 300TJ/day 200TJ/day	$27B total KGP investment $29Bn foundation phase $29B total
	BHP Billiton	Macedon	15km east of Onslow	200 TJ/day	$1.5B
	Woodside	North West Shelf JV	As above	As above	As above
Power Station	Contract Power Australia	Christmas Creek Cloud Break	260km SE of Port Hedland 240km SE of Port Hedland	58MW 30MW	
	KPS Power Generation	Nullagine			
	GE Energy	Mumbida	40km south east of Geraldton	55MW	
	Horizon Power	Pilbara Power Project Onslow Power Project Hedland Precinct	South Hedland Onslow Boodarie & East Hedland	110MW 9MW 60MW	$750M Part of Wheatstone project $180M
	ATCO	Karratha		86MW	
Desalination	Veolia Water	Sydney Kurnell Gold Coast Campo de Dalias	Sydney Gold Coast Spain	250ML/day 125ML/day 97ML/day	
	Degremont Australia	Aroona Perth Seawater Desalination Plant	Perth Kwinana	726ML/day 144ML/day	
	Water Corporation	Southern Seawater Desalination Plant Perth Seawater Desalination Plant	Binningup Kwinana	136ML/day 144ML/day	
Air Separation	BOC Gases	Karratha Dandenong	Karratha Victoria	60t/day 100t/day	$40M $65M
	Air Liquide	Kwinana		400t/day	
	Universal Industrial Gases	New Carlisle Carrollton	Indiana, USA Kentucky, USA	350t/day 350t/day	
	Siemens	Sasol	Secunda, South Africa	38,550t/day	
Ammonia/Urea	CSBP - Wesfarmers	CSBP Kwinana	Kwinana	740t/day	
	Yara Pilbara Fertilisers	Yara Pilbara Fertilisers	Burrup Peninsula	2,300t/day	$700M
	Latrobe Fertilisers	Latrobe Valley	Victoria	1,400t/day	$500M
	Impact Fertilisers	Various	17 plants in NSW, Victoria, Queensland, South Australia & Tasmania		
GTL or Domestic LNG	EDL	West Kimberley Power	Karratha	200t/day	
	Wesfarmers Kleenheat	Air Liquide plant	Kwinana	175t/day	
	Mobile LNG	None in operation,however proposed for: Port Hedland Kalgoorlie Adelaide Darwin	Port Hedland Kalgoorlie Adelaide Darwin	400t/day 400t/day 400t/day 400t/day	$250M $250M $250M $250M
	Chevron	Escravos GTL	Nigeria	325MCF/day	
	Inpex	Yufutsu GTL Pilot Plant	Hokkaido, Japan	7.3 barrels/day	

PROJECT	COMPANY	PROJECT NAMES	LOCATIONS	SIZE	CONSTRUCTION VALUE
Ethane Storage	Wesfarmers Kleenheat	Wesfarmers Kleenheat currently remove the ethane from the natural gas they source however they do not store it.			
	Cryoquip Australia	Gorgon	Barrow Island	Returned to the LNG system for use as a refrigerant	
	Cryeng Group Pty Ltd	Various static and transportable storage tanks			
Ethane Stripping from Domgas	BHP Billiton	Potential to integrate into existing and future projects			
	Apache	Potential to integrate into existing and future projects			
	Chevron	Potential to integrate into existing and future projects			
Ethane Cracker	Qenos				
	Exxon Mobil	Baytown	Texas, USA	1.5Mtpa	
	Formosa Petrochemical Group	Port Comfort	Texas, USA	0.8Mtpa	
	Nova Chemicals	Corunna	Ontario, Canada	0.8Mtpa	
	Chevron Phillips Chemical Co.	Cedar Bayou	Texas, USA	1.5Mtpa	
	Dow Chemical Co.	Freeport	Texas, USA	1.5Mtpa	